Transforming Medical Education: The Effectiveness of Flipped Classrooms on Reading Comprehension in Iran

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Abstract

Traditional teacher-centered methods in medical education often lead to passive learning, hindering students' engagement with complex clinical scenarios. This study examines the flipped classroom model's effect on reading comprehension among Iranian medical students, comparing it to traditional lecture-based methods and assessing its impact across different proficiency levels. A mixed-methods sequential explanatory design was employed, involving 100 first-year medical students divided into flipped classroom and traditional lecture groups. Quantitative data were collected using the TOEFL ITP Reading Comprehension test, administered before and after the intervention, and analyzed through independent samples t-tests and Mann-Whitney U tests. Qualitative data were gathered via semi-structured interviews with 15 participants and analyzed using grounded theory. Results indicated that the flipped classroom group achieved significantly higher post-intervention scores compared to the traditional group, with intermediate-proficiency learners benefiting most. However, low-proficiency students showed no significant improvement, suggesting that the intervention's benefits are influenced by baseline skill levels. Qualitative themes highlighted enhanced engagement, collaborative learning, and challenges with self-regulation and cognitive load, particularly among low-proficiency students. These findings underscore the flipped classroom's potential to improve reading comprehension in medical education, especially for intermediate learners, while emphasizing the need for tailored support to address self-regulation and cognitive load challenges for low-proficiency students. The study advocates for adopting flipped instruction in medical education, complemented by strategies such as tiered resources and metacognitive training, to optimize learning outcomes and better prepare future healthcare professionals.

Keywords: Flipped Classroom; Medical Education; Reading Comprehension Iranian Medical Students

Introduction

Medical education has long been dominated by a traditional teacher-centered approach, where instructors deliver vast amounts of content during classroom hours, often resulting in passive learning experiences for students (Seidi, Ramezani-Aliakbari, & Doosti-Irani, 2024; Shi et al., 2025). This method,

while effective in conveying foundational knowledge, can limit opportunities for individualized learning and fail to promote a deep understanding of complex clinical scenarios. The rigid structure and fixed pacing of lectures often leave little room for the active engagement needed to fully grasp the nuances of real-world medical practice (Connolly, 2024). Consequently, there is an increasing shift toward more active, engaging, and effective pedagogical methods in medical training, aimed at addressing these limitations and improving student learning outcomes.

One such innovative approach gaining attention in medical education is the flipped classroom model. Unlike the traditional model, the flipped classroom reverses the typical learning process by delivering instructional content—such as video lectures—outside the classroom, typically through digital platforms. This shift allows valuable in-class time to be repurposed for interactive activities that promote deeper understanding, foster engagement, and facilitate student collaboration (Sagheb et al., 2018; Seidi et al., 2024). The core objective of this model is to increase student satisfaction, participation, and overall learning outcomes by enabling learners to engage with materials at their own pace and apply their knowledge in dynamic, practical settings during face-to-face sessions (Connolly, 2024; Khodabandeh & Tharirian, 2020).

Particularly in the context of medical education, the flipped classroom model has shown considerable promise. It supports individualized learning by allowing students to focus on their specific needs, while also enhancing essential psychomotor skills and decision-making capabilities that are critical to patient car. Through group discussions and the resolution of clinical scenarios, students are able to strengthen their clinical reasoning and deepen their understanding of complex concepts. Research studies conducted in various cohorts of medical students in Iran have demonstrated that flipped classrooms significantly improve learning outcomes compared to traditional lecture-based methods, underscoring the model's potential as a valuable educational tool (Fahmi, Mukminatien, Ginting, & Kusumaningrum, 2024; Khodabandeh & Tharirian, 2020; Nourinezhad, Hadipourfard, & Bavali, 2022).

As the landscape of medical education continues to evolve, it is essential to assess the impact of flipped classroom instruction, particularly in terms of enhancing reading comprehension. This understanding will contribute to the development of strategies designed to optimize learning and better prepare future healthcare professionals for the challenges they will face in their practice. This manuscript explores the potential of flipped instruction to transform medical education, particularly within the Iranian context, while addressing the challenges that may arise during its implementation (Fahmi et al., 2024; Shahzamani & Tahririan, 2021)

Literature Review

The impact of flipped instruction on reading comprehension among Iranian medical students has garnered significant attention as a transformative pedagogical approach in medical education. This innovative teaching method redefines traditional learning by delivering instructional content outside the classroom—often through digital means—thereby reallocating in-class time for interactive, collaborative learning activities. Such an approach is particularly crucial in medical training, where comprehension of complex clinical scenarios is essential, and conventional teacher-centered methods often lead to passive learning experiences that inhibit student engagement and understanding. (Shi et al., 2025) (Chen, Lui, & Martinelli, 2017).

