



Language Learning Revolution: Flipped Classroom Approach for Engineering Students

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Abstract

Language achievement and motivation are essential dependent variables for assessing the efficacy of pedagogical methodologies in language learning. This study investigates the impact of the flipped classroom approach on enhancing language achievement and attitudes towards flipped classroom approach among engineering students at an Aeronautic University in Tehran, Iran. Employing a quasi-experimental research design, the study involved 40 senior and first-year students, aiming at improving their English language proficiency and finding their views and attitudes towards the flipped classroom approach. Data collection included surveys and quantitative questionnaires, classroom assessments. Results from the analysis of covariance (ANCOVA) ($F(1, 37) = 13.31, p = 0.001$), revealed that applying flipped classroom approach boosts ESP learners' language achievement. Additionally, the flipped learning questionnaire results showed high student motivation ($t = 4.96, p = 0.000$), and effectiveness of flipped learning ($t = 4.84, p < 0.000$). These findings showed the usefulness of flipped classroom model as an effective strategy to enhance language achievement and learner motivation, offering valuable insights for educators in diverse educational settings.

Keywords: attitude, engineering students, flipped classroom pedagogy, language acquisition

1. Introduction

Flipped learning has emerged as a transformative pedagogical model that redefines traditional classroom instruction. Unlike conventional methods, which typically center on direct content delivery during class sessions, flipped learning innovatively presents instructional materials outside the classroom, often through multimedia resources. This approach reallocates in-class time to engage students in active learning and collaborative activities, thereby enhancing their interaction with the material and improving overall learning outcomes (Baig & Yadegaridehkordi, 2023; Bishop & Verleger, 2013; Hung et al., 2015; Khodaei et al., 2022). The shift from a teacher-centered to a student-centered paradigm positions instructors as facilitators of learning rather than mere providers of content, fostering deeper student engagement and more effective learning experiences (Abeysekera & Dawson, 2015).

This study grounds its investigation in the theoretical framework of constructivist learning theory, which posits that knowledge is constructed through interaction with the environment and collaborative activities (Vygotsky, 1978). By situating flipped learning within this framework, the study

explores how this approach supports active construction of knowledge through student engagement with content outside of class and application of learned concepts during in-class activities. This theoretical lens provides a robust foundation for understanding how flipped learning enhances language acquisition among engineering students.

Engineering education presents unique challenges, particularly in mastering technical vocabulary and developing effective communication skills in English, essential for academic and professional success (Kim & Yoon, 2021). The flipped classroom model addresses these challenges by allowing students to engage with complex language concepts at their own pace before class, thus promoting more effective in-class application and interaction (Lo & Hew, 2017). However, it is crucial to acknowledge that traditional teaching methods also have strengths. Conventional approaches, characterized by structured teacher-led instruction, are effective in delivering foundational knowledge and facilitating initial learning. The limitations of traditional methods, such as passive learning and insufficient engagement with complex content, can be mitigated by integrating them with innovative models like flipped learning (Ma & Luo, 2022; O'Flaherty & Phillips, 2015).

The primary objective of this study is to evaluate the effectiveness of the flipped classroom approach in enhancing the language learning knowledge and strategies of undergraduate engineering students. The research specifically aims to improve students' proficiency in speaking, writing, grammar, and vocabulary, as well as their overall language acquisition strategies. By addressing these objectives, the study contributes valuable insights into the effectiveness of flipped learning in a non-native English-speaking context, particularly within engineering programs. Traditional classroom settings often fall short in engaging students actively and addressing their individual learning needs (Davari & MallAmiri, 2022; Karabulutlugu et al., 2018). In contrast, flipped learning promotes active participation and collaborative learning, which are critical for developing language skills (Gilboy et al., 2015; Samadi et al., 2024). Despite these advantages, there is a noticeable research gap regarding the application of flipped learning in engineering programs within non-English-speaking regions. This study aims to bridge this gap by providing empirical evidence on the impact of flipped classrooms on language learning among engineering students in Tehran, Iran.

The flipped classroom model presents a dynamic alternative to traditional methods by fostering active learning, critical thinking, and practical application of language skills (Lestari & Sundari, 2021; Thai et al., 2017). This research highlights the potential of flipped learning to enhance educational outcomes and provides practical insights for educators and institutions seeking to implement effective language learning frameworks in engineering education. By demonstrating the tangible benefits of flipped learning, this study advocates for its broader adoption in higher education, especially in disciplines that require robust language proficiency and active student engagement. The research underscores the transformative potential of flipped classrooms in equipping engineering students to meet the linguistic and professional demands of a globalized world.

