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Working Memory as a Predictor of Syntactic Complexity in Iranian EFL Learners' Argumentative Writing: Considering Different Planning Conditions

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Abstract

Working memory (WM) plays a pivotal role in complex cognitive tasks such as writing. As writing in a foreign language is a cognitively demanding task in the Iranian context and requires the integration of cognitive and strategic planning processes, the present study aimed to investigate the role of WM capacity in predicting syntactic complexity of argumentative writing tasks performed by Iranian female EFL upper-intermediate learners under two distinct guided strategic planning approaches: form-focused (FF) and content-focused (CF). After a careful selection of 90 upper-intermediate learners based on Oxford Quick Placement Test (OQPT), an automated working memory operation span test was employed. Next, the participants were assigned to two groups: FF and CF (45 participants in each group). The participants in each group were guided on how to pre-plan their argumentative writings during four sessions (two sessions for each group, held on the same day). Following these sessions, the participants were asked to write an argumentative writing using the pre-planning strategies already explained. Results from structural equation modeling (SEM) revealed that WM strongly predicted syntactic complexity in both groups; however, this prediction was superior in the CF group. The findings reveal the potential of WM as a significant factor in predicting the syntactic complexity of CF strategic planning, impacting overall writing quality. This study contributes to understanding how cognitive factors influence pre-planning writing strategies in language learners and have implications for the instruction of pre-planning for L2 learners, considering the importance of WM.

Keywords: content-focused, form-focused, strategic planning, syntactic complexity, working memory

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1. Introduction

Writing is a demanding cognitive activity that requires the simultaneous orchestration of numerous subprocesses, including initial planning, idea generation, sentence construction, lexical retrieval, and revision (McCutchen, 2011). It is often regarded as one of the most consequential communicational technologies developed by human societies, as proficiency in writing is essential for success in many professions. Unlike other fundamental language skills, writing not only assesses an individual's language proficiency but also their ability to express complex concepts (Liao & Zhao, 2024). Consequently, mastering writing is a critical academic development that all students must achieve (Graham & Perin, 2007). For English as a Foreign Language (EFL) learners, the writing process is further complicated by a complex interplay of linguistic, cognitive, and sociocultural factors.

Writing a well-structured text requires effective planning. Ellis (2003) distinguished between online planning and strategic planning. Online planning deals with the planning process during the performance of the task, while strategic planning occurs prior to the performance of the task. It is a form of pre-task planning which plays a crucial role in developing writing skills, as it involves setting goals, generating and selecting ideas, and organizing content in the pre-planning stage of writing (Eyre, 2022). It is important to note that pre-task planning, as investigated by Khomeijani Farahani and Faryabi (2016), differs from strategic planning in that it typically involves allocating additional time for learners to prepare before writing, without necessarily providing explicit guidance or goal-setting strategies. Foster and Skehan (1996) and Sangarun (2005) identified two types of planning: guided and unguided. Guided planning in writing emphasizes explicit instruction and structured tasks to scaffold learners' development through clear frameworks and targeted feedback. This approach aligns closely with strategic planning by facilitating the establishment of specific objectives and systematic skill development (Li, 2023). In contrast, in the unguided planning approach, learners are not engaged in a planning process with such specific instructions or guidance. During guided planning, learners are provided with particular strategies, monitoring techniques, and instructional support to help them effectively plan and execute language tasks. Common techniques used in guided writing include sentence-combining exercises, paragraph-writing frames, and model texts that illustrate desired writing features. These methods assist learners in overcoming the difficulties of writing in a second language and contribute to the development of precise and fluent writing abilities (Yi & Ni, 2015). Additionally, guided writing typically includes clear instruction on grammar, vocabulary, and writing norms to improve learners' linguistic knowledge and awareness (Kitajroonchai et al., 2022). In brief, this type of planning plays a crucial role

in language instruction, using various practical strategies that focus on either language or content (Ellis, 2005).

Regarding teachers' strategic planning, form-focused (FF) guided planning involves offering clear instructions and guidance for language forms, structures, and vocabulary to be utilized in a task (de Oliveira et al., 2021). Alternatively, content-focused (CF) guided planning incorporates language learning with the exploration of academic topics like science or social studies, providing a well-rounded approach that promotes the development of both language and content knowledge simultaneously (Langdon & Pandor, 2020). In contrast, unguided planning or no planning (NP) allows learners to process the content and language of their planned production and allows the learners to choose their paths (Khonamri et al., 2017).

Additionally, the role of working memory (WM) is critical as it involves processing and retaining complex linguistic rules during writing tasks (Nejadansari & Ahmadvand, 2012). WM serves as a vital cognitive function in writing by allowing for the temporary storage and manipulation of information necessary for complex cognitive tasks such as language processing and text generation (Olive, 2004). The capacity of WM can significantly influence the quality of writing by affecting its complexity, accuracy, and fluency. Moreover, the executive functions of WM—including inhibiting responses, shifting attention between tasks, and updating information—have differential associations with both the process and product aspects of writing (Li, 2023).

