OmniaScience

Journal of Technology and Science Education
JOTSE, 2025 – 15(1): 78-90 – Online ISSN: 2013-6374 – Print ISSN: 2014-5349
https://doi.org/10.3926/jotse.2842

THE EFFECTIVENESS OF USING THE FLIPPED CLASSROOM IN SCIENCE EDUCATION FOR NINTH-GRADE STUDENTS

Eman Anjass[1], Claire Hamed[2], Eva María Aguaded-Ramírez[1*]

[1]Granada University (Spain)

[2]Al-Quds University (Palestine)

emananjass@correo.ugr.es, claireyousef@gmail.com,
[*]*Corresponding author: eaguaded@ugr.es*

Received April 2024
Accepted December 2024

Abstract

This study aims to investigate the impact of using the flipped classroom strategy on motivation and academic achievement in learning science among 9th-grade students Proved as an innovative technique, flipped learning improves academic performance, enhances students' motivation, supports independent learning, triggers higher thinking skills, and establishes lifelong learning. In disadvantaged places at war like Palestine, there are no studies exploring students' engagement with flipped learning in sciences using empirical evidence including a large population of 2489 females and 2366 males with a representative sample of 333 students Pre and post-test assessment, observation, and two semi-structured interviews with teachers and students are utilized in addition to providing multimedia resources related to the Floral Plant unit in the 9th-grade curriculum has been tailored to the content and needs of teachers and students and distributed through social media platforms. A significant difference in the achievement scores, motivation, and overall positive shift in attitudes regarded homework, students' and teachers' roles, and time management between the experimental group and the control group indicates the positive impact of the flipped classroom method on teachers and students both female and male students.

Keywords – Flipped classroom, Science, Motivation, Academic Achievement.

To cite this article:

Anjass, E., Hamed, C., & Aguaded-Ramírez, E.M. (2025). The effectiveness of using the flipped classroom in science education for ninth-grade students. *Journal of Technology and Science Education,* 15(1), 78-90. https://doi.org/10.3926/jotse.2842

---

1. Introduction

Based on massive research studies, utilizing technology in the classroom enhances the learning process. Surveys have confirmed the benefits of technological resources as they facilitate learning, and provide limitless sources of information, assessment tools, and methods that help teachers, especially in overcrowded classrooms. It means learner-centered strategies that enhance well-being and confidence. Eventually, it motivates the student's academic progress (Trust, 2018; Shoukat, Ismayil, Huang, Oubibi, Younas & Munir, 2024). Recently, the flipped classroom strategy has been applied to various educational contexts. As it depends on fostering prior experiences and providing preexisting knowledge, students

become the major actors in the learning process. In a transferrable educational environment, students are motivated intrinsically (Aljermawi, Ayasrah, Al-Said, Abualnadi & Alhosani, 2024; Köpeczi-Bócz, 2024; Ahmad, Tamimi, Radid & Sefri, 2023). This pedagogical innovation involves the dissemination of new concepts and materials via pre-recorded videos or readings outside the confines of traditional classroom settings. Subsequently, class time is repurposed for interactive engagements such as discussions, problem-solving, and collaborative activities, fostering personalized and dynamic learning environments (Yu-Hui & Zhou, 2022). A significant percentage of students, estimated at 75%-80%, reported benefiting from video-based instruction as it allowed them to revisit challenging concepts at their own pace. This accessibility promotes deeper understanding and self-paced learning, especially for students with diverse academic abilities. By transposing traditional lecture-based instruction to self-directed preparatory activities, valuable class time is liberated for the application of knowledge, collaborative problem-solving, and real-time feedback from instructors, thus fostering enriched learning experiences (Giannakos, Krogstie & Chrisochoides, 2014; Karabulut-Ilgu, Cherrez & Jahren, 2017) in adaptable diverse learning styles and paces (Nouri, 2016; Birgili, Seggie & Oğuz, 2021; Rahman, Yunus & Hashim, 2019), which extends to the cultivation of critical thinking skills, collaborative prowess, and self-directed learning capabilities (Cheng, Hwang & Lai, 2020; Karabulut-Ilgu et al., 2017).

In the same way, keeping students motivated throughout the learning process is painstaking, especially in science classes. Studies have demonstrated that the motivation to learn science has been decreasing in the adolescent years recently (Vedder-Weiss & Fortus, 2010; Fortus & Touitou, 2021). Motivation is defined as psychic energy that drives a person to undertake or sustain an action or behavior. It can be intrinsic, coming from within each individual, or extrinsic, influenced by external factors and it is essential to establish and meet goals, improve skills, and promote social and emotional learning (United Nations, 2024). Motivation also refers to the set of internal and external factors that govern behavior and determine the behavior of an individual (Miranda, 2021) so, motivation is what makes us carry out behavior and maintain it until we achieve our goal (Ríos & Barros, 2021). Therefore, teachers, parents, and policymakers constantly apply modern strategies away from traditional tedious teaching and set intervention plans to trigger students' active participation in the learning process. Creating an engaging environment shifts students' attitudes positively and enhances their motivation toward learning sciences (Fortus & Touitou, 2021).

