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**Investigating the Impact of Digital Learning Environment
on Students' Cognitive Load and Their Performance in
Grammar, Vocabulary, and Writing.**

Case Study: Second Year EFL Students at the Level of
English Department, University of Dr. Moulay Taher, Saida.

A Thesis Submitted as Partial Fulfillment of the Requirements
for the degree of *Master* in Didactics.

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Declaration

I hereby declare that this submission is my original work, and that the list of references used indicates all the sources and quotes mentioned in this research. It contains no material previously published or written by another person nor material that has been accepted for the qualification of any other degree or diploma of a university or an institution.

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Dedication

I dedicate this work to my beloved brother and sister and my amazing parents for supporting me during this journey, and special gratitude goes to my dearest friend Abdelkader for his constant encouragement. This dedication is a small repayment for the enormous gift of your belief in me, I couldn't have achieved this without you. May Allah bless you and grant you everything you wish for. And my big thanks to my beloved cat for emotional support.

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Abstract

This research investigates how digital multimedia environments and tools affect the cognitive load and learning outcomes of second-year EFL students at the Department of English in Dr. Moulay Taher University of Saida, Algeria, during the 2025/2026 academic year. Although these digital tools are widely used, they can easily exceed working memory capacity and cause extraneous cognitive load. Using a convergent mixed-methods design, the researcher gathered data from 57 students and two teachers. The study relied on student questionnaires, teacher interviews, and non-participant classroom observations. The findings show that most students respond positively to multimedia, with 87.8% preferring visual formats and frequently using AI tools to improve their writing and vocabulary. And yet, these digital environments still present significant challenges. Survey data indicates that 60.7% of students feel mentally overwhelmed by digital tools, and 38.6% experience AI-induced cognitive exhaustion. While classroom observations confirmed the direct impact of instructional design on cognitive load. Instructors who applied signaling and segmenting principles achieved an 85% student recall rate, whereas poorly paced lessons caused working memory overload and led students to rely heavily on AI. Lastly, these findings supported the study's three core hypotheses, demonstrating that digital tools only benefit EFL learning when they align with human cognitive architecture. The study recommends that institutions provide pedagogical training to help teachers design lessons with cognitive load in mind, while establishing clear guidelines that position AI as a supportive learning aid rather than a replacement for critical thinking.

Keywords: cognitive load, multimedia learning, English as a foreign language (EFL), instructional design, artificial intelligence

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List of Acronyms & Abbreviations

AI: Artificial Intelligence

CLT: Cognitive Load Theory

EFL: English as a Foreign Language

ESP: English for Specific Purposes

GCL: Germane Cognitive Load

ICT: Information and Communication Technologies

E-learning: Electronic Learning

et al.:*et alii* (and others)

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General Introduction

General Introduction

Digital technology has deeply changed how students access and process information. In English as a Foreign Language (EFL) classrooms, tools like e-learning platforms, videos, and AI applications are now frequently used to study and improve vocabulary, grammar, and writing. Those instruments support language learning, but they can also exceed the cognitive capacity of students, because they present a large amount of information through multiple channels at the same time. Cognitive Load Theory, established by Sweller (1998), explains how the human mind handles new data, where working memory has a limited capacity, and when students receive too much information at once, learning becomes difficult. In Algeria, recent university reforms have encouraged the integration of technology. For example, second-year EFL students at Dr. Moulay Tahar University in Saida regularly use online dictionaries and digital platforms. Investigating how these tools affect their mental effort is necessary to improve the quality of teaching in this department and other educational settings.

There is a noticeable gap between the benefits of digital environments and the way they can overwhelm student memory. Many online tools provide helpful materials, but they can easily lead to mental fatigue. Most studies in this field focus largely on reducing extraneous cognitive load. Yet, they often ignore the need to balance all three types of load: intrinsic, extraneous, and germane (Sweller et al., 2011). There is little information on how teachers' planning decisions affect students in grammar and writing. When planning is not deliberate, learning outcomes tend to suffer.

To address this problem, this research investigates the impact of digital tools on the cognitive load of EFL students. The study checks whether technology actually improves academic performance or simply overloads student memory. This research is important for several reasons. One reason, students can learn to use digital platforms more effectively without experiencing exhaustion. Another reason, teachers can make better decisions when planning lessons that combine technology with traditional methods. Lastly, the university can use these results to improve teacher training and technology integration.

To achieve these goals, the study has three main research objectives:

1. To explore the impact of digital platforms on student cognitive load and determine whether they support or hinder language learning.
2. To identify the specific mental struggles and distractions students face when using these tools.

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3. To examine the level of teacher awareness of cognitive load and how they design digital lectures to support their students.

This research addresses three central questions:

1. What is the impact of digital tools on students' cognitive load, and how does this affect their learning of grammar, vocabulary, and writing?
2. What instructional strategies do teachers use with digital materials to manage student cognitive load in writing and grammar?
3. What challenges do students face when using digital tools to develop their language skills?

Based on these questions, the researcher proposes three hypotheses:

- H1:** The first hypothesis suggests digital tools improve student performance and help teachers manage cognitive load in grammar, vocabulary, and writing.
- H2:** The second proposes teachers use digital tools in different ways, with some using them only as extra resources to make lectures more engaging.
- H3:** The third states digital tools do not have a negative impact on cognitive load when they are designed properly to support human learning.

The study was conducted at the English department of Dr. Moulay Tahar University in Saida, Algeria, during the 2025/2026 academic year. Purposive sampling was used to select cases that actively use digital tools in class, as recommended by Palinkas et al. (2015). The participants include:

1. 57 second-year EFL students (from a total population of 247 students).
2. Two teachers who instruct the core grammar and writing modules.

To collect reliable data, the study uses a mixed-methods design with three instruments:

1. A student questionnaire with 14 items given to the 57 students to measure their mental effort and tool usage.
2. Semi-structured interviews with two teachers, consisting of 18 questions in total (9 for each module), to understand their views on technology and lesson design.
3. Non-participant classroom observations conducted over two weeks in writing and grammar classes to see how students react to digital tools in real time.

This thesis is organized into three main chapters where Chapter One presents the literature review, focusing on human cognitive architecture, Cognitive Load Theory, and digital tools in EFL learning. Next, chapter Two describes the research methodology, including the setting, the participants, and the data collection tools. Finally, chapter Three provides the analysis of the collected data, discusses the main findings, and offers pedagogical recommendations.

Chapter One

Literature Review

1.1 Introduction

Cognitive load is a fundamental determinant of the efficiency with which learners process and comprehend new information via working memory. In the context of English as a Foreign Language (EFL) instruction, mastery of writing, grammar, and vocabulary is essential for academic proficiency. Conversely, the inherent constraints of human working memory mean that excessive input can easily lead to cognitive overload, thereby obstructing the learning process. With the proliferation of digital tools in educational systems, managing cognitive load has become a pedagogical necessity. Effective integration requires instructional design that minimizes extraneous cognitive load, mental effort that does not contribute to schema construction, and optimizes germane cognitive load, which fosters productive schema acquisition. Under conditions where digital tools are utilized to facilitate the transfer of input, their design must be rigorously structured to align with human cognitive architecture. This chapter provides a comprehensive literature review on the interplay between digital tool integration and cognitive load in EFL learning environments, examining management strategies and the pedagogical challenges inherent in technological integration.

1.2 Theoretical Framework: Human Cognitive Architecture

Human cognitive architecture is what cognitive load theory is built on. This is important because it shows both what our minds can do and where they break down during learning. Sweller et al. (2011, p. 17) defined it as the intelligent natural information processing system, with working memory and long-term memory as its basic parts that work together. Kalyuga (2025) explained that cognitive load theory uses an evolutionary idea of human cognitive architecture. This gives a conceptual framework for the main principles of human cognition, and these principles affect how we teach and learn.

At first, this framework had five principles common to all natural information processing systems. These came from seeing similarities between biological evolution and how humans think. They apply to both biologically primary and biologically secondary knowledge: the information store principle, the borrowing and reorganizing principle, randomness as genesis, narrow limits of change, and environmental organizing and linking (Kalyuga, 2025, p. 2). Recently, Kalyuga (2025) added a sixth principle, the explicit intention to learn principle. Together, these six form a higher-level natural information processing system. For EFL students, secondary biological knowledge is the focus, because language

learning as an academic subject is culturally acquired and demands conscious effort, it is not innate (Sweller, 2018).

Sweller et al. (2011) outline the six key principles of information processing in biologically secondary knowledge:

- The information store principle: When individuals deal with a complex situation, they mainly depend on their biologically secondary knowledge to act rather than figuring out what to do from scratch.
- The borrowing and reorganizing principle: The system obtains the majority of biologically secondary information structures in a controlled manner directly from external sources, such as spoken and written texts or images. Eventually, this information is incorporated into preexisting knowledge.
- The randomness as genesis principle: New knowledge is sometimes generated through problem-solving in a conscious state, requiring the ability to adapt to new situations and modify old habits.
- The narrow limits of change principle: Working memory has two functions within human cognitive architecture: it protects stored knowledge in long-term memory from interference, and it facilitates the process of learning, moving new secondary knowledge to long-term memory when the intention to learn is present.
- The explicit intention to learn principle: In order to acquire biologically secondary knowledge, working memory must be in a conscious, controlled state, where learning requires mental effort. This principle influences the others because all of them depend on consciousness and effort to learn new material.
- The environmental organizing and linking principle: Working memory limitations can be bypassed when dealing with a familiar environment through the preexisting secondary knowledge stored in long-term memory.

1.2.1 Components of Human Cognitive Architecture

As mentioned above, human cognitive architecture rests on six principles that govern information processing during secondary knowledge learning. This architecture consists of three basic parts: working memory, long-term memory, and schemas. These parts are integrative, and each one helps the secondary knowledge learning process succeed. The Centre for Education Statistics and Evaluation (2017) defined them as follows:

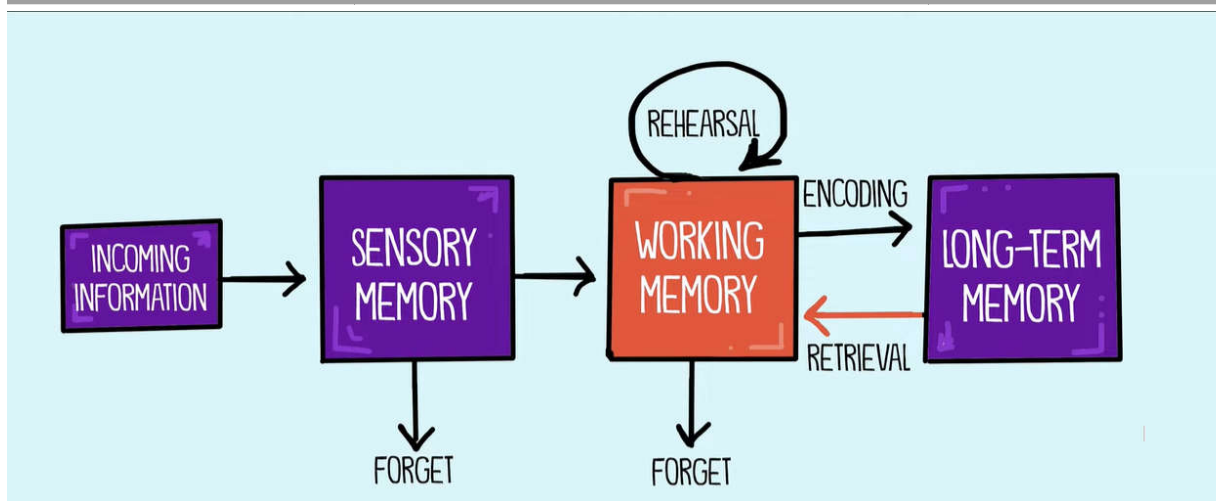


Figure 1.1: *Information processing diagram*

1.2.1.1 Working Memory

Working memory processes incoming information. It can only deal with a small amount, about four items, at a time in a conscious state through encoding, a process where the brain sorts and labels the information. If working memory gets overloaded, it causes confusion and prevents the information from being stored in long-term memory, which slows down learning (Centre for Education Statistics and Evaluation, 2017, pp. 2–3).

