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# A Critical Review of AI Chatbots as Interactive Media for Arabic Language Learning: Integrating Explainable AI and the Cognitive Theory of Multimedia Learning

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**Keywords:**
*Explainable AI, Cognitive Load, Arabic Language Learning.*

**Abstract**

*This study investigates the pedagogical limitations of AI chatbots in Arabic language learning, particularly the lack of integration of Explainable AI and the Cognitive Theory of Multimedia Learning (CTML). The aim is to develop a theoretical framework that promotes cognitive alignment and instructional transparency. A qualitative, library-based method was used, analyzing academic literature on Arabic instruction, AI systems, and multimedia learning. Findings reveal that current chatbot designs often neglect cognitive load and offer limited explanation of responses. As a result, learner trust and comprehension suffer. The study concludes that integrating CTML and Explainable AI can enhance the effectiveness, trustworthiness, and cognitive depth of chatbots in Arabic language education.*

**Kata Kunci:**
Kecerdasan Buatan yang Dapat Dijelaskan, Beban Kognitif, Pembelajaran Bahasa Arab

**Abstrak:**

Penelitian ini menyelidiki keterbatasan pedagogis dari chatbot berbasis AI dalam pembelajaran bahasa Arab, khususnya kurangnya integrasi antara Explainable AI (Kecerdasan Buatan yang Dapat Dijelaskan) dan Cognitive Theory of Multimedia Learning (CTML atau Teori Kognitif Pembelajaran Multimedia). Tujuan dari penelitian ini adalah untuk mengembangkan kerangka teoretis yang mendorong keselarasan kognitif dan transparansi instruksional. Penelitian ini menggunakan metode kualitatif berbasis studi pustaka, dengan menganalisis literatur akademik tentang pengajaran bahasa Arab, sistem AI, dan pembelajaran multimedia. Temuan penelitian menunjukkan bahwa desain chatbot saat ini sering mengabaikan beban kognitif dan hanya memberikan penjelasan yang terbatas atas respons yang dihasilkan. Akibatnya, kepercayaan dan pemahaman peserta didik menjadi terganggu. Penelitian ini menyimpulkan bahwa integrasi CTML dan Explainable AI dapat meningkatkan efektivitas, keandalan, dan kedalaman kognitif chatbot dalam pendidikan bahasa Arab.

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## Introduction

In the last few years, artificial intelligence especially in the form of chatbots aimed at language instruction has been drawing growing interest across educational fields (N. H. V. Nguyen & Pham, 2024). Still, beneath this widespread attention, there seems to be a noticeable misalignment. These systems are often built on frameworks that don't fully reflect how learners come to understand and internalize language through authentic, cognitive processes (Mohanty et al., 2024). A recent review confirms that most existing chatbots still fail to provide the kind of cognitive support and instructional transparency that would make them truly effective learning tools (Guan et al., 2025). The issue becomes even more visible when applied to Arabic, a language with rich morphological systems and meanings shaped by subtle contextual cues. Many of these technologies attempt to imitate conversation, yes but whether those simulations translate into meaningful learning remains an open question. Learners may engage and respond, yet without understanding the rationale behind chatbot feedback, it becomes unclear what meaningful learning if any is actually being internalized. That's where the challenge lies. Without a clear explanatory structure, users are left with little more than guesswork. And when learners don't understand the logic behind the system, trust naturally begins to erode. This paper approaches these issues by exploring how Explainable AI, combined with the Cognitive Theory of Multimedia Learning, might offer a more coherent foundation for designing educational chatbots that are not only intelligent, but also pedagogically credible (Spivack et al., 2024).

Building upon the observed disconnect between chatbot interaction and actual language acquisition, the literature shows that theoretical foundations for such tools remain underdeveloped (Bouhlali et al., 2024). There's no shortage of studies discussing chatbots in language education, but when it comes to their cognitive grounding especially in Arabic language contexts the literature often runs thin (Zaimah et al., 2023). Much of the existing work focuses on user reactions, system features, or performance outcomes. However, whether these tools are developed in accordance with how the brain processes language remains a largely unexamined issue. The Cognitive Theory of Multimedia Learning, for instance, receives surprisingly little attention, even though it offers important insights into how learners handle information and manage cognitive overload (Spivack et al., 2024). Similarly, the field of Explainable AI is notably underrepresented. In cases where learners don't quite understand how a chatbot arrives at its replies, the educational value of that interaction tends to diminish. It's not just a matter of misunderstanding it's about what gets lost when the system offers no insight into its reasoning. Over time, this kind of opacity doesn't just confuse; it gradually chips away at trust. Still, a large portion of the literature seems focused on highlighting surface-level positives, like how often students interact or whether their scores go up slightly, without really unpacking why those outcomes happen or whether they'd show up again in another context. This becomes particularly problematic when applied to Arabic, where language complexity adds an additional cognitive burden (Zaimah et al., 2023). In such cases, the absence of a solid theoretical foundation is more than an academic concern; it directly affects the viability of these tools in real learning environments. What's needed are not just better systems, but ones explicitly informed by cognitive science and sound instructional design.