2. Literature Review

Flipped learning, a pedagogical approach that has garnered considerable recognition for its innovative instructional methods (Hwang et al., 2019), involves reversing the traditional teaching model. In this approach, students engage with new content outside the classroom through multimedia resources such as videos. Classroom time is then dedicated to exercises, projects, and discussions that deepen understanding and facilitate active learning (Bergman, 2023; Sams & Bergman, 2013; Lage et al., 2000;

Samadi et al., 2024). This shift from a teacher-centered to a student-centered learning environment transforms the role of the teacher from a lecturer to a facilitator, thereby enhancing student engagement and learning outcomes (Abeysekera & Dawson, 2015).

The significance of flipped learning is particularly notable in engineering education, where students are required to master complex technical concepts and develop strong communication skills in English (Dong, 2016). Traditional teaching methods often fall short in addressing these needs, leading to passive learning and limited student engagement. Flipped learning, by contrast, enables students to interact with material at their own pace, fostering a more interactive and supportive learning environment that can enhance both language acquisition and technical proficiency (Lo & Hew, 2017). Historically, language teaching heavily relied on traditional methods characterized by teacher-led instruction and rote memorization. Communicative Language Teaching (CLT) emerged as an alternative, focusing on using language in real-life scenarios to improve communicative competence (Richards & Rodgers, 2001). Similarly, Task-Based Language Teaching (TBLT) emphasized task completion using the target language to promote practical language use (Nguyen, 2021; Nunan, 2004). Despite the advancements of CLT and TBLT, these methods remained largely dependent on classroom-based instruction and struggled to accommodate diverse learning paces and styles, leading to varying levels of language acquisition and engagement.

Research on flipped learning has demonstrated its effectiveness across various educational contexts, including language learning. Gilboy et al. (2015) and Mehring (2017) reported increased student engagement and satisfaction in flipped classrooms compared to traditional settings. Abeysekera and Dawson (2015) noted that flipped learning supports cognitive and motivational processes by allowing students to review material at their own pace, thereby enhancing understanding and retention. In language learning contexts, flipped classrooms have been particularly effective. Mehring (2018) found that flipped learning better met learners' needs and promoted active engagement, leading to improved language acquisition. A meta-analysis by Akçayir and Akçayir (2018) revealed significant improvements in language skills among students in flipped classrooms compared to traditional settings.

Studies from various countries support these findings. Shyr and Chen (2018) observed higher student performance and engagement in Taiwan when using the flipped model. Baig and Yadegaridehkordi (2023) reported similar positive outcomes in Italy, noting reduced confusion around complex grammar concepts and increased learning efficiency. Despite these promising results, there is a notable gap in the literature concerning the application of flipped learning in specific contexts, such as engineering students learning English as a second language (Ngo & Yunus, 2021). While existing research generally supports the benefits of flipped classrooms, there is limited focus on the unique challenges faced by engineering students who must master both technical vocabulary and effective communication skills. Additionally, much of the research has concentrated on general language skills, with insufficient attention to specific areas such as reading comprehension and technical language proficiency.

This study aims to address these gaps by investigating the impact of flipped learning on the language acquisition of engineering students in Tehran, Iran. The objectives of this study are as follows:

1. Evaluate the effectiveness of flipped learning in improving the language skills of engineering students.

2. Examine the impact of flipped classrooms on students' motivation and engagement in language learning.

3. Identify the specific challenges and benefits of implementing flipped learning in a non-native English-speaking engineering context.

The innovative aspect of this study lies in applying the flipped classroom model to a unique and underexplored population. By focusing on engineering students in Tehran, the research seeks to provide empirical evidence on the effectiveness of flipped learning in enhancing both general and technical language skills (Li et al., 2024). Additionally, the study utilizes a mixed-methods approach, combining quantitative and qualitative data to offer a comprehensive analysis of the flipped learning model's impact on language acquisition.

Based on the extensive literature review and identified research gaps, this study investigates the impact of the flipped classroom model on the language acquisition of engineering students. The research questions are designed to address the study's specific objectives and provide a structured framework for the investigation. These questions aim to offer a thorough understanding of the effectiveness and challenges of implementing the flipped classroom model for language learning among engineering students in a non-native English-speaking context. The primary goal is to evaluate how the flipped classroom approach enhances language learning knowledge and strategies among B.S. engineering students. Improving language proficiency is crucial for universities and colleges, as it equips students with the skills necessary to navigate a rapidly evolving global landscape. The flipped classroom model, an innovative teaching method, has demonstrated potential for positively impacting language learning and various other academic disciplines by reimagining traditional classroom dynamics and positioning students as active participants in their learning.