By emphasizing the importance of WM, Ellis (2021) suggested that the researchers should consider equality among learners in terms of WM capacity. While the role of WM in various cognitive processes is well-established, its specific predictive role in the syntactic complexity of EFL learners' writing remains under-explored. Existing research on pre- planning and WM often focuses on either general writing proficiency (Marzban & Norouzi, 2011) or specific aspects like spelling (Walda et al., 2024) or fluency (Li, 2023), neglecting a detailed analysis of syntactic complexity within writings guided by two types of planning: form-focused and content-focused guidance. This gap in the literature necessitates a focused investigation into how WM capacity, encompassing both its storage and processing components, influences the grammatical structures and sentence complexity employed by upper-intermediate EFL learners in argumentative writings in two different guided planning situations. Examining whether WM can predict syntactic complexity in argumentative writings, particularly under form-focused and content-focused guidance, reveals significant insights into how cognitive resources influence writing performance. By demonstrating the effectiveness of instruction on students' learning processes from cognitive aspects, education decision- makers can take full advantage of the latest findings in the writing

curriculum and contribute to the quality improvement of the language teaching processes in the classrooms. To do so, this study seeks to answer the following questions:

1. Does the WM capacity of Iranian upper-intermediate female EFL learners predict their syntactic complexity in argumentative writing tasks instructed by form-focused strategic planning?
2. Does the WM capacity of Iranian upper-intermediate female EFL learners predict their syntactic complexity in argumentative writing tasks instructed by content-focused strategic planning?

2. Literature Review

2.1. Strategic Planning and Writing

Numerous research studies have investigated the effects of strategic writing methods on the writing abilities of learners of EFL, uncovering important results. Okasha and Hamdi (2014) discovered that participating in strategic writing workshops enhanced not only the writing skills but also the attitudes of EFL students, highlighting the importance of employing intentional strategies to reach writing objectives. Asgarikia (2014) demonstrated that strategic planning enhanced written performance in terms of accuracy, fluency, and complexity compared to no planning. Graham et al. (2017) highlighted the importance of strategic writing behaviors and motivation in predicting writing quality, stressing the need for clear objectives and understanding the stages of the writing process. Khonamri et al. (2017) showed that form-focused pre-task planning led to better accuracy and complexity in argumentative writing than content-focused and no planning. Additionally, Yildiz and Yeşilyurt (2017) discovered that planning had a positive impact on the overall quality of writing, influencing both lexical and syntactic complexity, which aids in comprehending effective task-based language teaching. Together, these studies indicate that incorporating strategic planning into EFL education can greatly improve students' writing abilities and encourage greater independence as writers.

In line with all of these studies, El-Hilaly and Ebedy (2018) investigated the effects of task complexity and strategic planning on EFL students' narrative writing performance, finding that strategic planning positively influenced writing accuracy and motivation, especially with complex tasks, while higher task complexity correlated with lower accuracy and motivation. Zoghi and Shokri (2018) focused on pre-task strategic planning, revealing that it enhanced writing motivation and accuracy, particularly noting that form-focused planning was more effective. Abdi Tabari (2020) also demonstrated the benefits of strategic planning, showing significant improvements in writing accuracy and motivation among participants engaged in structured planning compared to a control group.

Similarly, Uludag et al. (2021) emphasized the importance of prewriting planning, noting its significant impact on L2 students' integrated writing performance. Chauhan (2022) emphasized the essential principles of academic writing, promoting a recursive writing approach that includes aspects of strategic planning. Furthermore, Fazilatfar (2020) analyzed task-based language teaching strategies, pointing out that both strategic planning and allocated planning time can boost fluency and enhance writing performance in learners of a second language. Together, these studies confirm the vital importance of strategic planning in advancing writing results across different settings and educational stages.

2.2. WM and Writing

Olive (2004) posits that comprehending the processes underlying text composition requires an elucidation of how writing activities are orchestrated within the cognitive system. A unique feature of this cognitive system is its limited capacity to maintain and process information at the same time. The connection between WM (WM) and writing is crucial, as writing is a multifaceted cognitive activity that requires substantial mental resources. WM acts as a short-term storage system, enabling writers to retain and handle information while they create a text. This includes managing ideas, linguistic structures, and the overall organization of the writing piece (De Vita et al., 2021). Gao et al. (2023) indicated that effective writing requires the integration of new information with existing knowledge, a process heavily reliant on the WM's capacity to retrieve relevant data from long-term memory while also planning future content.

Research on WM and its influence on writing proficiency reveals a complex and multifaceted relationship between cognitive functions and writing skills across various contexts. Hebert et al. (2018) identified the unique contribution of visuospatial WM to early writing skills. Their findings set the stage for understanding how different aspects of WM can affect writing development. Following this, Zabihi (2018) examined how WM capacity interacts with writing anxiety and self-efficacy, particularly in second language (L2) learners, demonstrating that these cognitive factors significantly influence writing outcomes. Expanding on these previous findings, Michel et al. (2019) explored the differences in WM (WM) functionality and how these variations affect the writing skills of young learners. Their study emphasized that different types of tasks could demonstrate varying effects of WM on performance, indicating that the connection between WM and writing is not consistent, but instead, it depends on the context. In further studies, Mujtaba et al. (2021) investigated individual differences like language aptitude, vocabulary size, and the role of WM in the accuracy of L2 writing. They found that these elements are significant indicators of writing performance,

emphasizing that cognitive traits are vital for writing proficiency. Vasylets and Marín (2021) built on this knowledge by examining WM's effects across various proficiency levels, uncovering that at lower proficiency levels, a more robust WM is associated with improved writing accuracy, whereas at higher levels, it is linked to greater lexical sophistication. Adams et al. (2021) added another dimension to this conversation by analyzing gender differences in cognitive skills related to the advancement of writing. Their results showed different predictors for boys and girls depending on their respective types of memory, implying that gender may affect how cognitive factors influence writing skills.

Recent research has further investigated the complex relationships between WM (WM) and the quality of writing. Studies by Son (2022) and Vasylets and Marin (2021) found that individuals with greater WM capacity tend to exhibit higher levels of syntactic complexity and accuracy in their L2 writing. Furthermore, Soto et al. (2021) pointed out the difficulties encountered by individuals with attention deficit hyperactivity disorder, where deficits in WM can considerably impede their writing skills.