1.2.1.2 Long-Term Memory

Long-term memory is the unconscious part where input is stored in a relatively permanent way within schemas and can be brought back when needed (Centre for Education Statistics and Evaluation, 2017, pp. 2–3). Unlike working memory, long-term memory has an unlimited capacity for storing knowledge (Forsberg et al., 2022), although this may vary from person to person.

1.2.1.3 Schema Construction

Schemas put information components in order based on how they are used. Schema theory says that skilled performance is built by putting components of lower-level schemas into higher-level ones and making them more complex. This includes the automation phase, which makes it possible to process information with less mental effort and can be achieved through practice (Centre for Education Statistics and Evaluation, 2017, pp. 2–3).

1.2.2 The Relationship Between Working Memory and Long-Term Memory

Working memory and long-term memory cannot be separated. Incoming information must be processed in working memory first before it can be stored in long-term memory. When a person needs specific information, schemas bring it back from long-term memory to working memory, as long as the retrieval itself does not create extra cognitive load (Centre for Education Statistics and Evaluation, 2017). Therefore, learning is the process of building and improving schemas in long-term memory. This, in turn, reduces the cognitive load on working memory when dealing with complex information.

1.3 Cognitive Load Theory (CLT)

Cognitive load theory is an instructional design framework presented by John Sweller in the late 1980s. It describes how people learn and retain information through working memory and long-term memory (Likourezos, 2021). The theory rests on two basic concepts: first concept, the amount of information the brain can process at one time is limited; and second concept is that long-term memory has no limit when it comes to storing and processing information (Centre for Education Statistics and Evaluation, 2017, p. 3).

CLT divides human knowledge into two categories. The first category is biologically primary knowledge. This refers to skills and competencies that our brains have evolved to acquire innately and automatically for generations without conscious effort, and it is necessary for survival (Likourezos, 2021). According to evolutionary psychology, this type of knowledge is considered a human universal where all individuals share the same capacities, such as recognizing faces or acquiring their mother tongue (Lespiau & Tricot, 2022). The second category is biologically secondary knowledge, which is the opposite of the first. It refers to input that is hard to acquire and learn because it requires much time and effort; the mind must be fully conscious in order to learn a specific task, and it is strongly related to an individual's motivation. Any knowledge that is outside our direct environment is considered secondary biological knowledge, and it is typically found in school curriculums and educational institutions (Lespiau & Tricot, 2022). However, primary and secondary knowledge can be strongly related. For example, although French is based on primary knowledge (the native language), it requires effort as secondary knowledge in an academic setting, where students study oral communication skills such as lectures (Sweller et al., 2011). Sweller et al. (1998) stated that the main purpose of cognitive load theory is to offer suggestions for presenting information in a way that promotes student behavior to maximize academic performance.

1.3.1 Types of cognitive load

Cognitive load theory identifies three types of load that affect learning (Sweller et al., 1998; Centre for Education Statistics and Evaluation, 2017):

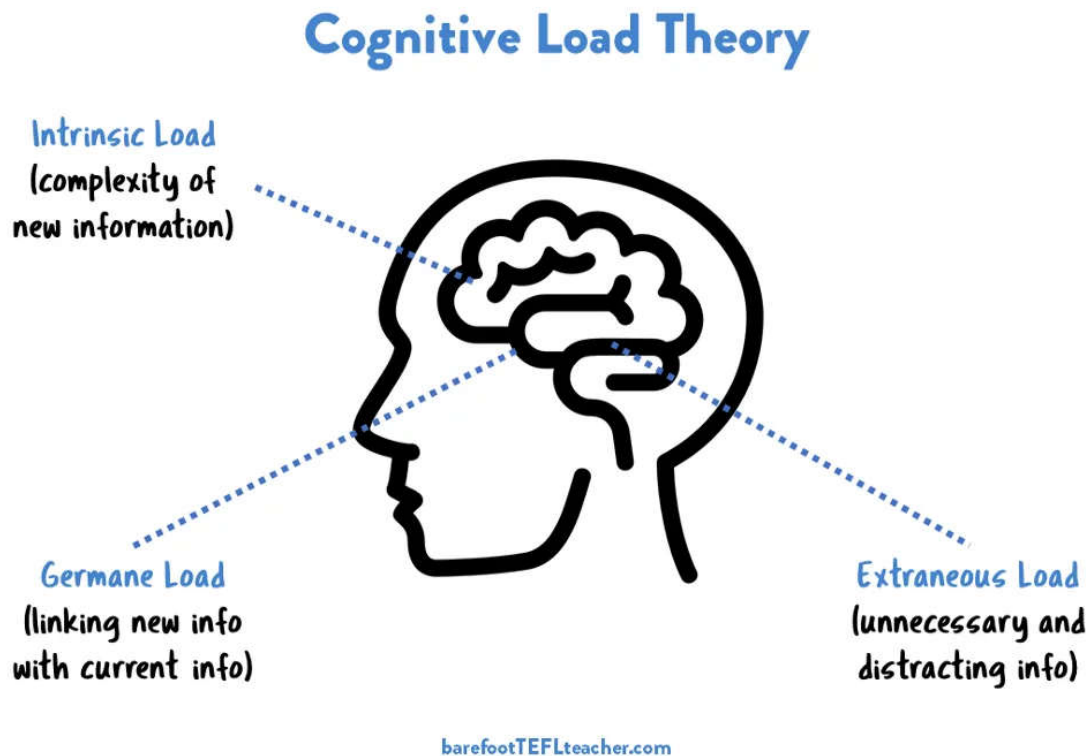


Figure 1.2: Cognitive Load Types

1.3.1.1 Intrinsic Cognitive Load

Intrinsic cognitive load is the mental strain from task complexity, based on how many elements must be processed at once (Sweller et al., 1998). This load decreases if students possess relevant prior knowledge. When students with little prior knowledge face a complex task with high element interactivity, intrinsic load increases (Van Merriënboer & Sweller, 2010). Instructional designers can help by introducing key terms early, for instance, through warm-up activities before a new lecture.

1.3.1.2 Extraneous Cognitive Load

Extraneous cognitive load is the mental strain caused by how information is presented, rather than the content itself (Sweller et al., 1998). Poorly designed instruction forces students to waste effort looking for connections. To reduce this unnecessary load, designers should present related information together, both spatially and simultaneously (Ayres & Sweller, 2005).

1.3.1.3 Germane cognitive load

Germane cognitive load (GCL) is the mental effort students put into creating and automating schemas (Sweller et al., 1998). Unlike intrinsic and extraneous load, GCL helps learning. It distributes working memory resources to manage intrinsic load. To free up resources for GCL, instructions should minimize unnecessary extraneous load (Van Merriënboer & Sweller, 2010). The imagination principle also helps by encouraging learners to visualize content, promoting activities like organizing and selecting information.

1.3.2 Measurement of Cognitive Load

When cognitive load theory emerged in the late 1980s, there was no direct measurement of cognitive load itself (Sweller, 2018). Fred Paas introduced the first measurement in the early 1990s: a rating scale, such as "How hard do you find this task on a scale from 1 to 10?" This helped determine the load invested in a task (Sweller, 2018). It remains the most common measurement because it is easy to use and takes less than one minute (Sweller, 2018). Most importantly, it identifies effective instructional design.

On the other hand, the Paas scale does not indicate which type of load learners experience. It measures total cognitive load, so it cannot distinguish if students struggle due to a poorly designed lesson (extraneous load) or content complexity (intrinsic load). Sweller (2018) noted that this scale primarily measures extraneous load, with intrinsic load being measured indirectly. If the material is simple (low ICL), the presentation method is less important. If ICL is high, managing ECL is necessary to prevent excessive pressure on working memory.

Sweller (2018) also identified the secondary task method as another measurement. This method gives learners a secondary task while performing a main one; underperformance in the secondary task suggests the main task puts more pressure on working memory. A third method uses psychometric scales to distinguish between ECL and ICL. These scales are not consistently dependable, as they rely on the learner's ability to distinguish between the two types. If students do not know that integrated instruction is easier than split-source instruction, they might think the content is too complex instead of recognizing that the teaching method is the issue. In such cases, the scales cannot accurately differentiate between the two load sources.

1.4 Multimedia Learning in the EFL Context

Using digital multimedia in the classroom has changed the way EFL students learn language skills. This section looks at how videos, audio, and images affect cognitive load during vocabulary, grammar, and writing tasks. While these tools make learning content more accessible, they require careful management to avoid mental overload.

1.4.1 Conceptualizing Multimedia Learning

Multimedia has become a trending tool in education due to the spread of technology, with increasing demand from both teachers and learners. In the EFL context, learners currently use various types of multimedia to improve their language skills. From the perspective of CLT, multimedia can greatly boost learning if used wisely, but it also risks overloading working memory if used incorrectly. Bayraktar et al. (2019) defined multimedia educational learning environments as approaches that use different technological tools, such as images, videos, and audio, to support teaching and learning. These environments aim to create engaging and stimulating educational experiences suited to the learner's level, encourage active participation, provide access to online resources, and enhance collaboration between teachers and students. Multimedia has the potential to improve education because it provides a complete and interactive framework that helps students understand, remember, and perform better (Bayraktar et al., 2019).

1.4.2 Cognitive Load in Multimedia Environments

Cognitive load must be taken seriously when integrating multimedia into the learning environment. The cognitive theory of multimedia learning was developed based on CLT (Mayer, 2009). Mayer (2009) identified three key principles of this theory: first, people can process information through visual and auditory channels; second, each channel has a limited capacity for information at any given time; and third, active learning occurs when learners select and organize relevant material and integrate it with prior knowledge. However, for learning to occur in a multimedia environment, human cognition must follow a specific process (Mayer, 2009):

First, sensory memory, which has an unlimited capacity, filters out unnecessary background elements. It then selects the required words and sounds through visual and auditory channels and moves them to working memory, which has a limited capacity. Working memory organizes the information and moves it to long-term memory to connect it with existing prior knowledge. The cognitive theory of multimedia learning identifies three

main types of cognitive processing during information handling: essential, extraneous, and generative. Essential processing occurs when students select and organize relevant words and pictures using multimedia, creating verbal and visual mental images in working memory. This type of processing is similar to intrinsic cognitive load in CLT. Extraneous processing results from poor instructional design and serves the same function as extraneous cognitive load in CLT. Generative processing involves organizing received information and integrating it with prior knowledge, which is similar to germane cognitive load in CLT.

1.4.3 Impact of Multimedia on Vocabulary, Grammar, and Writing

Vocabulary, grammar, and writing are fundamental skills for EFL learners during their academic journey because they form the cornerstone of the English language. Mastering these skills is essential for acquiring language and developing communication. The emergence of technology, specifically multimedia tools, has made learning these three elements easier. Multimedia provides teachers with opportunities to improve their lesson design quickly and helps students learn by integrating sound, images, and online platforms to make the content more engaging and understandable.

