

The Role of Neuroeducation Strategies on Developing English Spelling Skills for EFL Iraqi Students

Dr. Ahmed Ali Alwan Abbas

alwanahmed198244@gmail.com

Ministry of Education/ General Directorate of
Education in Babylon

Abstract

This study is an attempt to investigate the effectiveness of neuroeducation strategies on developing English spelling skills among students in the first intermediate stage in Iraqi schools. To achieve this, the study employed a quasi-experimental design. A checklist was created to define the essential spelling skills, and its validity was confirmed by a panel of experts in Teaching English as a Foreign Language (EFL). Based on these validated skills, a pre-post test was designed to assess the participants' spelling skills proficiency. Two existing classes from Hammurabi Intermediate School for Boys in Babylon were randomly chosen – one to serve as the experimental group (n = 36 students) and the other as the control group (n = 36 students). The experimental group was taught spelling using neuroeducation strategies, while the control group followed regular spelling instruction. The results revealed that incorporating neuroeducation strategies into daily lessons significantly improved students' spelling performance. The study concluded with valuable recommendations and suggestions to encourage the application of neuroeducation strategies in EFL classrooms.

Key words: Neuroeducation Strategies, Spelling, Spelling Skills.

دور استراتيجيات التعليم العصبي في تنمية مهارات الاملاء باللغة الإنجليزية لدى
الطلاب العراقيين الدارسين للغة الإنجليزية كلغة أجنبية

د. احمد علي علوان عباس

وزارة التربية/ المديرية العامة للتربية في محافظة بابل

المخلص:

تهدف هذه الدراسة إلى استكشاف فاعلية استراتيجيات التعليم العصبي في تنمية مهارات الإملاء باللغة الإنجليزية لدى طلاب مرحلة الاول المتوسط في المدارس العراقية. ولتحقيق ذلك، استخدمت الدراسة تصميماً شبه تجريبي. أُعدت قائمة مرجعية لتحديد مهارات الإملاء الأساسية، و جرى التحقق من صحتها من قبل لجنة من الخبراء في تدريس اللغة الإنجليزية كلغة أجنبية. و بناءً على هذه المهارات التي تم التحقق من صحتها، تم تصميم اختبار قبلي وبعدي لتقييم كفاءة المشاركين في مهارات الإملاء. تم اختيار فصلين دراسيين من مدرسة حمورابي المتوسطة للبنين في بابل عشوائياً - أحدهما ليكون المجموعة التجريبية (ن = ٣٦ طالباً) والآخر ليكون المجموعة الضابطة (ن = ٣٦ طالباً). تلقى طلاب المجموعة التجريبية دروس الاملاء باستخدام استراتيجيات التعليم العصبي، بينما اتبعت المجموعة الضابطة أسلوب التدريس التقليدي للإملاء. كشفت النتائج أن دمج استراتيجيات التعليم العصبي في الدروس اليومية قد حسن بشكل ملحوظ أداء الطلاب في الإملاء. اختتمت الدراسة بتوصيات واقتراحات قيمة لتشجيع تطبيق استراتيجيات التعليم العصبي في فصول اللغة الإنجليزية كلغة أجنبية.

الكلمات المفتاحية: استراتيجيات التعليم العصبي، الاملاء، مهارات الاملاء.

1. Introduction:

English is the language of instruction at many prestigious universities. It broadens mental horizons and enhances critical thinking and global communication skills, positively impacting a student's future academic and professional opportunities. English does not only play a role as a communication tool but can also make it easier for us to adapt to the environment and work in the present and future (Putra & Nopember, 2020). Because it is the primary language in the majority of the world's nations, English is a universal language. Additionally, one of the most crucial languages to study or master is English (Darma & Widiastuty, 2023).

Writing is one of four skills of English that should be mastered well in the school, university, or any other parts of writing needed. Writing is

a complex process that requires various skills. However, the learner can develop his writing abilities by following certain strategies and practicing various patterns (Jayanti, 2019) Besides, writing is a form of communication to deliver though, or to express feeling through written form. Writing in English language is nowadays a very important means of communication all over the world. It is the best way for expressing opinions, ideas, and thoughts. So, all the sub–skills for writing in English should be mastered by EFL learners in order to be able to communicate well in written English. Mostafa (2004) and Rizwan & Farhana (2022) stated that beyond a certain age perhaps the majority of learners' mistakes in written English are with spelling. Spelling instruction is still considered one of the most debated issues of the language. Some of the researchers often argue that formal spelling programs are necessary. In contrast, some teachers have neglected and ignored the formal spelling programs in the belief that spelling is learned best in context of reading and writing.

Spelling has been almost completely ignored in teaching methodology (Al–Jarf, 2011). So, attention should be given to developing spelling skills. Good strategies and activities can help in improving students' spelling skills such those based on neuroeducation.

The importance of teaching spelling in English can be understood through its many benefits, such as improving listening and written communication skills, developing the ability to associate sounds with letters, enhancing visual memory, developing critical thinking, and facilitating learning in all aspects of the language. Spelling instruction is important for the following reasons: (a) Difficulties with text transcription such as handwriting and spelling, can change the message that a writer is trying to convey, (b) Poor spelling can influence perceptions about a learner's competence, (c) Difficulties with spelling can interfere with the execution of other composing processes, and (d) Difficulties with

spelling may affect the vocabulary that student use in their writing. A student who does not know how to spell a word may decide not to use it or may select a word that is easier to spell (Reed, 2012).

Moreover, spelling instruction positively impacts students' phonological awareness, reading comprehension, and word recognition. However, two classroom-based gaps exist: one between research-supported spelling practices and instructor understanding, and another between beliefs regarding effective instruction and its actual implementation. These gaps are due to poor instructor training, content knowledge, and available resources (Tennefoss, 2021).

Neuroeducation is largely viewed and accepted nowadays as modifiable and influenced by knowledge gained from various sources such as the personal experience or other systematic experiences. Neuroimaging advances have thrown light on cognitive skills of human brain which enable social learning and knowledge sharing. Education and experience have a significant influence on brain development, leading to the existence of neuroeducation. This multifaceted field tries to enhance the transmission and assimilation of knowledge by integrating the neural processing (brain-processing) insights educational strategies and methods (Rueda, 2020).

Spelling instruction has been influenced by different learning techniques and the neuroeducation has not been the exception. According to different studies like Weber et. al (2013) and Taylor et. al (2023), the neuroeducation and teaching spelling are two factors that work really well together because the neuroeducation offers an integral way of teaching to the young learners; therefore it allows learners to multiply chances of success, understanding and retaining information.

