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Generative Artificial Intelligence and Reducing the Cognitive Load in Language Learning: A Study in the Algerian Educational Environment

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Abstract

This study examined the cognitive challenges faced by Algerian learners and teachers within a highly complex linguistic environment, where Classical Arabic, Algerian dialect, Amazigh, French, and English intersect, generating a compounded cognitive load that burdens mental processing. The study drew on Cognitive Load Theory (Sweller, 1988) and the theory of limited resources in second language processing (VanPatten, 2004). It addressed the following central question: How can generative artificial intelligence redistribute and relieve the linguistic cognitive load in the Algerian educational context? Three main axes were examined: the patterns of cognitive load resulting from multilingualism in Algeria; the potential of generative AI as a linguistic cognitive mediator; and the proposal of an integrated theoretical framework linking cognitive psychology, applied linguistics, and artificial intelligence. The study concluded with theoretical and applied recommendations aimed at building inclusive digital learning environments that account for the linguistic specificity of the Algerian learner

Keywords : cognitive load ; multilingualism ; generative AI ; Algerian learning environment ; linguistic justice

1. Introduction

The field of language education is undergoing fundamental transformations in light of the rapid proliferation of generative artificial intelligence (AI) tools, which are reshaping learning environments and changing the nature of interaction between the learner and linguistic content. However, employing these tools does not automatically mean improving language acquisition, as the fundamental cognitive question remains: how these technologies affect the processing capacity of the learner, especially in contexts of linguistic complexity.

Cognitive Load Theory (CLT) provides a theoretical framework for understanding the mechanisms of learning under complexity. It starts from a basic premise that working memory is limited in energy and duration, and that learning is more effective when cognitive resources are managed systematically in working and long-term memories (Sweller, 1988). This process is intensified when it comes to second

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language learning in a multilingual environment, where two or more language systems compete for the same cognitive resources, (*Paas et al., 2003*).

The Algerian linguistic environment constitutes a particularly complex case. At least five overlapping linguistic systems coexist within it : Classical Arabic serves as the official and educational language; Algerian Arabic (Darija) functions as the primary mother tongue; Tamazight is present in its regional varieties (Kabyle, Chaoui, Mozabite, Targuie); French remains historically, educationally, and professionally entrenched; and English is rising in prominence within contemporary academic and digital discourse. This multilingual coexistence does not merely constitute cultural wealth—it also imposes significant cognitive pressure on learners, teachers, and researchers alike

Recent research in this context reveals rapid shifts in the adoption of AI tools among Algerian educators. Bouzidi and Zarif (2025) conducted a study on a sample of Algerian teachers (n = 92) and found that, while the majority were familiar with generative AI tools-particularly ChatGPT, cited by 94.6% of respondents-actual pedagogical use remained limited, revealing a persistent gap between representations and practice. The gravity of this gap becomes apparent when one considers that deploying AI tools without awareness of their cognitive implications may, in fact, prove counterproductive. A randomized empirical study involving 120 students demonstrated that unregulated use of ChatGPT undermined long-term information retention, in line with what is known as the Desirable Difficulties Principle-the principle that excessive facilitation can impair the cognitive processing necessary for durable learning (Bertrand et al., 2025). A systematic review of research on generative AI in language education further revealed a scarcity of studies addressing non-Anglophone and non-European linguistic contexts (Li et al., 2025), confirming the research gap that the present study seeks to address.

Bouzidi and Zarif (2025) further observed four intertwined dimensions in Algerian teachers' representations of AI: perceived pedagogical potential, professional anxiety, ethical concerns, and institutional restrictions-dimensions that mirror, from the teacher's perspective, the same cognitive disruption experienced by learners in the multilingual classroom.

Against this backdrop, the present study seeks to illuminate the relationship between generative AI and the reduction of cognitive load in language learning, with specific attention to the psycholinguistic particularity of the Algerian multilingual educational environment

2. Problem Statement

The present study is grounded in the following central problematic: Given the multilingual complexity of the Algerian educational space-in, which multiple language systems compete for limited cognitive resources in the learner, is working memory-can generative AI, with its multilingual capabilities and adaptive features, function as an effective mediator in redistributing and alleviating linguistic cognitive load? What theoretical and practical conditions must be met for such mediation to be meaningful?

This central question gives rise to three subsidiary research questions:

- What is the nature of the cognitive load generated by the Algerian multilingual environment along the second language-learning trajectory?
- How do the mechanisms of generative AI intersect with the three types of cognitive load?

3. Significance of the Study

This study derives its significance from several considerations

- The clear research gap in Arab and Algerian studies linking cognitive psychology, multilingualism, and artificial intelligence technologies in an educational context.

