

The impact of Teachers' use of Neuro-cognitive strategies on enhancing EFL Students' Speaking Skills



أثر استخدام المعلمين للاستراتيجيات العصبية-المعرفية في تعزيز مهارات التحدث لدى طلاب اللغة الإنجليزية كلغة أجنبية

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Abstract

Enhancing speaking skills in language education has become a demand for learning another language that can be developed through learning strategies. Neurocognitive strategies are used in fulfilling this demand. This study have investigated the impact of neurocognitive strategies on improving EFL students' speaking skills. The study used a quasi-experimental design in which two groups of 28 (control group) and 28 (experimental group) students were selected. The experimental group

received instruction embedded with neuro-cognitive strategies which are: activating background knowledge, chunking and patterning, and dual-coding. Two tests were administered which are pre- and post-tests based on the IELTS speaking criteria to both groups. Both groups were assessed based on the speaking subskills: fluency and coherence, lexical resources, grammatical range and accuracy, and pronunciation. The data were analyzed by both descriptive statistics and a mixed-design repeated-measures ANOVA. The descriptive statistics indicated that all students improved across all speaking subskills, with the experimental group demonstrating higher gains in fluency, coherence, and lexical resource, while pronunciation improvements were substantial and similar across groups. A mixed-design repeated-measures indicates that neurocognitive strategies showed positive impact on the development of specific speaking-subskills. The study highlights the importance of using neurocognitive strategies into language instruction to support skill-specific development.

المخلص

اصبح تحسين مهارات التحدث في تعليم اللغات ضرورة ملحة لتعلم لغة أخرى، ويمكن تطوير هذه المهارات من خلال استراتيجيات التعلم. تستخدم الاستراتيجيات العصبية المعرفية لتلبية هذه الحاجة. هدفت هذه الدراسة إلى بحث أثر هذه الاستراتيجيات على تحسين مهارات التحدث لدى طلاب اللغة الإنجليزية كلغة أجنبية. استخدمت الدراسة تصميمًا شبه تجريبي، حيث تم اختيار مجموعتين من الطلاب، كل مجموعة تضم ٢٨ طالبًا (مجموعة ضابطة) و ٢٨ طالبًا (مجموعة تجريبية). تلقت المجموعة التجريبية تدريبًا مدمجًا باستراتيجيات عصبية معرفية، وهي: تنشيط المعرفة السابقة، والتجميع والنمط، والترميز المزدوج. أجري اختباران، أحدهما قبلي والآخر بعدي، بناءً على معايير التحدث في اختبار IELTS، على المجموعتين. تم تقييم المجموعتين



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بناء على مهارات التحدث الفرعية: الطلاقة والترابط، والمفردات، والنطاق والدقة النحوية، والنطق. تم تحليل البيانات باستخدام الإحصاء الوصفي وتحليل التباين ثنائي الاتجاه ذي القياسات المتكررة. أشارت الاحصاءات الوصفية إلى تحسن جميع الطلاب في جميع مهارات التحدث الفرعية، مع تفوق المجموعة التجريبية في الطلاقة والترابط والمفردات، بينما كانت تحسينات النطق كبيرة ومتشابهة بين المجموعات. وأظهرت دراسة ذات تصميم مختلط وقياسات متكررة أن الاستراتيجيات العصبية المعرفية كان لها أثر إيجابي على تطوير مهارات التحدث الفرعية المحددة. وتسلط الدراسة الضوء على أهمية استخدام الاستراتيجيات العصبية المعرفية في تعليم اللغة لدعم تطوير مهارات محددة.

1. Introduction

Language is the means of communication among individuals, and each group of people use a specific language to communicate and exchange information and ideas (FSUT, 2016; Delahunty and Garvey, 2010; Oviogun and Veerdee, 2020). Also, Sweet (1900) defines language as expressions of human thought through the use of speech- sounds for expressing those thoughts. And Rhoades (2014) defines "language as the gateway to mind" p.9. It's, therefore, imperative for EFL learners to not only focus on developing linguistic accuracy but also their ability to articulate thoughts, emotions and ideas coherently. The study of this duality of language concluded the knowledge of language, which includes phonology, morphology, syntax, semantics, and pragmatics (Anderson et al., 2022).

Language has other basic components such as fluency and accuracy in which they are important in producing language accurately and expressing oneself freely (Sárosdy et al., 2006). Speaking is one of the most emphasized and essential skills in the context of language learning and acquisition, as it plays an important role in facilitating effective oral communication for different purposes, such as succeeding in academic settings, enhancing social integration, overcoming language barriers and performing successfully in the workplace (Tsagari and Banerjee, 2016). Speaking skill is the most desired skill among other skills and for most people knowing a language means being able to speak that language (Celece, 2001). This is particularly relevant to EFL speakers, as they have a limited exposure to and engagement with real-life English-speaking environments beyond the classroom. This hinders their ability

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to engage in authentic communication. However, speaking skill with its own role in language education still remains more challenging than other skills, especially in contexts where opportunities for authentic communication are limited (Ur, 2000). Also, Ghafar and Amin (2022) state that lack of confidence, insufficient vocabulary, reluctance, nervousness while speaking, fear of making errors, lack of an appropriate setting to practice English, and lack of instructor enthusiasm were major problems of Kurdish students in using their EFL contexts. But still effective speaking practice can be achieved when learners frequently engage in speaking activities, demonstrate high motivation to communicate (AL-Garni & Almuhammadi, 2019; Ding, 2025), have equal opportunities for participation, and perform at an acceptable level of language proficiency (Nguyen & Nguyen, 2020).

Advancements in educational neuroscience have highlighted that learning is not merely a cognitive process but also a neuro-cognitive one, involving emotional, physical, and sensory pathways (Willis, 2007). This study have investigated whether incorporating neuro-cognitive strategies in teaching which are activating prior knowledge, chunking and patterning, and dual-coding—can significantly enhance the speaking performance of EFL students. By integrating insights from cognitive neuroscience and second language acquisition, the research provides an advanced framework for improving language instruction. The following research questions are intended to be answered:

1. Is there any significant difference in students' overall speaking performance when neuro-cognitive strategies (activating prior knowledge, chunking and patterning, and multimodal instruction) are used compared to when they are not?
2. Is there any significant difference in the improvement of the subskills and areas of language when neurocognitive strategies are used compared to when they are not?

Additionally, the first objective of this study is to examine the effect of using neuro-cognitive strategies (activating prior knowledge, chunking and patterning, and multimodal instruction) on EFL students' overall speaking performance, and to determine whether a statistically significant difference exists between students taught with these strategies and those taught through traditional instruction. The second objective of this study is To find out whether teaching through neuro-cognitive strategies leads to better development of individual speaking subskills, including fluency, accuracy, pronunciation, vocabulary, and grammar, compared to regular classroom instruction.





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2. Literature Review

This section discusses conceptual and theoretical foundations of neurocognition. It also looks at the importance of cognition, and brain's correlation with cognition and mental process. It defines cognitive theories and the application of the neurocognitive strategies in EFL context. Additionally, it explains the benefits of applying them. Furthermore, it talks about teachers' roles and awareness in using the strategies in EFL classrooms. Finally, it talks about the works of previous related studies.

2.1 Conceptual and Theoretical Foundations

Neurocognition is an interdisciplinary subject that links and combines fields such as neuroscience, neuropsychology and cognitive neuroscience to examine the brain structure and function of particular areas associated with cognitive functions such as perception, memory, association and recall to improve learning process, it is to say that neurocognition is the study of how brains' neurological processes give rise to behavior and cognitive functions which these neural circuits control the cognitive activities (Ramganesht & Hariharan, 2020). The work on the relation between neural system, cognitive development, and education began with working on reading development and how the circuit functions change during reading process (McCandliss, 2010).