Knowing how the brain works helps us to know that learning and memory occur over time and involve different individual events, for

example, assisting, coding (learning), and recovering (memory). Modern times necessitate the design of new teaching strategies that align with the brain's learning process (Aguilera et. al, 2018). Moreover, Bolland (2016) asserts that there is a gap between the way of traditional teaching and the way the brain learns, noting that teachers often lack innovation and fail to introduce and create something new in each lesson. Students must experience things that activate them, they want to explore the world that is being taught to them. The education system must be transformed, the students need more personalization.

This study was designed to incorporate neuroeducation to help first intermediate stage school students improve and develop their English spelling and determine the effect of these activities on their scores on the spelling test.

1.1 Problem of the Study:

In spite of the importance of early intervention for improving English language learning performances, mainly English spelling, and the good efforts to develop the English language courses in Iraqi schools, there is an increased percentage of intermediate students English spelling difficulties. The existence of this problem, was emphasized through the following steps:

1. The researcher identified the students' poor performance in English spelling through his personal experience in the educational field. The researcher noticed that students had low performance in English spelling, and that most of EFL teachers do not follow and use the right steps of teaching English spelling to their students.
2. Interviewing some of English inspectors and intermediate English teachers who affirmed the increased percentage of English spelling poor performance and difficulties among intermediate school students in spelling.

3. The researcher also designed a spelling test and administered it to 30 first intermediate stage school students. Results indicated that 21 students did not pass the spelling test.

The problem of this study could be identified in the first intermediate stage school, in Iraq, students' weakness in English spelling skills as they had many difficulties in their English spelling performance. Therefore, neuroeducation strategies will be used in an attempt to develop their spelling skills.

1.2 Questions of the study:

This study sought to find answer to the following questions:

- 1- What are the required spelling skills that should be developed for the first intermediate stage school students in Iraq?
- 2- What is the effect of neuroeducation strategies on developing first intermediate stage school students' English spelling skills?

1.3 Aims of the study:

The present study aimed at:

- Developing first intermediate stage school students' English spelling skills.
- Investigating the effect of neuroeducation strategies on developing first intermediate stage school students' spelling skills.

1.4 Significance of the study:

It is hoped that the present study would:

- Contribute to develop first intermediate stage school students' required English spelling skills.
- Enrich the research libraries with results about the applications of neuroeducation strategies and its effect on developing and improving the English spelling skills.
- Draw intermediate stage teachers' attention to the necessity of using neuroeducation strategies on developing English spelling skills, and try

to use this approach to develop other language skills and subjects in the same stage and other different stages.

1.5 Hypotheses of the study:

1– There is a statically significant difference between the mean scores of the experimental group and the control group students' on the post administration of the spelling test, in favor of the experimental group.

2– There is a statically significant difference between the mean scores of the experimental group students on the pre and post administration of spelling test, in favor of the post administration of the test.

1.6 Delimitations of the study:

The present study is limited to the following:

- A sample of 72 first intermediate stage school students:

The sample was randomly selected from one governmental school (Hammurabi Intermediate School for Boys) in Babylon Governorate, General Directorate of Education in Babylon, Iraq.

- Developing (6) required EFL spelling skills for first intermediate stage school students. These skills are shown in the final form of the spelling skills checklist (See appendix A).

- This study was implemented in the second semester of the academic year 2024–2025.

1.7 Definitions of the terms:

- ***Neuroeducation:***

Neuroeducation is the meeting point of three disciplines: neuroscience, cognitive psychology, and pedagogy. It aims to re-examine learning, teaching, and rehabilitation mechanisms (practices) by exploring the interactions and connections between the mind, brain, and educational science. Related terms include school neuropsychology, educational neuroscience, neuroscience of education, neurodidactics, neuropedagogy, and brain-based learning, all pointing to the accurate designation of how to teach and learn (Saleh & Khine, 2023).

Neuroeducation is a field of study that involves neuroscience, cognitive psychological science, and philosophical perspectives of learning (educational theory). It seeks to further develop ways of teaching (methods of instruction) by incorporating knowledge concerning neural dynamics and brain evolution into the learning environment (Pradeep et. al, 2024).

This study operationally defines neuroeducation strategies as pedagogical approaches that are based on an understanding of how the brain works and grounded in neuroscientific principles aimed at enhancing first-grade intermediate school students' spelling skills, as measured by their scores on an achievement test that includes writing short texts, correcting spelling errors, and applying spelling rules in practice by encouraging active student participation to stimulate desired neural connections in the brain.

– ***Spelling:***

Merriam Webster Dictionary (2015) defined spelling as:

- The act of forming of words from letters.
- The way in which a word is correctly spelled.
- A sequence of letters composing a word.

Puspandari (2017) defined spelling as representing spoken language in written form through letter sequences that create accepted words. It is a multifaceted process involving phonological, morphological, syntactic, and semantic knowledge, visual memory, and the application of orthographic rules.

The spelling in this study is defined as the ability to know how to form the letters of a word in the correct order (i.e., a group of letters representing a word correctly). It involves the sequence of letters that compose a word, according to standardized usage.

2. Review of literature

2.1 Neuroeducation

Neurobiology in education has been recognized since the 20th century with key advancements arising during the (Decade of the Brain) in the 1990's. Despite persisting criticism and arguments concerning the practical implications of neuroscientific results in classroom environments (educational settings), this development has contributed to rapid progress in educational neuroscience. Researchers are actively investigating and reaching the links between the neuroscience and education using a variety of methodologies, including an increasing demand for brain-related teaching in schools (Gkintoni, 2023).

There are some of authors who have contributed to neuroscience, focusing on altered states of consciousness, among them are (Yepes Landinez et al., 2024):

- Cristopher Timmerman explores the neural correlates of conciseness during experiences in his 2023 research published in Trends in Cognitive Sciences.
- Leor Roseman investigates the effects of psilocybin on brain activity and subjective experiences, highlighting neural mechanisms of altered conciseness.
- Robin L. Carhart-Harris examines the therapeutic potential of psychedelics for mental health conditions, emphasizing brain imaging and neural networks in his studies.

These contributions enhance understanding in the field of neuroscience and its relation to conciseness and education.

The boost provided by brain-based studies is a source of inspiration and change for teaching and for teacher training (Gola, 2022). The educational neuroscience, or neuroeducation, is an emerging interdisciplinary field that combines insights from various domains like cognitive science, pedagogy, and psychology to improve

learning and teaching. It points out the connection between brain processes and learning., including the importance of neuroplasticity. Advancement in neuroscience methodologies now allow for detailed tracking of the learner's brain development and the impacts of parenting and learning experiences (Gkintoni, 2023).

The integration of neuroscience into education, known as neuroeducation, has gained significant attention in recent years. By understanding how the brain learns, educators can develop more effective teaching strategies and create better ways to address the diverse needs of students (Teresa et al., 2023).

Neuroeducation has significantly evolved, with early investigations by some authors like Bruer, Gaddes, and Cruickshank exploring the interplay between neuroscience and education. Neuroscience is the scientific study of the nervous system, primarily focusing on brain activity and its relationship to human behaviour (Peregrina Nieves & Gallardo–Montes, 2023).