- The urgent need to guide educational decisions regarding the integration of artificial intelligence into Algerian education with solid theoretical data rather than mere technological fascination
- The mental health dimension of this issue, as the chronic accumulation of linguistic cognitive load leads to real psychological stress that affects learners' cognitive health and well-being.

This study contributes to the current body of knowledge in three distinct ways.

- It proposes a three-level “linguistic cognitive load” (LCL) model—a new theoretical construct that integrates cognitive psychology, applied linguistics, and artificial intelligence within a single integrative framework, which, to our knowledge, has not been previously addressed theoretically in the Arabic or Algerian academic literature.
- The study presents the concept of linguistic cognitive mediation as a formal theoretical description of the role of generative artificial intelligence in multilingual learning contexts.

4. Methodology : Theoretical Synthesis Approach

The present study employs a theoretical synthesis methodology informed by a systematic review of peer-reviewed literature published between 2019 and 2025. Sources were retrieved from Google Scholar, Scopus, and ERIC using the following search terms: "cognitive load theory," "generative AI," "multilingual education," "second language acquisition," and "Algeria." Inclusion criteria focused on: (1) theoretical and empirical studies on cognitive load in multilingual contexts; (2) research on generative AI in language learning; and (3) sociolinguistic analyses of the Algerian linguistic environment. Foundational theoretical works (e.g., Sweller, 1988; Cummins, 2000) were included regardless of publication date. Studies limited exclusively to monolingual Anglophone contexts with no transferable implications were excluded. The synthesized literature informed the construction of the three-layer Linguistic Cognitive Load (LCL) model proposed in this paper."

5. Background Literature

5.1 Algerian Multilingual Context and Cognitive Challenges

The problematic of the cognitive load in learning languages cannot be studied in isolation from the social and cultural context to which the learner belongs. The Algerian environment represents a linguistic landscape in which the linguistic identity of individuals is formed. It has a number of structural characteristics that make it unique in its regional environment. It is not limited to digital multilingualism, but is characterized by the depth of overlap and intertwining between these languages at the phonological, morphological, lexical, and pragmatic levels. We find a structural contradiction between the language of the family and the language of the school: the Algerian child acquires the mother tongue (vernacular and/or Berber) in the family environment, and then faces in the school language systems different from what he has acquired in standard Arabic, French and English, which have been included in the primary stage since the school season 2022/2023. This conflict produces what Cummins (2000) called the “cognitive linguistic transformation gap,” where conceptual competencies developed in one language do not automatically acquire a reflection on the other language, forcing the learner to reconstruct the same concepts with different linguistic tools.

In addition, languages in Algeria are subject to a clear social hierarchy that affects their perceived symbolic and cognitive value. Classical Arabic occupies the status of official and religion, and French is associated with science, professionalism and modernization, but it has recently retreated in front of English, which has become the language of teaching scientific subjects in Algerian universities, while Darija and Amazigh are traditionally classified in lower ranks than the institutional linguistic ladder. Despite its constitutional formalism, this hierarchy has profound psychological repercussions manifested in what Bourdieu (1991) calls symbolic linguistic violence, which overburdens the

individual's awareness of a sense of inferiority and exclusion when defined in his own language. Algerian sociological studies have documented these dynamics deeply in the Algerian urban space (Bedjaoui, 2019). This multilingualism leads to the so-called *interférence linguistique*, a phenomenon described by Weinreich (1953) as a deviation from the norms of one language as a result of the reciprocal influence between them in a bilingual mind. It is precisely in this context that the Algerian learner finds himself facing a double cognitive load when dealing with a second language, as he has to manage two or more competing linguistic systems for his limited cognitive resources (Bialystok, E., Craik, F. I. M., & Luk, G). This situation is further complicated by the fact that the Algerian education system has not settled on a unified approach in dealing with this multilingualism. While the educational stages (primary, intermediate, and secondary) adopt classical Arabic as a primary language, it turns into French and English in scientific and technical disciplines at later stages, which generates a sharp cognitive breakdown that affects the course of second language acquisition (Haddad & Mehadji, 2022).

5.2 Cognitive Challenges in Language Learning

Learning a second or third language is an inherently complex cognitive undertaking, involving the simultaneous coordination of multiple processes: parsing linguistic input, constructing meaning, retrieving lexical items, and analyzing grammatical structure. The second language acquisition (SLA) literature consistently indicates that these processes require continuous articulation between working memory and long-term memory, making language learning an informationally demanding task (Ellis, 2008). In multilingual educational contexts, these demands are amplified by the need to manage multiple language systems concurrently, a condition that substantially increases cognitive load.

