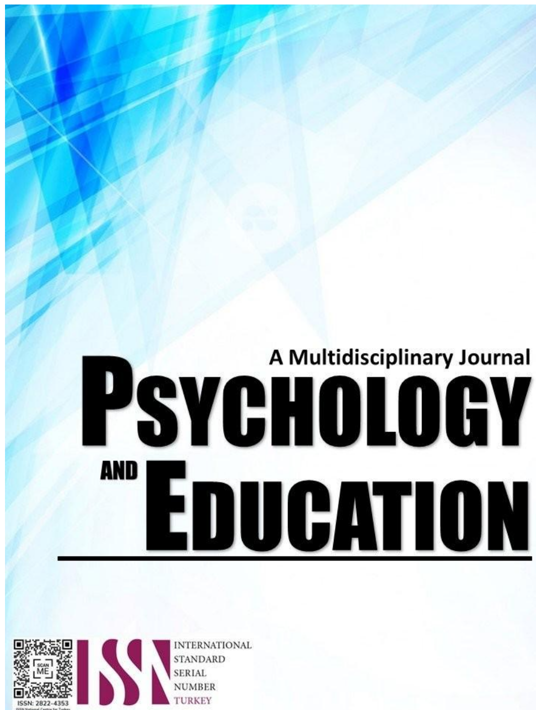
FLIPPED LEARNING STRATEGY AND LECTURE-BASED TEACHING: EFFECTS ON STUDENTS' ACADEMIC ACHIEVEMENT IN CHEMISTRY



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Research Article

Flipped Learning Strategy and Lecture-Based Teaching: Effects on Students' Academic Achievement in Chemistry

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Abstract

Strengthening students' understanding and performance in chemistry remains a top priority in Philippine senior high schools, underscoring the urgent need for effective and innovative teaching strategies. The purpose of this study was to investigate how two distinct teaching philosophies, flipped learning (FLS) and lecture-based teaching (LBT), influence the chemistry performance of grade 11 STEM students. With a quasi-experimental design, 70 students were divided into FLS (treatment) and LBT (control) groups. Academic achievement was assessed on the basis of pre- and post-tests using a 50-item multiple-choice test, and data were analyzed using paired sample t-tests and ANCOVA. Findings indicated that both groups made considerable improvement following the intervention. The FLS group, however, recorded considerably higher post-test scores (M = 31.82, "Fairly satisfactory") compared to the LBT group (M = 26.51, "Did not meet expectations"), and a statistically significant difference ($p < 0.05$) was found. The implication is that FLS is more effective in promoting greater understanding, increased engagement, and better achievement in chemistry than conventional lecture-based teaching. It is suggested that science teachers embed Flipped Learning in the classroom as a means to increase active learning and engagement. Subsequent studies can focus on how FLS and other student-focused strategies are used together to achieve optimal learning results for various science subjects.

Keywords: *flipped learning, chemistry, academic achievement, STEM, lecture-based teaching*

Introduction

Academic achievement in chemistry plays a vital role in a student's overall educational progress, particularly because of its foundational importance in science and technology. A strong chemistry education not only strengthens students' understanding of scientific principles but also cultivates essential skills such as problem-solving, critical thinking, and analytical reasoning. However, many students find chemistry challenging due to its abstract concepts and the mathematical skills it requires, which often hinder their academic performance (Ryan & Reid, 2015). In senior high school, students frequently encounter unfamiliar content without adequate preparation, leading to cognitive overload. They often require multiple examples and extended time to grasp new concepts fully. Without a solid foundation, students struggle to engage in discussions, tackle calculation-based problems, and understand complex topics.

In the Philippines, academic achievement is guided by the assessment framework set by the Department of Education (DepEd) through DepEd Order No. 8, s. 2015, which emphasizes both formative and summative assessments to monitor progress and guide instructional adjustments. These guidelines highlight the importance of aligning assessments with curriculum standards and providing timely feedback to support learner needs. Furthermore, the Philippine Professional Standards for Teachers (PPST) (DepEd, 2017) establishes benchmarks for effective instruction, encouraging student-centered and innovative practices. Flipped learning aligns well with the PPST's emphasis on differentiated instruction and active learning, allowing educators to meet students' diverse needs.