According to Ghafar and Sawalmeh (2024), grammar is the ability to recognize which words to use in specific situations and the correct order of those words. In language learning, grammar is more than a set of rules; it is a crucial tool in developing effective communication and language skills. Multimedia tools have made learning grammar much easier, as shown in a study by Illin et al. (as cited in Kanya & Afolabi, 2023). After studying the impact of videos on grammar instruction in an ESP grammar class, the results indicated that implementing videos had a beneficial impact on learners' grammatical proficiency. Students also became more engaged and actively participated in lessons.

Writing carries the same importance as grammar, as it is one of the fundamental academic skills EFL students should develop. According to Ignacio (2025), writing is an intellectual activity that requires mental effort and uses a variety of other cognitive skills, such as reasoning, attention, and memory. It serves as the cornerstone for self-expression, communication, and intellectual growth. Writing is also considered a crucial component of 21st-century competencies, including critical thinking, collaboration, and digital literacy, especially with the integration of technology and multimedia. Mekheimer (2025) supported this perspective, stating that a large number of EFL learners reported feeling more confident after using technology to enhance their writing skills, and their anxiety significantly reduced.

Technology not only helps correct writing mistakes but also increases students' confidence and reduces their fear of writing.

Vocabulary contributes another key area of focus. It is the knowledge that goes beyond identifying words, it involves knowing how to use them in specific situations and understanding their depth. Vocabulary indicates how much a learner has learned about a language (Teng, 2026). Studies have shown that multimedia digital tools have influenced vocabulary learning. In the L2 field, research has demonstrated that visual aids like images facilitate vocabulary acquisition. Martinez-Lage (1997) stated that multimedia provides full-time access to various annotated information, such as audio and images, allowing learners to continue reading and writing smoothly without stopping to consult a dictionary.

1.5 Pedagogical Challenges and Instructional Design

Using digital tools in EFL classrooms is not always simple. While multimedia can help students learn, it also brings real pedagogical difficulties. Teachers must design lessons carefully to prevent students from getting overwhelmed. This section explores how poor instructional design causes cognitive overload, and how teachers can organize digital materials to help students process information better.

1.5.1 Challenges in Managing Cognitive Load via Digital Tools

In the current digital age, students are more susceptible to cognitive overload than ever before, mainly because of the integration of multimedia in education. As mentioned previously, multimedia greatly benefits EFL learning, yet it may also hinder it. Complex multimedia can cause confusion and stress, which then decreases learners' motivation. The overwhelming amount of online information can stop students from focusing on useful content, and this affects learning efficiency (Arnold et al., 2023).

1.5.2 Role of Instructional Design in Optimizing Cognitive Load

Instructional design is crucial for managing cognitive load, including its three types: intrinsic, extraneous, and germane. The goal is to optimize the learning experience for higher education learners, specifically EFL students (Van Merriënboer & Sweller, 2010). Effective instructional design has three parts: the learning task, the design of the learning materials, and the activation of the learner's cognitive processes.

1.5.2.1 The learning task

Van Merriënboer and Sweller (2010) argue that this category focuses on the intrinsic cognitive load of the learner. The teacher first needs to address the learning content before assigning a task, but must also consider the students' prior knowledge to ensure better understanding. Pre-training, as described by Mayer (2009), provides learners with vocabulary related to the content before the main lesson. Another technique is the isolated elements procedure. Pollock et al. (2002) explain that working memory cannot hold a large number of variables at once. The task needs to be broken into parts so that each element is processed one at a time. This supports the formation of valuable schemas in long-term memory. Both techniques aim to reduce the pressure on working memory and activate students' prior knowledge before they start the lesson.

1.5.2.2 The design of learning materials

The way learning materials are presented can greatly affect the learning process. Good instructional design can lower extraneous cognitive load, while a poor design can increase it, which eventually hinders learning. Mayer (2009) points out that people learn best when text is accompanied by pictures rather than presented alone, because it clarifies the content. This is known as the multimedia principle. Staneviciene and Žekienė (2025) confirmed in their study that multimedia materials boost the motivation and engagement of higher education students and develop their practical and cognitive abilities. These tools simplify concepts and make them more accessible to promote active learning. However, teacher training and institutional commitment are also necessary to fully improve those materials (Staneviciene & Žekienė, 2025).

1.5.2.3 Activating Cognitive Processes for Learning

Germane cognitive load is responsible for active learning, and it represents the main purpose of instructional designers. Van Merriënboer and Sweller (2010) point out that germane load can be enhanced by three principles. The first is the task variability principle. Teachers should use tasks that differ in complexity and are based on real-world situations, rather than tasks that have similar surface features. The second is the contextual interference principle: teachers should avoid presenting tasks with similar items arranged in a particular order. Instead, they must be arranged randomly, leaving space for the learner to use critical thinking and problem-solving skills. Last but not least is the self-explanation principle. Rather than giving the same regular examples or tasks without additional support, the teacher should

add questions or cues to encourage the learner to reason about the relationship between elements.

1.6 Limitations of Multimedia Digital Tools

Multimedia tools are essential in modern education. They are necessary for teaching and learning worldwide, as they support instruction and student learning. However, research identifies limitations that prevent these tools from working well. Teachers and students must understand these challenges to use multimedia tools effectively. Table 1.1 outlines these key points. Key limitations are explored in Table 1.1 below.

Challenge	Description
Lack of digital literacy	Some students, especially those from remote areas, are not familiar with multimedia tools. This affects their learning process. Digital literacy goes beyond using technology; it involves evaluating and synthesizing digital information (Margaryan et al., 2011).
Internet accessibility	Most multimedia digital tools require a stable internet connection. A lack of internet services in villages outside main cities disrupts learning when digital technologies are used (Bisong et al., 2023).
Time limitation	Many teachers lack the time or skills to plan multimedia activities. Consequently, they avoid using these tools, leading students to feel that technology is a waste of time rather than a useful learning resource (Huda, 2024).
AI over-reliance	Excessive AI use can decrease learners' critical thinking skills and personal development. It also harms creativity, as students may rely too heavily on AI to generate ideas or complete assignments, losing the ability to think independently (Chan & Hu, 2023).
Ethical considerations	Some students misuse AI tools like ChatGPT to generate assessments and submit them as their own work (Li et al., 2024). This behavior undermines academic honesty, creating the unsolved issue of how to correctly credit AI content.

Table 1.1 *Key limitations of using multimedia digital tools*

Although multimedia tools are essential for teaching and learning, they present limitations that cannot be ignored. Technology must be treated as a helper, not a replacement. Specific limitations include students' poor digital literacy, lack of internet connectivity, time constraints for teachers, excessive AI dependence that impacts critical thinking and creativity, and plagiarism due to failing to properly credit AI content. Educators must therefore raise awareness among themselves and their learners to encourage responsible usage.

1.7 Conclusion

This chapter examined how multimedia influences cognitive load and the role of instructional design in effective learning environments. It analyzed how different types of cognitive load affect how learners acquire and process information. The discussion covered challenges EFL learners face with digital tools, specifically cognitive overload and distraction, as well as the benefits for developing vocabulary, grammar, and writing skills. Students gain access to varied sources, which increases their engagement and active participation. Yet, some limitations can disrupt education, such as a lack of digital literacy, poor internet accessibility, time limitations, AI over-reliance, and ethical considerations.

Chapter Two

Research Methodology

Chapter Two: Research Methodology

2.1 Introduction

This study investigates how teachers and students manage cognitive load in digital learning environments, focusing on the role of instructional design. This chapter outlines the research design, instruments, and analysis procedures. It also describes the target population sample and explains the mixed-methods approach.

2.2 Description of the Setting

This study was conducted at the University of Dr. Moulay Taher in Saida during the academic year 2025/2026. The research was carried out with second-year EFL students and their teachers at the level of the English department. According to the university's statistics, the English Department accommodates roughly 1500 students in both Master's and Bachelor's programs. There are almost no equivalent problems. The second-year level consists of 247 students divided into 6 groups. The department also employs approximately 45 teachers who specialize in various modules in the fields of didactics or literature.

2.3 Research Design and Methodology

This study uses a mixed-methods approach to understand how digital multimedia tools can manage cognitive load while improving the teaching of grammar, vocabulary, and writing. Combining qualitative and quantitative methods helped measure the cognitive load and mental effort students experience. This design also showed how multimedia tools help teachers improve their instructional design. Collecting different types of data allowed the researcher to explore perspectives from both teachers and students.

A structured methodology is important for organizing this kind of inquiry. Rajasekar et al. (2013) described research methodology as the procedures researchers use to describe, explain, and predict phenomena. A clear methodology helps the researcher systematically study a specific topic or phenomenon.

Kothari (2004) also explained that methodology is the science of how a research project is systematically planned and carried out from start to finish. This framework guides the researcher through the different stages of selecting appropriate instruments to identify and solve the research problem.

2.4 Target Population and Sample

According to Willie (2024), a study population consists of individuals sharing the same characteristics in a specific domain, and a sample is a portion of that population. Identifying this target group helps the researcher choose procedures and techniques that match the participants (Willie, 2024).

2.4.1 Target Population

The participants in this study were second-year English as a Foreign Language (EFL) students at the English department of Dr. Moulay Taher University in Saida, Algeria, and the EFL teachers at the same university. The research had 57 students and 2 teachers participants in order to collect in-depth data from different perspectives. All participants were from the Saida state in Algeria.

2.4.2 Strategy of Sampling

The researcher chose purposive sampling to select information-rich cases, specifically students and teachers who use the multimedia digital tools under investigation. Palinkas et al. (2015) explained that sampling choices must match the research goals. A qualitative approach seeks a deep understanding through a small number of cases, whereas a quantitative method aims for a broader overview from a larger population.

2.5 Research Instruments

This study employs three main data collection instruments: a *questionnaire*, *interviews*, and *classroom observations*. Combining these methods allows for methodological triangulation to ensure more reliable results. The questionnaire targeted second-year EFL students, while the interviews focused on EFL teachers in the same department. In addition to that, the researcher conducted classroom observations during grammar and writing sessions.

Questionnaires are widely used in academic research to gather diverse perspectives. As Roopa and Rani (2012) point out, "a questionnaire is the main means of collecting and sanitizing quantitative primary data. A questionnaire enables quantitative data to be collected in a standardized way so that the data are internally consistent and coherent for analysis.

Questionnaires should always have a definite purpose that is related to the objectives of the research and it needs to be clear from the outset how the findings will be used."

In the same way, Sharma and Ruikar (2025) note that a clear, well-designed questionnaire improves the validity and reliability of the collected data. Using simple and direct language helps avoid ambiguity, making the questions easier for respondents to understand. This reduces confusion and helps participants provide more accurate and thoughtful responses.

Interviews are another valuable research tool, and this study utilized semi-structured interviews. According to Chand (2025), this format combines flexibility and standardization. It allows the researcher to ask follow-up questions during the conversation while giving participants the freedom to express their views. This approach helps the researcher gain a deeper understanding of teacher perspectives through a natural, flowing dialogue.

The third instrument is classroom observation, which directly supports the validity of the collected data. This study used non-participant observation, meaning the researcher observed and recorded classroom activities without interacting with the students or teachers. This method is particularly useful for minimizing the researcher's influence on the class, allowing participants to behave more naturally (Chand, 2025).