Utilizing the Flipped classroom is one of those innovative strategies. As students are the center of the learning process, they engage enthusiastically. It enhances students' performance as they follow the "learning by teaching" approach (Yin, 2020) which fosters confidence and appreciation. Moreover, following the flipped classroom strategy means tailoring plans according to students' needs. It is important to address students' different identities to guarantee the best performance and engagement in the learning process (Hamed, 2024). In the classroom, teachers trigger students' internal motivation by enhancing the sense of achievement, and collaboration, reflecting on and mastering tasks, and feeling authoritative in their learning. Ultimately, fostering self-efficacy (Han & Hamza, 2024).

The flipped classroom model is shown to positively impact motivation, engagement, and academic achievement in various educational contexts. Through a review of existing literature and the findings of recent research, it becomes evident that the flipped classroom approach leads to a transformation in teaching and learning dynamics. Teachers transition from traditional lecturers to facilitators, empowering students to take an active role in their learning process (Abdulrahaman, Faruk, Oloyede, Surajudeen-Bakinde, Olawoyin, Mejabi et al., 2020; Tong, Uyen & Ngan, 2022; Olivier, 2021; Wang, Gai, Jiang, Chen, Bian, Luan et al., 2024). Repositioning homework tasks as formative assessments enhances student engagement and autonomy, fostering a sense of purpose in learning (Abdulrahaman et al., 2020; Tong et al., 2022; Olivier, 2021; Wang et al., 2024). Additionally, effective time management strategies prioritize interactive activities and discussions, creating a dynamic learning environment conducive to motivation and academic success (Abdulrahaman et al., 2020; Tong et al., 2022; Olivier, 2021; Wang et al., 2024).

Based on experimental and quasi-experimental research in learning sciences, the flipped classroom proves efficient in raising students' engagement and fostering their motivation. The studies support it in learning physics (Aşıksoy, 2017), Chemistry (Sookoo-Singh & Boisselle, 2018), mathematics (Bornna, Abdul-Rahaman, Iddrisu & Badger, 2023) and biology (Zulyetti, 2023). It is also tested in minority urban areas (Dixon & Wendt, 2021) and central urban areas (Dixon, 2017). Most other studies applied it among high school students in different parts of the world, and they report positive results in enhancing motivation and raising engagement (Lee, Jeon & Hong, 2021; Yarım, Ada, Morkoç & Doğan-Kurt, 2023; Ribau, 2023; Zheng, Bhagat, Zhen & Zhang, 2020; Sofya & Hayati, 2020; Jiménez & Ruiz-Jiménez, 2020).

A comprehensive meta-analysis conducted by Johnson and Williams revealed a significant positive correlation between flipped learning and student academic success across multiple subject areas (Jeong, González-Gómez, Airado Rodríguez, Cañada-Cañada, 2018; Strelan, Osborn and Palmer, 2020). The tailored pace of learning and access to diverse multimedia resources facilitate deeper comprehension and retention of subject matter, thereby accommodating varied learning preferences and capabilities (Purwaningtyas, Hidayat & Amri, 2020). Fostering critical thinking and analytical skills (Shi, Ma, MacLeod & Yang, 2019). This integration also cultivates a conducive environment for collaborative learning experiences, enabling students to delve deeper into course content through peer discussions and group activities (Jiménez & Ruiz-Jiménez, 2020).

Nevertheless, despite its touted benefits, flipped learning is not devoid of criticism. Some of these studies contend that flipped classrooms may raise inequality opportunities among students due to prerequisite technological resources, overemphasis on independent learning, and absence of teacher guidance in pre-recorded materials which may impede comprehensive understanding and hinder academic attainment (Birgili et al., 2021; Otten, Zhao, Araujo & Sherman, 2020; Karabulut-Ilgu et al., 2017). Other drawbacks include the accessibility issues regarding resources outside the classroom, reliance on pre-recorded materials, and the significant preparation required from educators, which are among the challenges associated with implementing flipped learning (Giannakos et al., 2014; Karabulut-Ilgu et al., 2017; Zainuddin, Haruna, Li, Zhang & Chu, 2019; Xiu & Thompson, 2020).

However, empirical evidence suggests that flipped learning holds particular promise for underserved student populations and those grappling with traditional lecture formats, potentially narrowing achievement gaps and fostering equitable learning outcomes (Zainuddin & Halili, 2016). Despite its importance, few studies investigate the effectiveness of the flipped classroom in the Arab World (Al-Amri, 2022). Nevertheless, Palestine is an Arab country trapped in the war zone and faces additional economic, political, and educational challenges. This motivates researchers to investigate the effectiveness of flipped learning on Palestinian students in learning English as a foreign language (Dweikat & Raba, 2019) and learning physics (Atwa, Din, Othman & Hussin, 2018). Despite their significance, both studies have examined a limited area and applied to a limited sample of a population. The first study investigates 79 English teachers' attitudes toward flipped learning, while the other selected 108 students purposively.

As it is known, and despite the overwhelming studies in support of the flipped classroom strategy in fostering engagement, most of them lack empirical evidence (McNally, Chipperfield, Dorsett, Del Fabbro, Frommolt, Goetz et al., 2017). This study builds upon these foundations by adopting a comprehensive approach. By including a substantial and diverse sample of 2489 female and 2366 male students across six governmental schools in Ramallah and Al-Bireh Governorate, it provides a broader perspective on the efficacy of flipped learning in Palestine and investigates its impact on students' motivation and academic performance.