Despite ongoing reforms, the Philippine education system continues to face challenges in sparking student interest in science, particularly in chemistry. Traditional teacher-centered approaches, which focus on passive information transmission, often fail to engage modern learners, leading many to view chemistry as abstract and difficult. This perception contributes to poor performance and low interest in the subject (Akkuzu & Uyulgan, 2016).

International and national assessments underscore these concerns. The Program for International Student Assessment (PISA) 2022 reported an average Philippine science score of 355, significantly below the OECD average of 489 (OECD, 2023). Similarly, the Trends in International Mathematics and Science Study (TIMSS) revealed low performance in science (Mullis et al., 2020). Results of the National Achievement Test (NAT) 2023 further highlighted the issue, with Grade 12 students recording a mean percentage score of 31.81 in science and 28.80 in problem-solving skills (Behiga, 2022). These findings indicate a limited understanding of scientific concepts and fundamental knowledge.

To address these persistent gaps, researchers have explored innovative instructional approaches. In contrast to traditional lecture-based methods, flipped learning promotes student engagement, critical thinking, and improved knowledge retention, as demonstrated by Jensen et al. (2015) and O'Flaherty and Phillips (2015). However, data on senior high school contexts are scarce, as most research has focused on higher education. Additionally, limited studies have explored how flipped learning aligns with national education policies, such as DepEd Order No. 8, s: 2015, and the Philippine Professional Standards for Teachers (PPST).

This research sought to fill these gaps by investigating how the flipped learning model affects the academic performance and chemistry proficiency of senior high school students in the Philippines. It also investigated the alignment of flipped learning with the competency-based teaching framework outlined in the PPST.

By highlighting the potential of flipped learning to enhance both student achievement and teacher practice, this research aimed to contribute evidence-based insights to guide science educators. Empowering teachers to adopt innovative strategies such as flipped classrooms can help students take greater responsibility for their own learning, strengthen their mastery of chemistry concepts, and ultimately improve national performance in science education.

Research Objectives

This study aimed to examine the effectiveness of the flipped learning strategy in chemistry education and identify best practices for its use by comparing it with traditional lecture-based instruction. Specifically, investigated students' levels of academic achievement in Chemistry before and after the implementation of the flipped learning strategy, as well as before and after a lecture-based intervention. It also analyzed whether a significant difference existed in the post-intervention academic achievement of students between the two groups, thereby evaluating which instructional approach more effectively improved learning outcomes.

Methodology

Research Design

This study employed a quasi-experimental design to examine the effect of the flipped learning approach on students' academic performance. It compared Grade 11 STEM students taught through flipped learning with those who received traditional lecture-based instruction, using intact classes. Both groups studied the same chemistry content and were given a standardized test before and after the intervention to measure achievement. This design is considered practical in educational settings as it accommodates existing class structures while still providing reliable data (Nantha, Pimdee, & Sitthiworachart, 2022). Results indicated that students exposed to the flipped classroom approach performed better academically than those in traditional settings.

Respondents

The respondents of the study consisted of 70 Grade 11 STEM students from Quezon Bukidnon Comprehensive National High School in Mibando, Quezon, Bukidnon. These students were drawn from two intact classes, with 35 students assigned to each group. The study employed purposive sampling, selecting participants enrolled in General Chemistry 2 to ensure their relevance to the research objectives.

Instrument

The instrument used in the study was a 50-item multiple-choice test based on the Department of Education (DepEd) modules and curriculum guides. This instrument was designed to assess the students' knowledge, understanding, and application of key chemistry concepts. The same standardized test was administered as both the pre-test and post-test to measure changes in academic performance.