2.5.1 Students' Questionnaire

A questionnaire was administered online to 57 second-year EFL students in the English department. This sample size ensured balanced data collection and allowed for an in-depth exploration of student experiences in vocabulary acquisition, grammar mastery, and writing development. Students were assured of anonymity. The questionnaire aimed to investigate whether multimedia digital tools help or hinder the management of cognitive load. It also sought to identify which digital tools are most frequently used by EFL students. The survey consisted of 14 items divided into three sections, utilizing a mix of open and closed-ended questions. Closed-ended questions provided structured options for ease of completion, while open-ended questions offered students the freedom to share detailed insights into their learning processes and mental load.

- **Section A: Demographic Information**

Questions 1 and 2 gathered demographic data concerning students' gender and age.

- **Section B: Experience and usage of multimedia and AI Tools (e.g., ChatGPT – Gemini... etc.)**

Questions 3, 4, 5, 6, 7, and 8 focused on how students use these tools and how effective they find them. Question 3 compared the effectiveness of educational videos versus text-only formats for simplifying complex concepts. Question 4 asked participants to identify the multimedia tools they rely on most to improve grammar and vocabulary, requiring them to justify their choices. Question 5 investigated whether multimedia tools present too much information, causing mental overload, and gathered student suggestions for improvement. Question 6 explored how frequently students use AI tools (like ChatGPT and Gemini) for academic tasks. Question 7 asked students to specify which skills (grammar, vocabulary, or writing) they aim to improve using AI and the methods they employ. Question 8 examined whether students experience mental fatigue when using AI tools for academic work.

- **Section C: Impact of Digital Classroom Environment on learning and Cognitive Load**

Questions 9, 10, 11, 12, 13, and 14 addressed cognitive load, classroom environments, and distractions. Question 9 explored if digital tools used by teachers distract students during lessons. Question 10 measured whether using AI tools for language learning in class causes mental fatigue. Question 11 asked students to identify common signs of feeling mentally overwhelmed by digital tools. Question 12 invited them to describe a specific situation where multimedia or AI tools were helpful or caused overload. Question 13 recorded the frequency of non-academic distractions when using digital technology. Finally, Question 14 gave students space to share additional thoughts on digital tool integration in the classroom and its impact on mental load.

2.5.2 Teachers' Interview

The researcher conducted a semi-structured interview with two EFL teachers teaching grammar and writing. This instrument explored how these instructors manage student cognitive load when using classroom technology. The interview consisted of 18 questions (9

per module) covering several key areas: teachers' familiarity with Cognitive Load Theory, their use of AI tools like ChatGPT for lesson planning, and their strategies for simplifying complex concepts. The questions also gathered teachers' advice on preventing mental fatigue and compared digital tools with traditional teaching methods. This approach helped the researcher understand how instructors balance technology with human cognitive limits (Mayer, 2009).

The interview followed two sets of identical themes, with each category specifically tailored to either the grammar or writing module:

Category 1: Grammar Module Interview Questions

Question 1. Checks the teacher's knowledge of Cognitive Load Theory and its influence on choosing activities.

Question 2. Investigates the actual use of digital tools during classroom sessions.

Question 3. Explores the use of AI assistants like ChatGPT for designing grammar lectures.

Question 4. Asks if the teacher recommends multimedia tools to students for grammar improvement.

Question 5. Looks at techniques for breaking down difficult concepts to prevent mental fatigue.

Question 6. Seeks the teacher's opinion on the effectiveness of YouTube videos for language learning.

Question 7. Collects advice on strategies, such as note-taking, to help students stay focused online.

Question 8. Assesses whether AI tools help or hinder the development of proper grammar skills.

Question 9. Compares the impact of traditional teaching methods against digital tool implementation.

Category 2: Writing Module Interview Questions

Question 1. Focuses on the teacher's awareness of Cognitive Load Theory when selecting writing tasks.

Question 2. Covers the implementation of digital technology within the writing classroom environment.

Question 3. Asks about using AI tools to design and plan writing activities.

Question 4. Examines the teacher's recommendations for students using digital tools to improve writing.

Question 5. Explores methods for simplifying complex writing concepts to manage mental load.

Question 6. Evaluates the teacher's perspective on why educational videos are useful or not.

Question 7. Requests suggestions for students on how to use digital resources without getting overwhelmed.

Question 8. Investigates if AI assistants support or prevent the improvement of writing skills.

Question 9. Weighs the outcomes of traditional methods versus digital tools for writing students.

2.5.3 Classroom Observation

To collect qualitative data and ensure transparency, the researcher used non-participant observation as a third instrument, adding credibility to the study. This method involves observing the classroom behaviors of EFL students and teachers to assess cognitive load in real time. The observations took place at Dr. Moulay Taher University in Saida, Algeria, during the second semester. Over a two-week period, the researcher focused on writing and grammar sessions. In both the first and second weeks, the researcher observed one writing session and one grammar session. This balanced approach provided a clear overview of how teachers used digital tools in both modules and how this affected student cognitive load and engagement.

2.6 Conclusion

This chapter detailed the research methodology. The study used a mixed-methods approach to investigate cognitive load among second-year EFL students in a digital learning environment. Conducted at Dr. Moulay Taher University in Saida during the 2025/2026 academic year, the research used purposive sampling to select 57 students and two teachers. Data were gathered through three main instruments: a student questionnaire, semi-structured teacher interviews, and non-participatory classroom observations in grammar and writing modules. Together, these tools examined how digital tools affect cognitive load and student engagement. The next chapter presents the analysis and discussion of the findings.

Chapter Three

Data Analysis

Chapter Three: Data Analysis

3.1 Introduction

This chapter presents and discusses the research findings to examine how digital tools affect the cognitive load of second-year EFL students. Data were gathered using three instruments: a student questionnaire, teacher interviews, and classroom observations. The analysis begins with the questionnaire data to show how students manage their mental effort when using technology. This is followed by the interview results, which outline the teaching methods of grammar and writing instructors. Finally, classroom observations show how students behave when interacting with digital tools in real time. Together, these findings offer practical recommendations for both teachers and students.

3.2 Analysis and Discussion of Students' Questionnaire

This part describes and analyzes the data collected from the students through the questionnaire.

3.2.1 Analysis of Students' Questionnaire

This section covers the results of the questionnaire, which are organized into three main themes.

Section A: Demographic Information

Item 1: *What is your gender?*

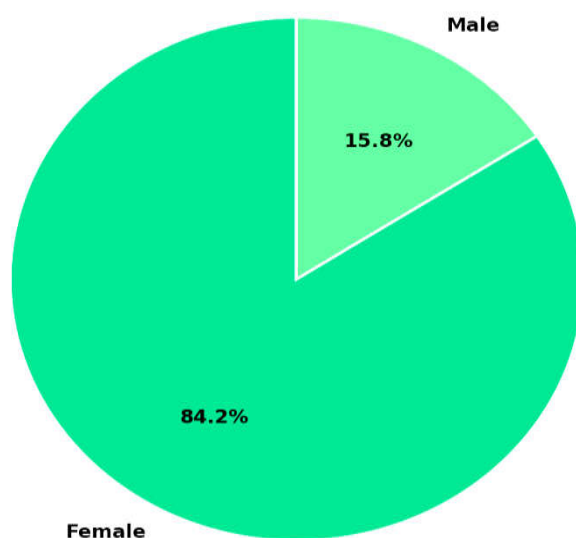


Figure 3.1. *Students' gender distribution.*

The first question focused on gender. Most of the respondents were female, with 48 students (84.2%) identifying this way. There were only 9 male participants. This result shows that the sample consists mostly of female students.

Item 2:*How old are you?*

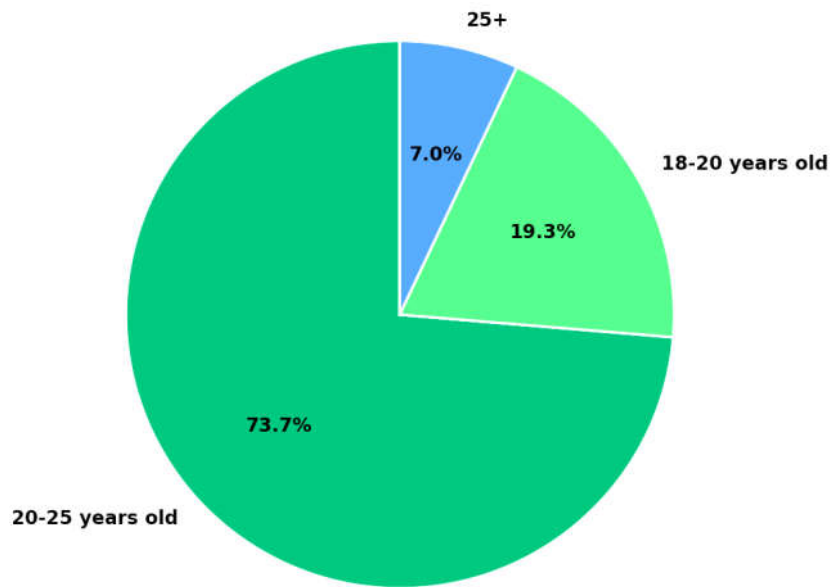


Figure 3.2. *Students' age distribution.*

The second item checked the age of the participants. A large majority of students (73.7%) were between 20 and 25 years old. Eleven students (19.3%) were slightly younger, aged 18 to 20. Only 4 people in the group were older than 25.

Section B: Experience and usage of multimedia and AI Tools (e.g., ChatGPT)

Item 3: *YouTube or educational videos help me understand complex concepts better than text alone.*

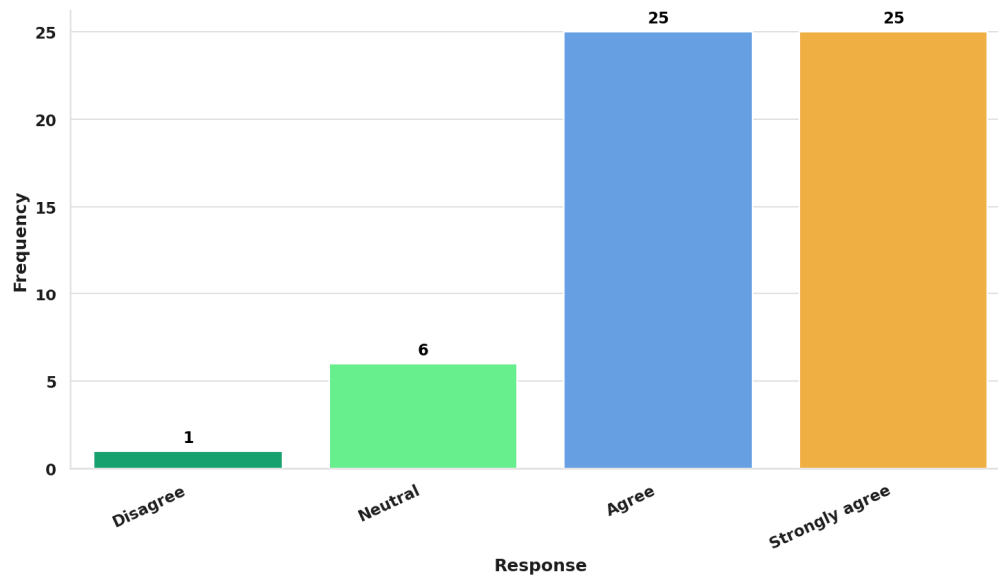


Figure 3.3. *Students' preference for YouTube/educational videos vs. text alone.*

Question 3 looked at student preferences for videos versus text. Out of the 57 participants, 50 (87.8%) agreed or strongly agreed that videos are more helpful. Six students (10.5%) were neutral. Only one person in the entire group disagreed with this statement.

