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Using Flipped Learning with Self-Regulated Learning Strategies to Develop Argumentative Writing

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Abstract

This quasi-experimental study investigated the effectiveness of integrating flipped learning (FL) with self-regulated learning strategies (SRL) to enhance medical students' argumentative writing (AW) skills. Participants included 240 senior medical students with intermediate English proficiency from an Iranian university, divided into an experimental group (FL with SRL, n = 120) and a control group (FL without SRL, n = 120). Over one semester, using Zimmerman's SRL model, the intervention aimed to develop students' AW skills through a structured FL approach. Results showed significant improvements in AW skills for both groups ($p < 0.001$), but the experimental group exhibited greater gains ($t = 6.22$, $p < 0.001$). The study also examined the impacts on the claim and qualifier elements, as per the Toulmin model, revealing differential improvements, with qualifiers showing larger gains ($p < 0.001$). The SRL intervention significantly enhanced students' self-reported SRL skills, particularly in motivation, planning, learning assessment, and self-directedness ($p < 0.001$). Overall, the findings offer insights into optimizing FL with SRL for AW development in medical education.

***Keywords*:** Flipped Learning, Self-Regulated Learning, Argumentative Writing, Medical Students, English for Specific Purposes

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INTRODUCTION

Flipped learning (FL) has been increasingly examined across various fields, with growing evidence suggesting positive influences on students' learning outcomes, motivation, and engagement (Liu et al., 2019). However, challenges in FL implementation—such as lack of prompt feedback, inadequate course structure, insufficient self-discipline, poor video quality, and time constraints—highlight the need for future research to prepare students for out-of-class lessons and provide resources to boost motivation and self-regulation (Al-Samarraie et al., 2020). Yoon et al. (2021) note that FL involves minimal instructor-student interaction during pre-class material review, requiring students to self-regulate their learning objectives. This underscores the recursive SRL process, where students set goals that closely link FL and SRL techniques. Additionally, students use SRL strategies to manage the location, timing, and method of studying outside class, especially in online environments (Van Alten et al., 2021). Zimmerman (2008) defined SRL as a comprehensive approach encompassing the cognitive, metacognitive, motivational, behavioral, and affective dimensions of learning. Students regarded SRL as a proactive strategy to enhance their academic abilities.

There has been limited investigation into the potential use of FL to enhance students' SRL skills, despite previous studies suggesting that engaging learners in the learning process through SRL solutions and FL classes could have a positive impact on students' self-regulation skills and competencies (Silverajah et al., 2022; Zheng et al., 2020; Zheng & Zhang, 2020). This means that discussions about including these tactics in the FL process in EFL classes were still rare. In line with the aim of this study, students in flipped classrooms had to assume responsibility for their learning before their in-class sessions. Considering this, it was advised that they enter the FL with highly developed SRL skills (Öztürk & Çakıroğlu, 2021). Moreover, according to Pionera et al. (2020), developing SRL skills enables students to communicate with peers through collaboration in writing,

particularly when debating and revising their drafts with peers. In other words, according to Zimmerman and Risemberg (1997), there were correlations between self-regulation and writing improvement, as writing was self-planned, self-initiated, and self-sustained. However, writing was frequently regarded as the most challenging of all linguistic abilities, specifically in EFL contexts (Sun & Wang, 2020). Students can engage in writing exercises and develop their communication skills differently by applying social media in a digital setting during out-of-class activities.

Purpose of the Study

Panadero's (2017) review of SRL models highlights two important findings: first, the SRL model provides a structured framework that supports both research and student training, and second, its effectiveness can vary depending on the developmental stage of students. Building on these insights, this study aimed to investigate the potential impact of SRL strategies on the Argumentative Writing (AW) achievement of English for Specific Purposes (ESP) students. Specifically, it compared the AW performance of students who applied SRL strategies with those who did not, thereby examining how incorporating SRL techniques might enhance writing outcomes. The study also emphasized the significant role of digital platforms and social media in fostering active learning and engagement in writing practices. Given the relatively limited research on integrating SRL within FL environments to address the specific challenges of AW, this study addressed a crucial gap in the field. By exploring this intersection, the research provides valuable insights for ESP teachers and students, aiming to optimize writing instruction through self-regulation techniques and flipped classroom practices.

Research Questions

To address the literature review gap, the present study addressed the following questions:

1. What is the statistically significant difference between medical students'

AW improvement in FL classrooms with and without SRL strategies?
2. Do FL classrooms with and without SRL strategies have different developmental effects on using claims and qualifiers in medical students' AW based on the Toulmin argumentative model?
3. Does writing with SRL strategies enhance the self-reported SRL skills of medical students?

LITERATURE REVIEW

Flipped Learning in EFL/ESP Contexts

This study examined how FL with and without SRL impacts students' AW proficiency, which ESP students often find tedious and challenging (Huang et al., 2023). Foreign language writing instructors should consider the challenges when students have limited opportunities to use the target language. Teachers should be encouraged to modify their teaching methods to reduce challenges and create more enjoyable, motivating, and independent classes. This issue could be addressed by incorporating technology into the classroom (Purcell et al., 2013). In addition to managing students' outside-class activities, specialized writing systems, such as those offering instructional support through automated evaluation and feedback, provide writers with a certain amount of support in digital writing environments (Yeganeh et al., 2025). Iskandar (2020) argued that using multimodal technology for writing instruction broadens the range of teaching strategies by leveraging digital platforms such as Facebook, X (formerly Twitter), Instagram, Telegram, and WhatsApp, which are frequently used for communication, thereby promoting the emergence of new writing styles and genres related to digital literacy. For instance, positive attitudes toward social media usage in ESL writing were revealed in Malaysia. This study found that social media was the most effective medium for students to develop their English writing skills (Wil et al., 2019).