As mentioned above, neuroeducation refers to the study of learning and memory processes from a neural perspective. It encompasses several disciplines, such as neuroscience and educational neuroscience. It aims to understand how the brain's structure and working mechanisms influence learning processes and to integrate this knowledge to improve learning methods or develop systems that mimic the brain. Neuroeducation explores key concepts such as neuroplasticity, which is the brain's ability to adapt in response to experiences, particularly in early childhood. It also examines memory formation and retrieval to improve educational practices and enhance information retention. Additionally, the field investigates how the educational environment interacts with the brain, proposing methods like chunking lessons and creating stimulating atmospheres to facilitate learning. Neuroeducation is built upon the contributions of each of its

foundational disciplines: neuroscience (studies the biology of the brain and helps explain how neurobiological processes influence learning. It also emphasizes the role of emotions), cognitive psychology (offers essential insights into the mental processes involved in learning), sociology (provides valuable understanding of how social context and interaction impact learning), and pedagogy (translates this knowledge into effective teaching strategies and techniques).

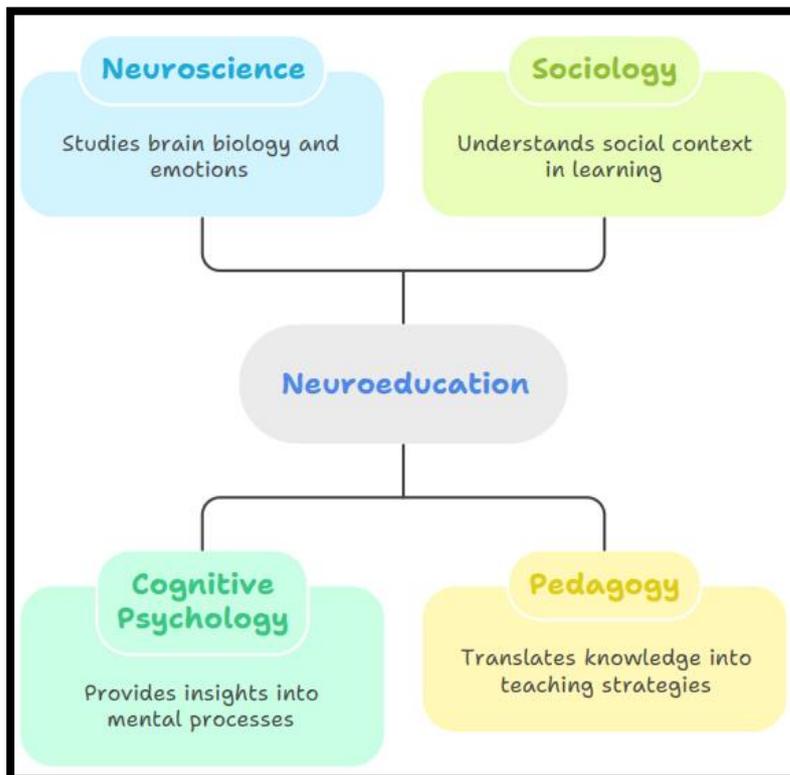


Fig. 1: Exploring Neuroeducation

2.1.1 Key Principles of Neuroeducation

Pappas (2024) and Yepes Landinez et al. (2024) all referred to the main principles of neuroeducation as follows:

1. *Individual characteristics and differences*: It recognizes each learner's cognitive uniqueness and diverse learning needs, aiding educators in tailoring curricula and employing varied learning modalities.

2. *Brain plasticity*: It describes the brain's ability to reshape itself through learning experiences, emphasizing the importance of adaptive

pedagogical practices that promote neurogenesis and enhance memory and data absorption.

3. *Memory systems*: It outlines the processes from formation to consolidation essential to for effective knowledge retention, highlighting the need for repetition, retrieval, and association in learning environments.

4. *Attention and focus*: It suggests neuroeducation techniques to enhance focus, improve memory retention, and make learning participatory by utilizing sensory channels and multimodal instruction.

5. *Emotion and learning*: It explains how emotions affect cognitive processes, supportive environments boost engagement while negative emotion can impede learning.

6. *Metacognition*: It is the awareness of one's cognitive processes, promote active participation in learning through reflection, enhancing critical thinking and problem-solving skills.

7. *Feedback*: It stresses the importance of constructive feedback in guiding metacognitive reflection and supporting learners in achieving their educational goals and fostering a lifelong love for learning.

2.1.2 Importance of Neuroeducation in Education

Neuroeducation or Educational Neuroscience (EN), can help teachers to teach in several ways (Barnes, 2019). These include: improved reading, deliver individualized learning for every student, help teachers move closer to creating learning environments, rather than simply delivering curriculum content, build the learning capacity of each student, so they learn more easily, free teachers' time to teach and add higher value learning opportunities, empower teachers with a new understanding about how students learn, and help students with a range of learning difficulties. Moreover, he mentioned that teaching using neuroeducation is valuable to teachers and students alike because it addresses the diversity of learners. Understanding how the brain works

and how neuroeducation can be used effectively is paramount to improving teaching and learning.

Neuroeducation is a multidisciplinary field which integrates neuroscience with education, emphasizing complex brain processes (neural processes) that underline learning and offering new knowledge and methodologies. By grasping brain plasticity, educators can modify strategies to increase cognitive engagement and improve learning outcomes. (Pradeep et al., 2024).

Many authors and researchers have emphasised the importance of neuroeducation in transforming modern teaching practices. By integrating insights from neuroscience into education, neuroeducation offers a more profound understanding of how students learn, retain, and apply knowledge – leading to more effective, brain-friendly learning environments. Among the advantages of neuroeducation in education are the following:

- Neuronal dynamics play a significant role in educational settings, demonstrating how brain plasticity affects learning strategies and cognitive engagement. Moreover, neuroeducation emphasizes aligning instruction with knowledge processes, utilizing neuroscience insights to develop effective curricula. (Garcia & Thompson, 2022).
- Many techniques that utilise multimodal learning experiences are noted for their ability to deepen understanding and retention of knowledge, suggesting that educational strategies must adapt to optimize these dynamics (Miller & Cohen, 2023).
- Understanding neuronal dynamics allows educators to apply pedagogical approaches that foster collaboration and critical thinking, and optimise learning outcomes (Johnson, 2024).

Moreover, ESL instructors having expertise in neuroscience and psychology can enhance and boost the learning outcomes for language learners by successfully using their research findings in the classroom.

Selecting the best information from an understanding of neuroscience will assist and support ESL instructors in meeting the rapidly changing needs of learners at all levels, handling complicated classroom problems and enhancing their professional growth (Sham, 2019).