Item 4: *Which type of multimedia tool do you rely on the most when seeking to improve your grammar and vocabulary?*

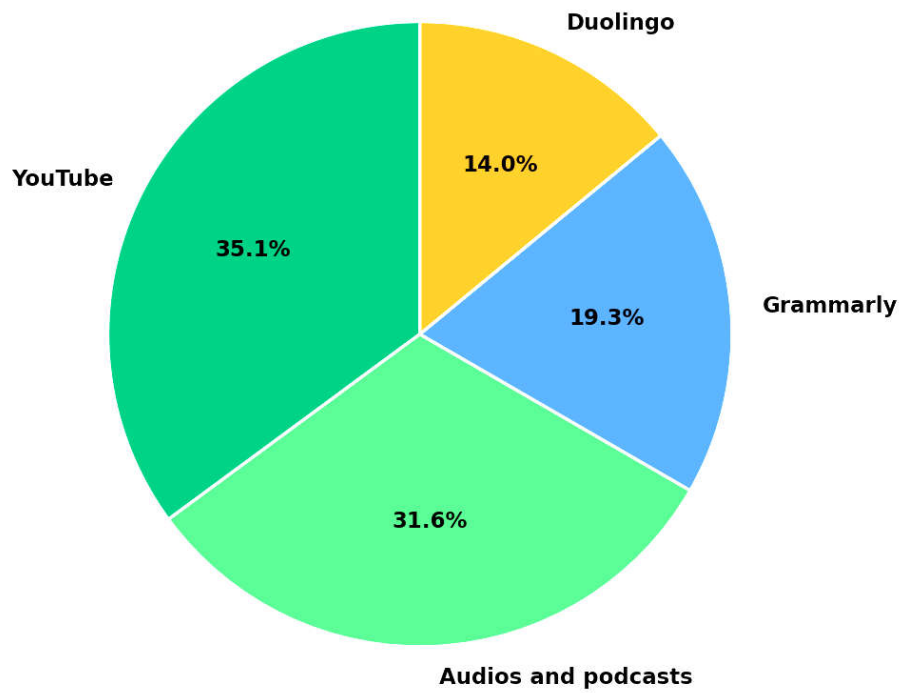


Figure 3.4. *Students' preference for multimedia tools.*

Students then identified the specific tools they use for language skills. YouTube was the top choice for 20 students (35.1%). Audio podcasts were also popular, with 18 people (31.6%) choosing them. Grammarly and Duolingo were selected by 11 and 8 students.

Item 4 (Follow-up): *Justify your answer.*

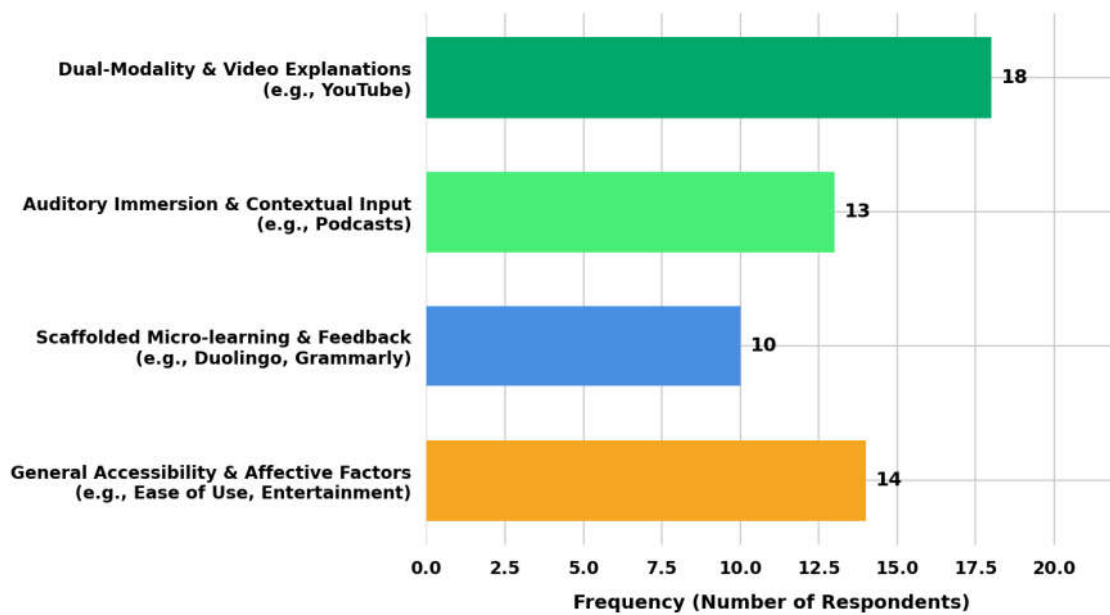


Figure 3.5. *Dominant qualitative themes in students' multimedia justifications.*

When students explained their choices, several themes emerged. Dual-modality and clear video explanations were the most common reasons, cited by 18 students. Fourteen participants liked that these tools are easy to access and use. Thirteen people preferred the auditory experience. Finally, 10 students chose tools that give them quick feedback and small, manageable lessons.

Item 5: *Do you think that sometimes multimedia instruments (YouTube, audios, apps, ChatGPT, etc.) present too much information that makes you feel overwhelmed mentally?*

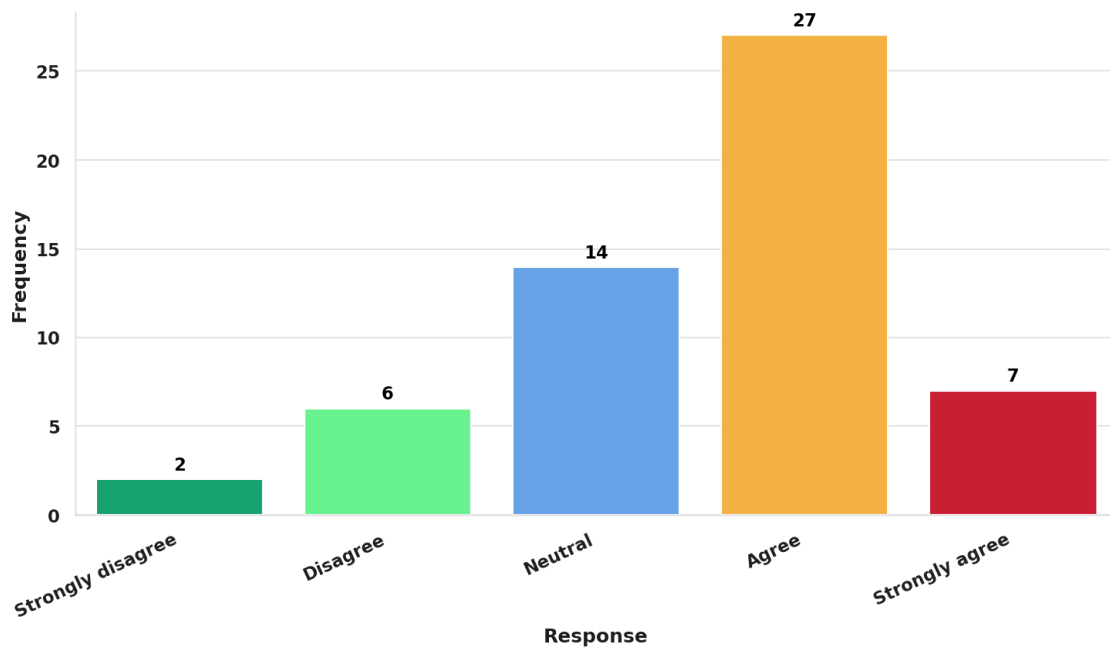


Figure 3.6. *Perception of mental overload from multimedia.*

Question 5 asked if digital tools cause mental overload. More than half the students (60.7%) said they feel overwhelmed by the amount of information. Fourteen people stayed neutral. Only 8 participants (14.3%) disagreed with the idea of feeling mentally exhausted.

Item 5 (Follow-up): *And how do you suggest using them for better outcomes?*

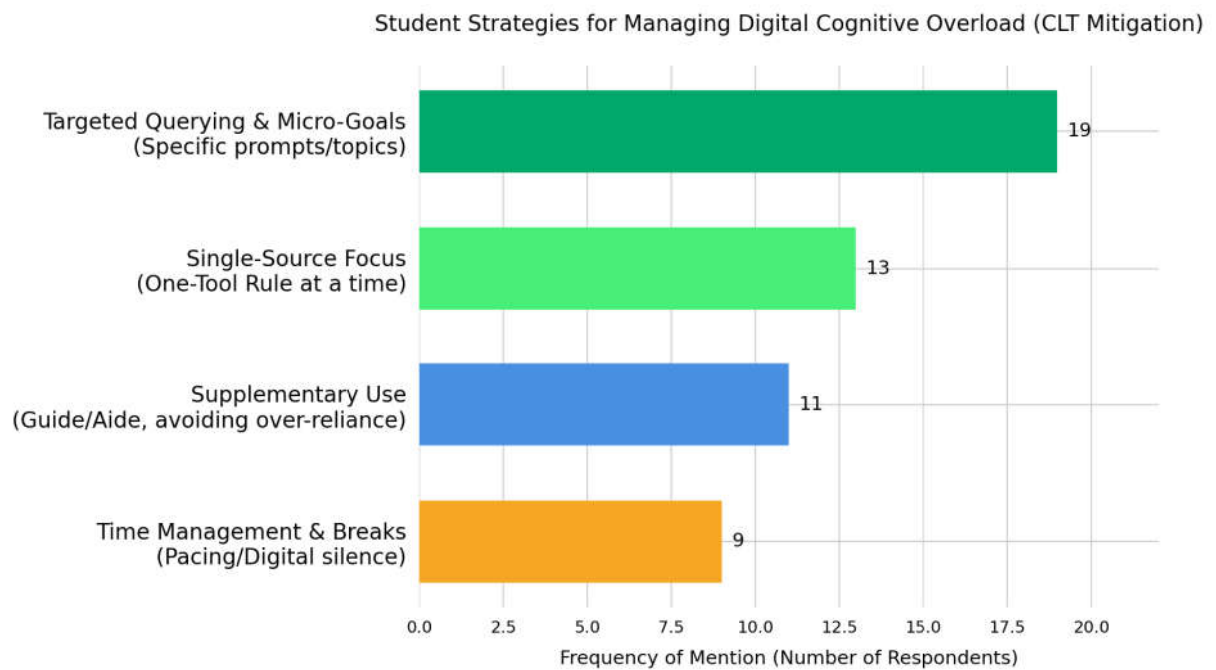


Figure 3.7. *Student strategies for managing digital cognitive overload.*

Students offered different ways to handle this overload. Nineteen participants suggested setting small goals and using specific searches. Another 13 students preferred to focus on only one tool at a time. Eleven people recommended using these tools as extra help rather than relying on them completely. Nine respondents mentioned the importance of taking breaks and managing time well.