Furthermore, to highlight the crucial significance of digital environments in enhancing students' ability to write persuasive arguments

through FL techniques, Al-Naabi (2020) analyzed the influence of the flipped classroom approach on the grammatical skills of EFL pupils, utilizing digital resources. As Al-Naabi (2020) stated, the flipped classroom has been recognized as a highly effective approach for teaching EFL in the context of contemporary educational methods. Furthermore, the pupils reported favorable views of the flipped method. Although FL has been extensively studied and shown to positively impact various educational elements, there is still limited research on combining FL with SRL tactics to enhance students' AW skills. Despite evidence supporting the effectiveness of FL in academic settings, AW remains challenging for many students at the educational level (Ekmekci, 2017). Prior studies have highlighted the challenges associated with FL, including the lack of timely feedback, inadequate course organization, and time constraints. This indicates the need for additional investigation to better prepare students for activities outside of class and provide them with resources to enhance motivation and self-regulation.

Integration of Self-Regulated Learning in Flipped Classrooms

The integration of self-regulated learning (SRL) into flipped classrooms has emerged as a promising approach to address limitations in traditional flipped models, such as uneven student preparation and varying levels of autonomy during pre-class activities. Drawing on Zimmerman (2008) cyclical model, which encompasses forethought, performance, and self-reflection phases, researchers have embedded SRL strategies to foster greater student agency and engagement. For instance, Öztürk and Çakıroğlu (2021) implemented SRL tools, including goal-setting diaries, self-efficacy assessments via online tests, and collaborative forums, in an EFL flipped course, resulting in notable gains in speaking, reading, writing, and grammar skills among beginner-level undergraduates. This design enabled students to plan independently before class and monitor their progress through reflective worksheets during in-class

interactions, highlighting how digital scaffolds can bridge out-of-class preparation with active application.

Empirical evidence further demonstrates that targeted SRL supports enhance outcomes in flipped environments. Yoon et al. (2021) developed a learner dashboard and reflection interface that visualized progress data from pre-class quizzes and videos, leading to improved behavioral, cognitive, and emotional engagement, as well as higher quiz scores in a quasi-experimental study. Similarly, Van Alten et al. (2021) found that embedding SRL prompts in flipped videos—such as reminders for self-monitoring and strategy adjustment—boosted the learning performance of secondary students over eight weeks, with sustained effects on motivation and retention. In medical education contexts, Zheng et al. (2020) observed that competency-based flipped learning encouraged SRL across achievement levels, where high-achievers focused on deep processing. In contrast, others benefited from structured help-seeking, ultimately improving academic results in a flipped setting.

In language-specific applications, SRL integration has proven effective for developing communicative competencies. Lai and Hwang (2016) adapted SRL scaffolds, including mobile prompts for time management and self-evaluation, to a mathematics flipped classroom, yielding medium-to-large effect sizes in performance; this framework translates to EFL by supporting vocabulary rehearsal and feedback loops during writing tasks. A systematic review by Silverajah et al. (2022) analyzed 34 studies, revealing common measurement methods like questionnaires and learning analytics, with key benefits including enhanced metacognitive awareness and reduced disengagement in flipped EFL courses. However, the review noted potential directions, such as incorporating AI to provide personalized feedback and mitigate strategy decline over time.

Despite these advancements, challenges persist, including the need for instructor training to facilitate SRL without overwhelming students. Studies like those by Van Alten et al. (2021) employed latent profile analysis to identify varying SRL profiles among secondary learners, suggesting the need

for tailored interventions for diverse groups in flipped language settings. Overall, combining SRL with flipped learning not only amplifies motivation and skill acquisition but also prepares students for complex tasks, such as argumentative writing, where self-monitoring evidence and refining claims are essential.

Argumentative Writing Model

Transitioning from SRL's role in writing processes, this study developed a subjective test in the essay writing format by referring to materials in AW. The study analyzed the test by considering the two parts of the six elements philosopher Stephen E. Toulmin developed. Toulmin's model is well-suited for analyzing tangible frameworks in AW since it is widely employed and acknowledged, and frequently encompasses the underlying structures of persuasive discourse. Furthermore, this technique is highly compatible with L2 AW (Cheng & Chen, 2009; see Figure 1).

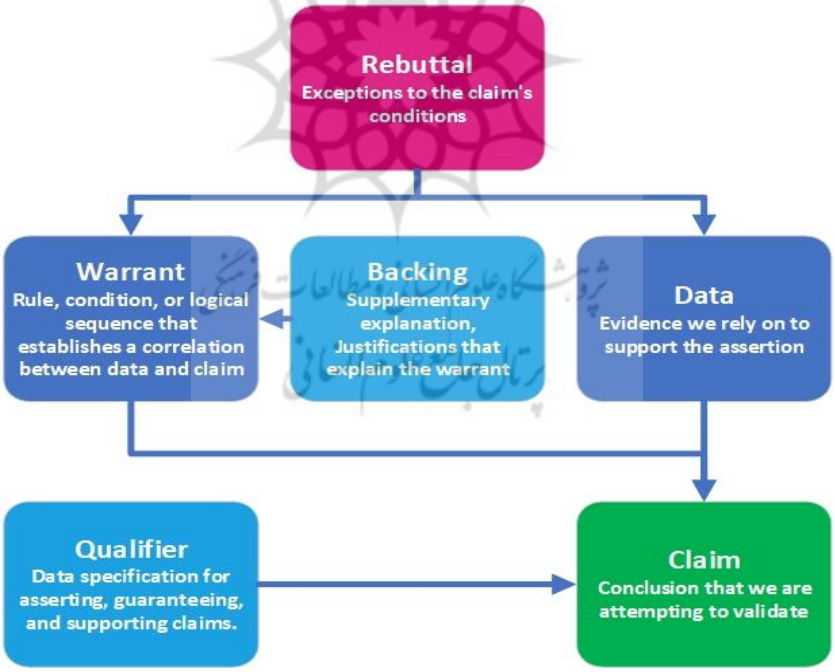

Figure 1: Argumentative Writing Model.