There are concepts or principles that emphasize the role of neurocognitive strategies in language education. One of the central concepts underlying these strategies is *neuroplasticity* which is a brain property that allows the brain to reorganize itself to achieve structural and functional changes and strengthens the neural networks and to relearn as a reflection to the environmental experiences, cognitive demands, or behavioral experiences such as language learning (Bates, 1999; Isel, 2021; Li et al., 2014; Shcherbukha & Vovk, 2025). In language education, this suggests that the brain organizes and shapes itself in response to language experience, and that language learning affects how human brain changes and restructures itself. Meaningful exposure to linguistic input strengthens neural circuits associated with language processing. (Li & Litcofsky, 2014; Isel, 2021). Another foundational concept is dual coding theory, which underlies human behavior and practices that is a characteristic of mental processes, and according to this theory students retain information more effectively when it is processed through both verbal and visual channels of brain system which are specialized for imaginary and linguistic knowledge (Clark & Paivio, 1991). Kanellopoulou et al. (2019) have supported combining auditory, visual, and kinesthetic elements such as images,



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gestures, and written text to create multiple retrieval paths in the brain to enhance the recall of information.

The theoretical basis of neurocognitive strategies is grounded in multiple cognitive and neurological perspectives that explain how language is learned and processed. From a cognitive perspective, language learning involves processing and organization of information (Ortega, 2009). This refers to the various mental processes used in thinking, remembering, perceiving, recognizing, classifying, etc. (Richards & Schmidt, 2013). According to Atkinson and Shiffrin (1968) as cited in Matlin (2005), the information processing theory explains how mind receives an input, processes it, stores it in mind and recall it (Srivastava & Srivastava, 2019). This process happens by three stages of encoding, storage, and retrieval of information which is a theory of human thinking and learning (Slate & Charlesworth, 1988). Likewise, schema theory is the knowledge in human mind that involves knowledge about events, concepts, experiences, or environment (Bo, 2023). Zhao and Zhu (2012) explain that this theory emphasizes how people use their background or prior knowledge with the new information in a text and it affects the comprehending and interpreting the meaning. The *Working Memory Model* (WMM) also provides an important theoretical basis, emphasizing the role of temporary memory systems in language processing (Demir, 2021). WM was not seen as only a storage memory but also as a system for manipulation or activation of information (Ortega, 2009). Mitchell et al. (2013) have explained that the term *Working Memory* used to refer to the process that is involved in the storing information temporarily (in which short-term memory (STM) is the temporary storage for the information) and manipulating those information during the cognitive process and functions such as comprehension and production of language. Also, Ortega (2009) stated that those people who use their WM capacity is better than others can learn author languages efficiently because their WM helps them increase the level of their achievements which is not because of its ability for storing information but instead because of its ability in controlling attention in which it is one of the essential components of cognition.

These theoretical perspectives have provided a comprehensive framework for the application of neurocognitive strategies in language education. Practically, this integration helps teachers and guide them to design language instruction that could be align with how students' brain learn best (M, 2024; Pradeep et al., 2024). Teachers are encouraged to integrate neuroplasticity, cognitive strategies, and emotional factors through using spaced repetition, multisensory engagement, and positive



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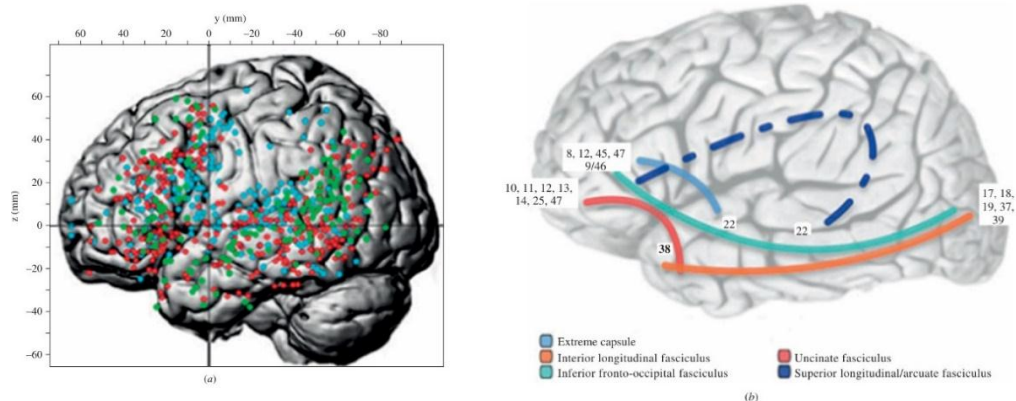
emotional to enhance memory consolidation and activate multiple brain regions (Abdelwahab, 2024). The classes that focus on emotional engagement, through using storytelling materials increase students' motivation and reduce their anxiety (Tobler et al., 2025). Additionally, teachers can design those tasks that activate students' schemata (background knowledge) to help students link the pervious knowledge with the new ones through using activities such as brainstorming (Al-Salmi, 2011). Overall, neurocognitive strategies in language education integrated both biological (neuroscience) and cognitive (cognitive psychology) process. Also, according to Verma and Kumar (2022) understanding the relation between brain structure and its functions which is one of the main goals of cognitive neuroscience. Thus, the neurocognitive approach provides a powerful framework for designing language education that is not only effective but also aligned with the natural workings of the human brain.

2.2 Brain, Its Neurological-Process Correlation with Cognitive Functions, and Cognitive Functions' Localization in Brain

Amaral and Guerra (2022) have stated that brain is the learning organ that happens through reorganization of the connections between neurons, these connections are called synapses, neuronal circuits, and interconnected neural networks. These connections will help the improvement of mental functions such as language, attention, motivation, emotion, and memory. There are relations between neurons of human brain and cognitive processes that the neurological processes are shaping cognitive functions such as perception, memory, attention, and decision-making. Also, according to Verma and Kumar (2022) understanding the relation between brain structure and its functions is one of the main goals of cognitive neuroscience. The brain imaging technologies such as Electroencephalography (EEG) Functional , Diffusion Tensor Imaging (DTI), and Magnetic Resonance Imaging (fMRI) make it easy to understand how human brain processes language that they can show the changes of human brain while they are performing tasks (Carreiras, 2010).Cui et al. (2025) have explained that language shapes both cognitive function and neurological process and explained that language is not only uses the two traditional regions of Broca's area and Wernicke's area but uses more regions of brain which are the left middle and inferior temporal gyri (MTG and ITG), frontal gyri (MFG and IFG), superior temporal gyrus (STG), hippocampus, cerebellum, and supramarginal gyrus (SMG). These areas interact with each other for performing the language functions and tasks. Also, Lupyan and Bergen

(2016) have indicated that language can be seen as a component of cognitive system because the language individuals use will affect their thinking, perceive, and their interaction with the environment because language is not only a reflection of the cognitive system, but also influences human mind and its cognitive functions.