According to Indahsari et al. (2025), learners realise the vital role of neuroeducation for developing personalised as well as inclusive learning environments. Neuroeducation has been recognised as an integrative area that presents insights into brain learners' processes and enhances teaching techniques and approaches, particularly in English language teaching.

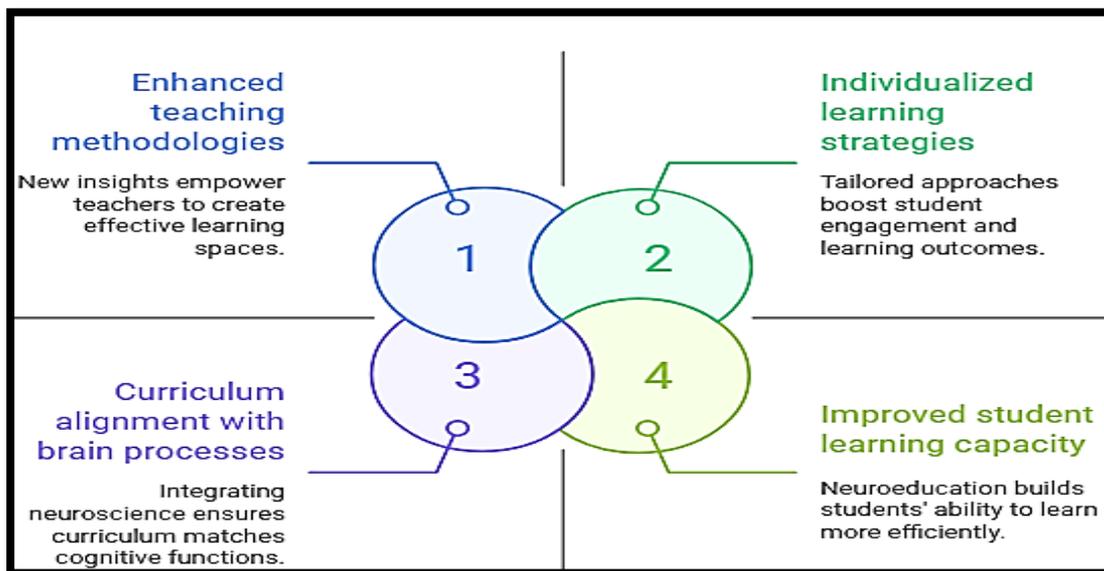


Fig.2: Importance of Neuroeducation in Education

2.1.3 Neuroeducation–Based Strategies

Neuroplasticity helps the brain to create and reorganise neural networks (connections), helping learners in integrating knowledge through engaged instruction (interactive learning activities) such as problem–solving and discussions. Memory aids such as visual tools and storytelling link new ideas to previously acquired knowledge by tapping into the brain's information–processing neural mechanisms (Tokuhama–Espinosa, 2015).

Self–directed and collaborative strategies increase and enhance neural growth (brain development) and independent learning by

encouraging reflective thinking (self-reflection) and goal-setting. Integrating these strategies with brain-centred learning optimises memorisation and performance by relating actions to mental operations. Moreover, real-world examples, movement-orientated activities, and immediate feedback serve as efficient pedagogical strategies that support and reinforce the brain's learning process. The findings and studies of AI and neuroimaging suggest more customised learning that uses cognitive personality traits, opening the pathways for neuroscience-driven strategies that enhance learning outcomes in a variety of contexts (Boon, 2024).

The neuroeducation-based strategies that make use of understanding of brain processes enhance knowledge transmission and assimilation. These strategies encourage and motivate participation, which is necessary for fostering and encouraging critical thinking and inquiry skills. Instructors can encourage active participation by organising and designing activities that attract learners' interests. Project development, collaboration, problem-solving, and game-based learning are numerous instances of effective neuroeducation strategies (Copaja et al., 2025).

In this study, the researcher suggests some neuroeducation-based strategies for developing spelling skills, such as:

1- *Multisensory Encoding and Retrieval*: It activates many brain regions using visual, auditory, and kinaesthetic inputs. Here, the instructors can use the Cover, Copy, Compare (CCC) technique, which involves viewing, saying, writing, and checking words for accuracy. Alshahrani (2019) concluded that CCC, in combination with writing strategies, substantially improves spelling skills in ESL students.

The objective of teaching with this strategy is to engage multiple brain areas and improve spelling by utilising different sensory inputs (visual, auditory, and kinaesthetic).

The Steps of Teaching:

- Present the target word visually (e.g. on the board or on the screen).
- Say the word aloud to the class to foster more auditory involvement.
- The learners cover up the word and try to write and recall it down using memory.
- Determine the original word and then compare it to the written spelling.
- Learners must correct any errors and repeat the process.
- Integrate the CCC technique in spelling activities, such as composing short and simple sentences with the target words.
- As an instance: for the word "careful", learners ought to view, say, write, compare, correct, and employ it in a sentence.

2- Repetition and Spaced Practice: This strategy promotes brain plasticity by utilising distributed and repeated practice, encouraging learners to perform and repeat spelling tasks periodically rather than cramming. The application of this strategy requires weekly introducing and representing spelling words in multiple settings and contexts. Evidence from Martínez García (2024) supports this strategy, noting that repeated exposure along with production enhances and increases spelling skills by expanding brain connections (neural pathways).

The objective of teaching with this strategy is to strengthen neural pathways through repeated exposure.

The Steps of Teaching:

- Introduce a small set of spelling words at the beginning of the week.
- Practise the words daily in various formats (e.g., writing, dictation, and games).
- Revisit the same words in new context (e.g., dialogues or reading passages).
- Schedule weekly reviews of previous word sets to reinforce memory.
- Utilise peer quizzers or flashcards to vary the methods.

- Example:

Week 1 words: necessary, environment, surprise. Practice includes spelling bee, sentence writing, and matching games throughout the week.

3– Emotionally Positive Learning Environments: It seeks to create safe and stimulating classroom environments that decrease stress and encourage memory retention (consolidation of memory). This strategy includes using animated storytelling and gaming tasks to increase enjoyment in learning. Some researchers of neuroeducation indicate that optimistic emotions promote and enhance retention (memory), while negative feelings hinder learning (Gaxiola–Romero et al., 2020).

The objective of teaching with this strategy is to reduce stress and enhance memory retention through enjoyable activities.

The Steps of Teaching:

- Create an attractive classroom atmosphere using constructive and positive reinforcement.
- Incorporate animated stories with target spelling words.
- Insert spelling games (e.g., hangman, team challenges, and word bingo).
- Celebrate progress with small rewards or recognition.
- Encourage support from peers and learning through collaboration.
- Example: a storytelling session with some terms like mystery, adventure, and friendship, followed by a spelling quiz based on the story.