The concept of flipped learning was initially introduced by Lage et al. (2000) and later popularized by Sams and Bergmann (2013). This model was designed to address the challenges faced by struggling students by providing learning materials through multimedia formats for pre-class engagement. This approach enables more interactive and application-focused class sessions, thereby enhancing understanding and engagement.

According to Sams and Bergmann (2013), flipped learning is based on four key principles:

1. Flexible Learning Environment: Allows learners to manage their study time, place, and methods according to their individual styles and strategies.

2. Learner-Centeredness: Transforms the classroom from a teacher-centered to a learner-centered environment, requiring more active participation from students.

3. Structured Learning Materials: Instructional materials are planned and developed by teachers for use before, during, and after class sessions.

4. Professional Teacher Facilitation: Despite its learner-centered nature, the flipped classroom model relies heavily on teachers' roles in evaluating and assessing student performance and preparing materials that meet learners' needs.

Research by Akçayır and Akçayır (2018) and Liu et al. (2016) highlights the increasing interest in flipped learning due to advancements in technology and internet accessibility. Bates (2017) reported significant improvements in student engagement and learning outcomes in flipped classrooms compared

to traditional settings. Shyr and Chen (2018) found that students in Taiwan experienced greater success in language learning with the flipped model. Similarly, Baig and Yadegaridehkordi (2023) observed reduced confusion over grammar concepts and improved learning efficiency in Italy.

3. Research Questions

This study seeks to contribute to the growing body of literature on flipped learning by providing comprehensive insights into its impact on the reading skills of engineering students. By examining a larger population within a specific educational context, this research aims to offer practical recommendations for educators seeking to enhance language learning through innovative pedagogical approaches. More specifically, this study focuses on the following research questions:

1. What is the impact of the flipped classroom approach on engineering students' language achievement?
2. What are the engineering students' views towards the flipped classroom approach?

4. Method

4.1. Research Design

This study utilized a quantitative quasi-experimental design to evaluate the impact of the flipped classroom approach on engineering students' language achievement and their perceptions of this instructional method. The study was conducted with two groups: an experimental group, which was instructed using the flipped classroom approach, and a control group, which received traditional lecture-based instruction. Each group comprised 20 students, totaling 40 participants. The design incorporated a pretest-posttest structure to allow for comparative analysis of language achievement scores before and after the intervention. The independent variable in this study was the type of instructional approach (flipped classroom versus traditional lecture-based), while the dependent variable was students' language achievement, measured through standardized language tests. Additionally, students' motivation and perceptions regarding the flipped classroom approach were assessed using a questionnaire adapted from Aljaraideh (2019) and administered to the experimental group.

4.2. Participants

The sample consisted of 40 engineering students drawn from a larger cohort enrolled in a language course at the university. The participants were randomly assigned to either the experimental group or the control group, each consisting of 20 students. This random assignment aimed to ensure comparability between the groups in terms of baseline characteristics. To confirm group homogeneity, all participants completed the Oxford Placement Test. The test results demonstrated homogeneity, with a Cronbach's alpha coefficient of 0.83, indicating a high level of reliability and internal consistency.

4.3. Instruments

Three instruments were used: 1) TOEFL and IELTS Tests, 2) Language Achievement Test, and 3) Flipped Learning Questionnaire. They are explained below.

4.3.1. TOEFL and IELTS Tests

The TOEFL and IELTS tests, recognized standardized measures of language proficiency, were used as both pretests and posttests to evaluate the participants' language achievement. These tests assess various skill areas, including reading, writing, listening, and speaking, providing reliable proficiency measures.

4.3.2. Language Achievement Test

A custom achievement test was developed to assess the language skills targeted by the instructional interventions. This test was administered following the intervention to evaluate the comparative impact of the flipped classroom approach relative to traditional methods.

4.3.3. Flipped Learning Questionnaire

A questionnaire was employed to gauge the experimental group's motivation and perceptions regarding the flipped classroom approach. This instrument was administered to the experimental group after the intervention. It included items designed to assess students' interest, motivation, and perceived effectiveness of the flipped classroom model in enhancing their language learning experience.

4.4. Procedure

Participants were randomly assigned to the experimental group (flipped classroom approach) or the control group (traditional lecture-based approach).