Stiles et al. (2015) have explained that the left hemisphere (LH) is mostly used and active in language processing than right hemisphere (RH). Also, Vigneau et al. (2006) have provided two images of mind which mapped three aspects of language that are *phonological*, *semantical*, and *syntactic processes* in the image (a) in which *phonological processes* (in blue) is happening in superior temporal sulcus (STS) Brodmann's area [BA] (22) near Heschl's gyrus. Also, *semantic processes* (in red) this process involves with different areas of brain which are frontal, temporal, and parietal regions. The inferior frontal gyrus (IFG) has strongly associated with this process, also other areas like angular gyrus, anterior fusiform, anterior temporal pole. The connection between these three areas is linked by inferior longitudinal fasciculus (ILF) that connects the posterior STS and angular gyrus to the temporal pole and the temporal pole is linked to the IFG through the uncinate fasciculus (UF), so that this connection creates meaning. Finally, *Syntactic processes* (in green) this process focuses on the sentence structure through relying on a pathway between pars opercularis (BA 44) and posterior STS (BA 22) through the arcuate fasciculus (AF). And the pathways between regions of brain in image (b). Image (b) shows the pathways between regions of brain that have been provided by Dick and Tremblay (2012) for processing language functions. These two images show that how brain processes language through connecting these areas and regions of brain through neural pathways for processing language sounds, meaning and syntactic structures. Meanwhile, this supports the idea that language as a cognitive function will be processed in different areas of brain through linking them.





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Image A: aspects of language that are phonological, semantical, and syntactic processes in brain.

Image B: Image (b) shows the pathways between regions of brain

2.3 Neurocognitive Strategies

This section provides the details about the neurocognitive strategies' definitions, and their uses in EFL classes.

2.3.1 Prior-Knowledge Activation: Definitions, and Schema Activation

Activating prior (background) knowledge involves techniques that can be used for activating an individual's existing knowledge about a topic (Belouiza et al., 2024). Teachers can use techniques that help learners activate their prior knowledge related to the topic at the beginning of the lesson. Hu (2012) has suggested the use of question asking about the topic to help the learners express their expectations based on their background knowledge. Brown (2001) has added that pre-learning activities helps learners' readiness by stimulating mental connections, lowering anxiety, and creating a meaningful context for learning tasks. Also, Bo (2023) has emphasized activating prior information through using technological tools such as apps, using videos, audio and animations in the classrooms for activating processes, also he has suggested that teachers can recommend the use of books, magazines and articles for helping the students for future lessons to make a background knowledge about the topics. Sharafi-Nejad et al. (2016) have explained that without activating appropriate schemata, learners may struggle with understanding new input even if the information itself is not difficult. According to Dale et al. (2010), this strategy helps learners with providing rich language input, helps them to make the language and content meaningful to them, encourage students to produce spoken and written language, help students to recognize language features, activating the cultural and background information, and so on (Dale et al., 2011). Additionally, it increases students' fluency, confidence, and willingness to speak actively (Dale et al., 2011; Shabani, 2013). According to Shabani (2013) students who activate their background knowledge in speaking tasks, it helps them to speak for longer period of time and more fluently and their previous information about the content enables them to produce language orally better. Mehisto et al. (2008) have explained that activation process helps students to find the gaps between previous and new knowledge and this increases their awareness in learning in which this awareness makes their learning more effective and the teachers can decide on the teaching instructions that could be useful for learners' need.



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Overall, the prior-knowledge activation strategy plays a central role in learning enhancement because it enables learners to access and apply their background knowledge structures.

2.3.2. Chunking and Patterning: Definition, and Applications

Chunking and patterning are brain-based learning strategies that emphasize the mind's ability to categorize information into meaningful patterns. According to Miller (1956), the human brain can only process a limited amount of information at a time that can be around seven units. Chunking helps students overcome this mind limitation by linking the pieces of information into a unit or meaningful chunks which this enhances process of retention, comprehension, and retrieval. Caine and Caine (1994) have explained that patterning is the innate ability of brain to find and detect relationships, similarities, and structures within information which is essential to create meaning by human. Chunking and patterning support cognitive processes and facilitate learning process. In educational contexts, chunking refers to breaking complex information into smaller and manageable units that students can understand and connect information together more easily. Patterning helps students recognize language structures, categories, rules, and relationships within language. When these two strategies are used together, they help students in organizing new information that can align with the brain processes of information in a natural way and can promote meaningful learning.

In EFL contexts, chunking and patterning are essential strategies for supporting and enhancing language learning. Because EFL learners often struggle with processing large amounts of language input so that chunking helps them to access language in manageable units, which increases both cognitive ability and confidence. Chunking and patterning is used by teachers through breaking down the information into smaller parts or chunks to help students understand in an easier way (Lah et al., 2014). After that, the broke down information will be reorganized through pattern level in which patterning helps students to search for meaning through linking them with the previous knowledge and helps them for understanding better through the reorganization and categorization of information and knowledge (Wilson et al., 2024). Chunking-based activities include formulaic sequences, reconstruction of dialogue chunks, using conversational chunks, and collocations and lexical chunks for enhancing and improving speaking proficiency (Nation, 2001; Richards, 2008). Patterning activities include categorization tasks, concept-mapping, sequencing, finding cause–effect relationships, and recognizing language patterns (Ellis, 2003; Novak et al., 2008).



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Furthermore, the students who learn through a chunking-based program can develop their literacy skills (reading and writing), enhance vocabulary retention in LTM, and have greater fluency in retrieving lexical chunks, raise students' awareness about the language patterns and structure, and encourage and motivate students to actively learn (Mohamed et al., 2019). This strategy has its usefulness in improving speaking fluency among students that increases automaticity in speech production, reduces hesitation, students speak for longer periods, helps to reduce speaking pauses and anxiety while speaking, students can produce more natural and native-like language, encourages students, and motivates them to speak confidently (Monica, 2022). Moreover, Mahdavi-Zafarghandi et al. (2015) have explained the benefits of teaching by lexical chunks on speaking fluency, which improves both accuracy, fluency, builds students' confidence by reducing hesitation, producing more native-like language, and increasing automaticity during speaking. This strategy assists in reducing cognitive load and support students in understanding how ideas and information can be put in a broader conceptual framework. Integrating chunking and patterning strategies into EFL teaching helps align classroom instruction with how the brain organizes information naturally.

2.3.3. Dual Coding: Definition and Classroom Application

Aryanto (2020) and Mir et al. (2023) have explained that dual coding is two cognitive processes. It processes information both verbally (which is language texts and spoken words) and non-verbally (images, visuals, diagrams) to reduce the cognitive load on human mind and helps the retention process (Ali and Alazzawi, 2025). It is used for helping learners to comprehend information and retain them in LTM through using both verbal and non-verbal representation of that information in which this strategy can enhance the learning process and makes it easier (Clark & Paivio, 1991; Mir et al., 2023). Also, this technique can reduce the cognitive load which this load is the limited amount of information that WM can handle before transferring it to LTM and retain there (Wooten & Cuevas, 2024). Graphic organizer, using charts, diagrams, Hands-on Experiments and Observations, maps, and other visual elements can be used for this purpose (Mir et al., 2023). Researches on multimedia learning support that combining both text and visual helps and improves the process of language comprehension and memory (Al-Seghayer, 2001).

In the EFL contexts, dual coding supports language comprehension by reducing cognitive load to help students understand new knowledge through both verbal and visual support. Mayer's (2009) multimedia

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learning principles have supported that using both words and visual together can enhance comprehension and long-term retention, especially for second-language learners who are facing difficulties in language processing. Additionally, using dual-coding activities in language classes helps students learn in a manageable way and reduces their cognitive load because students do not only depend on linguistic processing but also using their cognitive visual system (Aryanto, 2020). Additionally, this helps the word recognition process that through the phonological loop and using the visual systems of students through showing images, figures, or other visual images students can recognize words more easily and quickly through this combination and helps to move from unrecognized to recognized vocabulary items (Yanasugondha, 2016). Researches in vocabulary learning process have showed that learning new vocabularies with pictures improves retention process better than just using verbal explanation alone (Al-Seghayer, 2001). This is because visuals elements activate the non-verbal system of human mind to make meaning easier and allowing students to connect the English word with their mental image. Dual coding is also beneficial for developing speaking skills. In EFL contexts, students face challenges and fell hesitate during speaking because of limited vocabulary access in their mind (Nation, 2013). But, when speaking tasks are supported with visual activities and elements such as pictures, graphic organizers, visual maps, and picture-based story telling students can remember words more easily and speak fluently (Marzano et al., 2005; Paivio, 2007). Overall, dual coding is effective in EFL settings by linking both visual and verbal cognitive systems, EFL students can process more language input deeply, retain information for a longer time, and speak more confidently.