This study sets out to conduct a conceptually grounded and critical exploration of how AI chatbots function and might better function as interactive tools in the context of Arabic language education. Rather than merely cataloging existing systems, the primary aim is to develop a theoretical foundation that integrates insights from Explainable Artificial Intelligence (XAI) and the Cognitive Theory of Multimedia Learning (CTML). The intention is to propose a framework through which Arabic-focused educational chatbots can be designed with greater pedagogical coherence, cognitive alignment, and communicative transparency. Drawing from interdisciplinary literature in cognitive psychology, instructional design, and AI system development, the study seeks to address the persistent disconnect between educational theory and technological implementation. The framework proposed here is not

intended merely as a conceptual contribution it is meant to offer practical direction for those involved in the design and implementation of educational chatbots, particularly within Arabic language contexts. It may also offer a useful starting point for further empirical research. A key contention in this study is that when learners are able to understand how an AI system reaches its outputs, their sense of trust and sustained engagement tends to improve. At the same time, incorporating principles from the Cognitive Theory of Multimedia Learning is seen as vital for supporting deeper mental processing and enhancing the durability of what is learned. In contexts such as Arabic language instruction where linguistic complexity introduces additional cognitive demands these considerations are not optional but foundational. Positioned within broader academic discourse on AI in education, the study advocates for a design paradigm that is both scientifically rigorous and ethically responsive.

The necessity of this research becomes evident when considering both the conceptual and applied shortcomings in existing chatbot-based language learning systems, particularly for Arabic. Prior analysis has shown a consistent failure to integrate cognitive learning models with mechanisms that support interpretability, leaving a gap in how learners engage with these tools meaningfully. Given the dual challenge posed by Arabic's linguistic complexity and the opacity of AI processes, there is a compelling rationale to explore a combined theoretical approach. This study rests on the hypothesis that the integration of Explainable AI and the Cognitive Theory of Multimedia Learning can result in chatbot designs that better align with how learners process, retain, and trust educational content. When the design of chatbots aligns more closely with how learners process information and develop trust in the system, their role in education can move beyond superficial interaction. Instead of simply simulating conversation, such systems can begin to function as meaningful supports for cognitive engagement. This study, therefore, does not approach the topic as an abstract theoretical exercise. It addresses a pressing instructional challenge: the need for AI tools that are built upon principles attentive to both pedagogical integrity and the learner's experience.

The term "AI chatbot" gets thrown around a lot, but its meaning isn't fixed. Some use it to describe very simple programs, things that just follow a script. Others apply it to more advanced systems that adapt and respond in less predictable ways (Saoudi & Gammoudi, 2023). Both types still aim to mimic conversation, though how well they succeed is another matter. In the past, the interaction felt robotic limited, really. Newer models can respond a bit more naturally. Not perfectly, of course. Still, there's a difference. Especially in education, where timing and interactivity matter, that change feels relevant. Chatbots are now being considered for all kinds of uses language learning included (Zaimah et al., 2023). They reply instantly, don't need sleep, and offer something close to practice. Whether that's effective is debatable. Arabic, for instance, has layers of complexity that may be hard to capture in these systems (Almurayh, 2021). Just one small grammatical shift can mean something completely different. In this context, chatbots are often positioned either as instructional tools or as interaction devices yet it remains unclear which role they truly fulfill in practice (Bouhlali et al., 2024).