This approach to reasoning involves systematically analyzing arguments and dividing them into six distinct components: claim, grounds, warrant, qualifier, rebuttal, and backup. Toulmin's technique includes three essential components in every argument: the claim, the grounds (or data), and the warrant. The study ensured that all participants who were studying ESP had equal access to genuine resources. According to Figure 1, the Toulmin model consists of six steps for analyzing argumentative essay writing. However, this study focused on two elements of qualifier and claim as initiating components of an argument (Toulmin, 2003):

1. Seeking a claim or thesis to be argued.
2. Seeking evidence to substantiate the claim or thesis.
3. Seeking explanations to demonstrate how and why the evidence supports the claim.
4. Seeking additional proof to strengthen and clarify the claim.
5. Seeking examples of counterclaims that challenge the original claim.
6. Seeking evidence to support the counterclaim.

The Toulmin model is particularly relevant to this study, as it enables a nuanced analysis of students' argumentative writing by focusing on how effectively they formulate claims and provide qualifiers. In ESP, mastering these argumentative components is crucial for medical students who must articulate evidence-based reasoning and structured arguments in academic and professional settings. As suggested by Cheng and Chen (2009), using Toulmin's model is especially effective for analyzing L2 argumentative writing, as it provides a clear framework for structuring persuasive discourse. Furthermore, recent studies emphasize the incorporation of structured argumentation models in ESP contexts to develop students' critical thinking and analytical writing skills (Yang, 2022). By focusing on claims and qualifiers, this study aimed to develop students' ability to construct clear and persuasive arguments, thereby enhancing their overall academic writing proficiency. This focus aligns with the need for medical students to effectively present and justify their viewpoints in both written and verbal

communication, as highlighted by Du (2018) in the context of integrating critical thinking skills in higher education.

METHOD

Research Design

The study employed a quasi-experimental pretest-posttest design, dividing participants into two groups: an experimental group and a control group. A placement test was administered to ensure uniformity and to exclude students with low or high proficiency levels in AW, focusing solely on medical students with intermediate English proficiency. The research aimed to examine the impact of the FL model, integrated with SRL strategies, on improving AW skills. The intervention was grounded in Zimmerman's (1998) model, which emphasizes goal setting, strategic planning, self-monitoring, and reflection, aligning well with the study's focus on self-regulated language learning. A customized version of Zimmerman's model was specifically developed for this study to enhance its relevance to the FL environment. According to Winters et al. (2008), Zimmerman's model offers a comprehensive framework that supports various aspects of self-regulation, making it highly suitable for language education. Additionally, Chen and Bonner (2020) recognized its wide validation across educational contexts, reinforcing its credibility. The model's structured approach facilitated systematic data collection, analysis, and interpretation, enabling researchers to assess learners' engagement in self-regulatory practices throughout the study. This integration enabled comparisons with previous research and supported the study's goal of enhancing writing skills through a structured, self-regulated learning approach (see Figure 2).

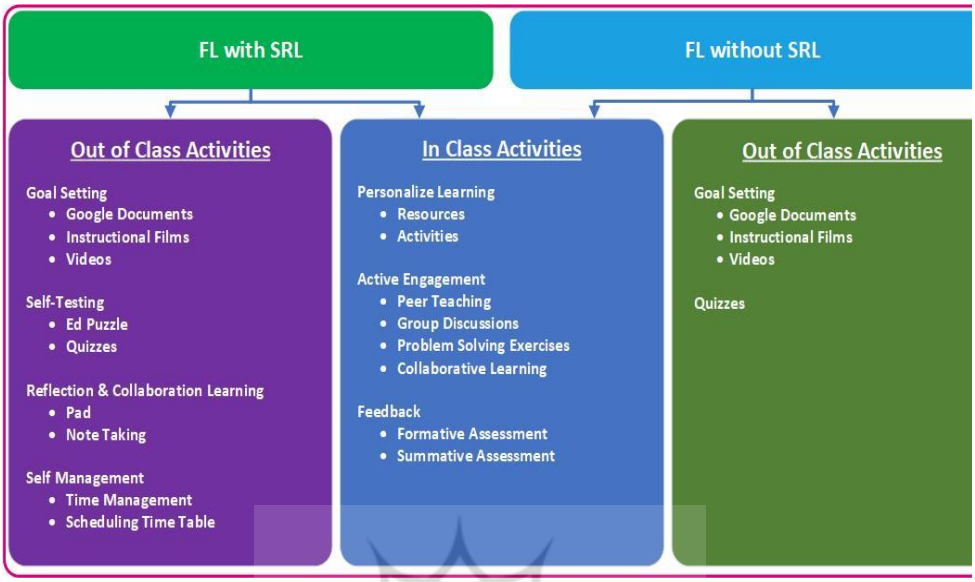

Figure 2: The Design of FL Model Classrooms with and Without SRL Strategies.

Participants

This study included 240 senior medical students with intermediate English proficiency, who were selected based on a standardized placement test. To ensure that the participants belonged to the intermediate English proficiency level, we administered a standardized placement test before the study, effectively identifying and excluding students with either low or high proficiency levels. The students, aged between 18 and 22, were from the medical department of a university in Iran. Medical students were chosen for this study due to their unique academic demands, which require advanced AW skills to effectively communicate complex medical concepts and evidence-based reasoning in academic and clinical settings. The participants were divided into two groups: the experimental group, which utilized FL with SRL strategies, and the control group, which used FL without SRL strategies. Each group consisted of 120 medical students (control group: N = 120 and experimental group: N = 120) who studied English as a specialized course. An ESP teacher, proficient in English and medical science, taught the course

for one semester in Fall 2022. This study adhered to the ethical guidelines for educational research in Iran, ensuring that participants' rights were respected, including obtaining informed consent, maintaining confidentiality, and ensuring anonymity (Gharaveisi & Dastgoshadeh, 2020). All participants were informed about the study's purpose, procedures, and their right to withdraw at any time without penalty. No personal identifying information was collected, and data was stored securely on password-protected servers accessible only to the research team. The study adhered to the principles of avoiding harm, truthful data representation, and fair authorship, aligning with prevailing perspectives on research ethics in L2 contexts in Iran.