2.4 Related Studies

There are many researchers are interested to work on the teaching methods that focus on the use of brain and mental functions in language acquisition, learning, and teaching process. So that there are studies that are reviewed in which they used the three strategies in EFL classrooms.

A study by Pratiwi et al. (2021) have examined the use of neurocognitive strategies for improving students' English-speaking performance through using different neurocognitive activities such as note-taking, giving input, and repetition, reviewing, and practicing. Also, they explored students' perceptions of their learning process. The study used 14 students from an Information Systems program which is non-English department. The authors found that the use of those strategies has a positive impact on students' speaking performance, and students showed a noticeable improvement in their speaking ability, vocabulary mastery, and





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comprehension. Additionally, the results further showed that students were more active, motivated, and felt confident while speaking.

Nshimiyimana et al. (2024) have investigated the effectiveness of a neurocognitive approach on language learning and speaking among secondary school students in Rwanda, which examined the brain activities and the multisensory effects on students' motivation, attention, memory, and emotional engagement during the learning process. The participants were 40 students who participated in the study. The authors have used pre- and post-tests to measure the effect of neurocognitive factors in enhancing students' English speaking ability. The quantitative results have indicated that the neurocognitive approach had a positive impact on students' English language learning and speaking performance, and their speaking improved in the post-test compared to the pre-test.

In addition, there are studies that examined each strategy's impact on EFL students' speaking skills separately. A study by Fahad and Musa (2024) have investigated the effectiveness of the lexical chunks strategy in improving students' speaking performance. The study used 120 third-year university students which are randomly divided into an experimental group with 60 students and a control group with 60 students. The authors have aimed to find if there were significant differences between students' speaking performance at the recognition level in the pre-test and the production level in the post-test. The findings have indicated that the use of this strategy had a positive impact on students' speaking performance, and the strategy helped students in improving their conversational performance.

Furthermore, Afrizal et al. (2025) have evaluated the speaking proficiency of 46 Indonesian senior high school students by using a picture description task as a dual coding technique or activity that aimed to measure the five components of speaking, which are comprehension, grammar, vocabulary, pronunciation, and fluency, and examined whether visual objects can effectively scaffold students' speech production in the classroom. The findings of the study have indicated that the students' speaking performance was very good with the use of the strategy. Among the five dimensions, vocabulary got a high range of development in which the strategy successfully activated learners' lexical knowledge, and the visual materials reduced cognitive load and facilitated lexical access, making word retrieval easier during speaking tasks.

Meanwhile, Affandi and Muhalim (2022) have investigated the use of the Plan-Ahead Brainstorming technique (a technique that activates students' background knowledge) to improve EFL students' speaking ability,

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especially in terms of fluency, accuracy, and comprehensibility. The participants were 28 students that are selected randomly. The findings showed that Plan-Ahead Brainstorming significantly improved students' overall speaking ability. Among the components of speaking fluency, the greatest improvement and this reduced students' cognitive load during speaking. Students became better at expressing their ideas.

3. Methodology

This section outlines the methodological framework employed in the research. The methodology includes an explanation of the research design, participants, instruments, data collection procedure, scoring scheme, test content validity, and ethical considerations.

3.1 Research Design

This study employs a quasi-experimental design involving two groups: an experimental group and a control group, to investigate the impact of neurocognitive strategies (activating prior knowledge, dual-coding, and chunking and patterning) on enhancing students' speaking performance. This approach of research design is a quantitative research design approach that helps researchers to examine the impact of an experiment on a variable, which is a nonrandomized experiment (Creswell, 2014; Reis & Judd, 2014). The experimental group has been taught by using neuro-cognitive strategies in the lessons, while the control group follows traditional methods of teaching without focusing on using any specific or special strategy. Both groups learn from the same content in the *Interchange 3* textbook and have the same amount of instruction the whole semester. The data were collected from two test types at the beginning and the end of the semester for measuring students' speaking performance to investigate the impact of the used strategies on the experimental group compared to the control one. A speaking pre-test is given before instruction begins, and a post-test is given afterward. This allows for a fair comparison and helps determine whether the neuro-cognitive strategies make a difference.

3.2 Participants

The study included 56 first-year Kurdish EFL students at the University of Halabja, English language department, first academic year, 2024-2025. All students in the two groups had similar background in terms of gender and academic background, reflecting the overall student population in the department. The participants' age was from 19 to 21, and their native language was Kurdish. All students had almost 1 years of experience with English language exposure. The number of students was 56, of which 46 were female, 10 were male. 28 students were taught using





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neuro-cognitive strategies, and 28 students were taught using other methods except the use of neurocognitive strategies.

3.3 Research Instruments

This section have provided the information about the instruments and their implementations that two tests (pre- and post-tests) have used and the strategy implementation phase was explained, which has conducted after the pre-test.

3.3.1 Pre- test

Data were collected using two IELTS-based speaking tests administered as pre-tests and post-tests to both the control and experimental groups. The pre-test was conducted prior to the beginning of the course. The speaking pre-test was developed based on the speaking progress check sections of *Interchange 3 Student's Book*. The test items were topics and tasks about students' daily life and things they might have faced throughout their life. The test consisted of four parts which were personal qualities, facing new challenges, environmental issues and storytelling. These tasks asked students to share opinions, present solutions, describe events and narrate stories which can measure the level of students' speaking ability.

3.3.2 Implementation Phase of the Use of Neuro-Cognitive Strategies

The study takes place in a face-to-face classroom setting at the University of Halabja. All lessons are taught in a traditional classroom with a whiteboard, projector, and audio speakers. The face-to-face teaching is important for interactive speaking activities such as pair dialogues, role-plays, and group discussions. Additionally, face-to-face teaching allows the teacher to use physical movement and real-time feedback, which are important for teaching through the use of the neurocognitive strategies.

The teaching period for finding the impact of the strategies lasted for one semester of an academic year of teaching. During this period, eight units (Units 1–8) of the *Interchange3* English textbook were covered in sequence. Both the experimental and control groups were taught through the same content on the same schedule. Typically, the classes met twice per week for 90 minutes each session (total of ~3 hours per week). By the end of all 7 weeks, both groups had received comparable exposure to the textbook material, focusing on speaking tasks of each unit. The data was collected from two test types at the beginning and the end of the semester for measuring students' speaking performance to investigate the impact of the used strategies on the experimental group compared to the control group. A speaking pre-test was given before instruction begins, and a



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post-test was given afterward. This allows for a fair comparison and helps determine whether the neuro-cognitive strategies make a difference

3.3.3 Post-test

While, speaking post-test followed the same format and level of difficulty as the pre-test but used different test items to ensure comparability. The test items developed based on the speaking progress check sections of *Interchange 3 Student's Book* and content covered throughout the semester. The test structure had four sections focusing on career development, job and working style, cultural awareness and travel experiences. The test items were designed to measure to which extend students gained instructional speaking tasks and their cumulative learning.

Both speaking pre-test and post-test were a 5–6 minute oral test per student, their format were one-on-one oral interviews between student and examiner. The pre-test was given during the first week before instruction starts, while the post-test was given after the course of study ended. Interviews were held in a quiet setting, recorded with consent and scored later by two instructors using the same scoring rubric. Students were reassured that the test was for diagnostic purposes to ease anxiety. The scores were used as a baseline later for the comparison process.