Among the most prominent cognitive challenges are the following. Limited working memory capacity is the central constraint: working memory processes incoming information in real time, but its capacity is finite. When this capacity is exceeded—as frequently occurs when learners encounter unfamiliar vocabulary and grammatical structures simultaneously—comprehension and integration are compromised (Sweller *et al.*, 2011). Language interference represents a second major challenge: transfer of phonological, morphological, or syntactic patterns from the first language into the target language generates systematic errors and processing difficulties, a phenomenon well-documented in applied linguistics (Cook, 2008). A third challenge concerns attentional management and executive control: operating in a multilingual environment requires the continuous activation of inhibitory mechanisms to suppress non-target languages, a process that consumes substantial cognitive resources, particularly in the early stages of acquisition, even if it ultimately contributes to enhanced cognitive flexibility (Bialystok, 2017). Input intensity and complexity constitute a fourth source of difficulty: simultaneous engagement with multiple dimensions of language—phonological, lexical, syntactic, and pragmatic—without adequate scaffolding impedes the construction of stable mental representations of the target language (VanPatten & Williams, 2015). Finally, individual differences in working memory capacity, attentional control, and metalinguistic awareness significantly modulate the pace and quality of language acquisition (Ellis, 2008).

In light of these challenges, the literature increasingly emphasizes the design of learning environments and instructional strategies that scaffold linguistic input, regulate cognitive demands, and support cumulative knowledge construction. In recent years, growing scholarly attention has turned to the potential role of generative AI in providing precisely this form of adaptive cognitive support.

Table 1

Cognitive Challenges in Language Learning and Their Impact

Impact on Language Learning	Scientific Description	Cognitive Challenge
Difficulty comprehending texts or speech when information density exceeds processing capacity.	Working memory has finite capacity for simultaneous processing ; exceeding it hinders integration of new linguistic input (Sweller <i>et al.</i> , 2011).	Limited working memory capacity
Systematic errors and difficulty processing target-language structures.	Transfer of phonological, grammatical, or syntactic patterns from L1 to the target language during acquisition (Cook, 2008).	Linguistic interference
Heightened cognitive demands, especially in early acquisition stages.	In multilingual settings, multiple languages remain cognitively active simultaneously, requiring continuous inhibitory control.	Attentional management and executive control
Increased cognitive load in early acquisition; risk of unstable target-language representations.	Language learning requires simultaneous engagement with phonology, vocabulary, syntax, and pragmatics.	Complexity of linguistic input
Variable pace of acquisition and differential use of processing strategies.	Learners vary in working memory capacity, attentional control, and metalinguistic awareness (Ellis, 2008).	Individual differences

Note Compiled by the authors based on Sweller et al. (2011), Cook (2008), Bialystok (2017), VanPatten and Williams (2015), and Ellis (2008). Challenges are organized according to whether they originate in the learner's cognitive architecture (e.g., limited working memory) or in the structural properties of the target language and its interaction with prior linguistic knowledge (e.g., interference, input complexity).

6. Cognitive Load Theory and Second Language Learning

Cognitive Load Theory (CLT) is among the most influential theoretical frameworks in educational psychology and language education. Sweller *et al.* 1998) proceeds from the premise that working memory has limited processing power, while long-term memory has unlimited storage power, and that the gap between these two structures is the main barrier to effective learning. The theory was based on the information processing model that the brain deals with cognitive load with limited resources, and that the distribution of these resources between different tasks determines the quality and extent of learning. Sweller *et al.* 1998). This framework was later developed to distinguish between three types of cognitive load.

Intrinsic load: Related to the degree of complexity of the learning material itself and its relationship to the previous level of the learner (Sweller, 2010).

Extraneous Load: Caused by inappropriate instructional design that depletes cognitive resources without an actual contribution to learning Sweller *et al.*, 1998);

Germane Load: associated with the cognitive effort exerted in building and developing mental schemas (Paas et al., 2003) the cognitive effort exerted in building and developing mental charts (Paas et al., 2003).

In the context of second language learning in particular, the intensity of these three types is compounded, as the learner faces simultaneously the processing of the phonological, morphological and structural structures of the new language, as well as the management of the existing overlap between the two linguistic systems (De Bot et al., 2007). He sees .Mayer (2009) Learning languages in multilingual or multicultural environments is an additional challenge as the concept of cognitive load acquires an additional dimension called the Linguistic Cognitive Load by researchers, which is the mental energy depleted in the processes of coding and linguistic decoding, the conversion between linguistic systems, and the management of conflicts between different linguistic structures. Several studies have demonstrated that multilingual individuals devote a significant portion of their working memory energy to observing this linguistic transformation, reducing the energy available for deep conceptual processing (Bialystok et al, 2012).