Interventions targeting WM have also been a focal point of recent research. Studies conducted by Colmar et al. (2020) and Shahbazi and Arjmandnia (2022) demonstrated that specific interventions aimed at enhancing WM can improve writing performance, particularly for students facing learning challenges such as dyslexia or mirror writing.

Recent investigations have further underscored the significance of WM in the context of cognitive load and anxiety. Ruffini et al. (2023) emphasized WM as a critical executive function linked to effective writing skills, while Güvendir and Uzun (2023) explored how L2 writing anxiety negatively impacts syntactic complexity under cognitive load conditions. Li (2023) reinforced the importance of understanding WM's role in L2 writing processes, suggesting that targeted training could enhance both fluency and accuracy in writing. In addition to these findings, Teng and Zhang (2024) conducted empirical studies focusing on L2 writing strategies in multimedia environments, identifying self-regulated learning strategies that highlight the positive influence of both WM and English proficiency on overall writing performance. Manchón et al. (2023) examined the effects of task complexity on L2 written performance, concluding that L2 proficiency was a more significant predictor of success than WM alone. Révész et al. (2023) investigated advanced learners' pausing and revision behaviors during essay composition, confirming the influence of WM on these processes while noting no significant differences in revision patterns based on memory capacity. Kormos (2023) revisited cognitive individual differences in L2 writing research, emphasizing the importance of cognitive factors in mediating learning outcomes during writing tasks and proposing a future research agenda.

Farrokhi et al. (2024) aimed to investigate the effect of strategic planning on the lexical complexity of Iranian EFL learners with a high WM capacity. According to the type of strategic planning, the learners with high WM capacity were categorized into three groups: form-focused (FF), content-focused (CF), and no planning (NP). After administering the pre-tests and post-tests of descriptive and argumentative tasks, based on ANOVA tests, it was revealed that the learners in FF instruction group produced better and more sophisticated writing in terms of lexis in both descriptive and argumentative tasks.

3. Method

3.1. The Design of the Study

This study employed a quantitative, correlational design to investigate the relationship between WM capacity and syntactic complexity in argumentative writing tasks among Iranian EFL upper-intermediate learners. The study utilized a between-groups approach, with participants divided into two conditions based on naturally occurring characteristics: form-focused strategic planning (FF) and content-focused strategic planning (CF). The researchers analyzed whether the strength or direction of the correlation between WM and syntactic complexity differs across these groups. This approach is useful for identifying patterns or differences in relationships across subgroups while maintaining the non-experimental nature of correlational research. However, it does not establish causation, since no variables are manipulated or controlled.

3.2. Participants

The study focused on EFL learners from five institutions in Iran. The participants, aged 20 to 27 (M=23.5), spoke Azeri, Persian, or Kurdish as their mother tongue and were all at the upper-intermediate level of English proficiency and all were female. They had prior experience studying English in secondary school and at the university level, although their majors were non-English. Initially, 220 learners volunteered for the study, but to ensure homogeneity, the Oxford Quick Placement Test (OQPT) was administered. This assessment revealed a range of proficiency levels from A1 to C2, leading to the exclusion of 56 lower proficient participants and 42 who withdrew during the study. A pilot study was conducted with 32 participants to test the methodology. Ultimately, the final sample consisted of 90 female participants, all classified as upper-intermediate (B1 and B2). This selection was deemed appropriate for the study's focus on writing essays of at least 250 words, as upper-intermediate learners possess sufficient language competence for meaningful analysis of the measures being examined. The study aimed to explore syntactic complexity measure, which is more relevant for this

proficiency level compared to advanced learners who may not exhibit significant language challenges.

3.3. Materials and Instruments

3.3.1. The Oxford Quick Placement Test (OQPT)

The Oxford Quick Placement Test (OQPT) is an assessment tool introduced in 2001 to evaluate the English language proficiency of non-native speakers and is commonly used by educational institutions and employers for appropriate placement. The OQPT consists of 60 items covering vocabulary, grammar, and cloze tests, which participants complete in 30 minutes. It has demonstrated high reliability and validity through various studies, including one by Smith et al. (2005), which confirmed its internal consistency and test-retest reliability. Scores range from 0 to 60, categorizing proficiency levels from beginner to very advanced, with upper-intermediate learners scoring between 40 and 47.

3.3.2. The Automated Version of the Operation Span Task (OSPAN)

The Automated Version of the Operation Span Task (OSPAN), developed by Turner and Engle (1989), is a widely utilized assessment tool in psychology and cognitive science that evaluates an individual's WM capacity by requiring simultaneous maintenance and manipulation of information. The task consists of a practice session divided into three sections: recalling letters, solving math operations, and performing both tasks together. As participants solve increasingly complex math problems, they must also remember and later recall a series of letters presented on the screen. The OSPAN has demonstrated high reliability and validity, with studies indicating strong internal consistency (Cronbach's alpha = 0.85; Unsworth et al., 2005) and test-retest reliability (r = 0.82; Conway et al., 2005). The entire task typically lasts 20–25 minutes and scores are based on the number of correctly recalled items across trials. The OSPAN is effective for investigating the relationships between WM and cognitive processes such as attention and language comprehension.

In order to assess the reliability, validity, and feasibility of the OSPAN, a pilot study was conducted. A representative sample of participants with the same characteristics as the target population was selected. This sample included 32 individuals considered upper-intermediate English learners. The OSPAN was administered to participants following standardized procedures and instructions. All the participants were provided with a laptop and all of them received the same version of the test. The relevant data were collected during the pilot study, including participants' performance on the OSPAN, completion time, and any subjective feedback regarding their experience with the test. The data were analyzed using appropriate statistical methods to assess the reliability and validity of the OSPAN. Specifically, Cronbach’s alpha was

calculated to estimate internal consistency reliability, yielding a coefficient of 0.86, which indicates good reliability. The validity of the test is supported by extensive prior research demonstrating its construct validity (e.g., Unsworth et al., 2005; Turner & Engle, 1989). Additionally, the pilot study results were evaluated for consistency with theoretical expectations, and no modifications were deemed necessary for future use of the OSPAN.