AI chatbots used in education don't all follow the same design. Some are extremely simple just pre-written responses mapped to keywords. Others behave a bit more fluidly, depending on what you feed them. The difference usually depends on whether the system is fixed or flexible (Chauncey & McKenna, 2023). That's the technical side. But in educational use, it plays out differently. For instance, I've seen bots that only give vocabulary tips. Others are more open and will try to hold longer conversations, even if the coherence slips (Gutiérrez, 2023). There are also distinctions in purpose: some are built to instruct, others to encourage, and a few just simulate casual talk. Developers now sometimes add features that let the chatbot explain itself why it said what it did. That matters, especially when learners feel unsure (Zaimah et al., 2023). In Arabic, this becomes more complicated. It doesn't take much for a sentence to change meaning just a slight grammatical variation can do that. And sometimes, even advanced learners miss those shifts. If the chatbot handles that incorrectly, what follows isn't always obvious at first but it can easily become a source of confusion. Instead of gaining clarity, the learner might walk away with a

misunderstanding that feels correct, which is harder to undo later on. That's not always easy to detect, especially in automated systems. So while some bots might seem technically impressive, that doesn't always translate into useful help. What really matters in the end is whether students feel guided not just responded to (Shao et al., 2022).

I've sat in Arabic classes where students practice one version of the language, but then outside the classroom, they hear something else entirely. What's in the textbooks Modern Standard Arabic is mostly formal, the kind used in announcements or scripted content. But everyday speech tends to follow regional dialects, which don't always resemble MSA (Moaiad et al., 2024). This causes uncertainty. Students sometimes find that they understand written passages but struggle with street-level conversations. No clear rule tells them when one form ends and another begins. Some programs try to teach both, but balancing them is messy (Tachicart et al., 2022). On top of that, Arabic morphology brings its own weight. Instead of memorizing words, learners work with roots and forms that shift depending on context. A small vowel or prefix can change how a word functions or even what it means entirely (Issa, 2023). That throws people off. Repetition can help, but only if the examples are real enough. Some teachers use reading aloud; others build listening drills or pattern matching. Results vary. Digital tools like mobile apps and chatbots have entered some classrooms, mostly to fill time gaps. But it's still hard to say if they reflect how Arabic sounds in actual use (Aljanabi, 2024). In my view, Arabic requires more than structured lessons it demands patience and long exposure. Most learners need time and trial, not just technique.

Learning Arabic doesn't look the same for everyone. In some places, students follow Modern Standard Arabic in structured lessons. Elsewhere, learning happens at home through conversation, storytelling, or community events using local dialects (Alkaabi & Almaamari, 2025). There are also learners who try to make sense of both at once, sometimes with little guidance on how to keep them apart. The reason someone studies Arabic matters too. It could be tied to faith, to work, or just a personal connection. And background plays a role a young student surrounded by Arabic at home may approach it very differently than an adult who's never heard it before. Learning environments are varied. Some are formal classrooms, others online forums, and many are in-between. Teachers bring their own styles. While some emphasize structure and rules, others lean toward conversation or interactive work. Recently, tools like language apps and chatbots have been added into the mix. A few teachers say they help with revision or light practice, though how well they support Arabic specifically is something people are still trying to figure out (Zaimah et al., 2023). And really, the whole picture is complicated. There isn't one way Arabic gets taught or learned. So when people design tools, especially AI-based ones, that difference needs to be taken seriously from the start (Zeiny et al., 2024; Shao et al., 2022).

There's been a long-standing interest in how people take in information through more than one sense at a time, but it was Richard Mayer's work especially the Cognitive Theory of Multimedia Learning that really gave it structure (Mayer, 2024). Instead of treating text and images as add-ons, the theory sees them as parallel inputs that the brain handles differently. Some call it the "dual channel" model one stream for words, one for visuals. But both streams have limits. In practice, when too much comes in too fast say, dense text combined with animation and narration it gets harder to absorb any of it. That's where the idea of "cognitive load" comes in. Designers are encouraged to cut down the clutter (Rohde et al., 2023). Some break lessons into parts, others use arrows or highlighting to point out key material. These aren't just aesthetic decisions; they're supposed to help the mind process things without getting overwhelmed. Of course, this doesn't always play out cleanly. In digital language tools, for instance, developers might pile on features speech, subtitles, icons but if it's not done with care, it can backfire. For Arabic learners using chatbots or apps, that's a real risk. CTML doesn't solve every problem, but it gives a useful way to think about how much, when, and how different modes should appear. It reminds us that design isn't just about delivery it's about timing, space, and what the learner is actually able to hold onto (Mungai et al., 2024).