3.4 Data Collection Procedure

The study used different data collection tools for evaluating the outcomes of the teaching period, which were: speaking proficiency tests, speaking performance assessment rubric (IELTS speaking band descriptors).

3.4.1 Pre-test

The first tool was a *speaking pre-test*, the test was about 5-6 minute oral test structured based on the format of an *Interchange 3* speaking skills evaluation. This test was used to assess students' speaking ability before taking the teaching course. The Format of the pre-test was an individual oral interview between the student and an examiner. It consisted of two parts: the first part was *an Introduction & Interview for 2-3 minutes*. The examiner asked the student a few simple questions about familiar topics, which were like warm-up questions. These warm-up questions assessed the student's basic fluency and ability to talk about everyday topics, like an IELTS Speaking Part 1 or an opening conversation in textbook tests. The second part of the test was about 2-3 minutes. The student was given a prompt for a slightly more extended speaking turn. Additionally, the student got a minute to think (notes optional) and then spoke for about 1-2 minutes on this. Follow-up questions or a brief dialogue ensured based on what the student said. This





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part assessed the ability to speak coherently on a single topic, use past tense narrative (likely), and demonstrate organization in speech.

3.4.2 Post-test

The second tool for collecting data was a *speaking post-test*, which was used by the end of the semester. The post-test speaking assessment had a similar format to the pre-test and a similar level of difficulty. The post-test was not a repeated form of the pre-test questions but used the same structure and scoring criteria. This test lasted about 5 minutes and used prompts derived from *Interchange 3* topics and language functions. This test also had two formats, such as the pre-tests: Part 1 was a *Short Interview* for two minutes – the introduction questions included general topics possibly linked to the units. In the second part was the *Extended Speaking Task*, which lasted for about 2-3 minutes. The student was given a prompt relating to one or more of the unit themes. The questions invited students to express an opinion and give reasons (practicing fluency and coherence). Another possible prompt could be scenario-based, combining multiple functions. The prompts were designed like that a student could demonstrate the speaking skills practiced (giving opinions, narrating experiences, making hypothetical statements, etc.). The student again got a moment to think and then spoke. The examiner asked 1-2 follow-up questions to probe for more detail or clarify points, ensuring the student spoke to their capability. Generally, the post-test content covered topics that were taught during the course of the study to align with what was taught, but not in a way that rewards rote recall of classroom dialogues. Instead, it assessed the ability to speak about these familiar topics in an unrehearsed manner.

The pre-test and the post-test were administered to both the experimental and control group. Each student was tested individually outside of class time in a quiet room in both tests. The same interviewer conducted all tests using a standardized script for consistency. The interviews were audio-recorded (with student consent) to allow for later scoring and analysis. Two English instructors (including the researcher) listened and scored each recording using the rubric (described below). Having two raters allows for more reliable scoring. The students were told that the test was to diagnose their speaking levels to reduce anxiety. The pre-test scores primarily serve as baseline data and also to verify that the two groups' average speaking ability is equivalent at the start. Additionally, each student's performance on the post-test will be compared to their own pre-test (to measure improvement) and to other students (to compare group averages).



3.5 Test Content Validity

Test validity was used to ensure the quality of both tests. Both tests were given to a group of expert members which consists of university teachers to ensure face and content validity that their native languages are Kurdish and Arabic. A group of 13 expert EFL instructors participated as jury members to evaluate the content validity of the two reading comprehension tests. All experts held MA or PhD degrees in Applied Linguistics or English Language Teaching, with professional experience ranging from 7 to 20 years in teaching EFL at the university level. Their teaching experience and background knowledge in language teaching and assessment process let them judge on the quality of the speaking test items to ensure that the items are useful to be used for measuring university students' speaking performance. The teachers commented on the quality of each item based on their comments the items were used, justified, or changed, before their real use.

3.6 Scoring Scheme

To evaluate the speaking tests, the researcher used the International English Language Testing System (*IELTS Speaking Band Descriptors*) as the scoring rubric. The IELTS speaking criteria were well-known and provided a comprehensive measure of speaking ability across four key dimensions, which were fluency and coherence, lexical resource, grammatical range and accuracy, and pronunciation. The decision to use the IELTS rubric was because it is comprehensive and internationally recognized. The speaking tests covered the main aspects of speaking that correspond to the objectives: fluency & coherence corresponds to the "fluency" and "coherence" objective, grammatical range & accuracy corresponds to "accuracy," lexical resource also to "accuracy" in terms of word choice (and richness of vocabulary), and pronunciation partly ties into speaking confidence and clarity. Although "confidence" is not an explicit IELTS category, a confident speaker often manifests as better fluency and even better pronunciation (less hesitant, clearer voice). Furthermore, IELTS descriptors gave concrete benchmarks, which were useful for evaluating the level of second-year students and to measure speaking improvements, which lent credibility to the assessment approach.

Each category in IELTS is typically scored on a band scale from 1 to 9. This study adopted this rubric for the scoring process. Each of the four categories is rated on a 0–9 scale, and then an overall speaking score (also 0–9) is determined (often the average of the four, in IELTS fashion). Two raters independently listened to each recorded test (pre and post) and assigned scores in each of the four categories. They referred to





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the public version of the IELTS Speaking Band Descriptors for guidance – for example, Band 6 Fluency is “able to speak at length with some hesitation, uses connectors, etc.”, Band 7 Fluency is “speaks smoothly with occasional repetition or self-correction,” and so on. If a student’s performance fell between descriptors, raters gave half bands (e.g., 5.5). For reliability, the two raters’ scores were compared: If scores were very close (within 0.5 band overall), they were averaged to get the final score. If there was a discrepancy greater than 0.5 in any category or overall, the raters discussed the recording, re-listen to relevant parts, and came to an agreement (or bring in a third rater if needed). In practice, training sessions and using sample IELTS benchmarks helped minimize large discrepancies.

The bands were interpreted in this context that second-year Kurdish EFL students might score around Band 5 to 6 on IELTS speaking at the start (assuming intermediate level). We anticipate that the experimental group may, on average, improve by perhaps ~0.5 to 1.0 bands more than the control by the end (hypothetically, experimental mean rising from 5.0 to 6.0, control from 5.1 to 5.5, etc.). These scores will be treated as continuous data for statistical analysis (even though they originate from band levels). The rubric also allows analysis per category. The researchers check if the experimental group has a particular improvement in fluency/coherence or perhaps lexical resource. Later, the category scores were analyzed to answer whether neurocognitive strategies have a beneficial impact on one aspect or not.

3.7 Ethical Considerations

This study followed standard ethical guidelines and principles, which is outlined in both the *Belmont Report* (1979) and the *British Educational Research Association (BERA) Guidelines* (2018) in which these sources emphasized being justice towards the participants, respecting them, and beneficence. The participants of the study were university-level English language students. Participants were informed about the purpose of the study. Students’ identities were kept anonymous through encoding their names to ensure anonymity and confidentiality. The assignment of which class would receive the new intervention was random to avoid selection bias. Students were informed that they would be part of a special program to improve speaking (to encourage motivation), but they were not explicitly told of the experimental/control status to minimize expectancy effects. All participants gave informed consent for their test scores and class performance to be used in the research. Both groups had a similar makeup in terms of gender and academic background, reflecting the overall student population in the department. There was no physical



or psychological harm to participants. The results of the data were reported in a way that prevented identification of the participants to ensure trustworthiness and protect the participants' rights. Before collecting data from the participants, the researcher asked the head of the English department and the instructor of the lesson for permission to do the work, and it was accepted by both the head of the department and the instructor agreed to follow legal and institutional rules.