Pretest: Prior to the intervention, both groups completed the TOEFL and IELTS tests to establish baseline language proficiency levels. These pretest scores served as covariates in the analysis to control for any pre-existing differences between the groups.

Intervention: During the semester, the experimental group received instruction through the flipped classroom approach, which involved studying course material at home using video lectures and reading assignments. Class time was dedicated to interactive activities, discussions, and practical applications of the content. Conversely, the control group was taught using a traditional lecture-based method, where content was delivered during class, and students completed assignments individually outside of class.

Posttest: At the conclusion of the intervention, both groups took the TOEFL and IELTS tests again as posttests. Additionally, the achievement test tailored to the instructional content was administered to measure the language skills developed during the intervention.

Questionnaire Administration: After the posttests, the flipped learning questionnaire was administered to the experimental group to evaluate their views on the flipped classroom approach. This questionnaire provided insights into students' motivation, interest, and perceived effectiveness of the flipped learning model.

4.5. Statistical Analysis

In order to analyze the data to answer the first research question which asked about the impact of the flipped classroom approach on engineering students' language achievement, one-way analysis of covariance (ANCOVA) was conducted using SPSS Software Version 24. Before performing ANCOVA, the assumptions of linearity, homogeneity of variances, and homogeneity of regression slopes were checked. In addition, to explore the engineering students' views towards the flipped classroom approach,

the results of the flipped learning questionnaire were analyzed through both descriptive statistics i.e., frequency, percentage, and inferential statistics i.e., one sample t-test.

5. Results

To examine the impact of the flipped classroom approach on engineering students' language achievement, analysis of Covariance was applied. Table 1 contains the results of checking the assumption of linear relationship between the dependent variable (posttest of language achievement) and the covariates (pretest of language achievement). As seen in Table 1, the linear relationship between posttest of language achievement and the covariate of language achievement was significant, $F = 26.62$, $p = 0.000$, therefore the linearity assumption was met.

Table 1

Linear Relationship between the Posttest and Covariate of Language Achievement

		Sum of Squares	df	Mean Square	F	Sig.
Between Groups	(Combined)	32.652	11	2.968	3.216	0.006
	Linearity	24.578	1	24.578	26.625	0.000
	Deviation from Linearity	8.074	10	0.807	0.875	0.567
Within Groups		25.848	28	0.923		
Total		58.500	39			

Table 2 reflects that the significant value associated with Levene's test (0.84) exceeded the selected significant level (0.05) and so the homogeneity of variance assumption was not violated for language achievement scores in the two groups.

Table 2

Levene's Test of Equality of Error Variances

Levene Statistic	df1	df2	Sig.
.039	1	38	0.844

Homogeneity of regression slopes is the fourth assumption. According to the results manifested in Table 3, the significance level of the interaction (Group Pretest) between group and the pretest of total language achievement was greater than 0.05, $F(1, 36) = 0.50$, $p = 0.82$, and therefore not statistically significant showing that the pretest and posttest of language achievement scores in the two groups met the assumption of homogeneity of regression slopes.

Table 3

Homogeneity Test of Regression Slopes

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	31.504	3	10.501	14.004	.000	0.539
Intercept	43.796	1	43.796	58.403	0.000	0.619
Group Pretest	0.037	1	0.037	0.050	0.825	0.001
Error	26.996	36	0.750			
Total	11961.000	40				
Corrected Total	58.500	39				

Since all assumptions were met, the researchers decided to employ one-way ANCOVA to investigate the effectiveness of flipped classroom approach on language achievement. The independent variable is type of teaching language achievement approach (flipped classroom or conventional approach), and the dependent variable is language achievement. Participants' scores on the pretest of language achievement are used as the covariate in this analysis.

Table 4 reports the mean, standard deviation, and standard error of means for the scores in the experimental and control groups. Table 4 and Figure 1 show that the mean of language achievement in the experimental group ($M = 13.17$, $SD = 1.57$) and control group ($M = 12.75$, $SD = 1.37$) are close to each other on the pretest.