Some of the ideas from the Cognitive Theory of Multimedia Learning have made their way into how educators and developers shape digital lessons (Mayer, 2024). The theory itself builds on a basic thought: we take in words and visuals through different systems in the brain, and both have limits (Litecká & Mitaľová, 2023). That's why, for example, showing too much text while also narrating it can be a problem. People miss things. One part of the theory says we should leave out anything that doesn't directly support the point. Another focuses on making important parts stand out. These aren't complex rules but they're easy to ignore. I've seen learning materials that try to do too much at once, and it often leads to overload (Jii Toh & Tasir, 2024). Choosing between animation or a still image may seem like a small detail, but in practice, it changes how learners make sense of things especially when time or motion is involved. CTML also makes room for flexibility. Not all learners process at the same speed, or in the same way. If a tool can slow down or simplify the input, it tends to help (Castro-Alonso et al., 2021). This matters in chatbot settings, where text, voice, or even visuals might come into play. But when those modes stack up without careful timing, it can confuse more than clarify. So using CTML isn't about perfect alignment it's about making smarter choices with what's shown, said, and when. That kind of judgment often makes the difference between a tool that teaches, and one that just talks.

## Method

This study focuses specifically on AI-based chatbots that are used or developed for Arabic language learning. These tools, whether deployed in formal instruction or self-paced learning environments, represent the primary object of inquiry (Zaimah et al., 2024). The research does not aim to evaluate chatbot performance per se, but rather examines how these systems integrate or fail to integrate key principles of cognitive instructional design and AI transparency (H T et al., 2024). The chatbots under consideration include those that feature multimedia components (text, audio, images) and those intended to simulate conversational practice in Arabic (Alkhatib et al., 2023). What links them is their educational intent and the assumption that they support learning. By examining these implementations through a conceptual and critical lens, the study aims to assess their theoretical grounding, particularly in relation to the Cognitive Theory of Multimedia Learning (CTML) and Explainable AI (XAI) (Ahmed et al., 2022). This focus allows the research to evaluate not just what chatbots do, but what pedagogical assumptions and cognitive demands underlie their design.

This study follows a qualitative path, built on a library-based research approach (N. H. V. Nguyen & Pham, 2024). There's no field data involved here, instead, the work is grounded in a close reading of academic literature. Most of the core material comes from journal articles, books, and published reports that deal with how AI chatbots are being used in language learning especially those that bring up issues like transparency in AI or connections to learning theory (Dang, 2025). These are what we treat as primary sources. Beyond that, there's a wider set of references studies on Arabic language instruction, multimedia learning, and how AI systems are designed that help fill in context. Those fall more into the category of supporting or secondary materials. The idea is to bring these pieces together to see what patterns or gaps show up when we consider both the tech side and the teaching side (Koç & Savaş, 2025). We chose the sources based on how up-to-date and relevant they were to this topic, and whether they offered something solid to build on. By combining focused texts with broader discussions, the study tries to make sense of where the field stands and where it might be missing something important.

This study doesn't include live participants in the usual sense. Instead, it draws heavily on thinkers whose work shapes how we understand learning and AI. Richard Mayer is central here. Mayer's writing on how people process visuals and text has been a useful reference (Mayer, 2024). He points out that the brain doesn't treat images and words the same way they go through different channels (Lin, 2024). That idea helps this study think about what might make a learning tool more effective. Some of his points show up clearly here, like the need to cut down clutter, avoid overwhelming the learner, and combine pictures with text in thoughtful ways (Keshavarz et al., 2022). They aren't always applied consistently in practice, but the framework offers a lot to work with. They guide how we look at the structure of

chatbots used for language education. The same goes for scholars working in the area of Explainable AI. Their writing offers ways to think through how systems can be made more transparent and trustworthy (Garcia et al., 2025). While we don't interview or observe these people directly, their research serves almost like expert input framing the lens this study uses to analyze chatbot tools. Taken together, these voices offer not just background but working ideas that this paper leans on when evaluating what's missing and what could improve in Arabic language chatbot design.

Instead of collecting data from live settings, the research was based entirely on written sources available through academic libraries and databases. The focus was on materials that engaged directly with three key areas: Arabic language instruction, the use of AI chatbots in learning environments, and multimedia-based learning theory (Koç & Savaş, 2025). Searches were carried out using terms closely tied to the topic such as "AI chatbot," "Explainable AI," and "Cognitive Theory of Multimedia Learning," which is consistent with methodologies used in recent literature-driven chatbot studies (Bekkar & Chtouki, 2024). These guided the retrieval process across several academic platforms, including JSTOR and ScienceDirect. Once the texts were gathered, they were reviewed not just for their publication year, but also for how well they held up in terms of relevance and argumentative clarity a standard practice in qualitative literature synthesis (Gökçearslan et al., 2024). Some works contributed technical depth; others helped shape the broader pedagogical framing. Rather than aiming for an exhaustive list, the effort leaned toward pulling together sources that could sharpen the study's perspective without overwhelming it (Tanvir & Kim, 2024). The way the materials were grouped was guided more by recurring themes than by rigid classification, allowing later analysis to proceed with more coherence and less noise.