The 50-item multiple-choice test was designed to assess different cognitive skills in Chemistry, including recall, analytical, and application abilities. Approximately 15 items focused on recall, measuring students' knowledge of basic concepts and definitions, while around 20 items targeted analytical skills, requiring interpretation of diagrams, equations, and chemical relationships. The remaining 15 items assessed application skills, involving problem-solving and real-life situations such as calculations of pH, equilibrium, and thermodynamic values. This distribution ensured a balanced evaluation of both lower- and higher-order thinking skills.

Procedure

The researcher followed institutional protocols to ensure systematic data collection, securing approvals from the Liceo de Cagayan Research and Ethics Board, the Dean of the School of Teacher Education, the Schools Division Superintendent, and the school principal. Data collection took place during the final term of the second semester of the 2024–2025 academic year. Eligible participants were Grade 11 STEM students enrolled in General Chemistry 2, and informed consent and assent were obtained prior to participation. An orientation was conducted to explain the study's objectives, procedures, and ethical considerations.

Data collection was carried out over five weeks in three phases: pre-testing, intervention, and post-testing. Both groups first completed a pre-test to assess baseline knowledge. The experimental group then engaged in flipped learning through pre-class materials and in-class activities, while the control group received lecture-based instruction. After the intervention, both groups took a post-test, and the results were analyzed using ANCOVA to determine the effectiveness of the flipped learning approach.

Data Analysis

For data analysis, both descriptive and inferential statistical methods were utilized. Descriptive statistics, including mean and standard deviation, were used to summarize students' academic performance. Inferential statistics, specifically the paired-samples t-test and Analysis of Covariance (ANCOVA), were employed to determine significant differences between the experimental and control groups while controlling for pre-test scores. The data were analyzed using Statistical Package for the Social Sciences (SPSS), with a significance level set at 0.05.

Ethical Considerations

Ethical standards were strictly observed throughout the study. Participation was voluntary, with students informed of their right to withdraw at any time without consequences. All data were handled confidentially, with physical documents securely stored and digital files protected through password security and anonymization using numerical codes. No identifiable information was included in reports, in compliance with the Data Privacy Act of 2012 and DepEd policies.

The researcher ensured transparency by clearly communicating the study's purpose, procedures, and results to students, guardians, and school officials in accessible language. There were no declared conflicts of interest, and the study was conducted solely for academic purposes. Cultural sensitivity and school coordination were maintained, and the findings were shared with the school community to support educational improvement and acknowledge participants' contributions.

Results and Discussion

This section presents the results of the pre-test and post-test assessments of Grade 11 Chemistry students' academic performance after exposure to both lecture-based instruction and the flipped learning approach. It also examines the extent of improvement in students' performance and determines which teaching strategy proved more effective. Furthermore, the study investigates whether there were significant differences in students' academic performance within each group before and after exposure to either the lecture-based or the flipped classroom method.

Participants' level of academic Achievement in Chemistry

Table 1. *Participants' Academic Achievement in Chemistry Exposed to the Flipped Learning Strategy*

Type of Performance	*Mean*	*SD*	*Interpretation*
Pre-test	17.47	4.16	Did not meet expectations
Post-test	31.82	4.39	Fairly satisfactory

(45-50- Outstanding 40-44 = Very Satisfactory 35-39 = Satisfactory 30-34= Fairly Satisfactory 0-29 = Did Not Meet Expectation)

Table 1 presents the academic performance of students in chemistry before and after exposure to the flipped learning strategy as reflected in their pre-test and post-test scores. As shown in the table, the students' pretest score had M = 17.47, SD = 4.16, categorized as "Did not meet expectation". This result indicated that the two classes had similar levels of prior knowledge to begin with, so any differences in them could be directly attributed to the teaching method rather than pre-existing academic ability. Additionally, these low baseline scores indicated that the students had difficulty with essential chemistry topics, a challenge commonly attributed to the subject's abstract and mathematical nature (Seery, 2015), and reflected a pressing need for a more engaging and conceptually supportive instructional design.