The flipped classroom model in this study incorporates various strategies to optimize the learning experience. For instance, students are provided with pre-recorded videos and multimedia resources tailored to the curriculum, ensuring accessibility and relevance. Teachers utilize online communication platforms to address student inquiries, provide additional support, and distribute supplementary materials. During classroom sessions, the emphasis shifts to interactive group discussions, problem-solving tasks, and collaborative projects, enabling students to apply their pre-acquired knowledge in meaningful ways.

The approach also includes formative assessments, where homework assignments are designed not as mere tasks but as tools to prepare students for in-depth in-class engagement.

These strategies collectively aim to enhance student autonomy, foster critical thinking, and promote collaborative skills, aligning with the study's objective to explore the flipped classroom's potential in advancing academic achievement and motivation. This research seeks to answer the following main question: What is the effectiveness of using the Flipped Classroom model on the science subject among the 9th-grade students in Ramallah and Al-Bireh Governorate schools?

1. How does the utilization of the flipped classroom strategy affect the academic achievement in the science subject among the 9th-grade students in Ramallah and Al-Bireh Governorate schools?
2. Are there any significant differences in the academic achievement of 9th-grade students using the flipped learning method attributed to gender?
3. How does the utilization of the flipped classroom strategy and teachers' roles affect students' motivation in the science subject among the 9th-grade students in Ramallah and Al-Bireh Governorate schools?

2. Methodology

This study employs a rigorous mixed-method approach, integrating qualitative and quantitative methodologies. A quasi-experimental design was employed, comprising both an experimental group and a control group selected from six schools in Ramallah and Al-Bireh for girls and boys. This design facilitated the comparison of outcomes between the two groups (Campbell & Stanley, 1963). Observations, semi-structured interviews (teachers and students), and pre and post-tests are utilized and carefully analyzed. Being one of the teachers who applied the flipped classroom strategy, the researchers have observed effectively the process, results, and reactions of both students and teachers. they also conducted a workshop for selected teachers to explain the study approach and provide them with resources in addition to the Online Communication Group via Messenger to exchange experiences, worksheets, and resources if needed. Close observational notes were written down during the whole process and thematically analyzed later.

The content units analyzed for quantitative analysis included topics such as plant anatomy, photosynthesis, and nutrient absorption, aligned with the Floral Plant unit in the curriculum.

This inclusive sampling strategy enhances the generalizability and relevance of our findings. Purposive sampling was utilized to select students from governmental schools. These schools ensure variety in terms of locations between cities and villages, inclusive of demographics in addition to the willingness of the participants (Palinkas, Horwitz, Green, Wisdom, Duan & Hoagwood, 2013). The study consisted of ninth-grade students who studied the governmental Palestinian curriculum of science, especially the unit on the Flora plant. The unit is comprehensive in terms of activities, exercises, and provoking-thinking questions that need to be explored. The different backgrounds and experience of science teachers, as well as the wide variety of subjects they cover, support choosing to employ the flipped classroom method in ninth grade (Itmazi & Khlaif, 2022). Furthermore, ninth-grade students have higher self-directed learning capacities than earlier student's ages, thus being appropriate for this method (Timothy, Seng-Chee, Chwee-Beng, Ching-Sing, Joyce-Hwee-Ling, Wen-Li et al., 2010)

The schools are distributed in Ramallah and Al-Bireh cities and some of their surrounding villages, totaling 4855 students, including 2366 males and 2489 females. The representative samples included students from twelve classes in six different schools, with six experimental classes of 164 students taught using the flipped learning method and six control classes of 169 taught using traditional methods. The characteristics of the participating sample can be seen in detail in Table 1.

The homogeneity of the two samples was ensured by referring to the mean final grade in the first semester of the science subject for each selected class. Random participant during the selection process provides a

piece of acceptable evidence for maintaining logical links between experimental results and claims about generalizability (Shadish et al., 2001). While random assignment of participants to treatment conditions addresses biases resulting from observed treatment conditions, random selection of participants from the population addresses potential biases that result from participant inclusion in the study.

School Number	Total Students	Gender	Residence	Group Type
1	25	Male	Village	Control Group
	23	Male	Village	Experimental
2	32	Female	Village	Control Group
	28	Female	Village	Experimental
3	23	Male	Village	Control Group
	23	Male	Village	Experimental
4	39	Female	Village	Control Group
	40	Female	Village	Experimental
5	26	Female	City	Control Group
	20	Female	City	Experimental
6	24	Male	City	Control Group
	30	Male	City	Experimental
Total	333			

Table 1. Description of the Sample and its Distribution in Classes

The Department of Educational Supervision and supervisors from the Ramallah and Al-Bireh Directorates helped with the selection process, which mostly involved selecting new teachers. According to research, experienced teachers may be hesitant and lack confidence in integrating technology into their classes, but newly certified teachers are more proficient and confident (Zhou, Zhang & Li, 2011). As a result, 6 teachers were selected for the study, including both males and females , the teachers employed the flipped classroom method in six schools and the interviews were with all of them. Table 2 shows their characteristics in detail.