Instruments

This study employed a homogeneity test prior to the intervention, as well as two essay writing tests and two questionnaires administered at the beginning and end of the academic term. Both experimental and control classes used specific tools based on the FL approach. Before each session, the teacher utilized various Google documents, instructional films, and videos, all of which were supervised by researchers. Additionally, using Ed puzzles in every session helped the FL classroom teacher evaluate students' understanding of the online instructional materials sent to them via Android apps. For collaboration and feedback on instructional materials, the FL classroom teacher allowed students to use the pad to easily share their ideas. Furthermore, using quizzes during FL classroom management gave each student a more individualized learning environment. It developed gamified formative assessment tasks that students could assign as homework and participate in independently. Furthermore, the camera recorded the teacher's instructions to make them accessible to students and ensure comprehensive control over teaching by preplanned syllabi.

Furthermore, Van Eemeren et al. (2002) used the book '*Argumentation'* as a syllabus during this study. Additionally, this study employed the Self-Regulated Questionnaire (SRQ), developed by Turan et al.

(2009), which has been widely utilized in educational research to assess self-regulated learning. For instance, Turan et al. (2009) reported that the SRQ demonstrated exceptional reliability with a Cronbach's alpha of 0.85 and significant convergent validity when applied to various academic settings. Thus, the SRQ score is a reliable indicator of self-regulatory functioning, as validated in previous studies (Boon, 2020; Roohani & Asiabani, 2015). Turan's scale model was selected due to its extensive utilization across several industries, including teacher education in diverse programs, and its publication in esteemed peer-reviewed journals (Boon, 2020). The surveys consisted of 41 statement items, formulated using a five-point Likert scale, with values ranging from 1 to 5 for assessment. In this study, the SRQ total scores were assessed using the following ranges, derived from clinical and collegiate samples: 1—Strongly Disagree, 2—Disagree, 3—Uncertain or Unsure, 4—Agree, 5—Strongly Agree.

Data Collection Procedure

As part of the procedure, medical students completed 480 time-constrained argumentative essays in English, consisting of 240 pretests and 240 posttests. Both assessments were administered at the commencement and conclusion of the semester, with the post-test distinct from the final examination. The samples were collected from two medical classes instructed using an identical pedagogical methodology. This study aimed to examine the impact of classroom tactics on medical students' AW skills. In this study, overall scores of the argumentative essay were evaluated as an independent factor, reflecting the general quality of the students and the elements of the argumentation, including claims and qualifiers. Two proficient assessors were invited to evaluate the papers to enhance the dependability of the scores. The scores obtained from the two raters were documented in an Excel spreadsheet and examined using SPSS 22.0. The correlation coefficient of the two sets of scores was evaluated. Furthermore, Table 1 shows students' scheduling and study plans during treatment. An ESP teacher was asked to cooperate in

teaching based on the FL classroom model, as outlined in the detailed procedure. All section instructions were recorded and made available to all students. A placement test was administered to identify students with varying levels of English proficiency.

Table 1: ESP AW Course Topics

Weeks	Topics
0	Pretest
1	Differences of Opinion
2	Argumentation and Discussion
3-4	Standpoints and Argumentation
5	Unexpressed Standpoints and Unexpressed Premises
6	The Structure of Argumentation
7	Fallacies (1)
8	Fallacies (2)
9	The Soundness of Argumentation
10-12	Written Argumentation
13-14	Oral Argumentation
15	Posttest

As it is outlined in Table 1, the ESP AW course spans 15 weeks, beginning with a pretest and covering foundational topics, such as "Differences of Opinion," before advancing to more complex areas, including "Fallacies" and "Written Argumentation." This schedule ensured progressive development of AW skills, aligned with the FL model. At the beginning of the study, a pretest in essay format was held among two groups of students with an intermediate level of English proficiency (FL with SRL strategies classroom as the experimental group and FL without SRL strategies classroom as the control group) among medical students to identify the normality of students' AW knowledge. All included students wrote an essay about the same medical question ("Has digital technology enhanced the gap in the quality of healthcare service being provided in the world?") within the same three-paragraph length and 60-minute period. Fifteen medical students piloted the test and questionnaire to ensure they were appropriate and standard tests for analyzing AW knowledge and self-regulated skills among medical students. (see Figure 3)

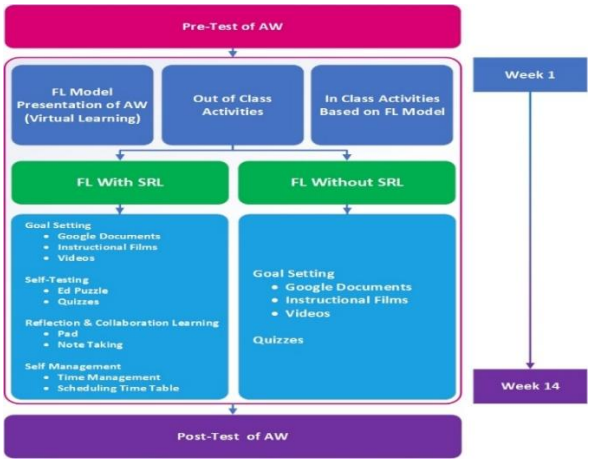

Figure 3: Flipped Classrooms with and Without SRL Strategies

The purpose of the two groups was to analyze the improvement of medical students in the area of AW. After starting the treatment, the teacher managed the classrooms for 14 sessions over one semester, based on pre-planned syllabi developed by researchers. After one semester, a post-test in essay format was held among two groups (experimental group and control group) of medical students to compare and contrast their scores and identify the possible effects of each classroom approach on students' AW improvement, as well as determine the most effective classroom approach in terms of writing development of medical students. Each AW essay was scored from zero to twenty, and each element of the AW essay was from zero to five (Claim: 0-5 & Qualifier: 0-5). Both classrooms followed the same steps to ensure ethical practices. However, what made a difference in the treatment class was an overemphasis on various SRL techniques, encouragement to take ownership of their learning process, asking for self-assessment, providing more flexibility in selecting supplementary resources, and offering feedback on their SRL efforts. The teacher needed to consider a step-by-step procedure for managing two scenarios in this study, focusing on the following concepts.