Table 4

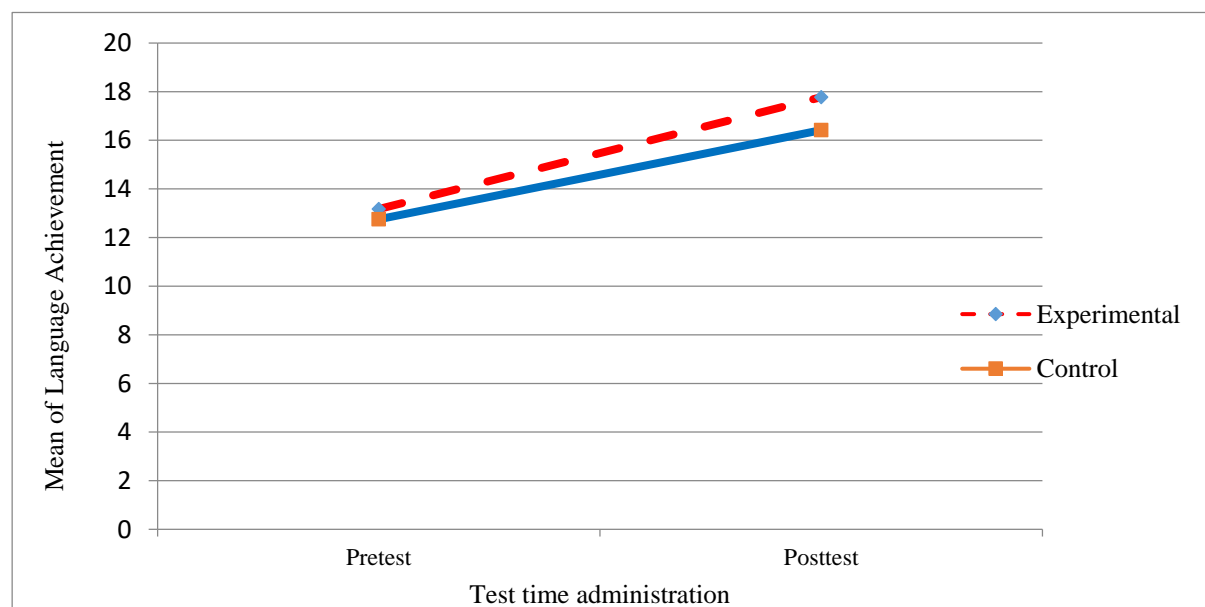
Descriptive Statistics of Language Achievement Scores on Pretest and Posttest by Group

Test	Group	N	M	SD	SEM
Pretest	Experimental	20	13.17	1.57	0.352
	Control	20	12.75	1.37	0.306
Posttest	Experimental	20	17.77	1.14	0.255
	Control	20	16.42	1.10	0.244

However, as shown in Table 4 and Figure 1, on the posttest, the mean of language achievement in the experimental group ($M = 17.77$, $SD = 1.14$) is much higher than the mean in the Control group ($M = 16.42$, $SD = 1.10$) on the posttest.

Figure 1

Line Chart for Two Groups' Means of Language Achievement (Pretest & Posttest)



The results of ANCOVA are provided in Table 5. After adjusting for the language achievement scores on the pretest, there was a significant difference between the two groups' language achievement scores on the posttest, $F(1, 37) = 13.31$, $p = 0.001$ ($\eta^2 = 0.28$); Thus, it can be inferred that implementing

flipped classroom approach is more effective than the conventional approach to boost ESP learners' language achievement.

Additionally, as it's observable in Table 5, there was seen a strong relationship between the pre-intervention and post-intervention scores on the total language achievement, as shown by a p value of 0.000, $F(1, 37) = 3346$ denoting that the language achievement scores gained on the pretest affected the language achievement scores gained on the posttest. Also, Table 5 indicates that the partial eta squared (effect size) value is 0.47.

Table 5

Tests of Between Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	40.962	2	20.481	30.146	0.000	0.620
Intercept	51.806	1	51.806	76.253	0.000	0.673
Pretest	22.737	1	22.737	33.467	0.000	0.475
Group	12.439	1	12.439	13.309	0.001	0.281
Error	25.138	37	.679			
Total	11762.500	40				
Corrected Total	66.100	39				

In order to explore the engineering students' views towards the flipped classroom approach, the results of the flipped learning questionnaire were analyzed through one sample t-test. As provided in Table 6, one sample t-test was significant for both total motivation and interest for flipped learning, $t = 4.96$, $p < 0.001$, $M = 3.90$, and total effectiveness of flipped learning, $t = 4.84$, $p < 0.001$, $M = 3.75$, implying that the students are highly motivated and interested in flipped learning, and they unanimously believe that flipped learning is effective to learn a foreign language.