4– Non-Phonological Training Strategy: This strategy emphasises teaching spelling using morphological, orthographic, and lexical content. It incorporates specific instruction on the roots of words, irregular structures, and affixes. Salas (2020) revealed that such strategy can enhance spelling proficiency and accuracy, especially with younger learners.

The objective of teaching with this strategy is to teach spelling skills through word structure, not just sound.

The Steps of Teaching:

- Introduce common prefixes, suffixes, and root words.
- Teach irregular spelling patterns and exceptions.
- Utilise word-building exercises for practising.(e.g., break down the word "unbelievable" into (un + believe + able).
- Supply visual charts or word families for assistance and guidance.
- Practice spelling through morphological analysis and word sorting.
- Example: focus on the root "spect" (inspect, respect, spectator).
Learners identify the root and build new words.

5- Metacognitive Reflection Strategy: This strategy encourages learners to reflect on their spelling errors. This can be performed through spelling diaries and error correction tasks to raise awareness and knowledge. The research of neuroeducation indicates that metacognition serves as essential for fostering self-regulated learning and maintaining long-term retention (Quigley et. al, 2018).

The objective of teaching with this strategy is to develop self-awareness and long-term retention through reflection.

The Steps of Teaching:

- Make use of spelling dairies to write down difficult words and mistakes.
- Motivate learners to reflect on their mistakes in judgment and reasons.
- Perform peer review or group discussion to determine common errors.
- Encourage and allow learners to set their own spelling goals.
- Every week, revisit of dairy entries to assess progression and enhance learning.

- Example: learner writes "I spelled definitely as definately. I confused the vowel sound. I'll remember it has 'finite' inside".



Fig.3: Neuroeducation–Based Strategies for developing spelling skills

2.2 Spelling

In his book, *Understanding and Teaching English Spelling*, Brown defines spelling as a complex system that requires a deep understanding of the history of the English language, its development, the effects of technology, and its current grammar. English spelling, as Brown sees it, is a combination of historical rules and phonetic and visual patterns used to represent words in writing. It depends not only on pronunciation but is also influenced by factors such as the linguistic origin of a word, historical changes, and borrowings from other languages. Brown emphasizes that teaching spelling must be strategic, taking these complexities into account and offering learners practical solutions to overcome its difficulties (Brown, 2018).

Spelling allows specific rules for writing correctly. Across the globe, school systems realize that incorrect spelling utilization is the

main challenge with writing; instructors remedy such deficiencies with different methods, supplies, and tools (Castro et al., 2022). Therefore, spelling is the correct formation of words from individual letters, governed by rules for writing a language using letters, words, and punctuation,, and an essential element of orthography. It is a fundamental skill for accurate written communication, as a single misspelled word can alter sentence meaning. It facilitates difficult clear and effective communication of ideas.

2.2.1 English Spelling Problems for L2 Learners:

Many researchers stated the spelling problems for L2 learners are as follows:

- The problems in sound and spelling of English can be grouped under the following headings: the same letter does not always represent the same sound, the same sound is not always represented by the same letter, some letters are not pronounced at all, ~~we~~ pronounce sounds ~~in~~ in some places where there is no letter, and there are variants of the plural and past tense morpheme: (s/es) /s, z, lz /; (ed) /d, ld, t/ (Umera–Okeke, 2008).
- Homophonous spellings refer to words that sound the same but have different spellings and meanings. Homophonous spellings such as (write / right), (ate / eight), (by / buy), and (cell / sell) are different but a more prevalent spelling problem for ESL students than for native speakers. Moreover, L2 learners whose first languages have alphabetic writing systems characterized by sound–to–letter correspondence, such as Arab learners, may continue to use sound–to–spelling correspondences when they are writing English (Al–Busaidi & Al–Saqqaf, 2015).
- Orthography is a system designed for readers, who know the language, understand sentence, and therefore know the surface structure of sentences. This means that ESL students who have incomplete command of English morphology and syntax might be

expected to have particular difficulty in spelling words of more than one morpheme. This difficulty can be seen, for example, the spelling of “affixed” words as in “ability” rather than “able” (Gahl & Plag, 2019).

– Among various difficulties faced by Arab learners of English, the most common error relates to the spelling of words in documents. learners, due to ineffective learning, continue to repeat the same spelling errors, even after they have completed high school or university or have started in their field of work, which can create obstacles to their progress and development (Altamimi & Rashid, 2019).

– Moreover, common spelling challenges in English are categorized into four types: omission, substitution, insertion, and transposition. Omission challenges occur when morphemes are left out, often due to poor sound perception. Substitution challenges, where letters are swapped, arise from inconsistent vowel pronunciations. Both omission and substitution are linked to "silent letters" that create pronunciation inconsistencies. Insertion challenges, characterized by the addition of extra letters, are frequent among Arab EFL learners and involve misordering letters, as seen in misspelling like "thier" for "their" and "freind" for "friend" (Almaiman, 2024).

In conclusion, English spelling poses significant challenges for L2 learners due to its irregularities and inconsistencies, requiring focused strategies and support to overcome.

2.2.2 Importance of English Spelling:

Regardless of the teaching style or instructional technique, spelling is an extremely important aspect of the school curriculum, especially in language arts (Templeton, 2011). Makszim (2021) believed that learning about spelling can enhance learner’s reading development, especially his/her ability to pronounce words correctly and decode unknown words. In addition, Wau (2022) added that learners need to

know how to spell and write words to communicate their ideas in written language.

Spelling should be an integral part of language instruction for every student. It helps students master the basics of language, especially pupils who may struggle with reading. Moreover, teaching spelling enables a struggling pupil to use different senses and strengths to learn and master the relationship between the sounds and symbols of the language, which is the backbone of reading. Other pupils will be able to understand the patterns of complex language and become master communications (Joshi et al, 2009).

In his book “why teach spelling, Reed (2012) explained that spelling is a tool for writing. The purpose of learning to spell is so that writing may become easier, more fluent, more expressive, and more easily read and understood by others.

Spelling is considered an essential component of written language. The potential mistakes in written spellings may change the meaning and understanding of written material and would make it unclear. Hence, it is essential to use the correct spelling of words in order to convey the exact intended meaning of the content (Altamimi & Rashid, 2019).

2.2.3 English Spelling Instruction

Acquiring literacy includes learning to produce the precise orthographic representation of spoken words, namely spelling. Spelling is a complex skill that involves children’s developing knowledge of phonology, orthography, and morphology. The difficulty and trajectory of spelling acquisition varies across writing systems, depending on factors such as orthographic consistency (Myeli, 2024). In 1965, some of the researchers said that English spelling is just a chaotic concoction of oddities without order and cohesion. These judgments may become more convincing when we know that over 60% of the words in English are not spelled consistently. Moreover, in English, words generally have

accepted standard spelling which can vary regionally or nationally. In the sense of standard, spelling is one of the elements of orthography and a prescriptive element of alphabetic languages. So, spelling instruction is a very important issue of the high school curriculum, regardless of how teachers implement its instruction in the classroom.