Flipped Classroom with Self-Regulated Learning Strategies

A structured approach to out-of-class activities was implemented for students

utilizing SRL strategies to enhance their argumentative skills, encompassing several key procedures to optimize their learning experience. Firstly, goal setting was facilitated through collaborative platforms such as Google Documents. This provided an accessible space where students could articulate and refine their learning objectives, allowing for continuous feedback and adjustment. The collaborative nature of Google Docs enabled peer interaction and support, further enhancing the clarity and achievability of their goals. Interactive resources, such as Ed Puzzle and various quiz applications, were employed to reinforce comprehension and promote self-testing. These tools provided engaging and interactive assessments, promoting independent understanding and retention of the material. Ed Puzzle enabled the integration of quizzes within video content, allowing students to immediately apply and test their knowledge in a dynamic learning environment. Applications like Padlet and other collaborative brainstorming tools cultivated reflection and cooperative learning. Padlet offered a versatile platform for collaborative brainstorming, allowing students to share ideas and resources in real-time. Note-taking tools were also utilized to encourage thoughtful review and consolidate insights. These tools supported the development of critical thinking, enabling students to reflect on their learning processes and outcomes.

Students employed various time management techniques and scheduling tools to promote effective self-management. In out-of-class learning endeavors, applications such as Trello and Google Calendar create well-structured timetables, fostering discipline and organization. These tools allowed students to set deadlines, prioritize tasks, and monitor their progress, ensuring their study schedules were balanced and efficient. Additionally, ongoing monitoring and feedback were integral components of this approach. Teachers provided regular feedback through digital platforms, helping students to stay on track and make necessary adjustments to their learning strategies. This continuous feedback loop and reflection enabled students to develop greater self-awareness and adaptability in their argumentative pursuits.

Flipped Classroom without Self-Regulated Learning Strategies

For students who did not adopt SRL strategies, out-of-class activities could still be tailored to promote engagement and comprehension. While explicit goal setting might not have been a primary focus, collaborative tools like Google Docs could still have been employed to facilitate group projects or the sharing of information. Instructional films and videos served as accessible resources for conveying information in a more dynamic and visually appealing way, catering to diverse learning preferences.

Table 2: Item Descriptions and Scores' Values of SRQ

SRL Skills	Items	Scores		The number of items
		Min	Max	
Motivation and Action	7	7	35	1, 2, 4, 5, 6, 8, 9.
Planning and Goal Setting	8	8	40	10, 11, 13, 14, 15, 16, 17, and 18.
Learning and Assessment	19	19	95	19, 21, 22, 24, 25, 26, 27, 28, 29, 30, 31, 33, 34, 35, 36, 37, 38, 40, 41.
Insufficient Self-Directedness	7	7	35	3, 7, 12, 20, 23, 32, 39.

In the context of quizzes, a simplified approach could have been taken to assess understanding without emphasizing self-testing as a primary learning strategy. These activities aimed to provide a more structured and interactive learning experience, accommodating a variety of learning styles for students who may not have inherently followed SRL strategies. Furthermore, to assess the impact of the SRL writing intervention on the self-reported SRL skills of medical students, two SRQs were given to groups before and after the intervention, serving as a pretest and a posttest, respectively. The SRL Scale was comprised of four dimensions and 41 items. Items were rated using a five-point scale, ranging from "strongly disagreed" to "strongly agreed". Scores for items were combined to generate both sub-dimension scores and

total scores. Regarding the overall score, the minimum attainable score was 41, while the maximum achievable score was 205. The specific components of the scale are defined in Table 2. The analysis included examining changes in scores to determine the effectiveness of the intervention. Additionally, subgroup comparisons were made to identify any variations in SRL skill development. The findings were then used to refine and improve future interventions.

Data Analysis

Initially, a comparative analysis of the average pretest scores was conducted for two groups of foreign language learners: one that utilized SRL strategies and the other that did not employ these strategies. An independent sample t-test was employed using SPSS Statistics to evaluate the homogeneity of the students' initial language acquisition abilities. Additionally, paired sample t-tests were conducted to compare the pretest and post-test results within the treatment and control groups, thereby assessing their respective improvements. To address the first research question concerning the statistically significant difference in the advancement of medical students' AW, an independent sample t-test was applied to compare the post-test scores of the experimental group (utilizing SRL strategies) and the control group. Further, each element of the argument, specifically the Claim and Qualifier, was individually evaluated to discern the differential impact of foreign language teaching strategies on these components. Two paired sample t-tests were conducted to assess, based on Toulmin's argumentation model, the medical students' AW, comparing their pretest and post-test results.

To examine the effect of the SRL writing intervention on the self-reported SRL skills of medical students, the treatment group was required to complete SRL questionnaires before and after the intervention. This evaluation aimed to determine the potential impact of the SRL writing intervention on their self-reported SRL skills. Subsequently, two Mann-Whitney U tests were performed using SPSS Statistics to compare the pretest and post-test SRQ scores of both groups. This analysis facilitated an

independent assessment of each group's self-regulated skill development, revealing the extent of their progress. The results are detailed in Table 3, which presents a sample analysis of students' AW based on the Toulmin model. The reliability coefficient for the inventory was calculated to be 0.85. The Planning and Goal Setting subscale exhibited a Cronbach's alpha coefficient of 0.91, indicating high internal consistency. The Strategy Use and Self-Evaluation subscale showed a Cronbach's alpha coefficient of 0.80, suggesting moderate internal consistency. Lastly, the Learning Dependency subscale had a Cronbach's alpha coefficient of 0.81, indicating moderate internal consistency. Given that these values fall within the range between 0.80 and 0.90, it is important to highlight that the scale employed in this research demonstrated high reliability.