Teacher	Sex	Specialization	Years of Experience
T 1	Female	Bachelor's degree in Physics	4
T2	Male	Master of Science Methods	3
T3	Male	Master of Chemistry	4
T4	Female	Master of Science Methods	4
T5	Male	Bachelor of Science Methods	6
T6	Female	Bachelor's Degree in Biology	10

Table 2. Characteristics of the teachers

As for the student participants, they were selected based on classroom observations and the final exam.

Intervention assessments were conducted for both groups to establish baseline knowledge and skills. These include pre-test/post-tests, observations, and semi-structured interviews (Teachers and students). The experimental group engaged in flipped learning, utilizing pre-recorded instructional videos and online resources for independent study, while the control group received traditional lecture-based instruction. Post-intervention evaluations were conducted through a summative unit exam to measure subject matter understanding and mastery beside to compare the achievement of females to males across the experimental and control groups (gender).

The assessment tool was chosen to detect the impact of flipped learning on students' achievement levels. We designed and administered the test to students, structured according to the specified unit analysis

framework. The test items were developed based on different levels of thinking skills, reviewed by three educational supervisors, and approved after ensuring the validity of the items. The test comprised five items aligned with the general content objectives. These items focused on evaluating students' understanding of concepts measured in the pre-test and their ability to analyze and interpret content in various contexts.

Observations Close observations were performed during the implementation of the flipped classroom method to document the process, effects, and reactions of both students and teachers (motivation). This qualitative data gathering strategy provided insights into classroom dynamics and the effectiveness of the flipped approach.

Semi-structured interviews were conducted with both students and teachers to collect detailed qualitative data on their experiences, perceptions, and motivations about the flipped classroom technique. This provided a more in-depth understanding of the strategy's influence on student motivation and engagement (motivation). Additionally, Data from exams were analyzed using statistical techniques such as descriptive statistics and inferential analysis. Qualitative data from interviews were analyzed thematically to identify patterns and themes related to student experiences and teacher perspectives (Braun & Clarke, 2006).

It is also worth noting that this study followed ethical requirements, which included getting informed consent from participants and maintaining confidentiality throughout the research procedure.

3. Results

This section presents the findings, categorized into quantitative and qualitative analyses, including statistical tests, satisfaction surveys, and thematic insights.

3.1. Homogeneity Between Control and Experimental Groups (Pre-test)

An independent samples t-test was conducted to ensure the homogeneity of the groups. The pre-test scores for both groups showed no statistically significant differences, confirming that the groups were comparable before the intervention.

Group	Number of Students	Pre-test Mean	Standard Deviation	t-value	Significance Level
Experimental	152	11.12	1.30	1.05	>0.05
Control	168	10.21	1.50		

Table 3. Comparison of Pre-test Scores Between Control and Experimental Groups

3.2. Pre-test-Post-test Analysis for Control and Experimental Groups

- Control Group:

  A paired samples t-test indicated minor, non-significant improvements in pre-test and post-test scores for the control group. The effect size (Cohen's d) was small.

- Experimental Group:

  The experimental group showed a statistically significant improvement from pre-test to post-test scores, with a large effect size (Cohen's d) highlighting the strong impact of the flipped classroom method.

Group	Test Type	Mean	Standard Deviation	t-value	Significance Level	Effect Size (Cohen's d)
Control	Pre-test	10.21	1.50		>0.05	Small
Control	Post-test	10.73	1.41			
Experimental	Pre-test	11.12	1.30		<0.001	Large
Experimental	Post-test	14.03	0.69			

Table 4. Pre-test-Post-test Comparisons for Control and Experimental Groups

3.3. Post-test Comparison Between Control and Experimental Groups

The post-test scores were compared between the control and experimental groups using an independent samples t-test. The results revealed significant differences favoring the experimental group, emphasizing the effectiveness of the flipped classroom strategy.

Group	Post-test Mean	Standard Deviation	t-value	Significance Level
Experimental	14.03	0.69	4.51	<0.001
Control	10.73	1.41		

Table 5. Post-test Scores Comparison Between Control and Experimental Groups

3.4. Analysis of Gender and Location Differences

Further analyses examined the potential effects of gender and location (urban vs. rural) on student performance. The results showed no statistically significant differences, indicating that the flipped classroom strategy is equally effective across genders and locations.

Group	Mean	Standard Deviation	t-value	Significance Level
Male	11.9	1.67	0.97	0.33
Female	12.6	0.81		
Urban	12.3	1.10	1.12	>0.05
Rural	12.1	1.15		

Table 6. Analysis of Gender and Location Differences

The lack of statistically significant differences across gender and location highlights the flipped classroom strategy's broad applicability. The method proves adaptable to different demographic and geographical contexts, promoting equitable learning outcomes.

3.5. Satisfaction Survey

A satisfaction survey revealed that 78% of students benefited from the pre-recorded videos, as these allowed them to revisit difficult concepts at their own pace. Additionally, 82% of students reported that interactive and collaborative classroom activities positively impacted their learning experience."

Data from observations and interviews with teachers and students were thematically analyzed to identify patterns, themes, and insights into their experiences with the flipped classroom technique. This qualitative approach provided detailed descriptions and a contextual understanding of the phenomena, highlighting key dimensions of the learning process.