6.1 Sources of Cognitive Load in the Algerian Linguistic Environment

Algeria is a unique sociolinguistic laboratory characterized by a complex multilingualism that directly affects the cognitive load of learners. Algerian linguistic reality oscillates between two main levels: bilingualism (Diglossia) and bilingualism (Bilingualism). The duality is represented by the conflict between classical Arabic (the language of education and formalities) and Algerian dialect (the language of daily communication), while dualism manifests itself in the sometimes coercive coexistence between Arabic and French, in addition to the growing presence of Berber and English as a new and essential newcomer in scientific research.

This configuration creates what may be described as a state of compounded cognitive dissonance in the learner: learners in the early stages of schooling are required to navigate disparate symbolic systems simultaneously, elevating self-generated cognitive load to critical levels. Cross-linguistic interference among these systems frequently impairs linguistic productivity; learners struggle to express themselves accurately in Modern Standard Arabic under the pressure of dialectal dominance, and encounter systematic confusion between French and English due to their partial orthographic similarity combined with divergent morphological logics.

Table 2

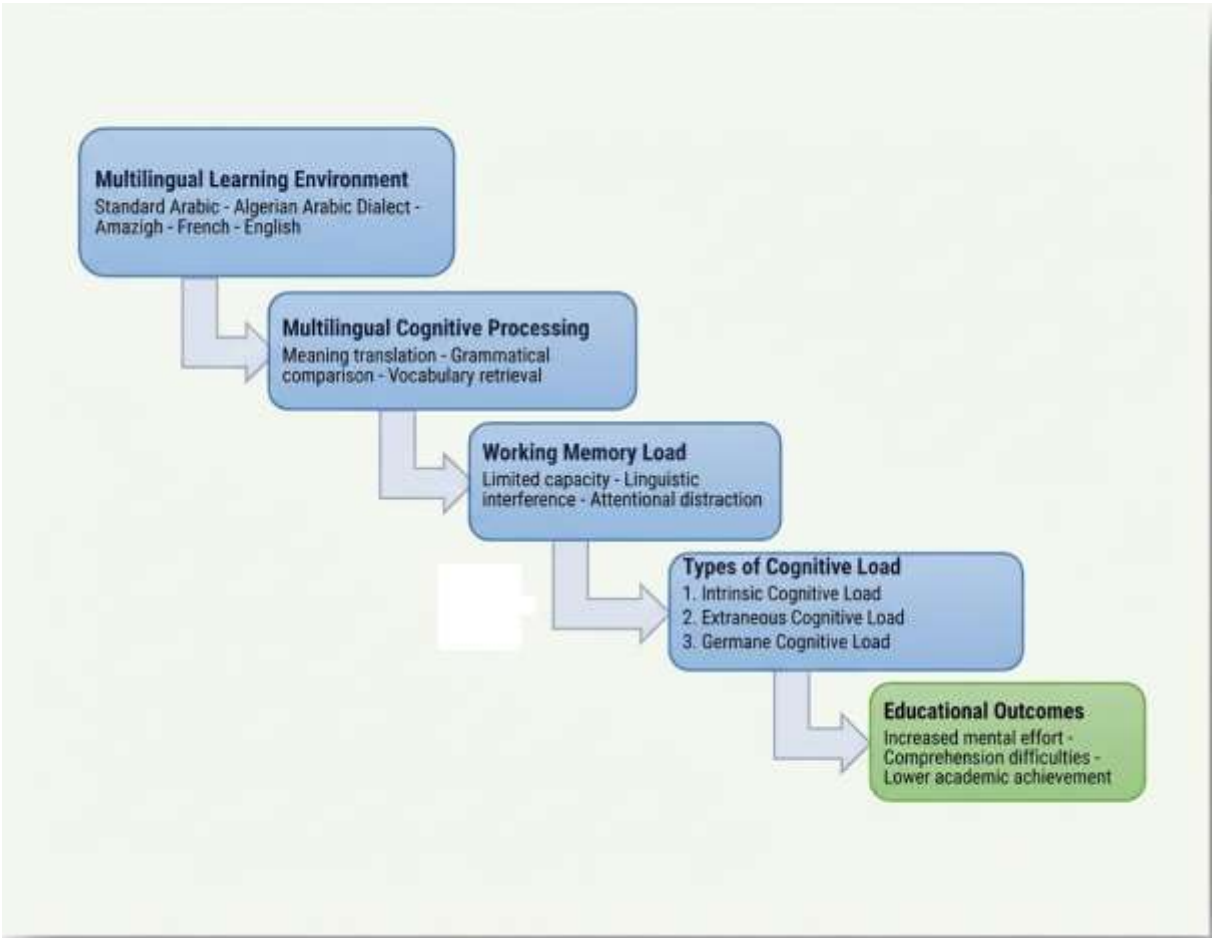
Sources of Cognitive Load in the Algerian Multilingual Educational Environment