Table 3: Sample Analysis of Medical Student Essays' Qualifiers and Claims Based on the Toulmin Model

	Qualifiers	**Claims**
1	From my point of view,	Technology can play a fundamental role in helping to tackle health challenges.
2	In my idea,	Humanity can develop treatment methods by using medical technology.
3	From my perspective,	Digital technology has raised the gap in the quality of health services.
4	In my opinion,	Digital technology can be more useful in various aspects, such as making people's medical histories accessible to treatment staff who follow patients online or having a medical commission of doctors who can be consulted from anywhere.
5	As I know,	More advanced countries have better computer facilities for utilizing health services.
6	According to my knowledge,	The advanced robots in this field can perform a wide range of complex and predefined movements with great accuracy and without fatigue, and they can even surpass the performance of a surgeon's hand.
7	As I know,	Robotic surgery has become a widely used treatment method, thanks to advancements in science and technology.
8	In my point of view,	Technology has significantly transformed the way medical science operates.
9	Based on my opinion,	Medical research and tests that used to take years to complete can now be completed within a few months or even weeks, thanks to the use of technology.
10	According to my personal experience	With the help of technology, medical professionals can accelerate progress and contribute to a historic breakthrough in the field of medicine.

Table 3 illustrates sample qualifiers and claims from student essays, based on the Toulmin model, such as "From my point of view," which qualifies the claim "Technology can play a fundamental role in helping to tackle health challenges." These examples highlight how students nuanced their arguments post-intervention.

RESULTS

Initially, the study compared the mean pretest scores of the two groups: the experimental group (FL with SRL strategies) and the control group (FL without SRL strategies). This comparison aimed to ensure that both groups demonstrated similar abilities in AW before the intervention, establishing a valid baseline for subsequent analysis. An independent samples t-test was performed using SPSS Statistics to assess this baseline similarity. This statistical test is particularly useful in determining whether there are significant differences between the means of two independent groups, thereby confirming the homogeneity of the sample at the outset. The statistical results of Levene's test, presented in Table 4, showed a p-value of 0.78, while the t-test revealed a p-value of 0.42. Since both p-values exceed the conventional alpha level of 0.05, it can be concluded that there was no statistically significant difference between the pretest scores of the experimental and control groups. This indicates that both groups were comparable and homogeneous in terms of their initial AW abilities, ensuring that any observed differences in post-test outcomes could be attributed to the intervention rather than pre-existing disparities. Establishing homogeneity between the groups is crucial in quasi-experimental studies, as it minimizes potential biases and strengthens the validity of the results. By confirming that both groups started from a similar baseline, the study ensured that any subsequent improvements in AW skills could be confidently linked to the FL with SRL intervention rather than external factors. This rigorous approach enhances the reliability of the study's findings, allowing for a more accurate assessment of the intervention's effectiveness.

Table 4: Independent Samples t-Test between Two Sets of Pretests

	F	Sig.	t	df	Sig.(2-tailed)	Mean Difference	Std.Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Assumed Equal variances	0.07	0.78	0.79	238	0.42	0.23	0.29	-0.34	0.81
Non-assumed equal variances			0.79	237.93	0.42	0.23	0.29	-0.34	0.81

As shown in Table 4, Levene's test ($p = 0.78$) and the t-test ($p = 0.42$) confirm that there are no significant pretest differences, establishing group homogeneity. After establishing homogeneity, paired-sample t-tests were conducted to measure the improvement in AW skills within each group by comparing pre-test and post-test scores (see Tables 5 and 6). The analysis revealed significant gains in the experimental group, where students exposed to FL with SRL strategies showed marked improvement in their AW abilities. This indicates that the intervention successfully enhanced writing skills, while the control group demonstrated comparatively less progress. These findings support the effectiveness of integrating SRL strategies within a flipped classroom framework. The results align with existing research that underscores the positive impact of self-regulated learning on academic writing. Future research could explore the long-term effects of such interventions and investigate how individual learner characteristics interact with SRL strategies to optimize instructional approaches in language education further.

Table 5: Paired Samples T-Test between Two Sets of Pre- and Post-Test

	Mean	N		Std. Deviation	Std. Error Mean
Pair 1	Pretest treatment	8.73	120	2.26	0.20
	Posttest treatment	16.80	120	2.48	0.22
Pair 2	Pretest control	8.50	120	2.30	0.21
	Posttest control	14.78	120	2.53	0.23

Tables 5 and 6 demonstrate significant improvements in AW skills for both

groups, with the experimental group (M_pre = 8.73, M_post = 16.80; t = -25.71, p < 0.001) showing larger gains than the control group (M_pre = 8.50, M_post = 14.78; t = -15.55, p < 0.001), supporting the effectiveness of FL with SRL. The two-tailed significance value for both groups is 0.00, which is lower than the alpha level of 0.05, indicating a statistically significant improvement in students' post-test scores in both the treatment and control groups.

Table 6: Paired Samples T-Test between two Sets of Pre and Post-Tests.

		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	Pretest and Posttest treatment	-8.06	3.43	0.31	-8.68	-7.44	-25.71	119	0.00
Pair 2	Pretest and Posttest control	-6.28	4.42	0.40	-7.08	-5.48	-15.55	119	0.00

To investigate the first research question regarding the statistically significant difference in improving medical students' AW skills, an independent samples t-test was performed between the post-test scores of the two groups (see Tables 7 and 8). The results demonstrate that the intervention had a positive impact, reflecting a meaningful enhancement in the students' writing abilities.

Table 7: Independent Samples T-Test between Pair of Post-Tests (Experimental and Control)

	groups	N	Mean	Std. Deviation	Std. Error Mean
Posttests	treatment	120	16.80	2.48	0.22
	control	120	14.78	2.53	0.23

As indicated in Tables 7 and 8, the experimental group outperformed the control group on post-tests (M_exp = 16.80, M_ctrl = 14.78; t = 6.22, p < 0.001), confirming a statistically significant difference in AW improvement due to SRL integration. Furthermore, this study scored each argumentative element of the Claim and Qualifier separately to compare and contrast the effect of FL classroom strategies on each.

Table 8: Independent Samples T-Test between Pair of Post-Tests (Experimental and Control)

		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Post-tests	Equal variances assumed	0.01	0.90	6.22	238	0.00	2.01	0.32	1.37	2.65
	Equal variances not assumed.			6.22	237.93	0.00	2.01	0.32	1.37	2.65

Two paired-sample t-tests were conducted to compare the pretests and posttests of each element, analyzing medical students' argumentation based on the Toulmin argumentative model. The two-tailed significance value for the first pair illustrated a value of 0.08, which is higher than the α value (0.05), meaning the homogeneity of the two sets of pretests (Claim & Qualifier). The p-value for the second pair (0.00) is less than the α value of 0.05, which means the improvement of students in the posttests for claims is different from that for qualifiers (see Tables 9 and 10).

