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Cognitive Load and Working Memory in Sharaf Rule Acquisition

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ABSTRACT

This study investigates cognitive load and rule acquisition in sharaf (Arabic morphology) learning, with particular attention to the role of working memory among third-semester students of the Arabic Language Education Program at IAIN Kerinci. Employing a qualitative case study design, data were collected through in-depth interviews with 10 students and participatory observation in sharaf classes. Thematic analysis revealed four primary challenges: (1) the linguistic complexity and irregularity of morphological patterns that burden memory, (2) limited working memory capacity that constrains the recall and application of rules, (3) pedagogical gaps caused by lecture-dominated methods with minimal student engagement, and (4) differences in students' educational backgrounds that affect comprehension. The study further identified effective strategies for reducing cognitive load, including material simplification with visual aids, structured and contextual repetition, task-based learning, and metacognitive training. These findings highlight the importance of adaptive teaching approaches aligned with students' cognitive capacities to enhance Arabic language instruction.

Keyword
Cognitive Load; Rule Acquisition; Sharaf Learning; Working Memory

ملخص

يهدف هذا البحث إلى دراسة عبء الإدراك واكتساب القواعد في تعلّم الصرف العربي، مع التركيز على دور الذاكرة العاملة لدى طلاب الفصل الثالث في قسم تعليم اللغة العربية، الجامعة الإسلامية الحكومية كيرنجي (IAIN Kerinci). اعتمد البحث المنهج النوعي بتصميم دراسة حالة، حيث جُمعت البيانات من خلال مقابلات متعمقة مع عشرة طلاب وملاحظة بالمشاركة في دروس الصرف. أظهرت نتائج التحليل الموضوعي أربعة تحديات رئيسة: (1) التعقيد اللغوي وعدم انتظام الأنماط الصرفية الذي يرهق الذاكرة، (2) محدودية سعة الذاكرة العاملة التي تعيق استدعاء القواعد وتطبيقها، (3) الفجوة البيداغوجية الناتجة عن هيمنة أسلوب المحاضرة وضعف تفاعل الطلاب، و(4) اختلاف الخلفيات التعليمية للطلاب مما يؤثر في مستوى الفهم. كما توصّل البحث إلى استراتيجيات فعّالة لتقليل عبء الإدراك،

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منها تبسيط المواد باستخدام الوسائل البصرية، التكرار السياقي والمنظم، التعلم القائم على المهام، والتدريب على المهارات فوق المعرفية. وتؤكد النتائج أهمية اعتماد أساليب تعليمية تكيفية تراعي القدرات الإدراكية للطلاب لتعزيز فاعلية تعليم اللغة العربية.

الكلمات الرئيسية العبء المعرفي؛ اكتساب القاعدة؛ تعلم الصرف؛ الذاكرة العاملة

INTRODUCTION

The learning of Arabic as a Foreign Language (AFL) presents intricate challenges, particularly in the domain of morphology (ṣarf). Arabic morphology is characterized by a complex system of derivation and inflection, encompassing vowel alternations, the addition of affixes, and irregular rules that are often unpredictable. This intricacy distinguishes the acquisition of Arabic morphology from that of structurally simpler languages such as Indonesian or English (Jabir, 2021). Research in the field of Second Language Acquisition has consistently demonstrated that highly rule-dense morphological systems tend to impose a substantial cognitive burden on learners, thereby impeding the fluency of communication. (Rivera, 2023).

The most relevant theoretical framework for understanding these challenges is Cognitive Load Theory (CLT). CLT posits that human working memory can only process a limited amount of information at any given time. When instructional material is excessively complex or presented in an unstructured manner, it generates extraneous load that disrupts comprehension (Mayer, 2014). In the context of ṣarf learning, students frequently encounter a high intrinsic load due to the necessity of recalling multiple derivational patterns simultaneously. This burden is further exacerbated when teaching methods remain lecture-centered without the support of visual aids or task-based practice.