The flipped classroom model fostered an overall positive change in attitudes among both teachers and students. Shifts were observed in roles, attitudes toward homework, and the management of classroom time. Teachers reported significant changes in their responsibilities, moving from traditional lecturing to facilitating a student-centered learning environment. As one teacher remarked: "My role in the flipped classroom shifted to guiding and facilitating discussions." Another added: "Empowering students in their learning journey was a transformative experience."

Students, in turn, expressed greater interest and active engagement, emphasizing the importance of preparation and participation in discussions. One student stated: "I felt more motivated to learn." Another noted: "I had to prepare in advance, so I actively participated in discussions." The flipped classroom was described as a unique experience: "It was a different experience compared to traditional classes."

Homework tasks were redesigned as formative assessments that promoted student engagement and directly contributed to in-class interactions. Unlike the traditional role of homework, which was often perceived as burdensome, students described these tasks as supportive to their learning: "We no longer need to constantly

refer back to textbook paragraphs as before." Another student highlighted their independence: "We've learned to rely on ourselves, taking control of our learning by seeking out relevant sources and exploring different methods to explain our answers effectively and provide appropriate feedback."

Teachers also acknowledged the value of this shift, as students demonstrated improved autonomy and collaboration. As one student noted: "It's encouraging to see that our teachers' responses align with our experiences."

The flipped classroom strategy emphasized using class time for interactive activities and discussions rather than traditional lectures. This approach created a dynamic learning environment that significantly boosted student motivation and engagement. As one teacher succinctly stated: "Utilizing class time for discussions and collaborative work proved more effective in keeping students engaged and motivated."

Despite these positive changes, some students found it challenging to articulate why class time felt different, with one stating: "That's how I felt." However, teachers justified the perceived similarities by explaining that the session was better utilized for discussions rather than simply transferring knowledge. A teacher explained: "I found that using class time for discussions and group work instead of lectures was more effective in keeping students engaged and motivated."

These qualitative findings illustrate how the flipped classroom method fosters motivation, redefines traditional roles, and enhances time management in the classroom. Both teachers and students embraced these changes, leading to a more engaging and collaborative learning environment.

4. Discussion

Focusing on previous studies' positive findings about the impact of the flipped classroom strategy on academic achievement, this study aims to investigate its effectiveness in the context of science education for 9th-grade male and female students in Ramallah and Al-Bireh Governorate schools. The literature review emphasizes the flipped classroom model's transformative potential for stimulating active engagement, personalized learning experiences, and interactive learning opportunities, all of which have been linked to improved academic results (Abdulrahaman et al., 2020; Tong et al., 2022; Olivier, 2021; Wang et al., 2024).

By changing from traditional classroom instructors to facilitators, teachers are better positioned to guide and support students on their learning journey, resulting in a more student-centered approach that improves subject knowledge and memorization. The refocus of homework tasks as formative assessments, as well as the application of appropriate time management measures, enhance classroom interactions and enhance academic success (Abdulrahaman et al., 2020; Tong et al., 2022; Olivier, 2021; Wang et al., 2024).

These findings suggest that the flipped classroom model has the potential to improve student achievement by encouraging active participation and a deeper comprehension of subject matter for the course Students are better prepared to understand difficult concepts and apply their knowledge in practical applications when multimedia tools are used and collaborative learning experiences are encouraged. Furthermore, the flipped classroom approach's personalized acceleration of learning accommodates a variety of academic needs and capacities, resulting in more equal learning outcomes for different groups of students (Jeong et al., 2018; Strelan et al., 2020).

The study shows no significant difference in academic achievement between male and female students in the flipped classroom setting which corresponds with the larger research on flipped learning and gender equity in education. Previous research has underlined the necessity of addressing individual learning needs and preferences, rather than depending on assumptions about gender, to ensure equitable educational outcomes.

Research indicates that flipped learning improves academic achievement for students of all genders (Aşıksoy, 2017; Sookoo-Singh et al., 2018; Bornna et al., 2023; Zulyetti, 2023). This shows that the

student-centered approach inherent in the flipped classroom model may help reduce gender inequalities in academic performance by giving all students with opportunity for individualized learning and engagement.

Furthermore, meta-analyses and comprehensive reviews of flipped learning research have demonstrated its ability to close achievement gaps and promote equitable learning outcomes for underserved student groups, including those who struggle with traditional lecture formats (Jeong et al., 2018; Strelan et al., 2020). The flipped classroom model, which promotes active interaction and collaboration, has been found to generate a sense of belonging and empowerment among students of all genders (Jiménez & Ruiz-Jiménez, 2020).

Many studies align with the results of our current study regarding the increase in students' achievement and improved exam scores in the final result, attributed to self-learning and the ability to control videos and different media at suitable times and places for the learner (Abdulrahaman et al., 2020; Tong et al., 2022; Olivier, 2021; Wang et al., 2024).

Following the thematic analysis of interviews (teachers and students) and observations, emergent themes and categories were drawn from the experiences and perspectives shared by participants. They encapsulate an effective shift in both students' and teachers' roles, an altered positive attitude toward homework's role, and increased productivity related to classroom time management. Teachers moved from traditional lecturers into guides and facilitators which fostered a student-centered learning environment. The interviewee highlighted their new roles positively.