Intrinsic Load Source	External Burden Source (Extraneous Load)
Syntactic complexity of second language with L1 overlap	Diversity-sensitive monolingual teaching materials
Conflicts between multiple audio systems	Vague or contextually inappropriate instructions
The gap between the colloquial and the eloquent lexicon	Immediate Feedback
Multilingualism in the classroom	Lack of linkage between mother tongue and language of education

Note Compiled by the authors based on Sweller (1988, 2010) ; Sweller et al. (1998); De Bot et al. (2007) ; Bialystok et al. (2012). This classification represents a theoretical synthesis applied specifically to the Algerian multilingual educational context.

Figure 1.

The Cascading Effect of Multilingualism on Working Memory and Cognitive Load in the Algerian Educational Context



7. Generative AI and the Potential for Cognitive Burden Mitigation

Recent years have seen a paradigm shift in generative AI capabilities, particularly with the advent of major multilingual language models such as GPT-4, Claude, Gemini, and DeepSeek. The capabilities of these systems go beyond the mere generation to encompass what the present study terms Cognitive-Linguistic Mediation-a formal theoretical concept introduced here to describe the capacity of AI systems to attenuate the linguistic conflicts experienced by multilingual learners (Jeon et al., 2025). As generative AI tools become increasingly widespread, it has become necessary to examine systematically the mechanisms through which they operate in language learning environments and to assess their cognitive effectiveness (Brown et al., 2020).

The period from 2023 to 2025 has seen significant growth in empirical research examining the integration of generative AI into language instruction, although the overwhelming majority of this research remains focused on Anglophone contexts and English language teaching specifically (Lee et al., 2025); Wang & Xue, 2024)-a fact that further underscores the research gap addressed by the present study.

The cognitive load mitigation potential of these tools operates through three principal mechanisms. The first is adaptive scaffolding: generative AI tools can deliver language content calibrated to the learner’s actual proficiency level, thereby reducing the intrinsic load associated with exposure to material that exceeds available cognitive capacity (Ouyang & Jiao, 2021). This mechanism aligns with what Martin

(2016) termed Load Reduction Instruction-a pedagogical approach that progressively facilitates difficulty before gradually withdrawing support. The second mechanism is immediate and personalized feedback: Hattie and Timperley (2007) identify effective feedback as among the most powerful determinants of learning outcomes, and AI tools are uniquely positioned to deliver instantaneous, learner-specific feedback, thereby reducing the extraneous load generated by delayed correction or contextually inappropriate responses. The third mechanism is linguistic personalization: generative AI tools can accommodate multilingualism by generating content that takes into account the learner's first language (Huang et al., 2023)-a feature of exceptional relevance in contexts such as Algeria's, where learners cannot be assumed to share a single dominant linguistic background.

This potential, however, is subject to significant limitations. Kasneci et al. (2023) note that current generative AI tools have been developed primarily for high-resource languages such as English and French, producing a marked disparity in response quality for languages with lower digital representation, including varieties of Arabic and Tamazight. This asymmetry raises serious concerns regarding linguistic justice (*équité linguistique*), constituting one of the most pressing challenges in the deployment of these tools within multilingual educational environments.

8. Generative Artificial Intelligence and Redistribution of the Cognitive Load

Drawing on the preceding analysis, this study proposes a three-layer model of Linguistic Cognitive Load (LCL) specific to the Algerian multilingual educational context. These three layers are cumulative and mutually reinforcing; they converge in the learner's cognitive reality to generate a complex and compounded cognitive pressure that collectively exceeds the sum of its individual components

Layer 1 - Structural Linguistic Load refers to the cognitive effort required to manage the fundamental structural differences among coexisting languages, encompassing directionality (right-to-left versus left-to-right), morphological paradigms, syntactic organization, and the logic of argumentation. This is a chronic, persistent form of load that does not dissipate with repetition, though individual learners may achieve partial adaptation over time.

Layer 2 Identity-Selection Load refers to the mental energy expended in selecting the contextually appropriate language for a given communicative situation (formal/informal, oral/written, scientific/everyday). This load intensifies with the number and variety of daily communication contexts the learner must navigate. It is closely related to what Norman (1988) calls "switching costs" the cognitive overhead associated with transitioning between distinct mental schemas.

Layer 3 Evaluative-Affective Cognitive Load refers to the cognitive-emotional burden associated with language anxiety and the fear of social judgment regarding one's linguistic competence. This form of load has an affective dimension that can systematically suppress the expression of actual linguistic ability and impair academic performance (Horwitz et al., 1986). It represents the most significant challenge to the learner's psychological well-being, and its cumulative effects can, over time, produce the phenomenon that the present study terms linguistic burnout.