The concept of working memory is also crucial in explaining how students manage ṣarf rules (Baddeley, 1992) defines working memory as a cognitive system responsible for temporarily storing and manipulating information during the learning process. More recent studies affirm that the capacity of working memory is directly associated with learners' ability to master the grammatical structures of a second language (Cowan, 2014). Therefore, examining the relationship between working memory capacity and the acquisition of Arabic morphology is essential, given the substantial cognitive demands inherent in ṣarf learning.

In Indonesia, Arabic is generally studied for academic and religious purposes, such as understanding the Qur'an, Hadith, and classical literature (Yul & Andrian, 2024). However, several studies have reported that students encounter significant difficulties in mastering ṣarf across various educational settings, including pesantren, madrasah, and universities (Syahruddin, 2015). Most previous research has primarily emphasized pedagogical factors, such as the prevalence of traditional lecture-based methods, while cognitive dimensions particularly the burden on working memory have rarely been the focus of investigation. This indicates a clear research gap in the study of ṣarf learning in Indonesia, especially regarding approaches that integrate perspectives from cognitive psychology.

In addition, previous studies addressing cognitive load in the context of language learning have predominantly focused on English or other European languages (Paas, 1994). Research specifically examining Arabic remains relatively limited, despite the fact that Arabic is characterized by a distinctive non-linear morphological system that differs significantly from Indo-European languages (Abu, 2018). Thus, this study is not only relevant to the local Indonesian context but also contributes to the broader global discourse on the teaching of Arabic as a foreign language.

The context of this study focuses on third-semester students of the Arabic Language Education Program at IAIN Kerinci. At this stage, students have already acquired the foundational knowledge of nahwu and ṣarf, yet they continue to experience difficulties in applying grammatical rules to reading and writing practices (Ayumi et al., 2025). Preliminary observations revealed a high cognitive burden when students were required to recall complex derivational patterns, particularly during written examinations or conversational practice. Accordingly, this study positions students of Arabic Language Education at IAIN Kerinci as a representative case for understanding the dynamics of cognitive load in ṣarf learning within higher education.

The main contribution of this study lies in its attempt to integrate the perspective of Cognitive Load Theory (CLT) with the teaching practices of ṣarf. The findings are expected to provide novelty by mapping students' cognitive challenges and identifying effective instructional strategies to reduce the burden on working memory. Contextual and application-based models have been shown to reduce cognitive load and foster deeper and more meaningful student understanding (Andrian & Yul, 2023) Thus, this study not only addresses a gap in the literature but also offers practical contributions to the development of curriculum and Arabic language teaching methods in Indonesia, particularly in the domain of morphology.

Based on the foregoing discussion, this study was designed to address three main research questions: (1) What cognitive and pedagogical challenges do students face in learning ṣarf? (2) How does working memory capacity influence students' ability to master Arabic morphological rules? (3) What instructional strategies can be applied to reduce cognitive load and enhance the acquisition of ṣarf rules? By answering these questions, the study seeks to provide a theoretical contribution to the field of second language acquisition while also offering practical recommendations for lecturers and curriculum designers to improve the effectiveness of Arabic language instruction.

METHOD

This study employed a qualitative approach with a case study design (Yin., 2018). The case under investigation was the process of ṣarf learning among third-semester students in the Arabic Language Education Program at IAIN Kerinci, with a specific focus on how students managed cognitive load in understanding Arabic morphological rules. The case study design was chosen because it allows researchers to gain an in-depth understanding of a complex phenomenon within its real-life context (Creswell & Poth, 2018).

The participants of this study consisted of 20 third-semester students of the Arabic Language Education Program who had completed the ṣarf course. From this group, 10 students were purposively selected for in-depth interviews based on variations in academic performance (high, medium, and low) in order to capture diverse perspectives. In addition, the lecturer responsible for teaching the ṣarf course was also involved as an additional informant to enrich the data.

The research instruments included: (1) a semi-structured interview guide containing questions related to students' experiences in learning ṣarf, the difficulties encountered, the strategies employed, and their perceptions of teaching methods; and (2) a participatory observation sheet used by the researcher to record classroom dynamics, lecturer–student interactions, and instructional strategies that influenced students' cognitive load. The interview guide was developed based on the principles of qualitative instrument design (Kvale & Brinkmann, 2009), while the observation sheet was constructed with reference to categories of learning activities as outlined by Spradley Spradle (1980).