On the other hand, the posttest score had a M = 31.82, SD = 4.39, and was categorized as "Fairly satisfactory." This indicates that after the intervention, the FLS group showed a significant and positive learning gain: from "Did not meet expectation" to "Fairly satisfactory". This significant improvement suggests that the transition to a constructivist, active-learning experience enabled participants to master the content. The FLS approach, which required students to acquire basic knowledge before class through self-learning and then spend in-class time applying the learned concepts and solving problems, not only helped address the foundational knowledge gap but also promoted the development of higher-order thinking skills required for deep understanding in Chemistry.

The academic performance of the Grade 11 students in Chemistry was initially low, primarily because Chemistry is not strongly emphasized in the science contents of earlier grade levels under the K–12 curriculum. Despite the lack of foundational Chemistry knowledge, the flipped learning strategy helped bridge this gap by allowing students to engage in pre-class preparation, such as watching video lessons, and participate in interactive, problem-solving activities during class. This approach supported deeper understanding, encouraged self-paced learning, and promoted active participation—resulting in a more student-centered learning environment.

These results are consistent with Olakanmi's (2017) study, which found that students in flipped classrooms have a better grasp of chemistry concepts than those taught in regular classrooms. Students who participated in interactive in-class activities and pre-class preparation did better than those who received standard lecture-based training, highlighting the effectiveness of flipped instruction in developing students' conceptual understanding.

Similarly, Hibbard et al. (2016) also supported the flipped approach, noting its impact on improved assessment scores through a shift to student-driven learning and collaborative work. The shift to self-paced, online content delivery, followed by collaborative in-class problem-solving, enabled students to participate more and better understand chemistry. Additionally, Nantha et al. (2022) found that a well-designed Flipped Classroom education significantly improved students' academic achievement and problem-solving skills. This demonstrated that both the traditional and problem-based learning groups were outperformed by the students in the flipped group.

However, while the strategy proved effective in raising performance, it did not yet elevate achievement to a higher level. Gündüz and Akkoyunlu (2019) noted that although flipped learning fosters student autonomy, it also poses challenges, such as limited immediate feedback and difficulty accessing online materials—barriers that may have hindered optimal performance. Similarly, Villarica (2023) noted that successful flipped instruction depends heavily on student motivation, consistent engagement, and reliable internet access—all of which can vary widely among learners, particularly in remote or underserved areas.

In addition, Satparam (2022) reported that in K–12 flipped classroom settings, variability in instructional design, student resistance, and technological access issues were common limitations. These same barriers could have restricted some students from fully capitalizing on the flipped model's benefits. Similarly, Smallhorn (2017) observed that although flipped learning enhances engagement and learner perception, it does not always translate into significantly higher academic outcomes. This shows that while the flipped model shifts classroom dynamics toward active learning, additional supports are essential to elevate student performance.

Participants' Level of Academic Achievement in Chemistry before and after the Lecture-based Intervention

Table 2. *Students' Academic Achievement in Chemistry when exposed to Lecture-Based Teaching*

Type of Performance	*Mean*	*SD*	*Interpretation*
Pre-test	17.37	4.21	Did not meet expectations
Post-test	26.51	3.36	Did not meet expectations

(45-50- Outstanding 40-44 = Very Satisfactory 35-39 = Satisfactory 30-34= Fairly Satisfactory 0-29 = Did Not Meet Expectation)

Students' achievement in Chemistry, as indicated by the pre-test and post-test, is shown in Table 2. It indicates that students who participated in lecture-based instruction achieved a pre-test mean score of 17.37 (SD = 4.21) and a post-test mean score of 26.51 (SD = 3.36), interpreted as "did not meet expectation". Despite improved student performance, their mean scores remain in the "did not meet expectation" category. This implies that although learning through lectures yielded some learning gains, it might not have fully met students' needs for grasping more complex Chemistry concepts.