The present framework suggests that generative AI is capable of intervening at each of these three layers through specific, empirically verifiable mechanisms.

At the level of structural load, AI systems can deliver instructional content in the learner's dominant language register while providing real-time, context-sensitive cross-linguistic transformation without disrupting the cognitive flow of knowledge acquisition. This is consistent with Sweller's Redundancy Principle, which holds that information should be presented through the most cognitively efficient channel rather than simultaneously across multiple channels.

At the level of identity-selection load, generative AI systems can provide what may be described as a linguistically neutral interactional space-one in which the user is not required to pre-select a language

before engaging with the system. The system adapts to the learner's natural mode of expression, including code-switching and mixed-language input. By relieving the burden of language choice, this feature liberates a portion of working memory capacity for genuine conceptual engagement.

At the level of evaluative-affective load, the non-judgmental character of AI interlocutors provides a psychologically safe space for linguistic production, in which errors are not met with social sanction. Empirical research has demonstrated that interaction with AI tools reduces language anxiety in second language learners and motivates learners with lower linguistic confidence to engage in productive output (Shaik Vadla *et al.*, 2024).

9. The Pedagogical Requirements for Employing Artificial Intelligence in Language Teaching

The research literature (Sweller, 1988 ; Bialystok *et al.* 2012 ; Bouzidi & Zarif, 2025 ; Lyu *et al.* 2025 ; Li *et al.* 2025) presents three indispensable structural conditions for employing AI in language teaching and becoming a genuine cognitive lever

Linguistic and cultural appropriateness: Empirical studies reveal that linguistic AI tools suffer from a clear deficiency in social and cultural adaptation, which leads to frustration among learners whose accents and references differ from the Western model integrated in these tools. This means that any non-critical use of tools such as ChatGPT in Algerian classes without adaptation may exacerbate rather than alleviate the external burden.

Balance between support and autonomy: Extensive studies reveal that the effectiveness of AI is not intrinsic but conditional on the extent to which its potential is compatible with pedagogical design, and that its positive impact peaks when it is employed as a complementary cognitive resource integrated into high-quality human education. This means that teacher-tool integration is the critical condition for effectiveness.

Teacher Professional Training: The above two conditions cannot be achieved without a teacher trained in critical handling of generative AI tools. Bouzidi and Zarif (2025)"; confirmed that 85.9% of the Algerian teachers interviewed expressed an urgent need for concrete - not theoretical - field training on employing these tools in real educational contexts, which embodies a real paradox in the system: the tool is available, but professional readiness to employ it is absent.

10. Limits of Generative Intervention in the Algerian Context

The theoretical model proposed above does not overlook the structural constraints that circumscribe the effectiveness of generative AI in the Algerian context and render unconditional optimism untenable.

The most significant of these constraints is the phenomenon of **monolingual bias** in large language models: studies have demonstrated that these systems perform substantially better in Modern Standard Arabic than in Algerian Arabic dialect or Tamazight varieties (Ma *et al.*, 2024), a disparity that risks deepening, rather than bridging, existing linguistic inequalities. The underrepresentation of Algerian vernacular languages in AI training data inadvertently positions these systems as instruments of linguistic dominance, raising deep concerns regarding digital linguistic justice.

A second structural constraint concerns the **regional digital divide**. Access to generative AI tools remains markedly unequal between Algiers and major urban centers, on the one hand, and rural and remote regions, on the other. Inadequate digital infrastructure and unstable internet connectivity in numerous localities limit the capacity of many learners to benefit from these

technologies, thereby reproducing a new form of cognitive inequality (Dallaa & Belhaoues, 2024; Idri & Outmoune, 2021).

Third, the educational effectiveness of AI tools is not an automatic consequence of their availability; it depends critically on the quality of pedagogical design and the degree of users' critical digital literacy. Institutional frameworks that maximize benefits and mitigate risks remain, as yet, underdeveloped in the Algerian context (Cotelli Kureth & Summers, 2025).

It should further be noted that deploying generative AI without deliberate pedagogical framing may itself generate a new form of cognitive load: the **burden of technology management**-that is, the effort required to interact with the tool, evaluate the reliability of its outputs, and integrate its responses into an ongoing learning process. The Cognitive Load Framework thus serves not as an endorsement of unconditional AI adoption, but as an analytical lens for identifying the conditions under which AI deployment is cognitively beneficial.