Data were collected through in-depth interviews with 10 students (each lasting 45–60 minutes), participatory observations conducted during six ṣarf class sessions, and document analysis of the syllabus and teaching materials. All interviews were audio-recorded with participants' consent and transcribed verbatim for further analysis.

Data were analyzed using a thematic analysis approach (Braun & Clark, 2006). The process involved six stages: (1) familiarization with the data through repeated readings, (2) generating initial codes for meaningful units, (3) grouping codes into categories, (4) identifying major themes, (5) reviewing and refining the themes, and (6) writing the analytical report supported by illustrative quotations from participants. The analysis was carried out independently by three researchers and subsequently compared to ensure consistency of interpretation. Data analysis was conducted using a thematic analysis approach. The process comprised six stages: (1) familiarization with the data through repeated readings, (2) generating initial codes for units of meaning, (3) grouping codes into categories, (4) identifying the main themes, (5) reviewing and refining the themes, and (6) writing the analytical report with illustrative quotations from participants. The analysis was independently conducted by three researchers and then compared to ensure consistency of interpretation.

From an ethical standpoint, the researchers obtained official approval from the faculty and the study program. Each participant was informed about the purpose of the research, the confidentiality of the data, and their right to withdraw at any time. Participation was entirely voluntary, with informed consent obtained through signed consent forms. To ensure confidentiality, participants' names were anonymized using codes.

RESULTS&DISCUSSION

Challenges in Managing Cognitive Load Among IAIN Kerinci Students

The findings of this study reveal that students at IAIN Kerinci faced multifaceted challenges in managing cognitive load when learning sharaf (Salvia,R et al., 2025). Empirical

data from interviews and observations show that learners struggle with (1) the complexity of morphological rules and numerous exceptions, (2) the limitations of working memory when recalling and applying rules, (3) the predominance of lecture-based teaching methods, (4) diverse linguistic and educational backgrounds, and (5) external stressors such as exam-related anxiety. These findings indicate that the learning process is burdened not only by the amount of information but also by how students process, store, and retrieve it in authentic contexts.

From a theoretical perspective, these difficulties align with Cognitive Load Theory (Sweller et al., 2011; Clark et al., 2006), which emphasizes that learning effectiveness decreases when the information load exceeds working memory capacity. For example, the need to memorize irregular patterns and exceptions (Syarifaturrahmatullah et al., 2023; Syuhada, 2011) represents intrinsic cognitive load that cannot be eliminated but can be managed through instructional strategies. Similarly, exam-induced stress was observed to disrupt working memory performance, confirming the theoretical link between extraneous cognitive load and reduced learning outcomes (Yul et al., 2022).

Comparing these findings with previous research, similar issues have been reported. Hajar & Qohar (2024) identified that irregularities in Arabic morphology demand more intensive memorization, while Lestari et al., (2023) demonstrated how positive or negative emotional states influence the efficiency of working memory in students. Pedagogically, Jafar & Haq (2024) and Olang & Soesanto (2023) observed that lecture-dominated instruction limits students' active engagement, consistent with the challenges documented at IAIN Kerinci. Meanwhile, studies advocating for task-based and participatory approaches support the argument that interactive methods can effectively lower extraneous cognitive load.