Spelling instruction has been in the primary curriculum since 1783, when Noah Webster introduced the first Blue-Backed Speller. This type of text, along with other such as the McGuffey Reader, taught pronunciation and grammar as well as spelling. These spelling texts included pronunciation and grammar because spelling was integrated into the language arts instruction (DiObilda& Petrillo, 2020). These spellers contain word lists for all of the students to memorize for weekly assessments and they are to be studied as a rote memorization task. Rote memorization was used as the study technique because it was assumed that the English language was too irregular to teach and would be best achieved through memorization–this technique led to the emphasis of teaching students to develop a memory for the spelling of words (Logvinenko, 2018).

Research came up with three main spelling perspectives that originate from diverse philosophical and research foundations that appear to parallel particular spelling practices: (a) traditional, (b) transitional, and (c) student oriented. In traditional paradigm, instructors are mainly givers of information: they determine what is taught while students are considered “empty vessels,” passively learning through imitation, memorization, and rote learning. Evaluation emphasizes formal procedures–end of week and unit testing as well as standardized tests. Instructors in the transactional paradigm integrate both direct and interactive instruction. Direct teaching is used for introducing word lists, word patterns, and spelling rules, while interactive strategies are employed when students use word sorts and play spelling games.

Compared with the traditional paradigm, students are more involved in their own learning and are seen less as empty vessels (Reed, 2012).

2.2.4 The Principles of English Spelling Instruction:

Paynter (2013) mentioned some principles that should be used to guide spelling instruction. These principles are as follows:

- Spelling should be viewed as a developmental process, for spelling ability develops over time and progresses through very predictable stage. Thus, learning to spell is best facilitated by structuring a learning environment where learners are allowed and encouraged to use invented spellings and are guided in their progression.
- Formal spelling instruction should not occur until students are developmentally ready.
- Writing should be the primary vehicle for building spelling skills.
- Spelling should be taught in relationship to word meaning. Thus, children should be taught to spell words as they learn their meanings.
- Spelling instruction should involve student choice, for choice is essential to the learning process. With guidance from the teacher, students should be allowed to master words they will use in their writing or encounter in their writing.

Melville (2024) lists five key principles of English spelling instruction:

- *Phoneme-grapheme correspondences*: Understanding alphabetic principle is necessary for spelling, as learners need to recognize in order to understand their corresponding graphemes.
- *Sound patterns*: Sound patterns require that different graphemes may represent the same morpheme, depending on its position inside a word (e.g., ‘ay’ is most commonly used at the end of base words but not in the middle or at the beginning) and neighbouring phonemes (the phonemes that come before or after a particular phoneme; e.g., ‘ck’ is used after a short vowel sound).

– *Letter combinations*: Certain spelling conventions exist outside phoneme positioning, including rules for consonant digraphs (e.g., consonant digraphs such as ‘sh’, ‘ch’ and ‘ng’ represent a single phoneme and are not doubled; ‘v’, ‘j’ and ‘q’ never appear at the end of words) and the multifunctionality of the ending letter ‘e’ (e.g., changes a short vowel into a long vowel hop–hope, changes the ‘g’ from /g/ into /j/ and the ‘c’ from /k/ into /s/, added to words ending in ‘s’ when it doesn’t occur after a short vowel so it doesn’t appear as the plural, etc.).

– *Etymology*: Knowledge of the historical influences on English spelling, originating from various languages, helps explain spelling patterns and enriches students' interest.

– *Morphology*: The morphemes also influence spelling, and proper spelling requires an understanding of prefixes, suffixes, and their different forms.

In short, effective English spelling instruction relies on clear principles that build phonemic awareness, pattern recognition, and consistent practice.

2.2.5 Neuroeducation and Teaching English Spelling

Spelling instruction in schools typically focuses on having learners memorize word lists for tests, often based on themes or common usage rather than spelling patterns. While techniques like visualization and writing help in memorization, they do not effectively teach learners the underlying principles of writing system (Treiman, 2018).

A good understanding of English spelling is crucial for the learners, as clarity in writing depends on accuracy in spelling. Because 21st-century learning involves communication in the form of writing, it is necessary to write sentences with correct spelling. Spelling mastery is an essential foundation for learning other English language skills. Hence, teachers need to closely guide the learners to build their spelling

repertoire and, in doing so, the instructors need to successfully link the new information to the students' cognitive framework (Yen & Mohamad, 2021). Teaching and learning to spell forms the basis for mastering English Language (Yen et al., 2022). They asserted the importance of writing sentences with correct spelling because communication through writing is emphasised in 21st-century teaching and learning. The typical way the instructors implement spelling into the classroom is through an approach that follows closely with a spelling textbook or series. This approach may also include doing activities such as: word sorts, writing words in sentences, word games (i.e. hangman or word searches), memorization of words, and putting words in alphabetical order. All of these spelling activities typically used in classrooms focus on the linguistic, logical-mathematical, and intrapersonal intelligences in the brain. Although these activities are beneficial for most students, some students may not have strengths in using these three intelligences. Students who have strength in these multiple intelligence areas are able to succeed without much difficulty, while other students need to draw on their own strengths to master spelling. To teach all students in the area of spelling, educators should incorporate a range of activities in all the multiple intelligence areas.

By combining teaching strategies with how the brain processes language, neuroeducation improves English spelling instruction and increases literacy and retention. Recent research demonstrates its role in activating visual and cognitive pathways required for mastering and learning spelling. The integrative discipline of neuroeducation, which combines psychology, neurology, and education, offers new perspectives on how learners master spelling (Gentry & Ouellette, 2025). Spelling is a cognitive process which requires memory, recognition of sounds, and visual representations rather than being merely a mechanical task. Spelling works as a visual code that maps

spoken language to written form, stimulating brain areas that are responsible for higher-level thought and reading. Instructors can produce and develop spelling lessons that leverage neuroplasticity – such as by using different methods and spaced repetition – to show how the brain records and retrieves spelling patterns (Gentry, 2025).

Recent studies evidence also highlights the crucial role of personalized and emotional stimulating learning settings in spelling teaching. In the line with Peña and Quesada's (2025) comprehensive study, implementing neuroeducational principles into English language learning, which include mental load management as well as attention, significantly enhances spelling mastery, especially among young EFL learners. These techniques help learners understand spelling guidelines and rules easier by aligning lessons to the brain's instinctive learning rhythms. As neuroeducation evolves and expands, its incorporation in teaching spelling offers to render knowledge of English easier to acquire, engaging, and neurologically appropriate.

Applying principles of educational neuroscience, such as personalized learning and emotional stimulation, can improve English language learning outcomes, with a focus on spelling and phonics comprehension. These neuro-educational principles contribute to purposeful learning by managing cognitive load and stimulating attention, making spelling learning more effective, particularly for learners of English as a foreign language.