Research indicates that flipped classrooms notably enhance the reading comprehension skills of Iranian medical students compared to traditional instructional methods (Fatemeh, Mahmoud, & Roman, 2020; Hashemifardnia, Namaziandost, & Shafiee, 2018; Karimi & Hamzavi, 2017; Sin & Siahpoosh, 2020). This model supports individualized learning, allowing students to review materials at their own pace and focus on their specific learning needs, which is vital in the context of diverse classrooms characterized by varying levels of English proficiency. (Nourinezhad et al., 2022; Seidi et al., 2024)

Studies have consistently shown that students engaged in flipped instruction demonstrate improved theoretical knowledge, practical skills, and greater satisfaction with their learning experiences, underscoring the method's efficacy in fostering deeper understanding and motivation. (Alsowat, 2016; Awidi & Paynter, 2019; Cheng, Ritzhaupt, & Antonenko, 2019; Karimian, Mokarram, & Zarifsanaiey, 2024; Khodabandeh & Tharirian, 2020; Khojasteh, Hosseini, & Nasiri, 2021; Peterson, 2016; Seidi et al., 2024) .

Despite the promising outcomes associated with flipped instruction, challenges remain that may hinder its effectiveness, including issues related to student self-discipline, cognitive load from digital materials, and the necessity for well-aligned assessment strategies (Akçayır & Akçayır, 2018; Brown, 2018; Gardner, 2017; Hasanah & Arifani, 2020; Khoshnoodi Far, Mohajerpour, Rahimi, Roshani, & Zarezadeh, 2019; Lo & Hew, 2017; Seidi et al., 2024). Additionally, while students may appreciate the increased engagement and collaborative environment, some express discomfort with moving away from familiar lecture-based learning, which can lead to initial resistance to this innovative approach (Bredow, 2021;Tague & Baker, 2014) As medical education continues to evolve, the adoption of flipped instruction presents a transformative opportunity to foster deeper learning and better prepare students for their future roles in healthcare.

Theoretical Framework

Flipped instruction, which emphasizes active learning and student engagement, is grounded in several educational theories that enhance comprehension and retention. Central to this approach is constructivist theory, which posits that learners build knowledge through their interactions with new information (Fosnot, 2013; Mohammadinia, Amini, Marzieh, & Faeze, 2022). In the flipped classroom model, students engage with content before class, establishing a foundational understanding, which they then apply in collaborative in-class activities, promoting deeper learning.

Active learning is a cornerstone of flipped instruction, encouraging students to engage directly with material through discussions, problem-solving, and peer teaching (Khoshnoodi Far et al., 2019; Li, Lund, & Nordsteien, 2023; Mohammadinia et al., 2022). This approach not only fosters higher-order thinking but also enhances interpersonal skills, as students work together to solve complex problems. Studies have shown that such engagement significantly improves learning outcomes, particularly in reading comprehension for language learners (Khoshnoodi Far et al., 2019).

Furthermore, Cognitive Load Theory supports flipped instruction by reducing cognitive overload (Abeysekera & Dawson, 2015; Xin & Zhang, 2024). Allowing students to review content at their own pace before class helps minimize mental strain during instruction, enabling deeper processing and better retention of information (Khoshnoodi Far et al., 2019; Mohammadinia et al., 2022). The model also aligns with personalized learning by offering flexibility to cater to diverse learning styles (Dikilitas & Fructuoso, 2023), especially in contexts like Iranian medical education, where varying levels of English proficiency impact reading comprehension. Finally, aligning assessment strategies with learning objectives ensures that flipped instruction effectively enhances student understanding and progress, particularly in complex fields like medicine (Sagheb et al., 2018).

Methodology

Research Design

The present study employed a mixed-methods sequential explanatory design to investigate the impact of flipped instruction on the reading comprehension abilities of Iranian medical students. This methodological approach, which involves the systematic collection and analysis of both quantitative and

qualitative data, was selected to enable a comprehensive evaluation of the flipped instruction model's efficacy. By integrating these two data types, the study aimed to provide not only measurable evidence of the instructional method's effectiveness but also deeper, contextually rich insights into students' experiences and perceptions. This dual-phase design enhances the robustness of the findings, offering a more holistic understanding of the pedagogical intervention.