Item 6: *How often do you use ChatGPT or Gemini to improve your academic skills (grammar, writing, vocabulary)?*

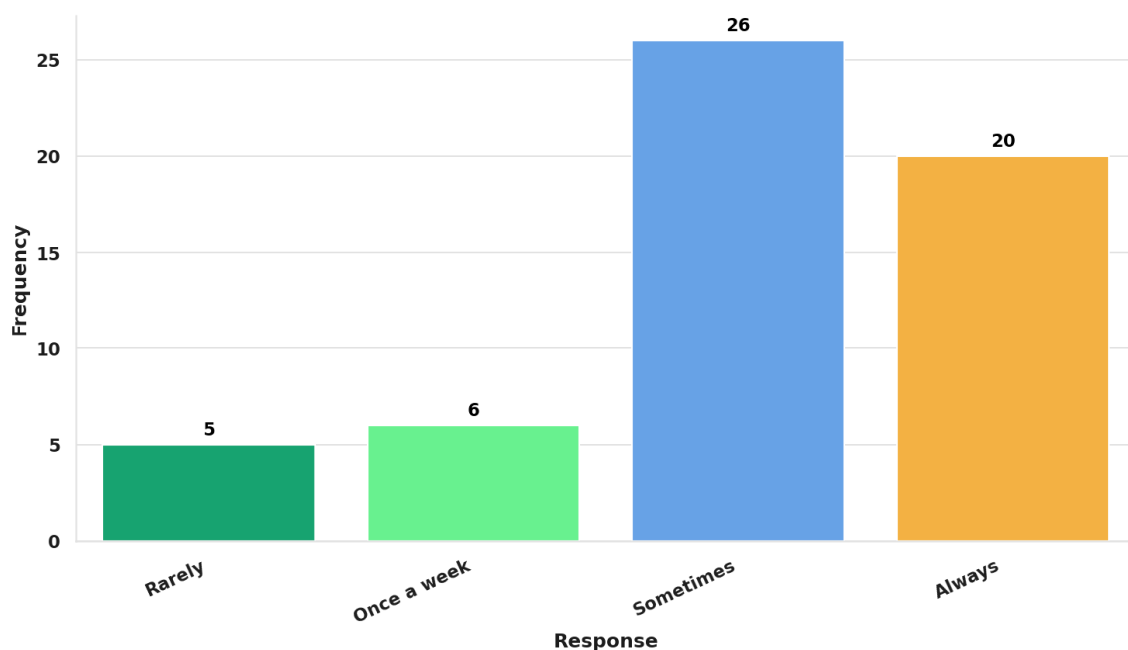


Figure 3.8. Frequency of AI usage for academic skills.

The sixth item checked how often students use AI for their studies. Most participants use AI sometimes (45.6%) or always (35.1%). Very few students said they use it rarely or only once a week.

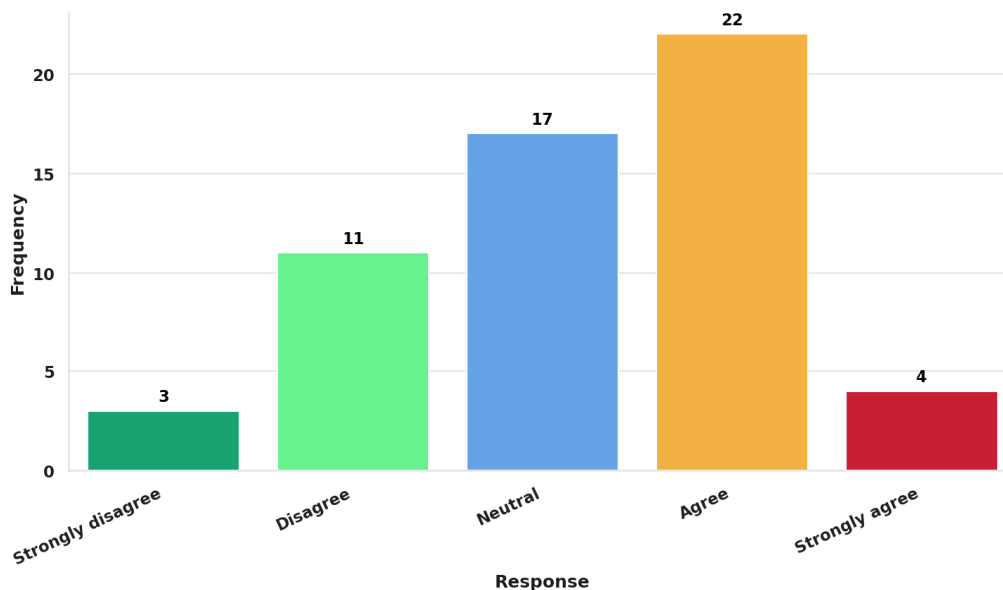
Item 7: Which one of the three skills (grammar, writing, vocabulary) are you trying to improve using AI assistance (ChatGPT, Gemini, etc.) and how?

Categorical Themes	Frequency of Mention
Writing & Formatting	21
Learning Vocabulary	20
Grammar Correction	9
Preference for Non-AI Tools (Books, YouTube)	4

Table 3.9. EFL skills targeted through GenAI assistance.

Question 7 looked at which skills students target with AI. Writing and vocabulary were the main focus for 21 and 20 students. Nine people use AI for grammar. Only 4 participants preferred traditional tools like books or YouTube over AI.

Item 8: When using AI tools for studying or improving my academic skills, I sometimes feel mentally overloaded or exhausted.

**Figure 3.10. Mental exhaustion when using AI tools for studying.**

Item 8 checked if AI causes mental fatigue. The largest group (38.6%) agreed that they feel overloaded during study sessions. Seventeen students remained neutral. Only 14 people (24.6%) disagreed with the idea of feeling exhausted.

Section C: Impact of Digital Classroom Environment on learning and Cognitive Load

Item 9: *If your teacher uses digital tools in class, could it distract students from the lesson.*

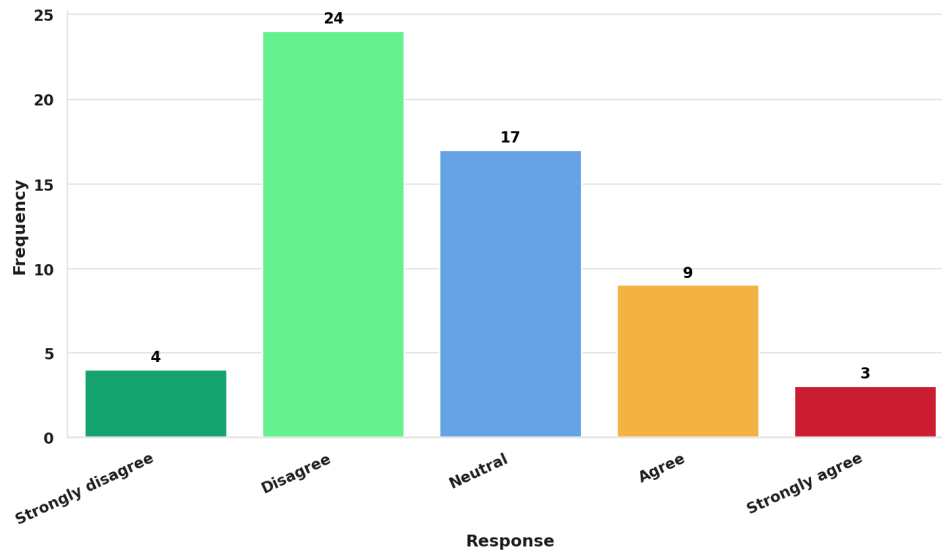


Figure 3.11. *Perceptions of digital tools as classroom distractors.*

Question 9 asked if classroom technology is distracting. Nearly half the participants (49.1%) disagreed with this. Seventeen people were neutral. Only 12 students felt that digital tools in class lead to distractions.

Item 10: *When using AI tools for improving my writing skills (grammar or vocabulary) in the classroom, I sometimes feel mentally overloaded or exhausted.*

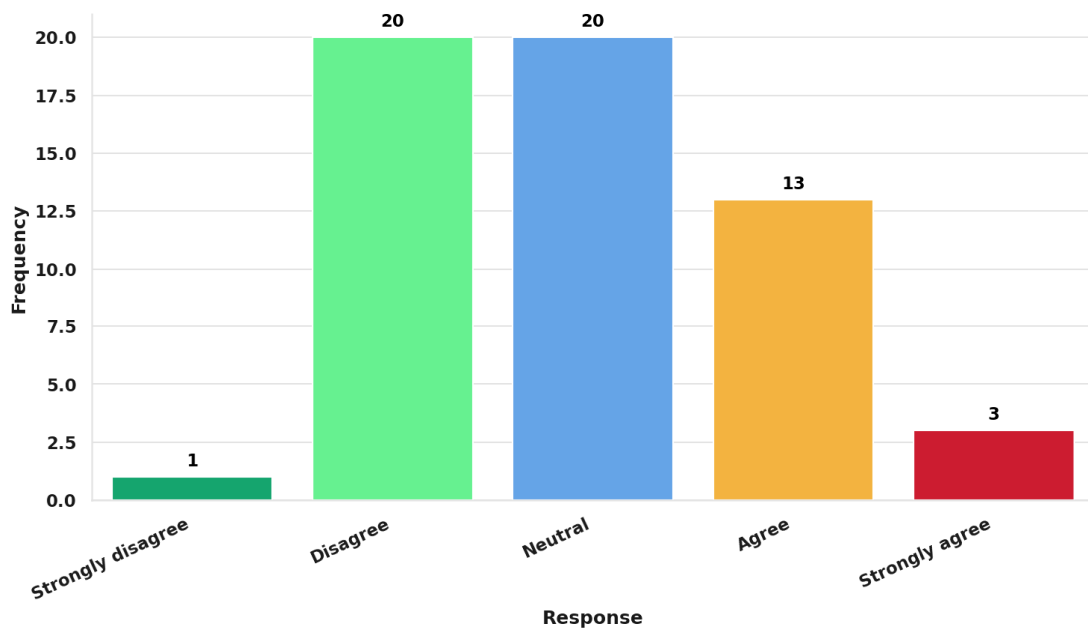


Figure 3.12. *Mental overload from AI use specifically in the classroom.*

This item looked at AI-related fatigue during class time. The results were split. Twenty students (35.1%) disagreed that they feel exhausted, while another 20 were neutral. Sixteen people (28.1%) agreed that they feel mentally overloaded in the classroom.

Item 11: *According to you, what are the signs that you are becoming mentally overwhelmed or fatigued when using digital instruments or online tools in the classroom?*

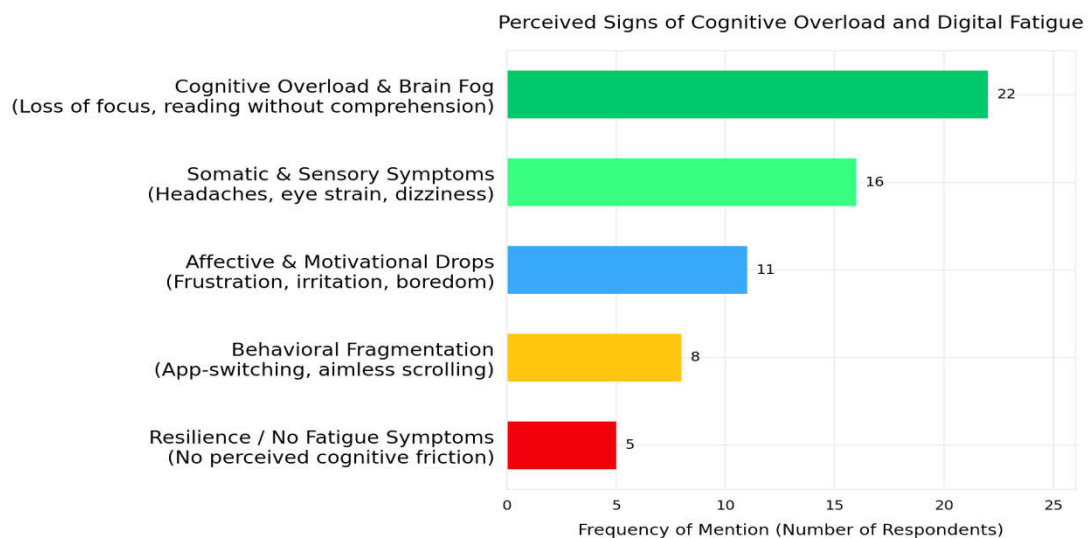


Figure 3.13. *Perceived signs of cognitive overload and digital fatigue.*

Item 11 asked about the signs of digital fatigue. Brain fog and cognitive overload were the top symptoms for 22 students. Sixteen participants reported physical issues like

headaches. Other signs included frustration, boredom, and aimless scrolling. Five students said they never feel fatigue.