3.3.3. L2 Syntactic Analyzer

The L2 syntactic complexity analyzer (L2SCA), developed by Lu (2010), was used to automatically assess the syntactic complexity of written English texts produced by the learners. The analyzer processed plain text samples and generated 14 indices of syntactic complexity, including measures related to length of production units, amounts of coordination and subordination, phrasal sophistication, and overall sentence complexity. It counted various syntactic structures such as clauses, T-units, dependent clauses, coordinate phrases, and complex nominals, utilizing the Stanford parser and Tregex for syntactic parsing and querying. The web-based interface of L2SCA facilitates easy input of texts and provides both numeric and graphical outputs of syntactic complexity measures, making it a widely used and reliable instrument in L2 writing research to objectively quantify learners' syntactic development (Lu, 2010).

3.3.4. Instructional Materials

While the study did not manipulate instructional conditions experimentally, participants received naturalistic instructional sessions designed to reflect typical form-focused (FF) and content-focused (CF) writing guidance as they were pre-planning for their writing. Materials for the FF group included vocabulary lists, model sentences, grammar exercises, and sentence-combining tasks aimed at enhancing grammatical accuracy and complexity. The CF group engaged with debate prompts, mind-mapping worksheets, mentor texts, and peer feedback activities focusing on content development and organization (See Appendix A).

3.4. Procedure

In the first week of the study, the informed consent form, described in ethical codes and regulations for human subjects, was distributed among 220 students. In the following week, those who agreed to participate in the present study took the OQPT test, which was used to select students with roughly equivalent proficiency levels. Based on this test, 56 students were identified as low-proficient and excluded from the study. One hundred and sixty-four students with scores above the mean were selected. Pilot studies involving 32 participants were used to refine the methodology and improve the likelihood

of clear outcomes. Moreover, 42 students withdrew halfway, leaving 90 participants.

In the third week, the remaining participants completed the automated WM operation span test (OSPAN) which lasted approximately for 20–25 minutes per participant and was administered individually by the researchers over the course of one week. The OSPAN is a widely used measure of WM capacity that requires participants to simultaneously solve simple mathematical operations while remembering a sequence of unrelated letters. Specifically, the test presents a series of math problems (e.g., "Is (7 × 2) – 5 = 9?") that participants must verify as true or false, followed by a letter to be memorized. After a set of operation-letter pairs, participants are prompted to recall the letters in the correct order. The test consists of multiple trials with varying set sizes, typically ranging from three to seven items per set. The scoring scheme is based on the total number of correctly recalled letters in the correct order across all perfectly recalled sets, reflecting participants' WM capacity. This dual-task format effectively assesses the ability to manage processing and storage demands simultaneously, making it a reliable indicator of WM function.

Participants were then naturally assigned to two groups: a form-focused (FF) group and a content-focused (CF) group, each consisting of 45 individuals.

In the following week, the participants in the FF group all received FF instructional sessions in argumentative writing tasks. Each instructional session lasted for 90 minutes, with 30 minutes of break time between each session. They consisted of two sessions and were held in two days. In this study, several key strategies were used in order to highlight the focus on form instruction in argumentative writing tasks. The strategies used to highlight the FF instruction included teaching vocabulary by encouraging the use of diverse argumentative words, providing word banks and lists of argumentative words, and exploring synonyms and antonyms. The instruction also focused on sentence structure by teaching different sentence types and analyzing model sentences for practical grammar usage. Sentence combining activities and grammar error identification and correction exercises were used to enhance understanding of sentence structure and grammar choices.

In the first session of the argumentative writing with FF instruction, the participants were provided with a vocabulary list that dealt with the argumentative topic. For example, the meaning of the word "recreation" (a set of activities for relaxing), the word's part of speech, and some sample sentences were presented. In addition, key language forms for making arguments such as: "on the other hand," "in contrast to," and "in conclusion" are introduced. Additionally, they learned how to introduce examples or evidence (specifically, for instance, etc.), how to add additional points (furthermore,

moreover, etc.), how to compare ideas (similarly, nevertheless, etc.), how to show cause and effect (consequently, thus, etc.), how to provide an alternative view (another possibility is…, yet another, etc.), and how to emphasize a point (indeed, specifically, etc.). They all were encouraged to use these expressions in sentences, followed by explicit corrective feedback. In the second session, they were taught some grammatical structures needed to make arguments, such as modals (should, must, ought to), conditionals, adverbs of degree (very, extremely, quite), and comparatives. A focused practice with these grammatical points in the context of the topic was provided. The researchers had the participants analyze model arguments to identify argumentative language and grammar. Then, they were asked to provide some drafts, and they were corrected using some error correction techniques like reformulation to highlight correct usage. By employing these strategies, the researchers helped the students develop strong and well-structured arguments. Following the instructional sessions, the participants were asked to write a text of 250 words in length on the proposed argumentative topic for 40 minutes.

Accordingly, in the following two sessions, all of the participants in the CF group received CF instruction in argumentative writing task. Two sessions with 30 minutes of break time between sessions, were held over two days.