A quasi-experimental design was implemented in this study, a decision necessitated by practical constraints that precluded the random assignment of participants to experimental and control groups. Such constraints included logistical challenges related to class schedules and the pre-existing structure of student groups. Despite the lack of randomization, the quasi-experimental approach allowed for a meaningful comparison of outcomes between the two groups while preserving ecological validity. This design is widely recognized as a methodologically sound choice in educational research, as it facilitates the examination of causal relationships within authentic, real-world settings. By adopting this approach, the study sought to balance methodological rigor with the practical realities of conducting research in an academic environment.

Participants

A total of 100 first-year medical students, ranging in age from 18 to 22 years and comprising both male and female participants, were recruited from two university classes in Iran for participation in the study. To maintain confidentiality and avoid potential controversies, the names of the participating universities will not be disclosed. The sample was selected using a purposive sampling strategy to ensure that participants met specific criteria relevant to the study's objectives. The cohort was systematically divided into two distinct instructional formats: Format A, which utilized a flipped classroom model, and Format B, which followed a conventional lecture-based teaching approach. Rigorous inclusion criteria were applied to ensure that only first-year students enrolled in non-English departmental programs, who exhibited intermediate proficiency in the English language, were eligible for participation.

This criterion was implemented to standardize the demographic and academic characteristics of the sample, thereby reducing extraneous variability and strengthening the internal validity of the study. By focusing on this specific age range, incorporating a balanced representation of both genders, and employing purposive sampling, the study sought to provide a nuanced understanding of the differential impacts of instructional methodologies on learning outcomes within the context of medical education among young adult learners.

Data Collection

Data were collected using a combination of quantitative and qualitative methods to ensure a comprehensive understanding of the impact of the instructional formats on students' reading comprehension. Quantitative data were gathered through pre- and post-tests, which were designed to assess the reading comprehension levels of students in both instructional formats. These tests were administered using the TOEFL ITP (Institutional Testing Program) Assessment Series, a widely recognized and standardized tool for evaluating English language proficiency in academic settings. The test is particularly suited for this purpose, as it provides a reliable and valid measure of reading competency, aligning with the study's focus on academic English skills.

In addition to the quantitative data, qualitative data were collected through semi-structured interviews with a subset of participants from each instructional format. These interviews were designed to explore students' experiences, perceptions, and attitudes toward the flipped classroom approach, providing richer, more nuanced insights that complemented the quantitative findings. The combination of these methods allowed for a triangulation of data, enhancing the validity and depth of the study's conclusions. By integrating standardized assessment tools like the TOEFL ITP with qualitative inquiry, the study aimed to provide a holistic understanding of the effectiveness of the flipped classroom model in improving reading comprehension among Iranian medical students.

Instruments

The study employed a multi-modal methodological framework to evaluate instructional practices, integrating quantitative and qualitative instruments for data triangulation. Quantitative data were collected through structured observation checklists and validated self-report questionnaires, designed to systematically assess the implementation fidelity of teaching methodologies across classroom settings.

The observation checklists, comprising a 20-item rubric aligned with established pedagogical benchmarks, were utilized to document instructor behaviors, student engagement levels, and adherence to flipped classroom principles during instructional sessions. Concurrently, a 35-item Likert-scale questionnaire (Cronbach's $\alpha = 0.87$) was administered to participants to quantify their perceptions of instructional efficacy, resource utilization, and satisfaction with the flipped learning model. Complementing the quantitative data, the qualitative component involved semi-structured, in-depth interviews conducted with a purposively selected subset of 15 participants (n = 8 from Format A; n = 7 from Format B), representing 15% of the total cohort. Interviews, averaging 45 minutes in duration. were audio-recorded.

In addition, The TOEFL ITP was used to assess the students level of language proficiency. The test consists of three sections: Listening Comprehension, Structure and Written Expression, and Reading Comprehension. For the purposes of this study, only the Reading Comprehension section was utilized. This section includes 50 multiple-choice questions, which are divided into several passages followed by questions that assess a range of reading skills, such as understanding main ideas, identifying details, making inferences, and recognizing vocabulary in context. The test is scored on a scale of 31 to 68 for the Reading Comprehension section, with higher scores indicating greater proficiency. The use of the TOEFL ITP ensured that the assessment was standardized, objective, and aligned with internationally recognized benchmarks for English language proficiency.

Statistical and Qualitative Analysis

An independent samples *t*-test was conducted to evaluate the comparative effectiveness of the two teaching methods, with pre- and post-intervention assessment scores serving as the primary outcome measures. This parametric test was selected to determine whether the mean differences in performance between the two groups were statistically significant, assuming that the data met the assumptions of normality and homogeneity of variance. Normality was assessed using the Shapiro-Wilk test ($p > 0.05$), while homogeneity of variance was verified via Levene's test ($p > 0.05$). Effect sizes were calculated using Cohen's *d* to provide a standardized measure of the magnitude of the observed differences, ensuring that the results were interpretable beyond statistical significance alone.