This study applied content analysis as the primary technique for interpreting the literature. The goal was to trace recurring patterns and ideas that appeared across the selected texts (Dökme & Yılmaz, 2024). Rather than following a fixed checklist, the analysis moved through several phases. It began with close reading to identify sections that discussed AI chatbot use, pedagogical alignment, and system transparency in language education (Bekeš & Galzina, 2023). From there, similar ideas were noted, grouped by theme, and reviewed for how often they appeared and how they were discussed. Some categories stood out clearly, while others revealed inconsistencies or areas that hadn't been fully explored (Gu & Yu, 2025). Particular attention was paid to connections between theory and practice especially how Explainable AI and CTML were or weren't being applied in the context of Arabic language instruction (H T et al., 2024). The process wasn't always linear; some themes had to be re-grouped or reframed as new insights came up. Through this approach, the texts provided more than just citations they offered an interpretive map of where the field currently stands and what questions remain open.

## Result

In reviewing the literature, it becomes clear that AI chatbots are being used in various educational settings, though not always in the same way (Bekkar & Chtouki, 2024). Earlier developments were mostly technical, focusing on the shift from rigid, rule-based systems to models that respond in more flexible ways using machine learning. That change made it possible for chatbots to handle less predictable inputs and seem a bit more conversational. In the case of language learning, several papers describe how these systems are now being positioned as tools for learners who need practice outside regular classrooms, often including features like feedback, pacing, and even gamification (Ying Soon et al., 2024). A handful of studies have tried to link chatbot design to learning theory, though this is rarely explored in much depth (Mungai et al., 2024). What stands out overall isn't just how common chatbots

have become, but how uneven the research is when it comes to connecting them with established educational principles (Chang et al., 2023).

Across the literature, AI chatbots are often described in practical terms as support tools that fill gaps in traditional language instruction (Satiti et al., 2024). Several studies highlight how conversational features can lower learner anxiety, offering more relaxed entry points into the language. Some reports note that these systems respond differently depending on the user, which may allow for a more tailored learning experience. Immediate feedback is mentioned frequently, especially in relation to vocabulary or grammar corrections that repeat common structures (N. H. V. Nguyen & Pham, 2024). Engagement strategies also appear throughout, including mentions of quizzes, storytelling, and role-play features. These seem to help maintain user interest, particularly when learners are working independently (Ying Soon et al., 2024). On a more technical note, a small number of sources examine how natural language processing models make these responses possible. Alongside these strengths, there's a growing call in the literature for tighter integration between these tools and established pedagogical thinking an area still evolving in the field (Chang et al., 2023).

Findings from the literature align closely with the practical challenges highlighted in this study. While many sources recognize the technical strengths of AI chatbots particularly their capacity for interaction there is a recurring concern about the lack of connection to instructional theory (Chetyrina, 2024). This disconnect reflects the central issue explored here: most chatbot systems, especially in language learning, operate without a clear pedagogical foundation. In Arabic learning environments, where linguistic complexity adds another layer of difficulty, this absence becomes more visible (Zaimah et al., 2023). Several studies note that these systems often fail to explain their responses, which signals a broader gap in how principles of Explainable AI are being applied (H T et al., 2024). This lack of transparency doesn't just limit usability; it also raises questions about learner trust and instructional value. In this way, the literature not only outlines the possibilities of chatbot use, but also reinforces the core concern of this research: that educational design and explainability are still underdeveloped in current AI chatbot implementations for Arabic instruction.

The literature on Arabic instruction tends to revisit a few consistent themes. Diglossia is one of them the divide between textbook Arabic and spoken varieties often leaves learners unsure of how to apply what they've studied (Asadi & Asli-Badarneh, 2023). This isn't limited to vocabulary shifts. Some forms change enough to disrupt comprehension altogether, especially when dialects differ sharply. Several sources also bring up structural elements Arabic's root-pattern system, the right-to-left script, and phonetic distinctions can be barriers early on (Abu-Liel et al., 2021). As for how Arabic is taught, many sources describe a mixture of traditional grammar work and conversation-focused practice. Some classrooms have started blending in digital materials, though it's unclear whether these are designed with Arabic's complexity in mind (Omar & Aldawsari, 2022). When it comes to tech, tools like apps and platforms are mentioned, but often with the caveat that they were built with general language learning in mind not Arabic specifically (Younes et al., 2020). Rather than clear solutions, the literature outlines a teaching landscape that's shifting, with challenges that haven't gone away.