More specifically, Table 6 shows that concerning motivation and interest for flipped learning section, Item 1 "Flipped classroom can improve interest in exploring topics," (Strongly agree/Agree: 18/20, 90%, $M = 4.10$, $p = 0.000$) was the most attractive item chosen by most of the students, followed by Item 3 "I feel more confident about my learning due to the flipped instruction," (Strongly agree/Agree: 17/20, 85%, $M = 4.10$, $p = 0.000$), Item 5 "I feel more motivated in a flipped classroom," (Strongly agree/Agree: 15/20, 75%, $M = 3.95$, $p = 0.002$), Item 2 "Flipped classroom can improve interest in knowledge construction," (Strongly agree/Agree: 15/20, 75%, $M = 3.70$, $p = 0.005$), and then Item 4 "Flipped classroom attracts my attention to learning and teaching process," (Strongly agree/Agree: 12/20, 60%, $M = 3.65$, $p = 0.01$) as the least chosen item.

Table 6*Frequencies and Percentages for the Participants' Responses to the Motivation and Effectiveness of Flipped Learning*

Motivation and interest for flipped learning	D	N	A	M	SD	t	Sig.
1. Flipped classroom can improve interest in exploring topics.	2	10%	0 0%	18 90%	4.10	0.85	5.77 0.000
2. Flipped classroom can improve interest in knowledge construction.	4	20%	1 5%	15 75%	3.70	0.97	3.19 0.005
3. I feel more confident about my learning due to the flipped instruction.	2	10%	1 5%	17 85%	4.10	1.07	4.59 0.000
4. Flipped classroom attracts my attention to learning and teaching process.	2	10%	6 30%	12 60%	3.65	1.04	2.79 0.012
5. I feel more motivated in a flipped classroom.	3	15%	2 10%	15 75%	3.95	1.19	3.56 0.002
TOTAL Motivation and interest for flipped learning					3.90	0.83	4.96 .000
Effectiveness of flipped learning	D	N	A	M	SD	t	Sig.
6. With flipped instruction I have to do more work out of the classroom.	1	5%	0 0%	19 95%	4.20	0.69	7.71 0.000
7. With flipped classroom model I am more prepared for my learning.	3	15%	1 5%	16 80%	3.80	1.05	3.38 0.003
8. Flipped classroom gives me the opportunity to ask more questions inside the classroom.	6	30%	5 25%	9 45%	3.20	1.36	0.65 0.519
9. I think flipped classroom guides me towards a better understanding of the lesson content.	8	40%	2 10%	10 50%	3.35	1.49	1.04 0.309
10. Flipped classroom learning has reduced my dependency on teachers.	2	10%	3 15%	15 75%	3.95	0.94	4.49 0.000
11. I can learn more in the flipped classroom.	3	15%	3 15%	14 70%	3.65	1.04	2.79 0.012
12. I believe that I am able to learn materials with flipped classroom instruction better than with traditional lecture based instruction.	4	20%	3 15%	13 65%	3.60	1.14	2.34 0.030
13. My performance on English tests is better with flipped classroom.	1	5%	2 10%	17 85%	4.20	0.83	6.43 0.000
14. A flipped classroom in is a better way of learning income prison with traditional classroom.	5	25%	1 5%	14 70%	3.65	1.22	2.37 0.028
15. The flipped classroom is more engaging than traditional classroom instruction.	3	15%	3 15%	14 70%	3.90	1.07	3.75 0.001
TOTAL Effectiveness of flipped learning					3.75	0.67	4.84 0.000

Also, as listed in Table 6, regarding effectiveness of flipped learning section of the questionnaire, the results indicated that Item 6 “With flipped instruction I have to do more work out of the classroom,” (Strongly agree/Agree: 19/20, 95%, $M = 4.20$, $p = 0.000$) was the most attractive item chosen by most of the students, followed by Item 13 “My performance on English tests is better with flipped classroom,” (Strongly agree/Agree: 17/20, 85%, $M = 4.20$, $p = 0.000$) as the second accepted item, and then Item 10 “Flipped classroom learning has reduced my dependency on teachers,” (Strongly agree/Agree: 15/20, 75%, $M = 3.95$, $p = 0.000$) as the third attractive item. In addition, Table 6 shows that Item 8 “Flipped classroom gives me the opportunity to ask more questions inside the classroom,”

(Strongly agree/Agree: 9/20, 45%, $M = 3.20$, $p = 0.52$) was the least preferred item followed by item 9 “I think flipped classroom guides me towards a better understanding of the lesson content,” (Strongly agree/Agree: 10/20, 50%, $M = 3.35$, $p = 0.31$).