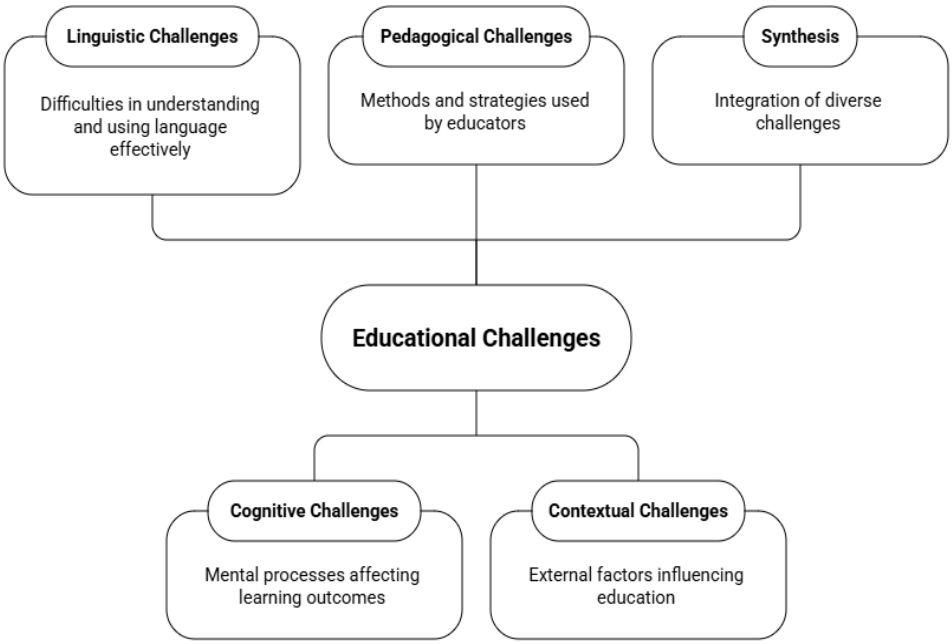

Figure1. Challenges in Managing Cognitive Load in Sharaf Learning

Based on Figure 1 above, it can be seen that the process of mastering sharaf is strongly influenced by the role and limitations of working memory. The limited capacity of working memory generates a higher cognitive load when students are confronted with the complexity of Arabic morphological rules. This cognitive load subsequently gives rise to various challenges in sharaf learning. To address these challenges, appropriate instructional strategies are required, such as material simplification, task or project-based learning, effective and contextual repetition, the use of visual aids, and metacognitive training. Through the implementation of these strategies, the expected learning outcomes can be achieved, namely deeper understanding and the effective application of sharaf rules across different contexts. The relationship between working memory, cognitive load, instructional strategies, and expected learning outcomes in sharaf learning can be summarized in the following table:

Table 1 : The Relationship between Working Memory, Cognitive Load, Instructional Strategies, and Learning Outcomes in Sharaf Learning

Problem / Challenge	Cognitive Aspect	Instructional Strategy	Expected Outcome
The intricacy of *ṣarf* rules and numerous exceptions	Limited working memory capacity to store morphological patterns and variations	Simplification of materials and the use of visual aids	Rules are processed more easily, and morphological patterns are understood more quickly
Overload resulting from rote memorization without comprehension	Increased cognitive load leading to mental fatigue	Contextual and structured repetition (reinforcement through varied sentence examples)	Memorization becomes more meaningful, and rules are easier to retain and apply
Theory–practice gap	Dual-task demand: recalling rules while applying them	Task-/Project-based learning (problem solving, conversational/writing application)	Smoother transfer of knowledge from theory to practice
Exam pressure and assessment demands	Stress disrupts working memory	Task-based assessment and incremental practice	Reduced anxiety and more stable information recall
Lack of reflection and learning regulation	Limited student metacognitive skills	Metacognitive training (study strategies, time management, self-reflection)	Students become more independent in managing cognitive load

Table 1 provide a visual synthesis of the challenges and strategies in managing cognitive load. The figure outlines how linguistic irregularities, working memory limitations, pedagogical gaps, and contextual differences interact to create significant strain in sharaf learning. Meanwhile, the table maps specific problems such as rote overload,

exam stress, or theory–practice gaps to corresponding instructional strategies. This visual representation highlights that students' learning difficulties are not isolated but systematically interconnected.

More importantly, these visual tools illustrated how effective strategies—simplification, contextual repetition, task-based learning, and metacognitive training can reduce unnecessary load and optimize working memory. By framing the learning process in terms of cognitive mechanisms, the figure and table translate abstract theory into practical pedagogy. This makes the findings more accessible not only for researchers but also for instructors designing interventions in Arabic language instruction.