These considerations carry implications that extend beyond language pedagogy to the broader question of learner mental health. When linguistic cognitive load accumulates over years of schooling without adequate intervention, it can transform into sustained psychological pressure that erodes learners' sense of linguistic self-efficacy, diminishes academic motivation, and, in advanced cases, produces *linguistic burnout*. From the perspective of Self-Determination Theory (Deci & Ryan, 2000), the persistent state of linguistic uncertainty in which the Algerian learner is placed simultaneously undermines the basic psychological needs for competence and autonomy, generating a self-reinforcing cycle of linguistic anxiety. Notably, this cycle affects teachers as well as learners, given the recurrent pressure teachers face in selecting an appropriate linguistic medium for each pedagogical situation.

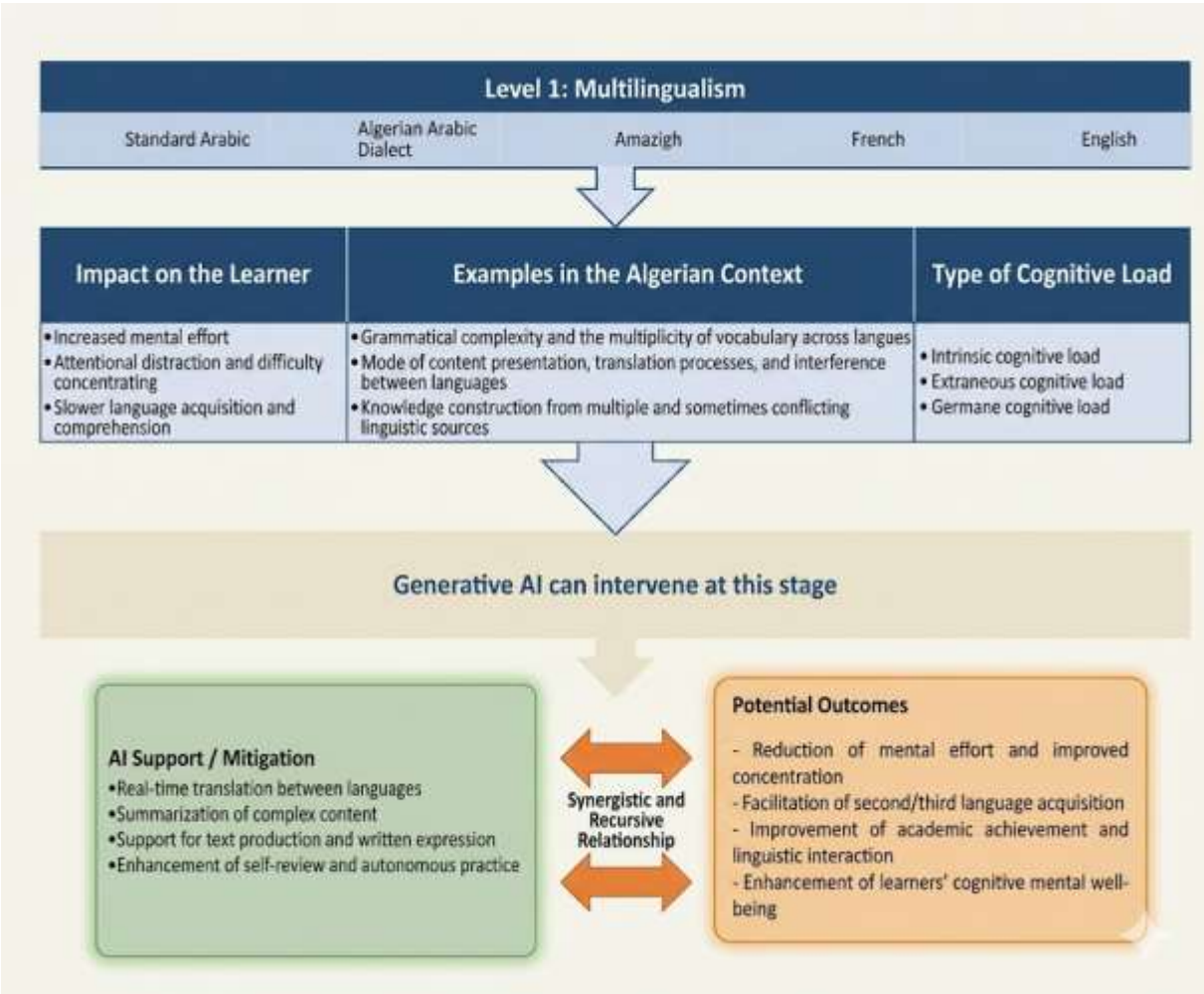
Realizing the potential of psychologically informed AI-that is, AI deployed in ways that are sensitive to users' affective states and that enhance rather than undermine their sense of linguistic safety-requires that policies for AI integration in Algerian education be grounded in a deep understanding of the local psycholinguistic context, rather than in the logic of uncritical importation of ready-made technological solutions.