Table 7

Tests of Between-Subjects Effects on Speaking Ability

Source	Types III Sum of Squares	df	Means Square	F	Sigs.	Partial Eta Squared
Corrected Models	148.156	2	74.078	100.950	0.000	0.780
Intercepts	4.837	1	4.837	6.592	0.013	0.104
Pre-test	117.339	1	117.339	159.904	0.000	0.737
Groups	17.791	1	17.791	24.244	0.000	0.298
Errors	41.827	57	.734			
Totals	13126.000	60				
Corrected Totals	189.983	59				

Also, as listed in Table 6, regarding effectiveness of flipped learning section of the questionnaire, the results indicated that Item 6 “With flipped instruction I have to do more work out of the classroom,” (Strongly agree/Agree: 19/20, 95%, $M = 4.20$, $p = 0.000$) was the most attractive item chosen by most of the students, followed by Item 13 “My performance on English tests is better with flipped classroom,” (Strongly agree/Agree: 17/20, 85%, $M = 4.20$, $p = 0.000$) as the second accepted item, and then Item 10 “Flipped classroom learning has reduced my dependency on teachers,” (Strongly agree/Agree: 15/20, 75%, $M = 3.95$, $p = 0.000$) as the third attractive item. In addition, Table 6 shows that Item 8 “Flipped classroom gives me the opportunity to ask more questions inside the classroom,” (Strongly agree/Agree: 9/20, 45%, $M = 3.20$, $p = 0.52$) was the least preferred item followed by item 9 “I think flipped classroom guides me towards a better understanding of the lesson content,” (Strongly agree/Agree: 10/20, 50%, $M = 3.35$, $p = 0.31$).

6. Discussion

This study aimed to assess the impact of the flipped classroom approach on engineering students’ language achievement in an English for Specific Purposes (ESP) context and to explore their perceptions of this pedagogical method. The findings offer valuable insights into the effectiveness of the flipped classroom model in enhancing language learning outcomes and student motivation in technical disciplines. However, it is essential to consider the potential limitations and contextual factors that may influence the implementation and effectiveness of this approach.

6.1. Impact of the Flipped Classroom Approach on Language Achievement

The analysis revealed that the flipped classroom approach significantly improved language achievement compared to traditional teaching methods. The ANCOVA results indicated that after controlling for pretest scores, the experimental group, which experienced the flipped classroom, achieved notably higher mean scores on the posttest compared to the control group receiving conventional instruction. These findings align with previous research that highlights the benefits of the flipped classroom in enhancing academic performance (Sams & Bergmann, 2023; Chen et al., 2014; Zainuddin & Halili, 2022).

The observed effect size, with a partial eta squared value of 0.28, suggests a moderate to large impact of the flipped classroom approach. This supports constructivist learning theories, which emphasize the role of active learning and student engagement in academic success (Lage et al., 2000; Bishop & Verleger, 2013). By allowing students to engage with instructional content at their own pace and participate in interactive activities during class, the flipped classroom model aligns with these theoretical perspectives. This is consistent with Shyr and Chen's (2018) findings that students in flipped classroom settings exhibited enhanced language proficiency and a deeper understanding of linguistic structures. Nonetheless, it is important to recognize potential discrepancies in the literature regarding the effectiveness of the flipped classroom approach. For example, Wang and Wang (2023) reported minimal differences between flipped and traditional classrooms. Such variations may arise from differences in implementation, student characteristics, or contextual factors. The current study, focusing on ESP learners, suggests that the flipped classroom model is particularly effective in specialized contexts, addressing the unique needs of technical students. However, generalizing these results to broader contexts should be approached with caution.

6.2. Engineering Students' Views on the Flipped Classroom Approach

The study also explored engineering students' perceptions of the flipped classroom approach. Analysis using a one-sample t-test revealed that the flipped classroom significantly enhanced students' motivation and interest. The statistically significant mean scores for motivation and perceived effectiveness support the Self-Determination Theory, which posits that environments fostering autonomy, competence, and relatedness enhance intrinsic motivation (Deci & Ryan, 2000). The flipped classroom's structure, which promotes student control over learning and active participation, appears to fulfill these psychological needs, thereby increasing motivation. These findings resonate with other research indicating that flipped classrooms can boost student engagement and motivation (Zainuddin & Attaran, 2016; Lo & Hew, 2017; Yildirim, 2017). The student-centered nature of the flipped classroom fosters critical thinking and collaboration, which are crucial for language acquisition and particularly beneficial in technical fields. Nevertheless, the positive impact on students' attitudes toward learning should be considered within the specific context of engineering education.