Item 12: *Describe a situation where AI assistance or multimedia tools proved helpful or overwhelming. What occurred, and what specific factors influenced that experience?*

Categorical Themes	Frequency of Occurrence
Specific Writing Feedback (Helpful)	19
Switching Between Apps (Overwhelming)	14
Too Much Information (Overwhelming)	12
Quick Exam Summaries (Helpful)	6

Table 3.14. Situational drivers of cognitive comfort vs. multimedia overload.

Students shared specific moments of comfort or overload in Question 12. Nineteen people found targeted help and scaffolding very useful. However, 14 students felt overwhelmed when they had to switch between different platforms. Twelve participants struggled with redundant information. Six people found that using AI to quickly finish tasks under pressure was helpful.

Item 13: *When using the internet or digital tools to improve your language skills, to what extent are you distracted by non-study-related content, such as social media, messages, or notifications?*

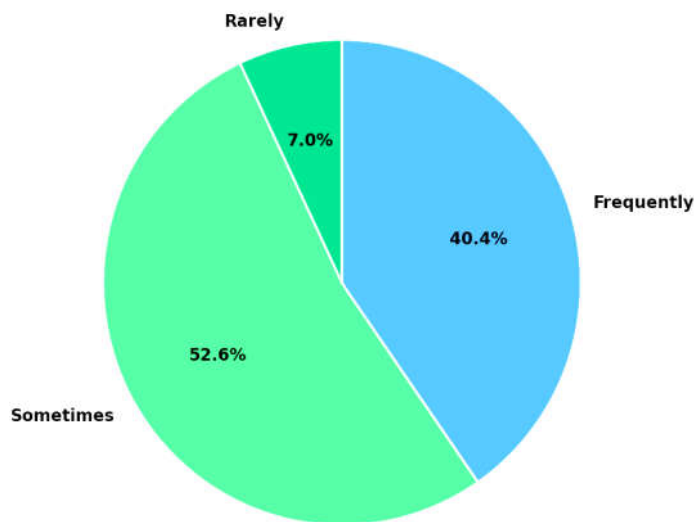


Figure 3.15. Students' Distraction by non-study-related content.

Question 13 asked how often notifications distract students. Over half (52.6%) said they get distracted sometimes. Another 40.4% said this happens frequently. Only 4 students (7.0%) reported that they are rarely distracted while studying online.

Item 14: *If you have any additional comments concerning the implementation of digital tools in the classroom and how they might affect your mental load, please do not hesitate to share your thoughts.*

Categorical Themes	Frequency of Mention
Social Media & Messages	24
Focus Modes & App Blockers	18
Ads & Too Many Tabs	7
Internet & Device Issues	5

Table 3.16. Primary digital distractors and student mitigation tactics.

The final question asked for extra comments. Social media notifications were the biggest distraction for 24 students. To fight this, 18 people use self-regulation methods like silent mode. Seven students mentioned structural distractions, and 5 participants noted hardware or internet problems.

3.2.2 Discussion of Students' Questionnaire Findings

The results show that most students (87.8%) prefer educational videos over reading text alone (Figure 3.3). This finding matches Mayer's (2009) theory that dual-modality helps students learn better because they use both words and pictures. But there is a problem. About 60.7% of the students feel overwhelmed by the high amount of information in these tools (Figure 3.6). Even though multimedia helps with writing and vocabulary, it also creates extraneous cognitive load (Sweller et al., 2011). If the tools are not designed well, they provide too much data for the limited working memory. This often causes the brain fog and fatigue reported by 22 students (Figure 3.13). These results support H3, which states that tools need better design to avoid mental overload. The data also shows a clear gap between how students use tools in class and the distractions they face online. Students generally do not find classroom digital tools distracting (Figure 3.11). On the other hand, 93% of them get distracted by social media notifications (Figure 3.15). These interruptions are a form of extraneous load that stops students from focusing on deep learning (Sweller et al., 2011). To solve this, 18 students use self-regulation methods like putting their phones on silent mode (Figure 3.16). This supports H1 because it shows that digital tools only help performance if students can manage their own attention. The physical signs of fatigue, such as headaches (Item 11), show that the human brain struggles in a distracting environment without help from teachers.

3.3 Analysis and Discussion of Teachers' Interview

This section analyzes and discusses the findings from the teacher interviews.

3.3.1 Analysis of Teachers' Interview

The interview results show that the two teachers have different views on how to handle student cognitive load in a digital environment. The grammar teacher is very familiar with cognitive load theory and uses it to simplify difficult lessons into smaller parts. This instructor uses tools like ChatGPT and YouTube to provide fast feedback and keep students engaged. They also recommend that students use these resources for extra practice. On the other hand, the writing teacher only has a basic idea of the theory. They believe writing essays

is a straightforward task that does not require much mental effort. This teacher uses smart boards and Moodle to save time but does not want students using AI assistants. They fear that students will lose their critical thinking skills or rely too much on technology. Even though both teachers use AI to prepare their own classes, they have different rules for their students. The grammar teacher supports a blended approach, while the writing teacher is more concerned about distractions and the loss of creativity.

3.3.2 Discussion of Teachers' Interview Findings

The manner how the two teachers perceive Cognitive Load Theory (CLT) show how teaching methods vary based on theoretical understanding. For instance, the grammar teacher designs lessons to break down information systematically, helping manage students' working memory (Sweller et al., 2011). Using YouTube and ChatGPT to simplify concepts supports the idea that the instructional method, rather than the technology itself, determines learning success (Mayer, 2009). In contrast, the writing teacher's view of essay writing as a low-effort task suggests a misunderstanding of intrinsic cognitive load. Writing is a complex secondary skill requiring significant mental effort. This supports Hypothesis 2, as this teacher uses tools like smartboards primarily for student engagement and saving time, rather than as a deliberate strategy to manage cognitive load. The interviews also reveal a clear disagreement over student access to AI tools. Although both instructors use AI to prepare lessons, they differ on whether students should use these tools. The writing teacher's fear that students will lose their critical thinking skills matches recent research by Li et al. (2024), which notes that over-reliance on AI can cause cognitive decline. This worry over academic integrity and the potential harms of human-computer interaction (Li et al., 2024) explains why some educators remain cautious about these tools. Yet, the grammar teacher's preference for a blended learning approach reflects a more optimistic perspective. This instructor believes that when students use digital tools responsibly, the immediate feedback reduces extraneous load and helps them focus on learning grammar rules. These results suggest that professional development for teachers must address both the advantages of AI and the dangers of student dependency.

3.4 Analysis and Discussion of Classroom Observation

This part focuses on the data gathered during the classroom observations.

3.4.1 Analysis of Classroom Observation

The classroom observation showed a clear contrast between the writing and grammar modules regarding student engagement and memory. In the writing session, the teacher used a smart board to present a PowerPoint with highlighted keywords. This setup kept almost the entire class focused, and 85% of the students successfully recapped the lesson. The teacher also paused between sections to give students time to think, which helped their working memory. In contrast, the grammar teacher relied on a traditional board and moved through the points too quickly. As a result, many students became distracted by their phones or used ChatGPT for quick answers. Only a few students could remember the main points at the end of the grammar class. These observations suggest that digital tools and better pacing help students stay interested and process information more effectively.

3.4.2 Discussion of Classroom Observation Findings

The observed writing session shows how clear design choices help manage student cognitive load. By highlighting key terms on the slides, the instructor applied the signaling principle to direct student attention (Mayer, 2009). Regular pauses also allowed students to process information in smaller chunks, which aligns with the isolated-interacting elements approach (Pollock et al., 2002). This deliberate pacing helps explain why most students could remember the main concepts. In contrast, the grammar session was fast-paced, which likely overloaded students' working memory (Sweller et al., 2011). The fact that students relied on ChatGPT for quick answers suggests they offload mental effort when they feel overwhelmed. This behavior matches the risks of AI dependency discussed by Li et al. (2024). These findings support Hypothesis 1 and Hypothesis 2, showing that digital tools are only effective when combined with sound instructional methods.

3.5 Pedagogical Implications and Recommendations

The findings of this study offer several practical recommendations for students and teachers to help manage cognitive load in a digital learning environment.

3.5.1 For Students

To avoid mental fatigue from digital distractions, students must focus on self-regulation. The findings show that social media notifications act as a major source of extraneous cognitive load. To remain focused, learners can use simple strategies like silencing notifications or setting clear goals for each study session. Also, they should treat AI assistants like ChatGPT as a supportive tool rather than a replacement for active thinking. Where relying too much on AI can reduce independent problem-solving skills (Li et al., 2024). Students should also combine digital videos with traditional note-taking to help encode new information into their long-term memory.

3.5.2 For Teachers

Teachers should plan digital lessons with a clear understanding of working memory limits. Applying the signaling principle, such as highlighting key terms on slides, helps students focus on essential learning points (Mayer, 2009). Instructors should also segment information by pausing after explaining complex rules, giving students time to process the input (Pollock et al., 2002). This adjustment prevents the cognitive overload seen in faster-paced lessons. Finally, educators need to balance traditional and digital methods. While digital tools improve student engagement, learning foundational grammar rules often requires direct instruction. Teacher training programs should focus on how to integrate AI tools without undermining students' independent critical thinking.

3.6 Conclusion

This chapter provided the analysis and discussion of the data gathered from the student questionnaire, teacher interviews, and classroom observations. The findings show that digital tools have a significant impact on the cognitive load of EFL students. While these tools improve engagement and retention, they also lead to mental fatigue if not managed well. Students generally prefer multimedia input, but they face challenges like information overload and social media distractions. Next, the study also highlights a gap in how teachers use technology and their awareness of cognitive load principles. Lastly, the results from the observations confirm that instructional strategies like pacing and signaling are key to reducing mental effort. In conclusion, the data supports the idea that a balanced approach to technology can improve student outcomes without overloading their limited memory.

General Conclusion

General Conclusion

This research investigated the connection between digital learning environments and the cognitive effort of second-year EFL students. The study focused specifically on how multimedia resources and AI tools affect learning outcomes in grammar, vocabulary, and writing modules. The findings suggest that while technology enhances student engagement, it also introduces significant mental challenges. Students showed a clear preference for combining verbal and visual information, particularly through educational videos, which helped them understand complex concepts better than text-only formats. However, the sheer volume of online information frequently creates an excessive cognitive load. This overload explains why many participants reported experiencing mental fatigue and concentration difficulties during digital tasks.

These findings address the central research questions and support the proposed hypotheses. Regarding the first question, digital tools only improve academic performance when instructors integrate them with a clear, structured plan, which supports Hypothesis 1. Specifically, using smartboards and highlighting key concepts helped students maintain focus and recall lesson content more effectively. The second question, concerning teaching strategies, supports Hypothesis 2. A clear distinction emerged between instructors who understand cognitive load principles and those who employ digital tools merely to save time or increase student interest. Finally, the third question revealed that while teacher-led classroom technology does not directly distract students, social media notifications and an over-reliance on AI present major challenges, confirming Hypothesis 3. These insights show that digital tools themselves are not harmful if they are carefully managed to support, rather than replace, active learning.