The teaching approach used in the study follows a traditional, teacher-centered model, in which instruction was structured and systematically delivered through direct explanation of concepts, the chalk-and-board strategy, and guided note-taking. As a result, students primarily served as passive recipients of information. This instructional setup provided a familiar and organized method for content delivery, but it offered limited opportunities for students to engage with the material actively.

While concepts of Chemistry are often abstract and require hands-on application, this method may not have been sufficient to support deeper conceptual understanding fully. This explains that despite the modest increase in performance, students may have struggled to retain and apply what they learned due to the lack of interactive tasks, collaborative activities, or real-time feedback. As implemented in this study, the lecture-based method was practical and manageable, but it may have fallen short in addressing the cognitive demands of complex Chemistry topics.

This outcome is consistent with findings from Reyes et al.'s (2022) study, which suggest that lecture-based teaching, while often criticized for its passive delivery, can still contribute to significant student learning when implemented with appropriate structure and reinforcement. Even in a mostly lecture-based structure, using an instructional cycle that included a mini-lecture, seatwork, and closure could vastly increase student participation and student learning.

Sanchez (2017) identified that lectures could be improved using an organized process, such as the Integrated Macro-Micro-Symbolic Approach (IMMSA), which increased students' learning of chemistry concepts. These findings suggest that lecture-based practices remain viable instructional techniques for encouraging student success in chemistry, especially in situations that require considerable conceptual explanation and structured content.

The work by Sugano (2020) showed that traditional lecture methods remain legitimate and practical means of instructional delivery in Philippine classrooms and, compared with other instructional methods, have significantly improved student academic performance. This is particularly applicable where the region has significant limitations to technological infrastructure and students are in the early development stages of self-regulated learning (emotional, cognitive, behavioral), or where the viability of flipped or inquiry-based models may not be accessible to students.

Significant difference in the Students' Academic Achievement in Chemistry Between Each Group of Participants

The paired-samples t-test results in Table 3 indicated a significant difference in students' academic achievement in Chemistry before and after the intervention for both groups (flipped classroom and lecture-based teaching).

Table 3. *Significant Difference in Students' Academic Achievement in Chemistry Before and After the Intervention for the Flipped Classroom and Lecture-Based Teaching Groups*

	Paired Difference					*T*	*df*	*Sig.*
				95% Confidence Interval of the Difference				
Group	*Mean*	*SD*	*SD Error Mean*	*Lower*	*Upper*			
Experimental	-11.71	5.49	.66	-13.03	-10.39	-17.72	68	.000
Control	-9.14	5.10	.86	-10.89	-7.39	-10.61	34	.000

In the experimental group of Flipped Learning Strategy, the mean difference between the pre-test and post-test was -11.71 (sd=5.49, se=0.66). The t-statistic of -17.72 (df=68) and the resulting significance value (p= .000) indicated a significant change in students' performance following the intervention. Therefore, the study's null hypothesis that there is no discernible difference between the students' pre- and post-test scores after using the flipped learning strategy is disproved. The rejection of the null hypothesis indicates that there was a statistically significant difference between the pre-test and post-test scores in both groups. This means that both the Flipped Learning Strategy and Lecture-Based Teaching produced measurable learning gains among students.

The control group, which engaged with Lecture-Based Teaching, demonstrated a mean difference of -9.14, a SD of 5.10, and a standard error of 0.86. A t-value of -10.61 with 34 degrees of freedom, resulting in a p-value of .000, indicates that their post-test results also showed a statistically significant improvement. These results demonstrate that although both teaching approaches enhanced students' academic performance in chemistry, the Flipped Learning Strategy resulted in a greater mean score gain. This leads us to conclude that implementing a flipped classroom model is a more effective way to improve students' academic performance in chemistry.