4. Data Analysis and Results

In this section the researcher has wanted to investigate the impact of the neurocognitive strategies on EFL students' speaking skill by comparing the performance in two different groups which are control and experimental group. The data were collected through giving two tests for both groups which are pre- and post-test. And the data were analyzed through using Mixed-design RM-ANOVA which is a statistical test used in this study because the study includes two different types of independent variables at the same time. Based on two methods of the test which are: *within-subjects (repeated-measures) factors* that used to measure the *same variable* more than once. Also, *between-subjects factors* is used for comparing different groups or variables. Moreover. This test examines the changes over time between groups by combining within-subjects and between-subjects comparisons in an analysis.

4.1 Statistical Analysis

This section reports the quantitative results addressing the research questions of the study, which examined changes in Kurdish EFL learners' speaking performance over time, differences across speaking subskills, and whether these developmental patterns differ between instructional groups. To address these questions, a mixed-design repeated-measures analysis of variance (mixed-design RM-ANOVA) was conducted with Time (pretest, posttest) and Skill (Fluency and Coherence, Lexical Resource, Grammar, Pronunciation) as within-subjects factors and Group (control, experimental), as the between-subjects factors. Descriptive statistics are presented first, followed by inferential statistics.

4.1.1 Descriptive Statistics

The descriptive statistics for learners' speaking performance across the four assessed subskills at pretest and posttest (time) for both instructional groups (group) that both time and group are variable are presented in Table 4.1 below:

Table 4.1

Descriptive Statistics for Speaking Subskills by Group and Time (N = 56)

Measure	Group	Mean	SD	N
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Measure	Group	Mean	SD	N
Pre_F&C	Control	2.75	1.21	28
	Experimental	3.04	1.20	28
Pre_LR	Control	2.82	1.36	28
	Experimental	3.04	1.11	28
Pre_Grammar	Control	2.61	1.26	28
	Experimental	2.79	1.29	28
Pre_Pronunciation	Control	2.79	1.29	28
	Experimental	3.50	1.58	28
Post_F&C	Control	3.79	1.34	28
	Experimental	4.25	1.32	28
Post_LR	Control	3.57	1.14	28
	Experimental	3.82	1.22	28
Post_Grammar	Control	3.21	1.48	28
	Experimental	3.32	1.31	28
Post_Pronunciation	Control	4.32	1.52	28
	Experimental	4.32	1.34	28

As shown in Table 4.1, both instructional groups demonstrated increases in mean scores from pretest to posttest across all four speaking subskills. At pre-test, mean scores for *Fluency* and *Coherence*, *Lexical Resource*, and *Grammar* were comparable across groups that there is a slight difference between groups, whereas *Pronunciation* showed a higher initial mean in the experimental group (M = 3.50, SD = 1.58) compared to the control group (M = 2.79, SD = 1.29). At post-test, mean scores increased in both groups for all subskills, with particularly large gains observed in *Pronunciation*, where both groups reached the same post-test mean (M = 4.32). While the experimental group tended to display higher posttest means in *Fluency* and *Coherence* and *Lexical Resource*, these descriptive differences alone do not establish statistical significance and therefore require inferential testing.

4.1.2 Inferential Statistics

To examine whether the observed descriptive patterns were statistically reliable, a mixed-design repeated-measures ANOVA was conducted. The results of the within-subjects effects are presented in Table 4.2.

Table 4.2

Tests of Within-Subjects Effects



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Source	df	F	Sig.	Partial η^2
Time	1, 54	77.728	.000	.590
Time * Group	1, 54	.478	.492	.009
Skill	2.317, 125.115	22.152	.000	.291
Skill * Group	2.317, 125.115	.683	.528	.012
Time * Skill	3, 162	6.759	.000	.111
Time * Skill * Group	3, 162	3.115	.028	.055

As shown in Table 4.2, a statistically significant main effect of *Time* was observed, $F(1, 54) = 77.728, p < .001$, partial $\eta^2 = .590$. This indicates that learners' speaking performance improved significantly from pretest to posttest when averaged across instructional groups and speaking subskills. The large effect size suggests that time-related development accounted for a substantial proportion of variance in speaking outcomes. A statistically significant main effect of *Skill* was also found, $F(2.317, 125.115) = 22.152, p < .001$, partial $\eta^2 = .291$, indicating that speaking performance differed systematically across *Fluency* and *Coherence*, *Lexical Resource*, *Grammar*, and *Pronunciation* when averaged across time and group.

In contrast, the *Time * Group* interaction was not statistically significant, $F(1, 54) = .478, p = .492$, partial $\eta^2 = .009$, indicating that the overall rate of improvement from pretest to posttest did not differ significantly between the control and experimental groups when speaking subskills were aggregated.

The *Time * Skill* interaction was statistically significant, $F(3, 162) = 6.759, p < .001$, partial $\eta^2 = .111$, indicating that the magnitude of improvement over time differed across the four speaking subskills.

Most importantly, Table 4.2 shows a statistically significant three-way interaction among *Time*, *Skill*, and *Group*, $F(3, 162) = 3.115, p = .028$, partial $\eta^2 = .055$. This interaction indicates that patterns of skill-specific development over time differed between the control and experimental groups.

To assess whether there was an overall difference in speaking performance between groups when averaged across *Time* and *Skills*, the between-subjects effects were examined. These results are presented in Table 4.3.





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Table 4.3

Tests of Between-Subjects Effects

Source	df	F	Sig.	Partial η^2
Group	1, 54	.850	.361	.015
Error	54			

As shown in Table 4.3, the main effect of *Group* was not statistically significant, $F(1, 54) = .850, p = .361, \text{partial } \eta^2 = .015$. This indicates that overall speaking performance, when averaged across time and speaking subskills, did not differ significantly between the control and experimental groups.

To clarify the nature of the statistically significant *Time * Skill * Group* interaction, estimated marginal means for speaking performance across instructional group, time, and speaking subskill are presented in Table 4.4 that for each subskill a number was used instead in which skill number 1 is fluency and coherence, number 2 is lexical resource, 3 is grammar and accuracy, and 4 is pronunciation. Also, time number 1 is pre-test and number 2 is the post-test.

Table 4.4

*Estimated Marginal Means for Group * Time * Skill*

group	time	skill	Mean	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
control	1	1	2.750	.227	2.294	3.206
		2	2.821	.234	2.351	3.291
		3	2.607	.240	2.125	3.089
		4	2.786	.272	2.241	3.331
	2	1	3.786	.252	3.281	4.291
		2	3.571	.223	3.125	4.018
		3	3.214	.263	2.686	3.742
		4	4.321	.270	3.780	4.863
experimental 1	1	1	3.036	.227	2.580	3.492
		2	3.036	.234	2.566	3.506
		3	2.786	.240	2.304	3.268
		4	3.500	.272	2.955	4.045
	2	1	4.250	.252	3.745	4.755
		2	3.821	.223	3.375	4.268
		3	3.321	.263	2.794	3.849



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4 4.321 .270 3.780 4.863

As shown in Table 4.4, both instructional groups demonstrated improvement from pretest to posttest across all four speaking subskills; however, the magnitude and pattern of these improvements differed across skills and between groups. In the control group, mean scores for *Fluency* and *Coherence* increased from 2.75 (SE = .227) at pretest to 3.79 (SE = .252) at posttest. *Lexical Resource* scores showed a more modest increase, rising from 2.82 (SE = .234) to 3.57 (SE = .223). *Grammar* improved from a mean of 2.61 (SE = .240) at pretest to 3.21 (SE = .263) at posttest, while *Pronunciation* exhibited the largest gain, increasing from 2.79 (SE = .272) to 4.32 (SE = .270).