People writing about Arabic learning often go beyond just describing the surface they try to show why it tends to be such a tricky language to master. A big part of that has to do with how its words are built. Root-based formations, with changes happening inside the word itself, require repeated exposure before they start to make sense (Joubran-Awadie & Shalhoub-Awwad, 2023). Then there's the matter of sound. Some of the consonants simply don't exist in many learners' native languages, which makes early pronunciation a bit of a wall (Asadi & Asli-Badarneh, 2023). Diglossia adds another layer of difficulty. Learners are expected to handle two forms: the formal one for books or news, and a more casual version used in everyday speech (Efendi & Makhisoh, 2023). But they don't always line up, and switching between them doesn't come naturally. That means teachers often have to improvise. A method that fits for classroom Arabic might fall apart in a street conversation. A few sources point out that knowing the

culture around the language plays a bigger role than people expect. It's not just grammar it's also how language fits into a situation or relationship (Omar & Aldawsari, 2022). Some tools, including apps or chatbots, try to step in here. But many feel too generic. If they're not built with Arabic's particular quirks in mind, they tend to miss the mark, especially when learners are already dealing with so many moving parts.

What's described in the literature on Arabic learning connects closely with the challenges outlined in this study. The language's complexity especially the way it handles roots, unfamiliar sounds, and the split between formal and spoken varieties demands more than just surface-level instruction (Hadi & Qohar, 2025). It requires tools that take those layers seriously. Right now, though, most AI chatbots don't reflect that (Zeiny et al., 2024). Several sources mention how digital platforms are being used more often, but also point out that they rarely focus on the kinds of issues Arabic learners face (Zaimah et al., 2024). This is where the research problem takes shape. A key gap is the lack of learning systems that are grounded in how people actually process language especially one as layered as Arabic (Asadi & Asli-Badarneh, 2023). Cultural context, too, shows up often in the literature as something that matters (Harbi, 2022). Learners aren't just translating words; they're trying to operate inside a culture. Most chatbot systems don't yet account for that (Zaimah et al., 2023). So, while the tech is there, the alignment with what Arabic learners really need both cognitively and socially is still missing.

The Cognitive Theory of Multimedia Learning appears often in education literature, especially in discussions about how people take in information from both words and images (Mayer, 2024). Richard Mayer, who developed much of the theory, outlines how the brain handles audio and visual input through two separate pathways. Since both have limits, materials that combine spoken explanations with images need to be planned carefully (Cavanagh & Kiersch, 2023). If too much is presented at once, learners can end up overloaded and miss the point. Some studies give examples of how this idea shows up in real tools like short videos with narration, clickable diagrams, or tutorials that focus attention using cues. These techniques are often linked to three terms that come up repeatedly: signaling, segmentation, and modality (Noetel et al., 2022). Most of the writing on this topic comes from science or instructional design fields. A few sources have started looking at its role in language learning, though there's not much yet about how it connects with chatbots or interactive AI (Neo, 2022). Even so, the ideas in CTML seem to offer practical clues about how to reduce overload and keep learners more focused when using digital materials.

Writings on the Cognitive Theory of Multimedia Learning go further than just defining its principles they also explore why those ideas tend to help learners. A key point is that people take in information through two systems: one for what they see, and another for what they hear (Mayer, 2021). When used carefully, this split allows visuals and narration to work together without overwhelming either channel. But when too much is presented at once say, dense graphics and heavy audio learners can struggle to keep up (Noetel et al., 2022). Several strategies are mentioned as ways to ease this load. Signaling, for instance, draws attention to key parts of the screen. Breaking up material into smaller chunks what the literature calls segmentation also makes a difference (Castro-Alonso et al., 2021). There's also the idea that pictures with spoken explanation work better than those with written labels, since it prevents the brain from competing for space in the same channel (Kutbay & Akpınar, 2020). These points show up often in studies measuring how much people remember or understand after using CTML-based tools. Some sources suggest these techniques fit well in digital settings where learners work through content on their own. Even though CTML has made its way into e-learning, it hasn't been used much in chatbots. That's interesting, especially now that many bots include images, speech, and interactive text. If CTML were applied there, it might help improve how those systems support learning.