Neuroeducation provides reinforcement to the concept of embodied mental activity, which argues that brain functions and cognitive processes are fundamentally connected with the body's interactions with the environment. There are some activities that actively use manipulative or creative body movements in remembering specific word orders and consonant-vowel patterns. The activities mainly focus on the bodily-kinaesthetic interactions. Some of these activities include (a)

spelling a word out loud while bouncing a ball or jumping rope, activating neural networks (motor systems), and strengthening brain's pathways that pertain to memory and language. (b) spelling a word using alphabet blocks or plastic materials, and (c) spelling a word out loud while standing up whenever a consonant appears and whenever a vowel appears. Many students discover strength in these activities because they are actively involved in spelling the words (Castro–Alonso et al., 2024). Thus, physical interaction, such as gestures and hand use, enhances learning by activating multiple brain regions, supporting the concept of embodied learning.

Neuroeducation recognizes that visual processing is a significant cognitive resource for retaining information, recognition of patterns, and language learning. Learning visual patterns in words is important for spelling success. Students may learn how to spell words using a visual approach without having to touch or feel them at the same time. Thus, some words can be easy for students to recognize their shape; for example, the word “monkey” has a tail (i.e., “y”) at the end, and the word “look” has two eyes (i.e., “oo”) in the middle looking at the reader. Activities involving the visual processing are helpful for those students. Some of these activities: (a) turning letters and words into pictures (i.e., an “s” can be a snake) to remember some aspect of its meaning, (b) using a coloured–word approach (each phoneme in the English language is given a particular colour), (c) using coloured backgrounds when writing words on paper, and (d) creating a doodle diary with pictures or images for each spelling word. Visual images allow students to remember words without having to strictly memorize (Williamson et al., 2025).

Neurotechnology is used to understand how the brain processes visual information and proposes image– and pattern–based learning strategies to enhance learning. Moreover, the visual processing is a

fundamental cognitive resource in learning, and the importance of using visual images and patterns in strengthening memory and language is emphasized, supporting strategies such as converting words into pictures or using colors in spelling.

Neuroeducation highlights that music and language share overlapping neural processes, particularly with regard to areas associated with memory, rhythm, and auditory processing. Music is a fun and beneficial way for learners to learn sounds and words. Ludke (2019) stated that students will begin to show interest in letter sounds and the flow of the words when instructors approach words with rhythm and melody. Moreover, Wu et al. (2023) and Ahokas et al. (2025) stated that words and music do have important connections in the brain that can facilitate the processing of language and literacy activities. Some activities that can help instructors with spelling include (a) creating a song from the week's spelling list, (b) spelling words rhythmically to background music or to percussion instrument sounds created by the class, and (c) using tongue twisters, poems, or chants to reinforce phonemes.

Based on the foregoing and from the researcher's point of view, music activates multiple brain regions, such as the auditory cortex, Broca's area, and Wernicke's area, enhancing language learning and long-term memory. This suggests activities like spelling songs and educational chants. Music influences cognitive functions, stimulating attention, memory, and emotional regulation, making it an effective educational tool, particularly in language learning. Furthermore, the relationship between music and language from cognitive psychology and neuroscience perspectives confirms that rhythm, intonation, and melody play a crucial role in the development of language, memory, and attention, thus supporting the use of musical activities in spelling instruction.

To enhance memory, neuroeducation provides multisensory, cognitively arousing ways to learn spelling. Learners will be able to generate a wide variety of associations with nature (i.e., animals, plants, and nonliving things), which will help them in remembering their spelling words. Some spelling activities that put emphasis on nature include (a) walking outside the school building to create words or sounds found in nature, (b) observing nature to find things that form the letters of the week's spelling words and drawing them on paper (i.e., tree branches and clouds), and (c) using natural things to create spelling words (i.e., sticks, leaves, and rocks). Besides stimulating imaginative thinking, these nature-integrated activities reinforce neuroeducational ideas that promote effective learning and engagement (Pradeep et al., 2024). To conclude, Learning based on sensory and cognitive interaction, such as using elements from nature, enhances brain dynamics and increases learning effectiveness. Furthermore, integrating nature into spelling activities not only strengthens memory and attention but also creates a stimulating, multi-sensory learning environment that aligns with the principles of educational neuroscience.

Neuroeducation emphasizes that the brain is a social organ, and learning is deeply influenced by interpersonal interactions. Learners are more likely to develop literacy skills through close friendships than through distant relationships. Although many brain spelling activities are completed individually, there is much to be learnt from peers during social interaction. Some ways to make spelling a social event include (a) giving each student a letter from a spelling word (mix them up) and having the class arrange themselves in the correct order to make the spelling words, (b) forming letters of the alphabet with groups of students (i.e., three students lie on the ground to make an "A"), and (c) giving each student a phoneme, then signalling the students to walk around the room and find all the other students that form a spelling

word. Thus, learners will master their spelling words if they incorporate them into their social world. By incorporating spelling instruction in socially interactive settings, instructors are making learning enjoyable and in line with how the brain learns best. By using the above activities, spelling can become an entertaining, brain-friendly activity rather than a rote task.

Spelling is a vital writing skill for effective communication and decoding, particularly for learners with literacy and phonological-processing problems. To effectively teach spelling, instructors must initially understand English language structure.

2.2.6 Evaluation of English Spelling

The evaluation of English spelling represents a vital aspect of acquiring a language, specifically for learners of English as a second or a foreign language. Considering variances and the complex nature of English orthography, evaluating English spelling skills needs multiple strategies which take into consideration phonological knowledge, morphological awareness, and orthographic patterns.

Evaluation of spelling is both formal and informal. Since formal spellers are frequently used in this paradigm, evaluation includes results from weekly and end-of-unit tests whereas less formal strategies include monitoring spelling competence in word sorting (Joshi & Carreker, 2012). McNeill & Kirk (2014) and Daffern, & Critten (2019) stated that the instructor's role changes dramatically from predominantly giving information to facilitating learning based on developmental levels and individual student need. Rather than emphasizing correctness in all spelling, teachers understand that initial spelling attempts improve with increased language experiences, good modelling, and teacher guidance. Moreover, the methods of monitoring and evaluating student development change too. Rather than measuring weekly test scores and tracking spelling errors in writing, spelling is evaluated over time as

students integrate numerous spelling strategies into their repertoire and spelling effort moves toward conventionally.

Nowadays, evaluating English spelling is not tied to rote retention or conventional examinations. Modern research concentrates on diagnostic (to identify individual students' areas of strength and need with a degree of precision), formative (to monitor growth/progress and provide timely feedback to students), and summative approaches (to measure student outcomes in spelling and evaluate the efficacy of teaching programmes), which offer deeper understanding of learners' abilities. These approaches encourage and support more tailored and effective learning, especially throughout multilingual and EFL contexts (Kahn–Horwitz & Goldstein, 2024).