A similar overall improvement pattern was observed in the experimental group, though the distribution of gains across subskills differed. For *Fluency* and *Coherence*, the experimental group's mean increased from 3.04 (SE = .227) at pretest to 4.25 (SE = .252) at posttest, reflecting a larger absolute gain than that observed in the control group. *Lexical Resource* scores in the experimental group increased from 3.04 (SE = .234) to 3.82 (SE = .223), again showing a slightly greater improvement relative to the control condition. *Grammar* scores increased from 2.79 (SE = .240) to 3.32 (SE = .263), indicating modest gains comparable to those observed in the control group.

Pronunciation displayed a distinct pattern across groups. While the experimental group began with a higher pre-test mean of 3.50 (SE = .272) compared to the control group's pre-test mean of 2.79 (SE = .272), both groups converged at an identical post-test mean of 4.32 (SE = .270). This convergence suggests substantial development in *Pronunciation* for both instructional conditions, despite differing initial performance levels. Taken together, the estimated marginal means indicate that although overall improvement occurred in both groups across all speaking subskills, the experimental group demonstrated relatively stronger gains in *Fluency* and *Coherence* and *Lexical Resource*, whereas gains in *Grammar* were modest and similar across groups. *Pronunciation*, by contrast, showed large improvements in both groups, resulting in convergence at the posttest stage. These skill-specific and group-dependent patterns of change account for the significant *Time * Skill * Group* interaction observed in the omnibus analysis and indicate that neuro-cognitive strategy-based instruction influenced the distribution and trajectory of speaking development across subskills, rather than producing a uniform increase in overall speaking performance. At the same time, the significant main effect of *Time* confirms that speaking





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performance improved overall from pretest to posttest, indicating that learners' development was robust across the instructional period, albeit differentiated by skill and instructional condition.

5. Discussion

This study has aimed to investigate the impact of neurocognitive strategies on enhancing EFL students' speaking skills across the speaking subskills, which are fluency and coherence, lexical resources, grammar, and pronunciation. The researcher used two groups (control and experimental groups) and gave them two tests (pre- and post-tests) to compare the performance of students in both groups and find the impact of the strategies. The results of the study have indicated that both groups performed better in the posttest, but the experimental group performed better than the control group across the speaking subskills, which have indicated that the neurocognitive strategies improved students' speaking skills significantly compared to the control group. Similarly, the study by Nshimiyimana et al. (2024), Pratiwi et al. (2021) have reported improvements in speaking performance following neuro-cognitive strategies that support the idea that such strategies can enhance oral proficiency. Furthermore, previous studies by Affandi and Muhalim (2022), Afrizal et al. (2025), and Fahad and Musa (2024) have investigated the impact of each strategy separately on students' speaking abilities and their findings have supported that the strategies have helped students improve their speaking performance. These findings confirm that speaking development is not only a matter of linguistic knowledge, but also of how efficiently students manage their cognitive resources during real-time speech production.

The descriptive statistics have showed a clear development in students' speaking performance of both groups from the pre-test to the post-test across all four subskills. In the control group, the mean score for *fluency and coherence* increased from 2.75 in the pre-test to 3.79 in the post-test, and SD increased from (SD = 1.21) to (SD = 1.34) in the post-test. The increase in the mean indicates that the control group became more fluent and coherent after instruction. Additionally, the increase in the SD



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indicates that students' scores are more spread out in the post-test, which means the group improved overall. These results have showed a greater difference between high and low students in the post-test, in which some students showed a great improvement, and some improved slowly. Furthermore, the mean score in the experimental group increased from 3.04 to 4.25 have indicated that students showed a significant difference in their performance that they became significantly more fluent and coherent after the treatment. This has suggested that the neurocognitive strategies had a clear positive effect on students' ability to organize ideas and speak more smoothly and effectively which is also supported by the findings of Nshimiyimana et al. (2024) and Pratiwi et al. (2021). Also, the SD increased from (SD = 1.20) to (SD = 1.32) in the post-test. This result in SD indicates that most students improved, but some students benefited more strongly from the treatment than others, which led to slightly greater differences in performance levels within the group in the post-test. A comparison of the fluency and coherence results between the groups shows differences in both initial level and degree of improvement. In the pre-test, the experimental group had a higher mean score than the control group, which have indicated that students in the experimental group had a slightly better level of fluency and coherence before starting the treatment. Although the SD suggests similar variability in both groups. After the course, the post-test results in both groups have showed students' improvement; however, the experimental group achieved a noticeably higher mean score compared to the control group. Similarly, the findings of Affandi and Muhalim (2022) support this result that the use of the neurocognitive strategy dual-coding helps students improve their fluency while speaking. However, Affandi and Muhalims' (2022) study only has focused on one technique which is related to one of the strategies, but the current study focused on using three important strategies. Overall, the larger achievements and higher mean scores in the experimental group indicate that the neurocognitive strategies were more effective than traditional instruction in enhancing students' fluency and coherence.





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While the *lexical resources* have improved from Mean = 2.82 to 3.57, this increase in the mean score shows that students in the control group were able to use a wider and more appropriate range of vocabulary in the post-test than in the pre-test. This suggests that the traditional teaching and practice had a positive effect on students' vocabulary use in speaking. The SD increased from 1.36 in the pre-test to 1.14 in the post-test indicates moderate variability among students' performance. This means that the students did not all improve to the same extent; some students made greater improvements in using vocabulary, while other students showed lower improvement in using vocabulary while speaking. This result has showed that the control group developed their lexical resources through the teaching instruction, but the moderate SD suggests that the improvement was not uniform across all students, which means they did not improve at the same rate. Also, the experimental group has showed improvement in using lexical resources; the mean score increased from 3.04 to 3.82, which has indicated that students were able to use a more accurate range of vocabulary resources while they are speaking in the post-test. In addition, the SD increased from 1.11 to 1.22, which has showed some variability in students' performance, which means not all students improved by the same degree; some students improved more than others. Overall, this shows that the neurocognitive strategies had a positive impact on enhancing students' ability to access and use vocabulary in speaking tasks. A comparison of lexical resource performance between the groups reveals differences in both the initial level and after the instruction. In the pre-test, the experimental group obtained a higher mean score than the control group, indicating that students in the experimental group had a stronger starting level in vocabulary use. In the post-test, both groups showed improvement; however, the experimental group got a higher mean score compared to the control group, which means the experimental group improved more and got more benefits from the use of neurocognitive strategies. Additionally, the findings of Afrizal et al. (2025) are in line with this study's results that the neurocognitive strategies are more effective in

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developing students' vocabulary better than the traditional instruction, but their only focused on the impact of one strategy which is activating background knowledge through using picture description activity. The SD in both groups suggest moderate variability in students' performance, which means that not all students did not improve in the same way; there are students who made great progress in vocabulary use, but still, there are students who cannot use vocabulary like them or could not make this great progress. Overall, the higher post-test mean in the experimental group provides evidence that the instruction was more effective in enhancing students' ability to access and use vocabulary during speaking tasks.