After the flipped learning intervention, classroom observations showed that students' performance had improved considerably. Before this strategy, the majority of the experimental group's students were passive and reluctant to participate. However, once they started engaging with pre-class video materials, they became more active during in-class discussions and activities. For example, students arrived at class prepared with clarifying questions and felt more confident in solving problems during group tasks. This change in behavior showed a growing sense of ownership over their learning and a better understanding of Chemistry concepts. In contrast, the lecture-based group also showed some improvement, but their classroom behavior remained mostly passive. Students continued to rely on teacher-led explanations and had limited initiative in exploring concepts on their own. These observations confirm that the flipped learning approach not only enhanced test results but also fostered more engaging and meaningful learning experiences.

This outcome aligns with Olakanmi's (2017) findings, which indicate that flipped classroom methods improve student achievement by fostering active learning, deeper engagement, and reflective thinking. This method resulted in much higher academic performance of chemistry students, especially because they were able to participate and prepare for class actively in other ways.

Liu et al. (2018) also reported that students in flipped and peer-led team learning modes of instruction were more motivated and demonstrated greater learning improvements than those receiving traditional lectures. The findings of this study are similar: the experimental group (flipped classroom) performed better than the control group (lecture-based), suggesting that the flipped approach offers a better opportunity to achieve conceptual mastery in Chemistry.

Additionally, Chen et al. (2019) highlighted the importance of student participation and reflective thinking in flipped learning settings. Because flipped learning is defined by its use of pre-class content delivery (e.g., videos, readings) and in-class active learning, the study found that students exposed to this method not only demonstrated higher academic performance but also higher levels of engagement and individualized learning. This is especially true in chemistry, where self-paced, iterative learning aided by technology-enhanced training is beneficial for abstract concepts.

In contrast, as noted by Amushigamo et al. (2018), lecture-based formats often lead to passive learning, with students becoming mere recipients of information rather than active constructors of knowledge. This limitation becomes particularly critical in subjects like Chemistry, where student interaction, application, and inquiry are central to meaningful learning. While some research, Bredow et al. (2021) and Vega (2024) reported that flipped instruction generally produces more favorable academic results, especially when carefully implemented with adequate scaffolding and support. Therefore, this study's findings contribute to the growing body of evidence supporting educators' need to embrace innovative, learner-centered strategies to enhance student outcomes in science subjects.

Significant Difference in the Students' Academic Achievement in Chemistry between Groups after the Interventions

Table 4. *Significant difference in Students' Academic Achievement in Chemistry Between Flipped Classroom and Lecture -Based Teaching Groups*

Source	*Type III Sum of Squares*	*Df*	*Mean Square*	*F*	*Sig.*	*Partial Eta Squared*
Corrected Model	523.148(a)	2	261.574	17.533	.000	.347
Intercept	2155.037	1	2155.037	144.446	.000	.686
Pretest	89.957	1	89.957	6.030	.017	.084
Group	437.888	1	437.888	29.350	.000	.308
Error	984.678	66	14.919			
Total	60060.000	69				
Corrected Total	1507.826	68				

R Squared = .347 (Adjusted R Squared = .327)

Table 4 shows a notable difference in post-test scores between the Flipped Classroom Strategy and Lecture-Based Teaching groups in Chemistry. The null hypothesis is rejected since the significant result ($p <.05$) is smaller than the alpha value of 0.05. This indicates that the post-test outcomes for students who were instructed using the Flipped Classroom Strategy and those who received Lecture-Based Teaching differed significantly [$F(1,66) = 29.350$, $p =.000$].

The moderate effect size (0.2 for small effects, 0.5 for moderate effects, and 0.8 for large effects), as indicated by the partial Eta Squared value of.308 indicates that the chemistry students' academic performance was significantly impacted by the teaching strategy used (lecture-based vs. flipped classroom). After adjusting for initial differences in pre-test scores, the R-squared value of.347 indicates a moderately strong effect of the intervention. It shows that the instructional method, specifically the Flipped Classroom Strategy, along with pre-test scores, explains 34.7% of the variance in students' academic success following the test. This study shows that, compared with traditional lecture-based instruction, the flipped classroom method significantly improves students' academic performance in chemistry.