Finally, the contribution of this study lies in integrating linguistic, cognitive, pedagogical, and contextual challenges into a unified model of sharaf learning. Unlike prior studies that treated these aspects separately, this research develops a comprehensive framework visually articulated through Figure 1 and Table 1 that connects working memory, cognitive load, instructional strategies, and learning outcomes. This novelty strengthens the application of Cognitive Load Theory in Arabic morphology learning and offers a pedagogical roadmap that can inform curriculum design in similar higher education contexts.

Working Memory and the Acquisition of Sharaf Rules

The findings of this study further emphasize the central role of working memory in the acquisition of sharaf rules. Empirical evidence from interviews and observations showed that students with limited working memory capacity struggle to process complex morphological information, such as word transformation patterns, the addition of affixes, and irregular rules. These challenges often lead to incomplete comprehension and frequent errors when applying the rules in authentic communication. Students reported that repetitive memorization without meaningful understanding causes mental fatigue, while the simultaneous demand to recall and apply rules in practical tasks further intensifies their cognitive burden.

From a theoretical standpoint, these results are consistent with Baddeley's conception of working memory as a cognitive system for temporarily storing and manipulating information during active processing (Asiva Noor Rachmayani, 2015). The limited capacity of working memory, typically constrained to 7 ± 2 units of information, presents a fundamental obstacle for mastering sharaf rules, which are characterized by high variability and exceptions (Sweller et al., 2011). This aligns with Sweller's Cognitive Load Theory, which highlights that excessive cognitive demands undermine the efficiency of working memory, thereby hindering learning effectiveness (Clark et al., 2006).

The empirical findings also resonate with previous studies. Gathercole and Baddeley, as cited in Charlota Lerik (2016), showed that individuals with larger working memory capacity handle complex information more successfully and apply it in broader contexts. In the context of sharaf, this explains why students with higher working memory are able to recall and apply rules in conversation or writing more effectively. Similarly, Walkup (2013) demonstrated that structured repetition at strategic intervals strengthens long-term memory, which corresponds with the finding that contextualized repetition of

sharaf patterns aids retention without overloading working memory. In addition, (Rati et al., 2017) proved the effectiveness of project-based learning in bridging theory and practice, which mirrors how dual-task approaches can optimize students' ability to recall and apply rules in real-life contexts. Furthermore, Rizkiyatul Amaliyah, as cited by Siti Maryam (2023), confirmed that students who are trained in metacognitive strategies such as reflection, time management, and study regulation are more successful in managing limited memory resources. These various strategies—repetition, task-based learning, and metacognitive regulation demonstrate how working memory performance can be optimized in sharaf learning. This relationship is visually summarized in Figure 2.