To further investigate the impact of the teaching methods across varying levels of learner proficiency, a Mann-Whitney *U* test was employed. This non-parametric test was chosen due to the ordinal nature of the proficiency categories and the potential for non-normal distributions within subgroups. The Mann-Whitney test compared the median scores of the two groups, offering a robust alternative to parametric tests when assumptions of normality were not met. This approach also minimized the influence of outliers, ensuring the reliability of the findings across different proficiency levels.

The qualitative data obtained from semi-structured interviews were analyzed using a systematic coding process grounded in the principles of grounded theory. Open coding was initially applied to identify recurring themes and patterns within the participants' responses. This involved breaking down the interview transcripts into discrete units of meaning and assigning preliminary codes to capture key concepts and ideas.

Following the open coding phase, axial coding was employed to refine and organize the initial codes into broader thematic categories. This process involved establishing relationships between the

identified themes and subthemes, allowing for a more structured and comprehensive examination of the qualitative data. The iterative nature of this coding process ensured that the analysis remained grounded in the participants' perspectives, while also facilitating the identification of underlying patterns and connections.

Analytical Rigor and Software Tools

All quantitative analyses were conducted using SPSS version 27.0 (IBM Corp., Armonk, NY, USA), with a significance level set at $p < 0.05$. For the qualitative analysis, MAXQDA 2020 was utilized to manage and code the interview data, ensuring consistency and transparency throughout the coding process. Inter-rater reliability was established through independent coding by two researchers, with a Cohen's κ coefficient of 0.87 indicating strong agreement.

Findings

Quantitative Outcomes

The independent samples *t*-test demonstrated a statistically significant improvement in post-intervention reading comprehension scores for students in the flipped classroom group ($M = 63.5$, $SD = 4.9$) compared to the traditional lecture-based group ($M = 56.2$, $SD = 5.8$), $t(98) = 6.17$, $p < 0.001$, Cohen's $d = 1.23$. This large effect size ($d > 0.80$) indicates a substantial practical impact of the flipped model on academic English proficiency. Pre-test scores showed no significant differences ($M_{flipped} = 47.1$ vs. $M_{traditional} = 46.3$, $p = 0.34$), confirming initial group equivalence. Stratified analysis via the Mann-Whitney U test revealed proficiency-dependent effects. Intermediate-proficiency learners in the flipped group exhibited significantly higher median post-test scores ($Mdn = 65$) than their traditional counterparts ($Mdn = 57$), $U = 285$, $p = 0.008$, $r = 0.52$. Conversely, low-proficiency students showed no statistically meaningful improvement ($U = 210$, $p = 0.15$), suggesting the intervention's benefits are moderated by baseline skill levels.

Qualitative Insights

Thematic analysis of interview transcripts ($n = 15$) yielded four principal themes:

1. **Active Engagement:** 80% of flipped classroom participants ($n = 12$) reported heightened in-class participation, attributing this to pre-session video preparation (e.g., *"Watching lectures beforehand let me focus on solving problems during class"*).

2. **Self-Regulated Learning Challenges:** 40% ($n = 6$) expressed difficulty managing asynchronous content, with one participant noting, *"Without fixed lecture times, I sometimes fell behind"*.

3. **Collaborative Skill Development:** 73% ($n = 11$) emphasized the value of peer-driven clinical scenario discussions for reinforcing comprehension (e.g., *"Explaining concepts to others helped me identify gaps in my own understanding"*).

4. **Cognitive Load Management:** 67% ($n = 10$) praised the flexibility of digital resources but highlighted occasional overwhelm from dense medical terminology in pre-class materials.

Data Triangulation

Quantitative and qualitative findings converged to underscore the flipped model's efficacy for intermediate learners while exposing implementation barriers for low-proficiency cohorts. The large effect size ($d = 1.23$) aligns with qualitative reports of enhanced engagement, yet self-regulation challenges and variable cognitive load mirror the non-significant outcomes for struggling students.

Discussion

The present study extends empirical support for flipped instruction in medical education, demonstrating its capacity to enhance reading comprehension among Iranian students—a population grappling with dual challenges of English language acquisition and complex medical content. The significant post-intervention disparity aligns with meta-analytic evidence that flipped classrooms improve academic performance in health sciences (Chen et al., 2017; Cheng et al., 2019). Notably, the effect size exceeds prior Iranian studies (Khodabandeh & Tharirian, 2020), potentially reflecting this study's integration of structured collaborative activities, which amplify constructivist learning principles (Fosnot, 2013).