In the control group, the mean score for *grammatical range and accuracy* increased from 2.61 in the pre-test to 3.21 in the post-test, indicating that students made noticeable progress in using correct grammatical structures after regular instruction. The increase in the mean shows that students became better at producing grammatically accurate sentences. While the slightly higher SD from 1.26 to 1.48 suggests that some students improved more than others, this shows that there are individual differences in grammatical development. Similarly, the experimental group showed improvement in grammatical performance, with the mean increasing from 2.79 in the pre-test to 3.32 in the post-test. This indicates that students in the experimental group also developed their ability to produce accurate grammatical forms. The standard deviation from 1.29 to 1.31 showed relatively stable improvement, which means the improvement was more consistent across all students compared to the control group. The slightly higher starting mean and post-test mean of the experimental group may indicate that the neurocognitive strategies used in the treatment helped students better retrieve grammatical structures during speaking. When comparing both groups, the experimental group consistently achieved slightly higher mean scores in both tests for grammatical range and accuracy. This suggests that while both teaching instruction led to improvement, but the experimental group got a slight advantage because of the strategies that helped students reduce cognitive





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load, organize grammatical structures, and monitor their speaking more effectively. The slightly lower SD in the experimental group post-test compared to the control group also shows that students' improvement in their grammatical knowledge is more consistent, which means the strategies not only help students increase their performance, but also minimized the extreme differences in grammatical development. Overall, the results support the effectiveness of neurocognitive strategies in enhancing grammatical accuracy and stabilizing performance, even though gains in grammar tend to be more moderate than in fluency or lexical resource. This may be because grammatical development is more cognitively demanding and slower to automatize. However, the study by Afrizal et al. (2025) findings are not the same as the current study, in which their study showed that the strategy showed better improvement in grammar above fluency, while the current study showed that students' fluency benefited more from the strategies that focused on grammar range and accuracy.

In the control group, *pronunciation* mean increased from 2.79 in the pre-test to 4.32 in the post-test. This large improvement in mean suggests that students made significant progress in their ability to produce clear and accurate pronunciation after the regular instruction helped students develop their pronunciation patterns. However, the high score in SD from 1.29 to 1.52 indicates that some students improved more than others, and not all students achieved the same level of pronunciation mastery, as individual differences between students remained. In the experimental group, pronunciation also increased from 3.50 in the pre-test to 4.32 in the post-test. This shows that students who received the treatment made substantial gains as well. Although both groups reached the same post-test mean (4.32), the lower SD in the experimental group 1.58 to 1.34 indicates that improvement was more consistent among students. It is clear that both groups gained the same level of pronunciation after instruction, which indicates that traditional instruction can be more effective in improving pronunciation skills in which the students in control group had a lower mean but improved their pronunciation skill

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and gained the same level of the experimental group. In parallel, the study of Afrizal et al. (2025) have shown that pronunciation recorded the lowest score compared to other subskills, which are fluency, vocabulary, comprehension, grammar, and pronunciation.

The study also employed a mixed-design repeated-measures analysis of variance (ANOVA) with *Time* (pretest, posttest) and *Skill* (fluency and coherence, lexical resource, grammar, and pronunciation) as within-subjects factors and *Group* (control, experimental) as the between-subjects factor. The results of the mixed-design repeated-measures ANOVA have indicated that students' speaking performance improved significantly over the instructional period. A highly significant main effect of *Time* was observed, $F(1, 54) = 77.728, p < .000$, with a large effect size (partial $\eta^2 = .590$), showing that students increased their speaking meaningfully from pre-test to post-test, which means that the instructions showed a positive effect on students' speaking skills regardless of each group and each skill. This confirms that the teaching instruction in both groups positively impacted students' speaking abilities, and students showed great overall improvement over time. The results support students' development across all subskills: fluency, lexical resource, grammar, and pronunciation in both groups. The large effect size of *time* also highlights the strong influence of repeated practice and exposure on skill acquisition. Additionally, a statistically significant main effect of *Skill* was also found, $F(2.317, 125.115) = 22.152, p < .001$, partial $\eta^2 = .291$, indicating that speaking performance differed systematically across *the subskills* when averaged across time and group, which means that students' performance among the subskills are not developed equally but there are subskills that developed better than other skills regardless of group type and the time. This supports the descriptive results that showed some numerical differences among the subskills. Importantly, this confirms that speaking is not a single skill but it is consists of multidimensional ability that students' performance across them will be differ.





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The results of between-subject effects indicated that the main effect of *Group* was not statistically significant, $F(1, 54) = 0.850$, $p = .361$, partial $\eta^2 = .015$, this means that both groups are improved similarly when ignoring time and the subskills. Similarly, the interaction between *Time* and *Group* was non-significant which is $F(1, 54) = .478$, $p = .492$, partial $\eta^2 = .009$, this means that although both groups showed clear gains over the time, means both groups showed a positive impact on students' overall speaking performance. This finding has implied that while both groups benefited from instruction, the neurocognitive strategy intervention did not produce a blanket advantage across all aspects of speaking. However, it also underscores the importance of examining skill-specific patterns of development because the influence of the instructions will not be uniform across speaking subskills. The *Time * Skill* interaction was statistically significant, $F(3, 162) = 6.759$, $p < .001$, partial $\eta^2 = .111$. This showed that improvement over time was not uniform across all speaking subskills, which means that students developed some subskills better than other subskills that some skills responded to the teaching instructions while others did not from pre-test to post-test. Specifically, students performed and developed their fluency, coherence, and lexical resource, but they showed smaller improvement in grammar. This result supports that speaking development is not uneven, but it is skill-specific. Most importantly, Table 4.2 shows a statistically significant three-way interaction among *Time*, *Skill*, and *Group*, $F(3, 162) = 3.115$, $p = .028$, partial $\eta^2 = .055$, indicating that the subskill development differed between the control and experimental groups from the pretest to posttest.

Overall, these results have indicated that the use of neurocognitive strategies as teaching instruction has showed a positive impact on the subskills over time from the initial level to the improvement level, which is the final level of the semester. The experimental group performed better, particularly in fluency and coherence, lexical resource, and grammatical range and accuracy, which have indicated that the



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neurocognitive strategies (activating prior knowledge, chunking and patterning, and dual-coding) have helped students reduce their cognitive load and enhance retrieval efficiency while speaking. The results have demonstrated that neurocognitive strategy-based instruction is more effective in controlling oral performance. By targeting the underlying cognitive mechanisms of speech production, neurocognitive strategies enable students to use their linguistic knowledge more effectively and confidently, which leads to higher-quality speaking performance. This suggests that the neurocognitive strategies were particularly effective for skills that involve planning, organizing ideas, and retrieving vocabulary, which are cognitive processes directly supported by these strategies. While grammar improvements were modest across both groups. This may show that grammar needs more cognitive demands and increases cognitive load because of its heavy reliance on controlled processing and explicit knowledge, which may not be responsive to strategy interventions. Pronunciation was substantial and equivalent for both groups. This may show that pronunciation often improves through using frequent repetition and auditory feedback, and it may need more time to be developed and improved. Taken together, these results have supported that neurocognitive strategies are particularly effective in shaping the development of certain speaking subskills rather than uniformly elevating all aspects of speaking performance.

Conclusion

Depending on the results of the study, the following conclusions are arrived at:

1. Integrating neurocognitive strategies into speaking instruction, which are: activating prior knowledge, chunking and patterning, and dual-coding, have a positive impact on students' speaking performance.
2. The strategies has shown a positive impact on the subskills over time, from the initial level to the improvement level.
2. In the experimental group, the students have developed their fluency, coherence, and lexical resources better than the traditional way of





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teaching, which means the strategies give students a specific advantage in these two subskills.

3. Neurocognitive strategies help students manage their cognitive load, organize ideas, and retrieve vocabulary more effectively during speaking.

4. The neurocognitive strategy-based instruction has helped students to better retrieve grammatical structures during speaking, but also helped students reduce their cognitive load, organize grammatical structures, and monitor their speaking more effectively.

5. Pronunciation improved substantially. Both groups gained the same level of pronunciation after the teaching instructions, which indicates that traditional instruction can be more effective in improving pronunciation skills.

6. The results are supporting the skill-specific growth rather than producing a uniform increase in overall speaking proficiency, in which the strategies help specific speaking subskills instead of overall speaking improvement or development.

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