These results bring practical implications for the English department. Instructors need to adopt design strategies like signaling and segmenting to support student working memory. At the same time, students must develop self-regulation skills to manage their attention and avoid digital distractions. Ultimately, technology is most effective when used as an educational aid rather than a complete replacement for direct instruction.

The researcher encountered several practical challenges during this study. First, low participation rates and cooperation issues from some students led the researcher to administer an online questionnaire rather than a printed version. Time constraints also posed a significant

General Conclusion

challenge. Frequent student absences during certain periods of the semester made it more difficult to collect consistent data through surveys and classroom observations. Consequently, the researcher had to adjust the original data collection schedule to complete the study within the academic term.

In conclusion, digital tools can either enhance or hinder learning in the EFL classroom. The final outcome depends heavily on how instructors integrate these resources into their teaching. By applying cognitive load principles, teachers can help students acquire language skills without overloading their mental capacity. Future research should investigate how to use AI tools to support student creativity rather than replace independent thought. Ultimately, this study demonstrates that the chosen teaching method remains far more important than the technology itself.

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Appendices

Appendices

Appendix A

Section A: Demographic Information

1. What is your gender?

☐ Male

☐ Female

2. How old are you?

☐ 17-20 years old

☐ 21-25 years old

☐ + 25 years old

Section B: Experience and usage of multimedia and AI Tools (e.g., ChatGPT – Gemini... etc.)

3. YouTube or educational videos help me understand complex concepts better than text alone.

☐ Strongly Agree

☐ Agree

☐ Neutral

☐ Disagree

☐ Strongly Disagree

4. Which type of multimedia tool do you rely on the most when seeking to improve your grammar and vocabulary? (Justify your answer)

☐ Duolingo

☐ Grammarly

☐ YouTube

☐ Audios

Justify your answer:

.....

.....

5. Do you think that sometimes multimedia instruments (YouTube – audios – apps – ChatGPT.... etc.) present too much information that makes you feel overwhelmed mentally?

☐ Strongly Agree

☐ Agree

☐ Neutral

☐ Disagree

☐ Strongly Disagree

And how do you suggest using them for better outcomes?

.....

.....

6. How often do you use ChatGPT or Gemini to improve your academic skills (grammar, writing, vocabulary)?

☐ Always

☐ Sometimes

☐ Once a week

☐ Rarely

7. Which one of the three skills are you trying to improve using (ChatGPT, Gemini) and how?

.....

.....

8. When using AI tools for studying or improving my academic skills, I sometimes feel mentally overloaded or exhausted.

☐ Strongly Agree

☐ Agree

☐ Neutral

☐ Disagree

☐ Strongly Disagree

Section C: Impact of Digital Classroom Environment on learning and Cognitive Load

9. If your teacher uses digital tools in class, could it distract students from the lesson?

☐ Strongly Agree

☐ Agree

☐ Neutral

☐ Disagree

☐ Strongly Disagree

10. When using AI tools for improving my writing skills, grammar, or vocabulary in the classroom, I sometimes feel mentally overloaded or exhausted.

☐ Strongly Agree

☐ Agree

☐ Neutral

☐ Disagree

☐ Strongly Disagree

11. According to you, what are the signs that you are becoming mentally overwhelmed or fatigued when using digital instruments or online tools in the classroom?

.....

.....

12. Describe a situation where AI assistance or multimedia tools proved helpful or overwhelming. What occurred, and what specific factors influenced that experience?

.....
.....

13. When using the internet or digital tools to improve your language skills (vocabulary, grammar, and writing), to what extent are you distracted by non-study-related content, such as social media, messages, or notifications?

☐ Frequently

☐ Sometimes

☐ Rarely

☐ Never

14. If you have any additional comments concerning the implementation of digital tools in the classroom and how they might affect your mental load, please do not hesitate to share your thoughts.

.....
.....

Appendix B

Technology has played a crucial role in shaping how students manage their cognitive load while integrating digital instruments into their learning process; the same goes for teachers. This interview

seeks to investigate how teachers manage their students' cognitive load in the presence of technology.

Section A: Grammar Interview Questions

1. Are you familiar with the idea of cognitive load theory in teaching and learning? And how does it impact your selection of grammar activities?

.....
.....

2. Do you implement any sort of digital tools during your classes?

.....
.....

3. Do you use any AI assistance, such as ChatGPT, when designing your lectures and activities?

.....
.....

4. As a grammar teacher, do you recommend your students use multimedia digital tools such as ChatGPT, YouTube, Grammarly, etc., to improve their grammar?

.....
.....

5. How do you break down complex concepts to your students in order to avoid cognitive overload?

.....
.....

6. Students sometimes watch videos on the YouTube platform during their learning process. In your opinion, what makes these videos effective or ineffective for them?

.....
.....

7. How do you advise your students to use those digital tools in a sufficient way that prevents them from getting mentally overwhelmed? Do you suggest note-taking, for example, or any other strategies?

.....
.....

8. Do you think that AI assistance like ChatGPT and Gemini help or prevent students from improving their grammar skills properly?

.....
.....

9. According to you, which method has the best impact on students' outcomes: the traditional method of teaching or digital tools implementation? Please justify your answer.

.....
.....

Section B: Writing Interview Questions

1. Are you familiar with the idea of cognitive load theory in teaching and learning? And how does it impact your selection of writing activities?

.....
.....

2. Do you implement any sort of digital tools during your classes?

.....
.....

3. Do you use any AI assistance, such as ChatGPT, when designing your lectures and activities?

.....
.....

4. As a writing teacher, do you recommend your students use multimedia digital tools such as Grammarly, YouTube, ChatGPT, etc., to improve their writing skills?

.....
.....

.....
5. How do you break down complex concepts to your students in order to avoid cognitive overload?
.....

.....
6. Students sometimes watch videos on the YouTube platform during their learning process. In your opinion, what makes these videos effective or ineffective for them?
.....

.....
7. How do you advise your students to use those digital tools in a sufficient way that prevents them from getting mentally overwhelmed? Do you suggest note-taking, for example, or any other strategies?
.....

.....
8. Do you think that AI assistance like ChatGPT and Gemini help or prevent students from improving their writing skills properly?
.....

.....
9. According to you, which method has the best impact on students' outcomes: the traditional method of teaching or digital tools implementation? Please justify your answer.
.....
.....

الملخص:

تبحث هذه الدراسة في كيفية تأثير بيئات وأدوات الوسائط المتعددة الرقمية على الحمل المعرفي ونتائج التعلم لدى طلاب السنة الثانية في برنامج اللغة الإنجليزية كلغة أجنبية بجامعة الدكتور مولاي طاهر في صيدا، الجزائر، خلال العام الدراسي 2026/2025. وعلى الرغم من الاستخدام الواسع النطاق لهذه الأدوات الرقمية، فإنها قد تتجاوز بسهولة سعة الذاكرة العاملة وتسبب حملاً معرفياً زائداً. وباستخدام تصميم متقارب يعتمد على مناهج مختلطة، جمع الباحث بيانات من 57 طالباً ومدرسين اثنين. اعتمدت الدراسة على استبيانات الطلاب ومقابلات مع المعلمين وملاحظات غير مشاركة في الفصل الدراسي. تظهر النتائج أن معظم الطلاب يستجيبون بشكل إيجابي للوسائط المتعددة، حيث يفضل 87.8% منهم التنسيقات المرئية ويستخدمون أدوات الذكاء الاصطناعي بشكل متكرر لتحسين كتاباتهم ومفرداتهم. ومع ذلك، لا تزال هذه البيئات الرقمية تمثل تحديات كبيرة. تشير بيانات الاستطلاع إلى أن 60.7% من الطلاب يشعرون بالإرهاق الذهني بسبب الأدوات الرقمية، و38.6% يعانون من إرهاق معرفي ناتج عن الذكاء الاصطناعي. في حين أكدت الملاحظات الصفية التأثير المباشر لتصميم التعليم على الحمل المعرفي. حقق المعلمون الذين طبقوا مبادئ الإشارة والتقسيم معدل تذكر لدى الطلاب بلغ 85%، في حين تسببت الدروس ذات الوتيرة الضعيفة في إثقال كاهل الذاكرة العاملة ودفعت الطلاب إلى الاعتماد بشكل كبير على الذكاء الاصطناعي. وأخيراً، دعمت هذه النتائج الفرضيات الثلاث الأساسية للدراسة، حيث أثبتت أن الأدوات الرقمية لا تفيد تعلم اللغة الإنجليزية كلغة أجنبية إلا عندما تتوافق مع البنية الإدراكية للإنسان. كما أوصت الدراسة المؤسسات بتوفير تدريب تربوي لمساعدة المعلمين على تصميم الدروس مع مراعاة الحمل الإدراكي، مع وضع إرشادات واضحة تجعل الذكاء الاصطناعي أداة مساعدة تعليمية داعمة وليس بديلاً عن التفكير النقدي.

الكلمات المفتاحية: العبء المعرفي، التعلم بالوسائط المتعددة، اللغة الإنجليزية كلغة أجنبية (EFL)، التصميم التعليمي، الذكاء الاصطناعي.

Résumé :

Cette étude examine l'impact des environnements et outils multimédias numériques sur la charge cognitive et les résultats d'apprentissage des étudiants de deuxième année en anglais langue étrangère (EFL) à l'Université Dr Moulay Taher de Saïda, en Algérie, au cours de l'année universitaire 2025/2026. Bien que ces outils numériques soient largement utilisés, ils peuvent facilement dépasser la capacité de la mémoire de travail et entraîner une charge cognitive superflue. À l'aide d'une méthodologie mixte convergente, le chercheur a recueilli des données auprès de 57 étudiants et de deux enseignants. L'étude s'est appuyée sur des questionnaires destinés aux étudiants, des entretiens avec les enseignants et des observations en classe sans participation. Les résultats montrent que la plupart des étudiants réagissent positivement au multimédia, 87,8 % d'entre eux préférant les formats visuels et utilisant fréquemment des outils d'IA pour améliorer leur écriture et leur vocabulaire. Et pourtant, ces environnements numériques posent encore des défis importants. Les données de l'enquête indiquent que 60,7 % des étudiants se sentent mentalement submergés par les outils numériques, et 38,6 % souffrent d'épuisement cognitif induit par l'IA. Les observations en classe ont quant à elles confirmé l'impact direct de la conception pédagogique sur la charge cognitive. Les enseignants qui ont appliqué les principes de signalisation et de segmentation ont obtenu un taux de mémorisation de 85 % chez les étudiants, tandis que les cours mal rythmés ont provoqué une surcharge de la mémoire de travail et conduit les étudiants à s'appuyer fortement sur l'IA. Enfin, ces résultats ont confirmé les trois hypothèses principales de l'étude, démontrant que les outils numériques ne favorisent l'apprentissage de l'anglais langue étrangère que lorsqu'ils s'alignent sur l'architecture cognitive humaine. L'étude recommande également aux établissements de proposer des formations pédagogiques afin d'aider les enseignants à concevoir des cours en tenant compte de la charge cognitive, tout en établissant des lignes directrices claires qui positionnent l'IA comme un outil d'apprentissage complémentaire plutôt que comme un substitut à la pensée critique.

Mots-clés : charge cognitive, apprentissage multimédia, anglais langue étrangère (EFL), conception pédagogique, intelligence artificielle.