By incorporating strategies such as pre-writing activities, guided discussions, analysis of mentor texts, connecting to an authentic audience and purpose, peer feedback and revision, reflection and self-assessment, and real-world application, the researchers could effectively teach argumentative writing focusing on content. This process included two sessions for 90 minutes. Firstly, a class debate was organized, and students argued for and against the notion that children should have educational activities in their leisure time. They were permitted to research and present evidence to support their arguments. They were all instructed to consider the long-term effects of educational vs. non-educational leisure activities on children's overall growth and development. Then, they started to prepare the mind maps and brainstorm more arguments and counterarguments. In the second session, transition words and phrases used in argumentative texts were taught implicitly in different examples. During this session, some real-world examples were provided, and they were given feedback on their planning and mind map settings. These strategies helped students develop a deeper understanding of the content and purpose of their arguments, convey meaning effectively, engage with the topic, and create persuasive and impactful arguments. Afterwards, the participants were asked to write 250 words within 40 minutes on the pre-determined argumentative topic. Instructions involving FF and CF were provided at the beginning of each part, and the researchers directly supervised the completion of the writing tasks. No dictionaries or other reference tools were allowed while writing argumentative tasks. It is worth noting that instructional sessions

were naturalistic and standard teaching methods, not experimental interventions.

3.5. Data Analysis

3.5.1. Structural Equation Modeling (SEM)

The data collected in this study were analyzed using structural equation modeling (SEM) with IBM SPSS AMOS version 26. SEM was employed to test the hypothesized relationships between Iranian EFL learners' WM capacity, strategic planning (form-focused vs. content-focused), and syntactic complexity in argumentative writing.

3.5.2. Syntactic complexity

In the present study, syntactic complexity was used as an analytic measure to assess the structural intricacy of the participants' argumentative writing. Syntactic complexity refers to the intricacy of sentence structures, often associated with advanced language proficiency and cognitive abilities, influenced by factors such as native language, education, and exposure to diverse linguistic patterns. It encompasses characteristics such as sentence length, variation in morphemes, and the interdependence of clauses, facilitating the nuanced expression of ideas. However, excessive complexity can impede comprehension, particularly for non-native speakers. Researchers advocate using varied measures to assess different subcomponents of syntactic complexity rather than relying on singular metrics. The current study focuses on L2SCA to measure the syntactic complexity (See Appendix B).

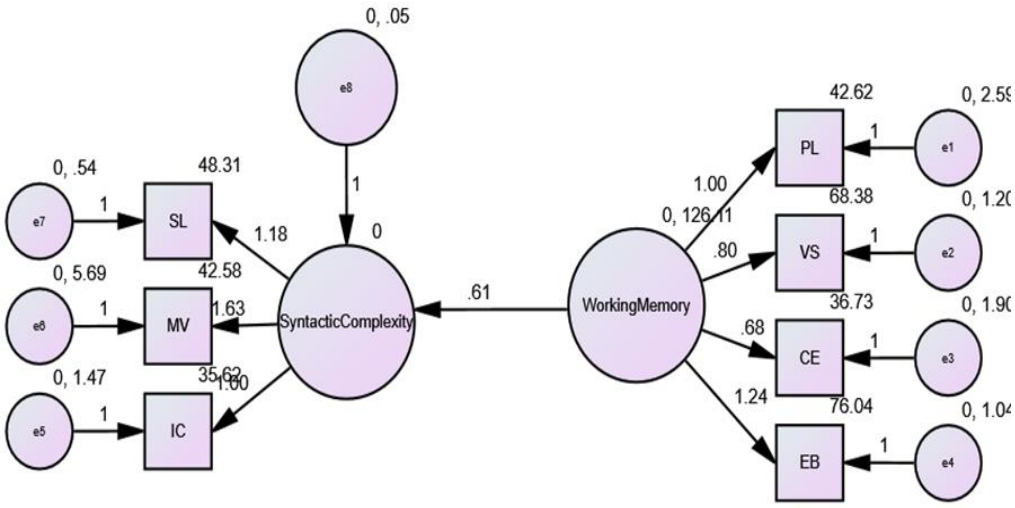
4. Results

4.1. Investigation of the First Research Question

Research question 1 was an endeavor to determine the extent to which Iranian EFL upper-intermediate learners' WM capacity predicted their syntactic complexity in argumentative writing task type instructed by form-focused strategic planning. As a result, the researchers used SEM for analyzing the obtained data. Figure 1 provides the model of the predictors of EFL learners' syntactic complexity in FF Strategic Planning Instruction (FFSPI).

Figure 1

Model of EFL Learners' Syntactic Complexity in FFSPI



The researchers examined the regression weight of EFL learners' WM to determine the degree to which it predicted EFL learners' syntactic complexity. Table 1 shows these results:

Table 1

Regression Weight of the Model in FFSPI

			Estimate	S.E.	C.R.	P
Syntactic Complexity	<---	Working Memory	.615	.028	2.825	.000

As shown in Table 1, EFL learners' WM was a significant predictor of their syntactic complexity in FFSPI (C.R.>1.96; p <.05). Therefore, the researchers examined the standardized estimates. Table 2 provides the relevant results:

Table 2

Standardized Estimates of the Model in FFSPI

Syntactic Complexity			**Estimate**
PL	<---	Working Memory	.990
VS	<---	Working Memory	.993
CE	<---	Working Memory	.984

According to Table 2, the VS (.993), PL (.990), and CE (.984) sub-components of EFL learners' syntactic complexity were respectively the first, the second, and the third variables that were significantly predicted by their WM in FFSPI. Consequently, the researcher examined the model fit. Table 3 shows these results.

Table 3
Model Fit in FFSPI

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	22	39.832	13	.571	2.064

According to Table 3, the model fit was satisfactory (p>.05; CMIN<3). Consequently, the researchers examined the baseline comparisons of this model to ensure its fit. Table 4 shows these results. As shown in Table 4, EFL learners' model fit in FFSPI was acceptable (IFI>.90; TLI>.90; & CFI>.90).