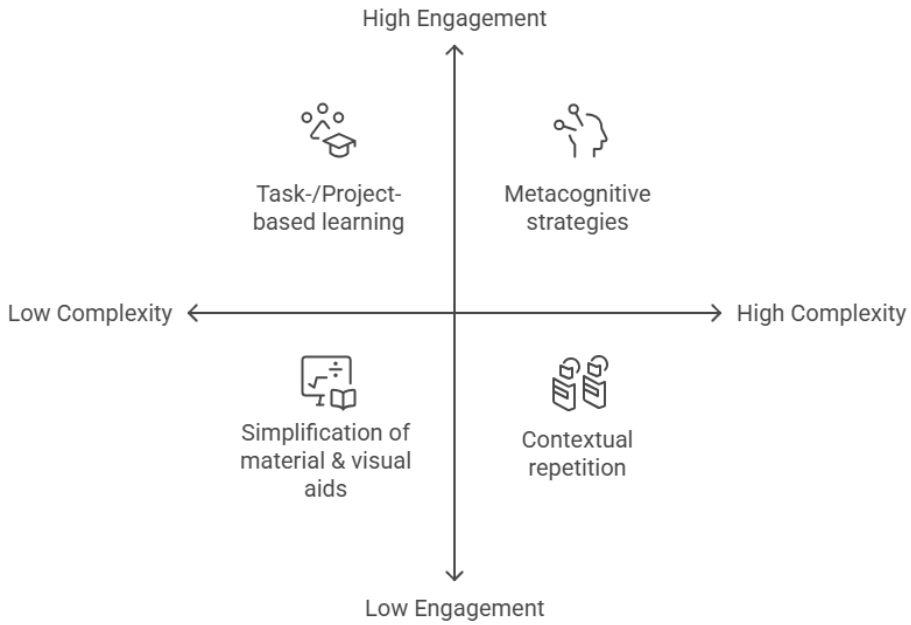

Figure 2. Strategies to Enhance Working Memory for Mastery

Figure 2 illustrated that students' working memory capacity, while inherently limited, can be supported through carefully designed instructional strategies. Simplification of materials, structured repetition, task-based or project-based learning, and metacognitive training are shown to strengthen memory function and facilitate the mastery of complex sharaf rules. These strategies allow students to shift from rote memorization to meaningful application, thereby enhancing long-term retention and practical language use.

Positioning these findings among existing theories and studies showed that the case of IAIN Kerinci students uniquely demonstrates how working memory limitations interact with linguistic complexity and instructional practices. Whereas previous research often examined these aspects separately, this study integrates them by showing that morphological irregularities, rote learning habits, and test-related anxiety jointly pressure working memory. This integrated perspective underscores the multifactorial nature of cognitive challenges in second language acquisition, particularly in Arabic morphology.

The contribution of this study lies in empirically validating the role of working memory in sharaf acquisition within the Indonesian higher education context and offering a set of practical pedagogical strategies to address its limitations. Simplification of materials,

use of visual aids, contextualized repetition, dual-task learning, and metacognitive training are shown to enhance the efficiency of working memory and promote deeper understanding of morphological rules. The novelty of this study is its ability to translate Cognitive Load Theory into a comprehensive pedagogical framework for Arabic morphology, demonstrating how theoretical insights can be operationalized into instructional practices that directly support students' cognitive conditions.

Implications of Sharaf Teaching Techniques at IAIN Kerinci

The empirical findings of this study indicate that teaching practices in sharaf at IAIN Kerinci still rely heavily on lecture-based methods, which often overload students' working memory with dense information. Observations during classes show that students tend to memorize rules mechanically but struggle to apply them in authentic contexts such as conversation and writing. This confirms that rote instruction, without sufficient scaffolding, limits students' ability to transfer knowledge and reinforces the theory–practice gap. The findings also reveal that when instructional strategies integrate visual aids, task-based assignments, and structured repetition, students demonstrate higher levels of comprehension and confidence in applying morphological rules.

From a theoretical perspective, these results align with Sweller's Cognitive Load Theory, which posits that instructional design must minimize extraneous load to optimize learning efficiency (Clark et al., 2006; Sweller et al., 2011). In the case of sharaf, the complexity of word-pattern transformations and irregularities inherently imposes a high intrinsic load. Therefore, the role of teaching techniques is crucial in ensuring that unnecessary cognitive strain is reduced. This study confirms that task-based learning, visualization, and spaced repetition serve as mediating strategies that allow students to process morphological rules within the limits of working memory.

These implications are consistent with previous research. The benefits of structured repetition are supported by by Capeda et al., 2006), who demonstrated that reviewing material at strategic intervals strengthens long-term memory retention. Furthermore, studies on collaborative and interactive learning (Hayatul Mardhiyah et al., 2024) emphasize that feedback and integrated learning approaches not only reduce isolation but also foster deeper conceptual understanding.

Positioning the present findings within these studies shows that the pedagogical challenges in sharaf at IAIN Kerinci reflect a global issue in second language acquisition: the tendency of traditional methods to neglect students' cognitive limitations. However, this study provides an added dimension by showing how teaching practices interact directly with working memory capacity and cognitive load management. Unlike previous works that highlight strategies in isolation, the IAIN Kerinci case demonstrates the combined importance of simplification, contextualization, visualization, and interactivity in designing instruction that is both cognitively sensitive and pedagogically effective.