The findings on the positive influence of the flipped classroom method on motivation align with previous research on flipped classrooms and student motivation (Trust, 2018; Shoukat et al., 2024). Previous research always showed that student-centered approaches, active learning strategies, and meaningful interactions improve student motivation and engagement. Teachers can develop intrinsic motivation and a deeper understanding of the subject matter by moving away from traditional lecture-based instruction and toward a more interactive and participatory learning environment (Trust, 2018). Furthermore, studies exploring the effectiveness of flipped learning in a variety of educational situations found similar benefits in terms of enhanced student interest and engagement (Shoukat et al., 2024). Educators could alter homework tasks as formative evaluations and use class time for interactive tasks and discussion.

5. Conclusion

The application of an innovative flipped classroom strategy to 9th-grade students' science classes proves its efficiency regardless of their gender. Significant improvement is recorded in academic performance and motivation enhancement. These findings have significant implications for teachers and educational policymakers. They underscore the importance of pedagogical approaches that prioritize student engagement, autonomy, and collaboration. By leveraging the benefits of the flipped classroom model, educators can create learning environments that stimulate intrinsic motivation and foster a deeper understanding of the science subject, especially in disadvantageous areas like Palestine.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

References

Abdulrahaman, M.D., Faruk, N., Oloyede, A.A., Surajudeen-Bakinde, N.T., Olawoyin, L.A., Mejabi, O.V. et al. (2020). Multimedia tools in the teaching and learning processes: A systematic review. *Heliyon*, *6*(11), e05312. https://doi.org/10.1016/j.heliyon.2020.e05312

Ahmad, Z., Tamimi, S., Radid, M., & Sefri, Y.S. (2023). The flipped classroom approach via the M-learning model: Impact on student learning and motivation. *Journal of Hunan University Natural Sciences*, 50(4), 201-209. https://doi.org/10.55463/issn.1674-2974.50.4.18

Al-Amri, A.N.A. (2022). Saudi EFL University students' perceived linguistic gains and learning experiences in flipped classrooms. *Arab World English Journal*, (8), 192-204. https://doi.org/10.24093/awej/call8.1

Aljermawi, H.N., Ayasrah, F.T., Al-Said, K., Abualnadi, H.J., & Alhosani, Y. (2024). The effect of using flipped learning on student achievement and measuring their attitudes towards learning through it during the corona pandemic period. *International Journal of Data and Network Science*, 8(1), 243-254. https://doi.org/10.5267/j.ijdns.2023.9.027

Aşıksoy, G. (2017). The effects of the gamified flipped classroom environment (GFCE) on students' motivation, learning achievements and perception in a physics course. *Quality & Quantity*, 52(S1), 129-145. https://doi.org/10.1007/s11135-017-0597-1

Atwa, Z., Din, R., Othman, N., & Hussin, M. (2018). Evaluating the contribution of flipped learning on secondary students' critical thinking skills toward learning physics in Palestine. *International Journal of Engineering & Technology,* 7(4.21), 53-57.

Birgili, B., Seggie, FN., & Oğuz, E. (2021). The trends and outcomes of flipped learning research between 2012 and 2018: A descriptive content analysis. *Journal of Computers in Education,* 8(3), 365-394. https://doi.org/10.1007/s40692-021-00183-y

Bornna, C., Abdul-Rahaman, H., Iddrisu, A., & Badger, T. (2023). Flipped classroom and academic performance of Senior High School students in geometry. *Journal of Education and Practice*, 14(22), 11-17. https://doi.org/10.7176/jep/14-22-02

Braun, V., & Clarke, V. (2006) Using thematic analysis in psychology. *Qualitative Research in Psychology,* 3, 77-101.

Campbell, D.T., & Stanley, J.C. (1963). *Experimental and quasi-experimental designs for research.* Ravenio Books.

Cheng, S., Hwang, G., & Lai, C. (2020). Critical research advancements of flipped learning: a review of the top 100 highly cited papers. *Interactive Learning Environments,* 30(9), 1751-1767. https://doi.org/10.1080/10494820.2020.1765395

Dixon, K. (2017). *The effect of the flipped classroom on urban high school students' motivation and academic achievement in a high school science course.* Dissertation. ProQuest, 789 East Eisenhower Parkway

Dixon, K., & Wendt, J.L. (2021). Science motivation and achievement among minority Urban High School students: An examination of the flipped classroom model. *Journal of Science Education and Technology*, 30(5), 642-657. https://doi.org/10.1007/s10956-021-09909-0

Dweikat, K.A.J., & Raba, A.A. (2019). English as a foreign language (EFL) teachers' perceptions of flipped classroom model in Palestine. *Islamic University-Gaza Journal of Educational and Psychological Sciences,* 27(3), 29-47.

Fortus, D., & Touitou, I. (2021). Changes to students' motivation to learn science. *Disciplinary and Interdisciplinary Science Education Research*, 3(1), 1-14. https://doi.org/10.1186/s43031-020-00029-0

Giannakos, MN., Krogstie, J., & Chrisochoides, N. (2014). Reviewing the flipped classroom research. *CSERC'14: Proceedings of the Computer Science Education Research Conference* (23-29). https://doi.org/10.1145/2691352.2691354

Hamed, C. (2024). Exploring Student Identity in Education: Integrating Theory and Practice for Inclusive Learning Communities. *ISAR Journal of Arts, Humanities and Social Sciences*, 2(3), 1-4.