Much of what the Cognitive Theory of Multimedia Learning (CTML) proposes seems directly relevant to the learning challenges discussed in this study particularly the need to manage input across visual and auditory channels to avoid overload (Mayer, 2021). Yet, these principles are rarely found in the actual

design of AI chatbots used for Arabic instruction. Most existing tools rely heavily on text and overlook strategies like signaling and segmentation, which CTML identifies as effective for guiding attention and easing cognitive load (Vu et al., 2022). This disconnect is especially problematic in Arabic learning contexts, where features such as right-to-left script and complex root-based morphology introduce additional processing demands. Research shows that even in general chatbot use, neglecting cognitive design can increase user frustration and reduce effectiveness (Schmidhuber et al., 2021). What emerges from the literature is a clear opportunity: to improve chatbot design by applying CTML principles that better align with how learners actually process complex language content

## Discusion

### AI Chatbots and the Challenges of Arabic Language Instruction

Looking across the findings, there's a clear mismatch between how advanced chatbot technologies have become and how well they support real learning especially for Arabic (Ahmed et al., 2022). These systems are capable of holding conversations and responding in real time, but they rarely draw from established learning theories (Abdulkader & Al-Irhayim, 2022). That's a problem, since Arabic instruction involves more than just vocabulary drills it includes cultural cues, morphological patterns, and context-specific usage that need careful support (Rohmawaty et al., 2024). The literature also points out that even when multimedia is used, it often lacks structure. Few tools seem to manage mental overload or adapt the way content is presented to match how learners actually process information (Zaimah et al., 2023). What comes through is a pattern: tech has moved fast, but its connection to cognitive design and transparent feedback hasn't kept up. This suggests a need for more grounded models ones that treat chatbots not just as software, but as part of an intentional learning system that makes sense to the user and supports how people learn.

### Integrating Cognitive and Ethical Perspectives in Chatbot Design for Arabic Instruction

Many earlier studies on AI chatbots in education tend to focus on either the technical side such as how systems are built or on broad outcomes like user satisfaction. What often gets left out is a solid theoretical grounding, especially one that connects how learners process information with how these systems function (Mungai et al., 2024). This study tries to fill that space. By bringing together ideas from cognitive psychology and AI ethics specifically the Cognitive Theory of Multimedia Learning and Explainable AI it offers a way to think about chatbot design that isn't just about functionality (Rohde et al., 2023). Instead, it puts learning and transparency at the center. That makes the evaluation more than just a checklist of features it becomes a way to ask whether these tools actually support understanding, and whether learners can trust them (Zaimah et al., 2023). In the case of Arabic, where both structure and context matter deeply, this kind of framing could help shift development toward tools that are smarter in how they teach, not just in how they talk (Naz & Robertson, 2024).

### Cognitive and Transparent Design in Arabic Chatbots

One of the most important takeaways from this study is the value of bringing learning theory and system transparency together in the same design process. In the case of chatbots for Arabic instruction, this means using both cognitive models and explainability features not just to deliver content, but to make the interaction itself part of how learning happens. Recent work highlights how Explainable AI can increase user trust, particularly when explanations are integrated into chatbot responses in a way that supports cognitive understanding (H T et al., 2024). Meanwhile, chatbots developed for Arabic learning contexts remain limited, with many lacking features aligned with multimedia learning principles such as signaling, segmentation, and modality (Alkhatib et al., 2023). By drawing from CTML and Explainable AI, there's a real chance to move away from tools that simply respond, toward ones that actually support

how learners process and understand language. This is especially relevant in Arabic, where subtle changes in form and meaning require more nuanced instructional support (Ahmed et al., 2022). When designed with learning in mind, these tools don't just work they teach.

**Instructional and Design Implications for Arabic Language Chatbots**

This study offers a few practical takeaways that could guide future work in both education and technology. For instructional designers, it points to ways of building learning tools that take cognitive load into account like breaking tasks into smaller parts, using clear visual cues, or combining images with narration (Schmidhuber et al., 2021). These aren't just nice features; they shape how well learners can take in and remember new information. For developers, there's a strong case for adding explainable features into chatbot systems so learners know why the system responds the way it does (H T et al., 2024). That kind of clarity builds trust, especially when learners get something wrong and want to understand why (Mungai et al., 2024). Educators and decision-makers might also use this framework to evaluate whether a tool fits with how learning actually happens, not just how it performs technically. The bigger picture is collaboration. Better results will likely come when cognitive scientists, language instructors, and AI developers work together from the start (P. T. Nguyen & Dinh, 2024). This matters even more in Arabic education, where the complexity of the language leaves little room for one-size-fits-all tech solutions.