Table 9: Paired Samples T-Test between 2 Pretests and Posttests of Used Claims and Qualifiers

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest claim	1.52	120	0.50	0.04
	Pretest Qualifier	1.46	120	0.50	0.04
Pair 2	Posttest Claim	2.75	120	0.72	0.06
	Posttest Qualifier	3.19	120	0.66	0.06

Tables 9 and 10 reveal homogeneity in pretest claims and qualifiers ($p = 0.08 > 0.05$) but differential post-test improvements, with qualifiers showing greater gains ($M_{claim\_post} = 2.75$, $M_{qual\_post} = 3.19$; $t = -9.70$, $p < 0.001$), rejecting the null hypothesis for RQ2. In addition, according to Table 10, the mean value of qualifiers used in the posttests was higher than that of claims used in the posttest. Accordingly, this analysis rejected the null hypothesis "There is no difference in the improvement of claims and qualifiers in AW of medical students in the FL group based on the Toulmin model".

Table 10: Paired Samples T-Test between 2 Pretests and Posttests of Used Claims and Qualifiers

		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	Pretest Claim - Pretest Qualifier	0.05	0.23	0.02	0.01	0.10	2.71	119	0.08
Pair 2	Posttest Claim - Posttest Qualifier	-0.44	0.49	0.04	-0.53	-0.35	-9.70	119	0.00

This study examined the effect of the SRL writing intervention on medical students' self-reported SRL skills, utilizing two non-parametric Mann-Whitney U tests in SPSS Statistics. Table 11 displays the impact of the SRL writing intervention on the self-reported SRL skills pretests of both the control and experimental groups. Table 12 illustrates the impact of the SRL writing intervention on the self-reported SRL skills posttests of both the control and experimental groups. The findings from both tables indicate a significant improvement in the experimental group compared to the control group. This suggests that SRL interventions can effectively enhance specific argumentative skills. Moreover, the study highlights the potential for broader application of SRL techniques in various educational contexts. These insights pave the way for further research into optimizing teaching strategies for different learner groups.

Table 11: Mann-Whitney U Test between a Pair of Pre-Interviews

1	The distribution of Motivation Activity is consistent throughout the control categories.	The Mann-Whitney U test for independent samples.	0.14	The hypothesis remains.	null
2	The distribution of Planning Goal Setting is consistent across the control categories.	The Mann-Whitney U test for independent samples.	0.13	The hypothesis remains.	null
3	The distribution of the Learning Assessment is consistent throughout the control categories.	The Mann-Whitney U test for independent samples.	0.15	The hypothesis remains.	null
4	The distribution of Self-directedness is consistent throughout control categories.	The Mann-Whitney U test for independent samples.	0.12	The hypothesis remains.	null
5	The distribution of Sums is consistent throughout the control categories.	The Mann-Whitney U test for independent samples.	0.14	The hypothesis remains.	null

In Table 11, pre-intervention scores showed no significant differences in self-reported SRL skills across dimensions (p-values ranging from 0.12 to 0.15, all>0.05), confirming baseline equivalence between groups. As shown in Table 12, the experimental group demonstrated significant post-intervention improvements across all SRL dimensions ($p < 0.05$), refuting the null hypothesis and indicating a positive effect of the SRL writing intervention on self-reported skills (RQ3). To achieve meaningful outcomes with the Mann-Whitney U test in SPSS Statistics, the significance value should be 0.05 or lower. In this case, the values of 0.14, 0.13, 0.15, 0.12, and 0.14 exceed the alpha value of 0.05, suggesting that the null hypothesis cannot be rejected. Therefore, there is insufficient evidence to support the claim that a significant difference exists between the groups in self-reported SRL skills before the intervention. Furthermore, this confirmed there is no statistically significant difference between the two groups at pretest.

Table 12: Mann-Whitney U Test between a Pair of Post-Interviews

1	The distribution of Motivation Activity is consistent throughout the control categories.	The Mann-Whitney U test for independent samples.	0.00	Refute the null hypothesis.
2	The distribution of Planning Goal Setting is consistent across the control categories.	The Mann-Whitney U test for independent samples.	0.00	Refute the null hypothesis.
3	The distribution of the Learning Assessment is consistent throughout the control categories.	The Mann-Whitney U test for independent samples.	0.00	Refute the null hypothesis.
4	The distribution of Self-directedness is consistent throughout control categories.	The Mann-Whitney U test for independent samples.	0.00	Refute the null hypothesis.
5	The distribution of Sums is consistent throughout the control categories.	The Mann-Whitney U test for independent samples.	0.00	Refute the null hypothesis.

In Table 12, the post-intervention scores, all with significant values of 0.00, are lower than the alpha value of 0.05, suggesting that the null hypothesis can be rejected. Therefore, there is sufficient evidence to support the claim that a significant difference exists between the groups in self-reported SRL skills after the intervention. Furthermore, this confirms there is a statistically significant difference between the two groups at posttest.

DISCUSSION

Results demonstrated a significant positive impact of FL combined with SRL strategies on medical students' AW skills, addressing RQ1 by showing greater gains in the experimental group compared to the control ($p < 0.001$). Throughout the one-semester intervention, incorporating SRL strategies proved beneficial, promoting goal setting, enhancing self-efficacy, seeking assistance, organizing information, rehearsing, managing time effectively, receiving feedback, and engaging in self-evaluation (Roohani & Asiabani, 2015). Notably, the differential improvement in qualifiers over claims ($p < 0.001$) aligns with RQ2, suggesting that SRL fosters nuanced argumentation, possibly because it encourages metacognitive reflection on the strength of evidence and uncertainty in claims (Yang, 2022). For RQ3, the experimental group's enhanced self-reported SRL skills ($p < 0.001$) indicate that explicit SRL training builds autonomy in digital learning environments, as evidenced by improvements in motivation, planning, and self-directedness. One key aspect was that learning extended beyond classroom sessions through pre-class preparation, emphasizing the role of FL materials in enabling learners to apply instructional digital notes in post-test essays. Formative assessments, such as quizzes and error feedback managed by the ESP teacher, significantly reduced grammatical issues and boosted AW proficiency, highlighting how SRL amplifies active engagement.