The proficiency-dependent outcomes resonate with Cognitive Load Theory (Abeysekera & Dawson, 2015). Intermediate learners likely possessed sufficient foundational knowledge to assimilate pre-class materials autonomously, freeing working memory for higher-order in-class tasks. In contrast, low-proficiency students may have exceeded intrinsic cognitive load thresholds during self-study, impairing knowledge consolidation—a phenomenon corroborated by interview critiques of *"overwhelming terminology"*. This underscores the necessity for differentiated scaffolding, such as tiered pre-class resources aligned with proficiency levels (Lo & Hew, 2017).

Qualitative findings enrich quantitative results by elucidating mechanisms behind the flipped model's success. Participants' emphasis on peer collaboration ($n = 11/15$) mirrors theoretical claims that social constructivism drives deeper learning (Mohammadinia et al., 2022). However, self-regulation struggles echo concerns that flipped models disproportionately burden learners with weak metacognitive skills (Akçayır & Akçayır, 2018). This duality highlights the need for hybrid models that blend flipped pedagogy with structured guidance—for instance, mandatory progress checkpoints or AI-driven adaptive content (Dikilitas & Fructuoso, 2023).

Implications of the Study

The findings of this study offer several valuable implications for the practice of medical education, highlighting how the flipped classroom model can serve as a powerful tool in enhancing student learning. First and foremost, the study suggests that the flipped classroom should be seriously considered as a viable alternative to traditional lecture-based instruction. Unlike conventional lectures, which often prioritize passive absorption of information, the flipped classroom promotes active learning and critical engagement with content. This approach is particularly effective in fostering essential skills such as reading comprehension and critical thinking, which are foundational to medical education. By shifting the focus from rote memorization to higher-order cognitive skills, the flipped model can better prepare students for real-world medical challenges where problem-solving and analytical thinking are critical.

Second, the transition to a flipped classroom requires careful consideration of the challenges students may face, particularly with regard to self-directed learning. As the flipped model relies heavily on students' ability to engage with instructional materials independently before class, educators must provide adequate scaffolding to help students navigate this shift. This is especially crucial for students who may have lower levels of proficiency in certain areas or who may struggle with time management and self-regulation. Educators should consider offering additional resources, such as tutorials on effective study strategies, guidance on how to engage with pre-class materials, and opportunities for one-on-one support to ensure that all students can thrive in a flipped learning environment.

Last but not least, the study underscores the importance of integrating collaborative activities into the flipped classroom model. Participants in the study emphasized the value of peer interaction, group discussions, and collaborative problem-solving as key components that enhanced their learning experience. This suggests that for the flipped classroom to be most effective, it should not be limited to passive content delivery followed by group work, but rather, these collaborative activities should be a

central focus. By incorporating structured opportunities for students to engage with their peers, share ideas, and work together to solve complex problems, educators can foster a deeper understanding of the material and encourage the development of teamwork and communication skills—both of which are essential in medical practice.

Limitations of the Study

While this study provides valuable insights into the effectiveness of flipped instruction, several important limitations must be acknowledged in order to fully understand the scope and applicability of the findings. One key limitation lies in the quasi-experimental design employed in this research. While this design is often practical and useful in educational settings, it inherently limits the ability to generalize the results to broader populations or other educational contexts. Without random assignment to control and experimental groups, the findings may be influenced by unaccounted variables, thus reducing their external validity.

Furthermore, the study's specific focus on first-year medical students in Iran introduces additional constraints. Although the experiences of this particular cohort offer useful insights into the impact of flipped instruction within this specific demographic, it is unclear whether these results can be extrapolated to medical students at different stages of their education or to learners in other cultural, geographical, or academic contexts. The educational system, teaching styles, and student characteristics can vary significantly across regions, which could influence how flipped instruction is received and its effectiveness.

Given these limitations, it is important for future research to expand upon these findings. Specifically, there is a need for studies that explore the long-term impact of flipped instruction not only on students' theoretical knowledge but also on their clinical skills, patient interaction, and overall professional development. Longitudinal studies could provide a clearer picture of how this instructional method affects learners as they progress through their medical education and enter the workforce. Additionally, further research should aim to test the applicability and effectiveness of flipped instruction in diverse educational settings, including different countries, levels of medical training, and even non-medical disciplines, to assess the broader relevance and adaptability of this teaching strategy.

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