Table 4
Baseline Comparisons of Model in FFSPI

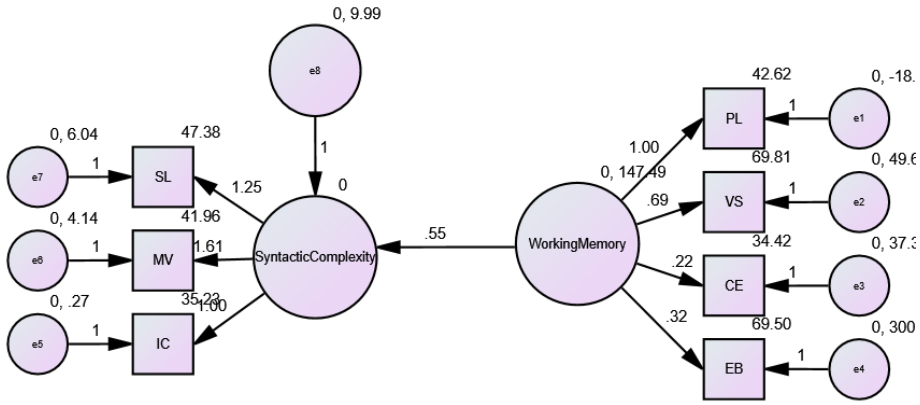
Model	IFI Delta2	TLI rho2	CFI
Default model	.953	.924	.953

4.1.1. Investigation of the Second Research Question

Research question two strived to determine the extent to which Iranian EFL upper-intermediate learners' working memory capacity predicted their syntactic complexity in argumentative writing task type instructed by content-focused strategic planning. As a result, the researcher used SEM to analyze the data. Figure 2 shows the model of the predictors of EFL learners' syntactic complexity in Content-Focused Strategic Planning Instruction (CFSPI).

Figure 2

Model of EFL Learners' Syntactic Complexity in CFSPI



The researchers scrutinized the regression weight of EFL learners' WM to determine the degree to which it predicted their syntactic complexity in CFSPI. Table 5 provides these results.

Table 5

Regression Weight of the Model in CFSPI

			Estimate	S.E.	C.R.	P
Syntactic Complexity	<---	Working Memory	.555	.041	3.556	.000

According to Table 5, EFL learners' WM was a significant predictor of their syntactic complexity in CFSPI (C.R.>1.96; p<.05). Consequently, the researchers examined the standardized estimates. Table 6 provides the relevant results:

Table 6

Standardized Estimates of the Model in CFSPI

Syntactic Complexity			Estimate
PL	<---	Working Memory	.982
VS	<---	Working Memory	.766
CE	<---	Working Memory	.695

According to Table 6, the PL (.982), VS (.766), and CE (.695) sub-components of EFL learners' syntactic complexity were respectively the first, the second, and the third variables that were significantly predicted by their WM in MFSPI. Therefore, the researchers examined the model fit. Table 7 shows these results:

Table 7
Model Fit in CFSPI

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	22	56.740	13	.674	1.037

According to Table 7, the model fit was satisfactory (p>.05; CMIN<3). Therefore, the researchers examined the baseline comparisons of this model to ensure its fit. Table 8 shows these results. As shown in Table 8, EFL learners' model fit in CFSPI was acceptable (IFI>.90; TLI>.90; & CFI>.90). As a result, WM is able to predict both types of strategic planning. However, as the model fit indices were higher in CFSPI, it is evident that the predictivity of WM was stronger in CFSPI compared to FFSPI.

Table 8
Baseline Comparisons of Model in CFSPI

Model	IFI Delta2	TLI rho2	CFI
Default model	.964	.974	.960

4. Discussion

The present study's findings underscore the significant predictive role of WM in predicting the syntactic complexity of argumentative writing among EFL female learners. The strong positive correlations observed suggest that learners with higher WM capacity tend to produce more complex syntactic structures. This outcome aligns with cognitive theories of writing, which posit that writing is a demanding process requiring simultaneous management of multiple cognitive tasks (Olive, 2004). Specifically, WM supports the coordination of idea generation, linguistic formulation, and text organization, all of which are essential for constructing syntactically complex sentences.

Interpreting these results, it appears that WM capacity facilitates the ability to manage cognitive load effectively during writing. Learners with greater WM resources can sustain attention on syntactic formulation without being overwhelmed by the concurrent demands of content generation and language encoding. This interpretation is consistent with Gao et al. (2023), who elucidate that effective writing necessitates the integration of new information with existing knowledge, a process crucial for the development of sophisticated arguments in writing. For EFL learners, this integration is particularly challenging as it requires simultaneous navigation of linguistic proficiency and composition skills. The significance of WM in this context can be attributed to several reasons: first, higher WM capacity enables learners to

manage cognitive load effectively, allowing them to focus on producing complex syntactic structures without becoming overwhelmed; second, strong WM capabilities facilitate the integration of new ideas with previously acquired knowledge, enhancing the construction of sophisticated arguments; third, maintaining hierarchical relationships between components is essential for producing grammatically correct and complex sentences; fourth, more complex writing tasks demand greater WM involvement due to their intricate nature; fifth, strategic planning improves accuracy and fluency while contributing to greater syntactic complexity; and finally, writing anxiety can impair WM utilization, leading to simpler structures.