6.3. Implications and Contributions to the Field

The results of this study contribute significantly to the field of language education, particularly within the ESP context for engineering students. The evidence supports the flipped classroom approach as an effective method for improving language achievement and motivation among technical students, aligning with and extending previous research on flipped learning (Sun et al., 2018; Hao, 2016). This study highlights the potential of flipped classrooms to meet the specialized needs of students in technical disciplines. However, it is crucial to consider the limitations and contextual factors influencing the implementation of the flipped classroom model. The effectiveness of this approach may depend on factors such as student preparedness, the subject matter, and the quality of instructional design (Strayer, 2012; Abeysekera & Dawson, 2015). Therefore, educators should carefully plan and adapt the flipped classroom model to fit their specific educational contexts and student needs. In conclusion, the study supports the notion that the flipped classroom model is a promising pedagogical approach for enhancing language achievement and motivation in specialized contexts such as ESP. The observed improvements in language skills and student motivation advocate for broader implementation of flipped learning in higher education, particularly in disciplines requiring strong language proficiency and active

engagement. As the demand for technical and professional skills increases, innovative teaching methods like the flipped classroom will be essential in preparing students to navigate a rapidly evolving world.

7. Conclusions and Implications

This study has provided significant insights into the impact of the flipped classroom model on the language proficiency and motivation of engineering students learning English for Specific Purposes (ESP). The results indicated that the flipped classroom approach significantly enhances language acquisition compared to traditional teaching methods, as evidenced by higher post-test scores in the experimental group. Additionally, the findings revealed that students in the flipped classroom reported greater motivation and engagement, suggesting that this pedagogical model effectively fosters a more interactive and student-centered learning environment.

The importance of this study lies in its contribution to the existing body of knowledge on the efficacy of innovative teaching methodologies in ESP contexts. By focusing on engineering students, this research highlights the potential of the flipped classroom model to address the specific learning needs of this demographic, who often require targeted language skills relevant to their field. This study underscores the utility of the flipped classroom in not only improving linguistic competencies but also in promoting autonomous learning habits and increasing student engagement—critical factors for academic success in technical disciplines.

Despite the growing body of literature on the flipped classroom approach, there remains a paucity of research specifically examining its impact on ESP learners, particularly within technical disciplines such as engineering. Previous studies have predominantly focused on general English learners or those in humanities and social sciences, leaving a gap in understanding how such pedagogical models influence learners with specific professional language needs. This study addresses this gap by providing empirical evidence of the flipped classroom's effectiveness in an engineering ESP context, thereby laying the groundwork for further exploration into subject-specific language instruction.

While the findings of this study are promising, several limitations must be acknowledged. First, the sample size was relatively small, consisting of only 40 engineering students from a single institution, which limits the generalizability of the results. The study's design also involved a short intervention period, which may not fully capture the long-term impacts of the flipped classroom on language learning outcomes. Additionally, the study relied on self-reported data for measuring student motivation and engagement, which could be subject to response bias. Finally, the study did not account for potential differences in students' prior knowledge and technological proficiency, which could have influenced their experience and outcomes in the flipped classroom.

Future research should aim to address these limitations by expanding the sample size to include a more diverse range of participants from various institutions and disciplines. Longitudinal studies could provide valuable insights into the sustained effects of the flipped classroom model on ESP learning outcomes over time. Moreover, incorporating mixed-method approaches that combine quantitative measures with qualitative data, such as interviews or focus groups, could offer a more comprehensive understanding of student experiences and perceptions. Research should also explore the role of individual differences, such as prior knowledge, learning styles, and technological proficiency, in influencing the effectiveness of the flipped classroom. Furthermore, comparative studies examining the

impact of the flipped classroom across different fields of study and educational levels would be valuable in determining its broader applicability and effectiveness.

In conclusion, this study contributes to the growing evidence supporting the flipped classroom as a viable and effective approach for enhancing language learning in ESP contexts, particularly for students in technical fields. By addressing the specific needs of engineering students, this research not only fills a critical gap in the literature but also provides practical implications for educators seeking to implement innovative teaching methods that promote active learning and student engagement. As educational landscapes continue to evolve, it is imperative that further research continues to explore and validate effective pedagogical strategies that can meet the diverse needs of learners across various contexts.

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Authors' Contributions

All authors have conducted the study, collected data, analyzed and interpreted the data, and written up the manuscript.

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Competing Interests

The authors declare that there is no conflict of interest.

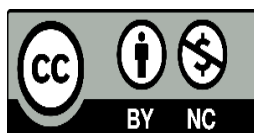
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