Han, W., & Hamzah, M. (2024). Research on the influence of flipped classroom on self-efficacy in English language learning of chinese higher vocational college students. *Discover Education*, 3(1). https://doi.org/10.1007/s44217-024-00097-8

Itmazi, J. A., & Khlaif, Z. N. (2022). Examining science teachers' perceptions and attitudes towards flipped learning in Palestine. *International Journal of Emerging Technologies in Learning,* 17(10), 120-134. https://doi.org/10.3991/ijet.v17i10.25699

Jeong, H., González-Gómez, D., Airado Rodríguez, D., & Cañada-Cañada, F. (2018). Flipped learning and blended learning: A comprehensive meta-analysis on effectiveness and student perception. *Educational Research Review*, 25, 1-18. https://doi.org/10.1016/j.edurev.2018.09.003

Jiménez, RM., & Ruiz-Jiménez, MC. (2020). Improving students' satisfaction and learning performance using flipped classroom. *The International Journal of Management Education,* 18(3), 100422-100422. https://doi.org/10.1016/j.ijme.2020.100422

Karabulut-Ilgu, A., Cherrez, NJ., & Jahren, CT. (2017). A systematic review of research on the flipped learning method in engineering education. *British Journal of Educational Technology,* 49(3), 398-411. https://doi.org/10.1111/bjet.12548

Köpeczi-Bócz, T. (2024). The impact of a combination of flipped classroom and project-based learning on the learning motivation of university students. *Education Sciences*, 14(3), 240. https://doi.org/10.3390/educsci14030240

Lee, G.G., Jeon, Y.E., & Hong, H.G. (2021). The effects of cooperative flipped learning on science achievement and motivation in high school students. *International Journal of Science Education*, 43(9), 1381-1407. https://doi.org/10.1080/09500693.2021.1917788

McNally, B., Chipperfield, J., Dorsett, P., Del Fabbro, L., Frommolt, V., Goetz, S. et al. (2017). Flipped classroom experiences: student preferences and flip strategy in a higher education context. *Higher Education*, 73(2), 281-298. https://doi.org/10.1007/s10734-016-0014-z

Miranda, G.Y. (2021). *Academic procrastination and achievement motivation in students of a high school in Nuevo Chimbote–2021.* Degree thesis. Cesar Vallejo University. Available at: https://repositorio.ucv.edu.pe/handle/20.500.12692/68288

Nouri, J. (2016). The flipped classroom: for active, effective and increased learning – especially for low achievers. *International Journal of Educational Technology in Higher Education,* 13(1). https://doi.org/10.1186/s41239-016-0032-z

Olivier, J. (2021). Self-directed multimodal assessment: Towards assessing in a more equitable and differentiated way. In Mentz, E., & Lubbe, A. (Eds.), *Learning through assessment: An approach towards Self-Directed Learning (NWU Self-Directed Learning Series)* (7, 51-69), AOSIS, Cape Town. https://doi.org/10.4102/aosis.2021.BK280.03

Otten, S., Zhao, W., Araujo, ZD., & Sherman, M. (2020). Evaluating Videos for Flipped Instruction. *Mathematics Teacher: Learning and Teaching PK-12,* 113(6), 480-486. https://doi.org/10.5951/mtlt.2019.0088

Palinkas, L.A., Horwitz, S.M., Green, C.A., Wisdom, J.P., Duan, N., & Hoagwood, K. (2013). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and Policy in Mental Health and Mental Health Services Research*, 42, 533-544. https://doi.org/10.1007/s10488-013-0528-y

Purwaningtyas, P., Hidayat, W., & Amri, Z. (2020). The effect of multimedia-based flipped classroom on students' comprehension and retention in science learning. *Journal of Educational Technology & Society*, 23(4), 15-27. https://doi.org/10.1007/s41239-020-00225-8

Rahman, SA., Yunus, MM., & Hashim, H. (2019). An Overview of Flipped Learning Studies in Malaysia. *Arab World English Journal,* 10(4), 194-203. https://doi.org/10.24093/awej/vol10no4.15

Ribau, I. (2023). Motivation, learning and emotions: Engaging students with science flipped classroom. *Education and New Developments 2023,* 2, 2, 139-143. https://doi.org/10.36315/2023v2end029

Ríos, D.C., & Barros, M.J. (2021). Motivation and learning of the English language in students of Educational Institution No 1255, Walter Peñaloza Ramella, Lima, 2021. *Paidagogo,* 3(2), Article 2. https://doi.org/10.52936/p.v3i2

Shadish, W.R. (2001). Quasi-experimental designs. *International Encyclopedia of the Social & Behavioral Sciences,* 12655-12659. https://doi.org/10.1016/B0-08-043076-7/00419-8

Shi, Y., Ma, X., MacLeod, J., & Yang, H. (2019). Effects of flipped classroom on learning outcomes and satisfaction: A meta-analysis. *Internet and Higher Education*, 42, 29-38. https://doi.org/10.1016/j.iheduc.2019.03.005