An expected finding of the current study was the positive relationship between WM and syntactic complexity, which corroborates earlier research by Daffern et al. (2017) and Son (2022), who similarly reported that enhanced WM capacity is associated with improved writing quality and syntactic sophistication. However, the study also highlighted the moderating influence of strategic planning on this relationship, which adds nuance to the understanding of WM's role. The finding that strategic planning contributes to syntactic complexity supports the theoretical framework that cognitive resources, including WM, are optimized through structured pre-task planning (Asgarikia, 2014; Khonamri et al., 2017). This suggests that WM does not operate in isolation but interacts dynamically with metacognitive strategies to enhance writing performance.

One plausible explanation for these findings is that strategic planning reduces the cognitive load during the actual writing process by allowing learners to organize ideas and structure arguments beforehand (Nowak, 2021). This preparatory phase likely frees WM resources, enabling more attention to syntactic detail and complexity. Moreover, strategic planning may mitigate writing anxiety, which is known to impair WM utilization and lead to simpler sentence structures. This interplay between cognitive capacity and affective factors highlights the multifaceted nature of writing proficiency development.

Critically, while the results affirm the centrality of WM in writing, they also suggest that interventions targeting WM alone may be insufficient. The integration of strategic planning workshops, as advocated by Okasha and Hamdi (2014), appears crucial for fostering both cognitive and motivational aspects of writing. This holistic approach addresses the cognitive demands of writing while empowering learners with effective strategies, thereby promoting greater syntactic complexity and overall writing quality.

In linking these findings to the theoretical underpinnings of the study, the results support models of writing that emphasize the interaction between cognitive resources and metacognitive control (Flower & Hayes, 1981). WM capacity serves as a foundational cognitive resource, but its effective deployment depends on strategic regulation and planning. This synergy is

particularly vital in second language contexts, where linguistic processing demands are higher.

5. Conclusion and Implications

This study set out to examine the extent to which Iranian EFL female upper-intermediate learners' WM capacity could predict their performance on syntactic complexity in argumentative writing tasks instructed through form-focused and content-focused strategic planning. The findings revealed that WM was a significant predictor of Iranian EFL upper-intermediate learners' syntactic complexity in argumentative writing tasks instructed by form-focused and content-focused strategic planning. These findings suggest that EFL learners with higher WM capacity were able to better utilize the form-focused and content-focused strategic planning instruction to enhance the syntactic complexity of their argumentative writing performance. The substantial influence of WM capacity on argumentative writing performance in the form-focused and content-focused strategic planning instructional contexts underscores the critical importance of acknowledging and addressing individual variations in cognitive aptitudes when implementing writing instruction, especially for more intellectually challenging task types such as argumentation. The CF group's superiority highlights the importance of WM in balancing content generation with linguistic precision, as learners with robust WM capacities can allocate resources more efficiently during planning and execution. Conversely, FF planning's narrower focus on grammatical form may impose higher cognitive loads, limiting syntactic innovation despite WM support.

The implications of these findings are profound for EFL instruction. Educators should consider incorporating activities designed to enhance WM alongside strategic planning techniques to optimize writing outcomes. By doing so, they can create a more supportive learning environment that addresses the unique challenges faced by EFL learners. Educators should prioritize CF approaches for upper-intermediate learners, as these methods align more closely with WM's role in managing complex, multidimensional writing tasks. By aligning strategic planning methods with learners' cognitive profiles, Iranian EFL instruction can foster both linguistic precision and creative expression.

Moreover, the relationship between WM and writing performance suggests that instructional practices should be informed by empirical research on cognitive processes involved in writing. Investigating other cognitive factors alongside WM, such as phonological awareness and executive functioning, can provide a more comprehensive understanding of their interplay in writing tasks. Longitudinal studies on WM training could establish causal links between WM improvements and sustained writing proficiency

gains. Cross-linguistic comparisons can reveal how WM's role varies across different L1-L2 pairings. Additionally, examining task complexity and its impact on WM allocation, as well as using neuroimaging techniques to study neural correlates of WM engagement, can offer deeper insights into cognitive processes during writing. Integrating technology to personalize writing instruction based on WM capacity and expanding outcome measures to include fluency and lexical diversity are also promising avenues. Finally, exploring how learner variables like proficiency and motivation moderate the WM-syntactic complexity relationship can help tailor instructional strategies to individual needs.

In summary, the study confirms that WM is a key predictor of syntactic complexity in EFL writing, with strategic planning playing a critical mediating role. These findings have important pedagogical implications, suggesting that EFL instruction should integrate cognitive training with strategy development to enhance writing proficiency. Future research might explore additional moderating variables, such as writing anxiety or motivation, and gender to further elucidate the complex mechanisms underlying L2 writing development.

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Appendix A
Strategic Planning Options

Form-Focused Instruction

Sample vocabularies

Vocabulary	Meaning
Enrichment	additional educational experiences that supplement regular schoolwork
Intellectual stimulation	activities that challenge the mind and promote cognitive development
Creativity	the use of imagination and original ideas to produce something new
Self-confidence	a feeling of trust in one's own abilities and worth
Skill development	opportunities to build specific abilities like problem-solving, creativity, communication
Academic preparation	activities that help reinforce and expand on school curriculum
Well-rounded education	a balance of academic, social, physical, and creative pursuits
Lifelong learning	cultivating a love of learning and curiosity beyond the classroom
Overscheduling	having too many structured activities leaving little free time
Burnout	mental, emotional, or physical exhaustion from excessive demands
Social isolation	fewer chances for unstructured social interaction with peers
Extracurricular	school-sponsored activities that complement the academic curriculum
Recreation	activities done for enjoyment, relaxation, and personal fulfillment
Overcommitment	taking on more activities and responsibilities than one can reasonably handle
Resentment	a feeling of indignant displeasure or hostility towards something
Quality time	meaningful, undivided attention and interaction between family members

Discourse markers

Introducing a claim or argument: In my opinion... I believe that... It is my view that... My position is that...	Providing supporting evidence: For example, ... Specifically, ... To illustrate this point, ... This is demonstrated by...
Acknowledging Counterarguments On the other hand, ... Some might argue that... It could be said that... However, it is important to note that...	Transitioning Between Ideas Furthermore, ... Additionally, ... In fact, ... Consequently, ... As a result, ...
Emphasizing a Point: Indeed, Certainly, Undoubtedly, Clearly,	Concluding an Argument In conclusion, ... Ultimately, ... All things considered, ... Therefore, ...