These findings align with prior research on FL's effectiveness in EFL contexts (Lai & Hwang, 2016; Van Alten et al., 2021) but extend this line of inquiry by demonstrating the additive value of SRL in ESP writing. For instance, the greater qualifier improvements resonate with recent studies showing SRL enhances metacognitive awareness in argumentative tasks (Koh et al., 2024). Similarly, the integration of digital platforms, such as Google Classroom, EdPuzzle, Padlet, and Quizizz supported personalized learning, aligning with blended models that utilize videos and interactive tools to foster engagement (Alamri et al., 2021). However, as Van Alten et al. (2021) cautioned, SRL must be structured to avoid disengagement, which our

overemphasis on self-assessment and feedback addressed. Recent evaluations in medical education further corroborate this; for example, a 2025 study on FL in medical research methods courses reported significant boosts in motivation (from ~7 to 12 on Likert scales) and critical thinking (from ~8 to 15), attributing gains to collaborative discussions that mirror our SRL-enhanced activities (Khadawardi et al., 2025). In allied contexts, teaching SRL through reflective writing in first-year medical students improved self-regulated skills and metacognition, though without direct FL integration (Koh et al., 2024). Du (2018) emphasized the importance of technology in language education, and our results confirm that FL with SRL enhances outcomes by incorporating supplementary activities. Moreover, a recent systematic review of FL in medical education highlighted variance in effects but confirmed overall improvements in student performance, aligning with our quasi-experimental evidence (Spaic et al., 2025). These connections suggest that SRL acts as a mediator, enhancing the impact of FL on complex skills, such as AW, in high-stakes fields like medicine.

Theoretically, our results support Zimmerman (2008) cyclical SRL model by demonstrating how the phases of forethought (planning), performance (self-monitoring in FL activities), and self-reflection translate into tangible gains in writing. The emphasis on qualifiers indicates SRL promotes epistemic awareness—students' ability to qualify claims based on evidence limitations—a key aspect of critical thinking in ESP (Cheng & Chen, 2009). This extends Panadero (2017) framework, where SRL effectiveness varies by student development, as our intermediate-level medical students benefited from tailored digital scaffolds. Recent syntheses on SRL in online/blended environments reinforce this, noting stronger academic achievement when self-regulation is explicitly taught (Broadbent et al., 2023). In medical contexts, where evidence-based argumentation is crucial, integrating SRL with FL can bridge gaps in traditional lecture-based training, thereby fostering lifelong learning habits.

Despite these strengths, the study has limitations. The quasi-experimental design, although practical, lacked random assignments, which

could potentially introduce selection bias. The sample was drawn from a single Iranian university, limiting generalizability to other cultural or educational contexts. Additionally, reliance on self-reported SRL measures may be subject to social desirability bias, and the focus on only two Toulmin elements (claims and qualifiers) overlooks broader argumentative structures. Future studies could incorporate objective SRL observations, such as log data from digital platforms, or longitudinal designs to track sustained effects.

This study highlights the effectiveness of combining FL with SRL in improving medical students' AW skills, providing educators with a structured approach to foster writing competence and self-regulatory practices applicable beyond the classroom. For ESP instructors in medical education, these findings suggest prioritizing metacognitive training in digital platforms to enhance evidence-based reasoning in professional settings, potentially reducing challenges in communicating complex ideas. Broader implications include adapting this model to other disciplines, as supported by recent evidence on SRL in hybrid environments (Liu & Hung, 2025). Further research could explore long-term effects, individual learner differences (e.g., via latent profile analysis; see Van Alten et al., 2021), or integrations with emerging AI tools for personalized feedback in AW. Comparative studies across cultures or with advanced proficiency levels would also enrich understanding. By addressing these, educators can better optimize FL-SRL intersections for improved educational outcomes in the digital era.

CONCLUSION

This study investigated the efficacy of incorporating SRL strategies into the FL classroom paradigm for improving the AW abilities of medical students. The research findings elucidated various crucial facets of this integration. Initially, the study validated the efficacy of FL instruction and SRL methodologies in enhancing students' AW abilities. The analysis of the pretest and posttest scores demonstrated a notable enhancement in both the treatment and control groups, indicating that FL alone can potentially improve AW

skills. Nevertheless, the treatment group, which was provided with supplementary SRL tools, exhibited even more significant progress, underscoring the beneficial influence of integrating SRL in FL classrooms. Furthermore, the examination conducted using the Toulmin argumentation model revealed a noteworthy differentiation between claims and qualifiers in the writing of pupils. Although both groups demonstrated improvement, the qualifiers displayed a more significant enhancement in the posttest. This discovery suggests that SRL interventions may have a particularly potent impact on students' ability to construct and effectively express their arguments.

Moreover, the study evaluated the self-reported SRL abilities of medical students both before and during the SRL intervention. The findings demonstrated a noteworthy enhancement in the self-reported SRL skills of the experimental group. This highlights the need to integrate SRL tactics into FL courses to augment students' capacity to manage their learning. This study contributed to knowledge about using SRL mechanisms in FL classes, particularly enhancing AW skills among medical students. The results indicate that educators can enhance learning and academic achievement by implementing a pedagogical strategy integrating FL instruction and SRL. Furthermore, this study highlights the importance of addressing assertions and modifiers in enhancing students' writing skills. It emphasizes the beneficial influence of SRL interventions on students' ability to regulate their learning. Ultimately, the study offered significant knowledge for educators, curriculum designers, and researchers interested in improving students' AW skills through creative teaching methods. Using SRL methods in conjunction with FL can enhance students' autonomy in their learning and writing proficiency in the digital era. Additional investigation in this field has the potential to enhance and broaden our understanding of the interactions between FL and SRL, leading to improved educational outcomes.

Disclosure statement

No potential conflict of interest was reported by the authors.

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