**Barriers to Cognitive Integration in AI Tools**

There are a few reasons why many AI chatbots still don't measure up in terms of actual learning. A big part of it is how these systems are built and evaluated mostly around speed, accuracy, or how smooth a conversation feels (Hidayat-ur-Rehman, 2024). But those aren't the same as helping someone understand something better. That disconnect means the tools may sound impressive, but don't really teach (Naz & Robertson, 2024). Another factor is how separate the tech and education worlds often are. AI teams may not be thinking about how people learn, and educators may not be familiar with how the systems actually work. So, designs that could bring both sides together often don't happen. And in Arabic, the challenge gets harder. The language requires custom solutions ones that account for structure, meaning, and context and those rarely come from general-purpose tools (Zaimah et al., 2023). This all helps explain why ideas like CTML or Explainable AI are discussed in theory but barely show up in real systems (Mungai et al., 2024).

**Strategic Actions for Advancing AI Chatbots in Arabic Education**

Fixing chatbot design for Arabic instruction may not require major breakthroughs, but rather a shift in who gets involved and when. Involving teachers early in development especially those with deep knowledge of language structure could lead to systems that prioritize learning, not just functionality. Research supports this by highlighting how current Arabic chatbots often fall short due to limited pedagogical integration and contextual understanding (Ahmed et al., 2022). Another critical but often overlooked element is explainability. When a learner receives a response without understanding the reason behind it, an opportunity for growth is missed. Studies on chatbot effectiveness emphasize that transparent feedback helps learners stay engaged and build trust in the system (Zaimah et al., 2023). Bridging the communication gap between developers and educators could lead to more grounded and usable tools (Chiu et al., 2023). Classroom testing early and often would provide practical feedback, allowing developers to refine tools based on how learners actually interact with them (Yao et al., 2025)

## Conclution

Perhaps the most striking finding of this study is the realization that despite the rapid advancement of AI chatbots in educational technology, their actual pedagogical contribution to Arabic language learning

remains critically underdeveloped. It is both surprising and concerning that tools engineered with such linguistic precision and interactive fluency often fail to embody even the most foundational principles of instructional design. The absence of Explainable AI features and the neglect of cognitive learning principles such as those articulated in Mayer's Cognitive Theory of Multimedia Learning reveal a blind spot in current practices. This disconnect underscores a larger issue: technological sophistication alone does not guarantee educational effectiveness. The study reveals that without intentional integration of pedagogical theory and transparency frameworks, AI chatbots risk functioning as hollow communicative shells impressive in form but lacking in substance. This insight not only challenges assumptions about AI in education but also compels a reevaluation of how such tools are conceptualized and applied in real learning environments.

What this research tries to do is bring two different ideas into the same space cognitive learning theory and AI explainability because both seem necessary, but rarely show up together in actual chatbot systems, especially in Arabic language education. The theory part matters: how learners process language, how visuals and words interact, and where things go wrong when overload happens. That's not something most chatbots are designed for. On the practical side, the study points toward design decisions that aren't difficult, just overlooked. Adding short explanations, showing why a response was chosen, or shaping content around how memory works these are adjustments that could make real difference. But they only matter if developers and educators start talking to each other. This isn't a blueprint; it's an invitation. And if some of what's explored here pushes the conversation in a more grounded direction, especially for Arabic learners, then the work is already doing something useful.

This study presents an early step toward connecting cognitive theory and AI chatbot design in Arabic language education. It uses only secondary sources, which limits the depth of validation, but still offers enough ground to shape what comes next. Instead of treating this limitation as a flaw, it is better understood as a reason to continue the work starting from ideas, and eventually testing them in actual learning spaces. There is value in observing how learners interact with chatbot systems in real time. The way feedback is received, how much of it is retained, and whether explanations support understanding depend on more than just system quality. Factors like background knowledge and familiarity with Arabic structures can affect how the tool is used. These things won't show up in literature reviews they need trials, observations, and small adjustments along the way. This paper doesn't try to settle the problem. It simply opens space for more joined-up thinking. When learning science, applied linguistics, and AI development move together, the outcomes may not be perfect, but they will be closer to what real learners need.

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