Sample grammar rules

1. Conditional Sentences:
   Meaning: Conditional sentences express a condition and its resulting action or consequence.
   Structure:
   If-clause (condition) + main clause (result)
   Example: "If children have educational activities in their leisure time, they may gain valuable skills."
2. Modal Verbs:
   Meaning: Modal verbs express possibility, necessity, obligation, or permission.
   Examples:
   "Children may benefit from educational activities in their leisure time."
   "Parents should consider the potential drawbacks of overscheduling children."
   "Children must have time for unstructured play and relaxation."
3. Comparative and Superlative Adjectives:
   Meaning: Comparative adjectives compare two things, while superlative adjectives compare three or more things.
   Comparative structure: Adjective + -er or "more" + adjective

Superlative structure: The + adjective + -est or "the most" + adjective
Examples:
"Educational activities can be more beneficial than pure leisure time."
"Unstructured play is the most important aspect of a child's development."

4. Gerunds and Infinitives:
   Meaning: Gerunds are verb forms used as nouns, while infinitives are verb forms used to express purpose or intention.
   Gerund structure: Verb + -ing
   Infinitive structure: To + verb
   Examples:
   "Engaging in educational activities can enhance a child's learning."
   "To provide a balanced approach, parents should allow time for both enrichment and free play."
5. Transition Words and Phrases:
   Meaning: Transition words and phrases help connect ideas and show the relationship between them.
   Examples:
   "However, this view fails to consider the drawbacks of overscheduling children's lives."
   "Additionally, quality family time is often sacrificed when children are constantly shuttled between activities."
   "On the other hand, proponents might argue that a balanced approach is possible."

Content-focused instruction

Paragraph 1 (Introduction)

In today's fast-paced, competitive world, some parents believe that children should make the most of every moment, even their leisure time, by engaging in educational activities. The argument is that this approach maximizes children's learning and development, ensuring they are well-prepared for future academic and career success. However, this view fails to account for the vital importance of unstructured play and downtime in a child's life. While educational enrichment has its merits, it should not come at the expense of a child's overall well-being and healthy childhood.

Paragraph 2 (Advantages of Educational Leisure Activities)

Proponents of educational leisure activities make a compelling case. In an era of increasing global competition, parents understandably want to give their children every possible advantage. Participating in activities like educational summer camps, coding workshops, or language classes can provide valuable intellectual stimulation and skill development that complements school curriculum. Children may gain a deeper understanding of

academic subjects, build critical thinking abilities, and even get a head start on future career paths. Additionally, many educational leisure activities are structured to be engaging and fun, allowing children to learn through play. From this perspective, making the most of leisure time is simply good parenting.

Paragraph 3 (Disadvantages of Educational Leisure Activities)

However, this view fails to consider the drawbacks of overscheduling children's lives with educational activities, even those disguised as recreation. Constant academic pressure and a packed schedule can lead to burnout, stress, and resentment in children. Unstructured free time is essential for children to recharge, explore their own interests, and develop important social skills through play. Childhood is a precious, fleeting time, and children need space to be children - to daydream, to get bored, to use their imaginations. Filling every moment with enrichment activities robs them of the many benefits of true leisure and play. Additionally, quality family time is often sacrificed when children are constantly shuttled between activities.

Paragraph 4 (Counterargument and Rebuttal)

Proponents might argue that a balanced approach is possible, with a mix of educational activities and free play. However, in reality, the structured, adult-directed nature of most educational activities means that even when children are not directly in school, their time is still heavily scheduled and controlled. True free time and self-directed play are squeezed out. The stress of trying to excel at multiple activities can also take a toll on children's mental health and family life.

Paragraph 5 (Conclusion)

While the intentions behind educational leisure activities are understandable, the disadvantages ultimately outweigh the benefits. Childhood is a crucial period for cognitive, social, and emotional development, and play is essential to this process. Filling children's leisure time with even more academics, no matter how engaging, is counterproductive. A balanced approach that allows ample time for both enrichment and free play is ideal. But when push comes to shove, it is vital that children have the space to simply be children - to rest, to explore, and to grow into happy, well-adjusted adults.

Appendix B

An Example of the L2 Syntactic Complexity Analyzer (L2SCA) Output

The following table illustrates sample syntactic complexity indices generated by the L2SCA for a written text sample from an upper-intermediate EFL learner. The indices reflect various aspects of syntactic complexity, including length of production units, coordination, subordination, and phrasal sophistication. Based on the example L2SCA indices, the text appears syntactically complex, reflecting a good command of varied grammatical structures appropriate for upper-intermediate learners.

	A	B	C	D
1	Index Abbreviation	Index Name	Description	Example Value
2	MLT	Mean Length of T-unit	Average number of words per T-unit	12.5
3	MLC	Mean Length of Clause	Average number of words per clause	9.8
4	C/T	Clauses per T-unit	Number of clauses divided by T-units	1.4
5	DC/C	Dependent Clauses per Clause	Ratio of dependent clauses to total clauses	0.35
6	CN/C	Complex Nominals per Clause	Number of complex nominals per clause	0.8
7	CP/C	Coordinate Phrases per Clause	Number of coordinate phrases per clause	0.6
8				