11. Proposed Conceptual Model : Generative AI as a Cognitive-Linguistic Mediator

Drawing on the foregoing synthesis of multilingualism research, Cognitive Load Theory, and recent scholarship on AI in education, the present study proposes a conceptual model of the relationship among these variables within multilingual educational environments. The model holds that multilingualism in the educational setting increases the complexity of the learner's information-processing demands, elevating cognitive load through the simultaneous activation of multiple language systems in working memory. Generative AI, however, can function as a cognitive-linguistic mediator that organizes and scaffolds information, provides adaptive support, and thereby reduces extraneous cognitive load while fostering the construction of target-language knowledge. The relationship between multilingualism and cognitive load is thus not linear but mediated: through principled AI integration, the cognitive challenges inherent in multilingual language learning can be transformed into opportunities for deeper

understanding and greater linguistic proficiency (Sweller et al., 2011; Mayer, 2009; Kasneci et al., 2023).

Figure 2 A conceptual model of generative artificial intelligence in reducing cognitive load in Algerian language learning environments “multilingual”



Note This figure illustrates the cascading relationship between multilingualism, the three layers of linguistic cognitive load, AI-mediated intervention mechanisms, and learning outcomes in the Algerian educational context.

Conclusion The results' section is not clearly mentioned

The theoretical synthesis conducted in the present study yielded three principal outcomes. First, the proposed three-layer Linguistic Cognitive Load (LCL) model—comprising the structural linguistic load, the identity-selection load, and the evaluative-affective load—offers a novel integrative framework that accounts for the compounded and layered cognitive pressures specific to the Algerian multilingual educational context, extending Sweller’s (1988) original CLT framework beyond its predominantly monolingual assumptions. Second, the concept of Cognitive-Linguistic Mediation, introduced to formally describe the role of generative AI in multilingual learning environments, provides a theoretically grounded descriptor for the mechanisms through which AI tools may redistribute and alleviate linguistic cognitive burden across all three layers of the LCL model. Third, the analysis reveals that the effectiveness of

generative AI as a cognitive-linguistic mediator is not automatic but is conditioned upon the quality of pedagogical design, the cultural and linguistic appropriateness of the tools deployed, and the level of critical digital literacy among teachers and learners. Taken together, these findings suggest that the integration of generative AI in Algerian language education holds significant potential, provided that institutional policies are grounded in a thorough understanding of the learner's psycholinguistic context, rather than in uncritical adoption of technologically ready-made solutions.

Conclusion

The present paper proceeded from the fundamental premise that cognitive load in the Algerian educational context is not a simple, one-dimensional phenomenon but a multilayered form of pressure in which structural-linguistic, identity-selective, and evaluative-affective determinants are inextricably intertwined. A thorough theoretical understanding of this complexity is, accordingly, the necessary methodological precondition for any principled integration of generative AI in this context. As a theoretical synthesis, the present study is subject to the inherent limitations of conceptual research, foremost among which is the absence of empirical validation. Future studies are therefore invited to test the proposed LCL model through mixed-methods designs incorporating classroom observation and psychometric instruments adapted to the Algerian sociolinguistic context.

The proposed framework seeks to bridge a research gap defined by the absence of an integrated explanatory model linking three intersecting fields: cognitive psychology-through Cognitive Load Theory (Sweller, 1988, 2010); applied linguistics-through a structurally informed analysis of the Algerian multilingual reality in its structural, identity-based, and symbolic dimensions; and generative artificial intelligence-conceptualized here through the notion of Cognitive-Linguistic Mediation. The overarching conclusion is that the effectiveness of AI in reducing linguistic cognitive load is not given automatically; it is a variable contingent upon the quality of pedagogical design and the depth of critical awareness of the learner's psycholinguistic context.

Recommendations

Development of psychometric instruments for linguistic cognitive load: Context-sensitive measurement tools must be developed for the Algerian setting, through multidisciplinary research teams bringing together specialists in cognitive psychology, applied linguistics, and psychometrics, with the aim of producing validated instruments that enable a transition from theoretical conceptualization to rigorous empirical measurement.

Formulation of evidence-based institutional AI integration policies: Algerian educational and university institutions should develop clear policies informed by comparable experiences in multilingual contexts, enabling teachers and learners to interact with AI tools in their available languages, and incorporating professional training modules that equip teachers to engage critically with AI outputs rather than adopting them uncritically.

Investment in the development of computational language resources for Algerian languages: Participatory research projects between Algerian universities and international partners working on digital linguistic diversity should aim to build large-scale corpora for local

languages and to develop natural language processing models specifically designed for the Maghrebi linguistic context, in alignment with the principles of digital linguistic justice.

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