The contribution of this study is twofold. Theoretically, it operationalizes Cognitive Load Theory in the specific domain of Arabic morphology, illustrating how cognitive principles can guide teaching interventions. Practically, it proposes a pedagogical roadmap that integrates visualization, task-based activities, structured repetition, interactive feedback, and technology-assisted tools into sharaf instruction. This novelty lies in translating

abstract cognitive principles into concrete practices that reduce learning strain while enhancing linguistic competence. Thus, the study contributes both to the refinement of second language acquisition theory and to the development of more effective Arabic pedagogy in higher education.

Differences in Students' Cognitive Abilities

The findings of this study reveal that students at IAIN Kerinci exhibit significant differences in their cognitive abilities when learning sharaf. Interview data show that while some students are able to process information quickly, retain rules, and apply them in various contexts, others struggle with connecting different concepts, remembering irregular patterns, and overcoming anxiety during assessments. Classroom observations further confirm that students with prior exposure to Arabic or other languages with complex morphological systems perform better in managing the cognitive demands of sharaf than those encountering Arabic for the first time.

From a theoretical perspective, these differences can be explained through constructivist principles. Piaget and Vygotsky, as cited by Langford, (2005), emphasize that knowledge is more easily assimilated when it connects to prior experience. Students with stronger linguistic foundations are therefore able to integrate sharaf rules more efficiently. Similarly, Cummins' Bilingual Cognitive Theory suggests that proficiency in a first or second language influences how learners process information in subsequent languages (Ummah, 2019). These theories help explain why cultural and linguistic backgrounds shape students' performance in Arabic morphology learning.

The empirical evidence also resonates with previous studies. Fadlul (Amdhi Yul et al., 2023) found that effective use of cognitive strategies such as visual learning and structured organization supports better understanding of complex material. Research by by Amelia & Hikmah (2005) confirmed that learning styles—visual, auditory, or kinesthetic affect how students absorb new material. In addition, by Lestari et al., (2023) highlighted the role of emotional states in working memory efficiency, explaining why stress and anxiety negatively affect students' ability to recall and apply sharaf rules. These studies support the observation that cognitive differences among IAIN Kerinci students are shaped by strategies, learning styles, and affective conditions.

Positioning the present findings among these studies showed that while previous research tends to isolate specific factors such as working memory or motivation, this study integrates them into a broader framework of cognitive diversity. At IAIN Kerinci, students' cognitive performance in sharaf learning is not determined by a single factor but emerges from the interplay of memory capacity, prior experience, learning strategies, emotional regulation, and cultural background. This integrated understanding underscores the complexity of language learning in heterogeneous student populations.

The contribution of this study lies in its holistic account of cognitive diversity in Arabic morphology learning. Theoretically, it expands the application of constructivist and bilingual cognitive frameworks by showing how they operate in a higher education context with mixed linguistic backgrounds. Practically, it provides recommendations for adaptive instruction that considers variations in memory capacity, learning styles, motivation, and affective factors. The novelty of this study is the integration of cognitive, affective, and

contextual dimensions into a single pedagogical perspective, offering a foundation for designing flexible teaching strategies that can accommodate diverse student needs in Arabic language education.

CONCLUSIONS

This study found that students at IAIN Kerinci faced significant cognitive challenges in mastering sharaf rules. The obstacle and irregularity of morphological patterns, coupled with limited working memory, exam-related anxiety, and lecture-based instruction, increase cognitive load and hinder effective rule application. These difficulties reflect the combined influence of linguistic, cognitive, pedagogical, and contextual factors rather than a single cause. Theoretically, the findings validate Cognitive Load Theory in Arabic morphology learning by showing how intrinsic, extraneous, and germane loads interact in shaping outcomes. Practically, they highlight the importance of strategies such as simplification of materials, contextual repetition, task- and project-based learning, visualization, and metacognitive training to optimize students' memory resources and reduce learning strain. This study is limited by its small sample size and qualitative scope, which restrict generalizability. Future research should adopt larger, mixed-methods or longitudinal designs to deepen the understanding of how cognitive load affects Arabic learning across diverse contexts. Despite these limitations, the study contributes to refining second language acquisition theory and provides a pedagogical roadmap for more effective Arabic instruction in higher education.

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