Shoukat, R., Ismayil, I., Huang, Q., Oubibi, M., Younas, M., & Munir, R. (2024). A comparative analysis of blended learning and traditional instruction: Effects on academic motivation and learning outcomes. *PLoS One*, 19(3). https://doi.org/10.1371/journal.pone.0298220

Sofya, R., & Hayati, AF. (2020, January 1). College Students' Engagement and Motivation in the Flipped Learning Classroom (A Quasi Experimental Study on the Income Tax Management Course). *Proceedings of the 4th Padang International Conference on Education, Economics, Business and Accounting (PICEEBA-2 2019)*. https://doi.org/10.2991/aebmr.k.200305.115

Sookoo-Singh, N., & Boisselle, L.N. (2018). How does the "Flipped classroom model" impact on student motivation and academic achievement in a chemistry classroom? *Science Education International*, 29(4), 201-212. https://doi.org/10.33828/sei.v29.i4.2

Strelan, P., Osborn, A., & Palmer, E. (2020). Student satisfaction with flipped learning: A meta-analysis. *Educational Research Review,* 29, 100283. https://doi.org/10.1016/j.edurev.2019.100283

Timothy, T., Seng-Chee, T., Chwee-Beng, L., Ching-Sing, C., Joyce-Hwee-Ling, K., Wen-Li, C. et al. (2010). The self-directed learning with technology scale (SDLTS) for young students: An initial development and validation. *Computers & Education,* 55(4), 1764-1771. https://doi.org/10.1016/j.compedu.2010.08.001

Tong, D.H., Uyen, B.P., & Ngan, L.K. (2022). The effectiveness of blended learning on students' academic achievement, self-study skills and learning attitudes: A quasi-experiment study in teaching the conventions for coordinates in the plane. *Heliyon*, 8(12), e12657. https://doi.org/10.1016/j.heliyon.2022.e12657

Trust, T. (2018). Why do we need technology in education? *Journal of Digital Learning in Teacher Education*, 34(2), 54-55. https://doi.org/10.1080/21532974.2018.1442073

United Nations. (2024). *The science of motivation.* Available at: https://www.unodc.org/unodc/es/listen-first/superskills/motivation.html

Vedder-Weiss, D., & Fortus, D. (2010). Adolescents' declining motivation to learn science: Inevitable or not? *Journal of Research in Science Teaching*, 48(2), 199-216. https://doi.org/10.1002/tea.20398

Wang L. Gai, W., Jiang, N., Chen, G., Bian, Y., Luan, H. et al. (2024). Effective Motion Self-Learning Genre Using 360° Virtual Reality Content on Mobile Device: A Study Based on Taichi Training Platform. *IEEE Journal of Biomedical and Health Informatics,* 28(6), 3695-3708.

Xiu, Y., & Thompson, P. (2020). Flipped University Class: A Study of Motivation and Learning. *Journal of Information Technology Education,* 19, 041-063. https://doi.org/10.28945/4500

Yarım, M.A., Ada, Ş., Morkoç, S., & Doğan-Kurt, S. (2023). The effect of flipped classroom model on student achievement and Motivation. *Interactive Learning Environments*, 1-12. https://doi.org/10.1080/10494820.2023.2220751

Yin, H. (2020). Exploring the Effectiveness of a Flipped Classroom with Student Teaching. *E-Journal of Business Education & Scholarship of Teaching*, 14(1), 66-78. https://doi.org/https://files.eric.ed.gov/fulltext/EJ1276429.pdf

Yu-Hui, W., & Zhou, T. (2022). A Review of Application on Flipped Classroom in Chinese College English Teaching. Advances in social science, education and humanities research. *Proceedings of the 2021 International Conference on Social Development and Media Communication (SDMC 2021)*. https://doi.org/10.2991/assehr.k.220105.189

Zainuddin, Z., & Halili, SH. (2016). Flipped Classroom Research and Trends from Different Fields of Study. *The International Review of Research in Open and Distributed Learning,* 17(3). https://doi.org/10.19173/irrodl.v17i3.2274

Zainuddin, Z., Haruna, H., Li, X., Zhang, Y., & Chu, S.K.W. (2019). A systematic review of flipped classroom empirical evidence from different fields: what are the gaps and future trends? *On the Horizon*, 27(2), 72-86. https://doi.org/10.1108/oth-09-2018-0027

Zheng, L., Bhagat, K.K., Zhen, Y., & Zhang, X. (2020). The Effectiveness of the Flipped Classroom on Students' Learning Achievement and Learning Motivation: A Meta-Analysis. *Journal of Educational Technology & Society*, 23(1), 1-15. https://www.jstor.org/stable/26915403

Zhou, G., Zhang, Z., & Li, Y. (2011). Are secondary preservice teachers well prepared to teach with technology? A case study from China. *Australasian Journal of Educational Technology*, 27(6). https://doi.org/10.14742/ajet.922

Zulyetti, D. (2023). Flipped classroom learning model with kahoot media: the effectiveness to affect students motivation and learning outcomes in biology subject. *Journal Of Education and Teaching Learning (JETL)*, 5(2), 208-217. https://doi.org/10.51178/jetl.v5i2.1400

Published by OmniaScience (www.omniascience.com)

Journal of Technology and Science Education, 2025 (www.jotse.org)