This was evident during the actual interventions. The flipped learning group consistently showed more independence and engagement in the classroom. Students who reviewed the pre-class materials were better prepared to join discussions, work with peers, and apply concepts in hands-on tasks. For instance, students in the flipped group took the initiative to solve problems and clearly stated their arguments during exercises on atomic structure and chemical reactions, requiring little teacher assistance.

Conversely, students in the lecture-based group relied more on detailed instructions and often required more explanation before starting their work. They showed less initiative in applying what they learned on their own. These variations in classroom conduct and instructional methods corroborated the study's findings that the flipped learning approach not only enhances academic achievement but also fosters students' greater comprehension and independence in chemistry.

This finding is consistent with Olakanmi's (2017) research, which reported that students exposed to the flipped classroom model demonstrated a significantly higher understanding of chemical reaction rates and performed better than their counterparts in traditional settings. Similarly, students who participated in a flipped chemical process did better on standardized chemistry assessments, according to Hibbard et al. (2016). They ascribed this improvement to the opportunities for in-class activities that provide real-time feedback and active learning. Jawalekar et al. (2024) presented further proof of the effectiveness of the flipped approach in fostering deeper learning and engagement, highlighting a significant increase in students' test scores and overall satisfaction.

Furthermore, allowing learners to get to know the content at their own pace before attending class, utilizing the flipped learning approach, promotes better preparation and fosters active participation during face-to-face sessions. This aligns with Liu et al. (2018) and Chen et al. (2019), who found that reflective thinking and student engagement are important for achieving successful learning outcomes in flipped environments.

While other research, including that of Cabi (2018) and Smallhorn (2017), found no statistically significant gain in academic accomplishment despite favorable views toward the flipped approach, these conflicting results highlight the importance of factors like the caliber of the teaching materials, how the classroom is run, and how well students control their own behavior. However, the whole of the evidence—including the present study's findings—attests that the Flipped Learning Strategy is a superior and effective teaching method compared to lecture-based instruction for improving students' academic performance in chemistry.

Conclusions

The research results show that students who experienced the flipped learning approach achieved better academic results than those who received instruction primarily through traditional lectures. This suggests that the flipped learning approach outperforms the conventional lecture method in fostering student progress. Understanding, retention, and overall learning outcomes improve when students are allowed to study foundational material at their own pace before class and then participate in interactive discussions and activities during class, in line with the principles of active learning theory. Furthermore, both the Flipped Learning Strategy and Lecture-Based Teaching groups saw improvements in their pre-test and post-test results. Nevertheless, students in the Flipped Classroom group achieved higher scores, indicating that this approach enhances performance in chemistry. This suggests that, although both methods offer benefits, the Flipped Classroom Strategy is a significantly more effective intervention for improving the academic performance of chemistry students.

Based on the findings, the following are the recommendations:

School administrators may organize professional development workshops and training sessions to help chemistry teachers effectively implement the flipped learning strategy. These sessions should focus on enhancing the quality of pre-class learning materials and developing engaging, student-centered in-class activities that foster deeper understanding and improve overall learning performance. Chemistry teachers may consider utilizing the flipped learning method to boost students' academic achievements. Educators may encourage critical thinking and improve students' understanding of key chemical concepts by developing engaging video lessons for pre-class preparation and facilitating thought-provoking class discussions. Students may enhance their academic performance through the Flipped Learning approach by taking ownership of their pre-class learning sessions and video viewing, and by actively participating in class discussions and activities facilitated by their teachers.

Support and encouragement from teachers might also help students develop the learning discipline and study habits they need for success in a flipped classroom. Lastly, future researchers may explore the use of the Flipped Learning Approach in other science courses and in different educational situations. Researchers could also examine how integrating the flipped approach with other teaching strategies, such as problem-based learning or group projects, may further enhance students' performance in Chemistry and other subjects.

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