Accordingly, it is unlikely that each spelling programme corresponds entirely to one theoretical perspective, as the evidence shows that educators utilise strategies from each of the three perspectives. Nevertheless, those perspectives were offered as a means of analysis to point out essential differences and similarities, therefore encouraging an expanded comprehension of spelling teaching strategies at the intermediate grade level.

3. Method and Procedure

3.1 Participants of the Study:

The participants in the present study comprised seventy-two (72) first intermediate stage school students chosen from Hammurabi Intermediate School for Boys in Babylon Governorate, Iraq. They were divided into an experimental group (n=36) and a control group (n=36). The experimental group was taught through the proposed activities by the researcher during the second semester of the academic year 2024–2025, whereas the control group followed the regular instruction.

3.2 The EFL Spelling Skills Checklist (SSC):

Before designing the instrument of the study, i.e., the pre–post test of the required spelling skills, the required spelling skills should have been determined. So, the researcher of the study had set the EFL Spelling Skills Checklist (SSC) for required skills in its initial form.

3.2.1 Aim of the EFL Spelling Checklist:

The EFL Spelling Skills Checklist (SSC), prepared by the researcher of the present study, aimed to identify EFL spelling skills required for first intermediate stage school students.

3.2.2 Sources of the EFL Spelling Checklist:

The spelling skills that consisted of the checklist were determined through reviewing:

- The Terry O'Neill and Peter Snow (2024) *English for Iraq* teacher's guide as well as the student's book and activity book.
- Previous literature and related studies to developing EFL spelling skills such as Al-Jarf (2011), Reed (2012), Gagen (2013), Alshahrani (2019), Tennefoss (2021), Makszim (2021), Castro & Castro (2022), and Taylor et al. (2023).
- The Ministry of Iraqi Education Directives for teaching English in secondary schools. The objectives to be fulfilled by the students in those directives were as follows:
 - a) Learning the standard pronunciations for frequently misspelt words.
 - b) Developing a phonemic awareness and understanding the phonemic nature of spelling.
 - c) Promoting students' recognition and use of spelling patterns.
 - d) Using accurate spelling and correct punctuation and capitalization.
 - e) Using new vocabulary correctly in English.

3.2.3 Content of the Checklist:

The initial form of the Spelling Skills Checklist (SSC) consisted of (12) skills. These skills had to be rated by a panel of five jury members

on a rating scale containing three levels: “very necessary”, “necessary” or “not necessary”. Each level of necessity was given an estimated value to be scored by the researcher (i.e., very necessary = 3, necessary = 2, and not necessary = 1) for first intermediate stage school students.

3.2.4 Validity of the EFL Spelling Skills Checklist (SSC):

The checklist was submitted to a panel of five jury members specialized in the field of curriculum and instruction (EFL). They suggested the following:

- Rephrasing the skill of “establish new ways to learn and spell new vocabulary” to “produce and write new vocabulary correctly”.
- Modifying the skills of “find the spelling and punctuation mistakes” and “underline the incorrect words” to “identify the misspelt words”.
- Omitting the skills of “learn the phonemic code” and “create their own difficult-to-spell lists”.

Taking the valuable remarks of the jury members into consideration, the checklist was modified and finalized. The final form of the Spelling Skills Checklist (SSC) is shown in the following table:

Table (1): The Final Form of the Required Spelling Skills Checklist

| No | EFL Spelling Skills |
|----|---------------------------------------------------|
| 1 | Memorize specific and tricky spelling. |
| 2 | Identify and use the rules of spelling correctly. |
| 3 | Identify the misspelt words. |
| 4 | Rearrange the anagrams. |
| 5 | Produce and write new vocabulary correctly. |
| 6 | Master the spelling of troublesome words. |

This final form of the checklist is also shown in appendix (A). Thus, the first question of the study, about the required spelling skills, was answered.

3.3 The Pre-post spelling Test:

Having arrived at the required spelling skills, the researcher could design the pre–post test shown in Appendix (B).

3.3.1 Aim of the Test

The test aims at measuring the progress of the control group and that of the experimental group in spelling skills. Being used as a pretest, it aims at showing that both groups are equivalent in terms of English language spelling. Then being used as a posttest, it aims at identifying any possible progress and difference in the achievement of both groups in spelling.

The final version of the pre–post test consisted of five questions. Each contained 5 items. The twenty–five items required the students either to identify the correct spelling of a word or to write the correct spelling of another. All words included in the pre–post test were taken from the student’s English book, *English for Iraq*, which was previously taught in the first term. The final score of the test was set at 25 marks, with each question allocated 5 marks.

For establishing the validity of the pre–post test, a group of five jury members was consulted. Very light changes were made according to what the jury members suggested, but all the members agreed upon the validity of the test in the final form shown in Appendix (B). As for the reliability of the test, the researcher administered it to a sample of 35 first intermediate stage school students who differed from those of the participants of the present study. Then, he administered it to them again after two weeks. The rates of the reliability it got was high (0.884). So, it was reliable, as it was valid, and this indicates that the test was suitable for conducting such a study.

3.4 The Proposed Activities

3.4.1 The Aim of Activities: The main aim of the proposed activities was developing first intermediate–stage school students' English spelling skills. (i.e., to enable students to write and spell the words correctly).

The researcher proposes well-defined criteria for creating and producing some activities that can develop English spelling skills for first intermediate-stage students, in keeping with neuroeducation concepts. The activities were taught three times a week in a 45-minute period for two months. Activities were chosen or developed according to the following criteria:

- Consistency with the goals of the Ministry of Education in Iraq for English in secondary schools.
- Suitability to the age of the target population (first intermediate stage).
- Relevancy of the suggested activities to neuroeducation as follows:
 - *Multisensory Integration Activities:* Activities should utilise different senses, including visual, auditory, kinaesthetic, and touch, to create brain pathways and connections. The instructors can use letter tiles to spell, air-write, clap rhythmically, or sketch words in sand.
 - *Emotionally Captivating and Inspiring Activities:* Activities should provoke positive thoughts and emotions to strengthen attention and recall (memory and focus) by using narratives (storytelling), role-playing, or spelling games that make connections to students' passions or actual-life situations.
 - *Spelling Pattern and Word Identification Activities:* Activities should aim to assist learners recognizing and absorbing phonics rules, morphemes, and spelling patterns. The instructors can utilise word-root puzzles, word classification, or rule-driven spelling assignments.
 - *Scheduled Repetition and Retrieving Instruction Activities:* Activities should be constructed to review spelling content over time and improve memory consolidation by using visual aids (flashcards), aggregate spelling bees, and regular review games.
 - *Brain Load Management Activities:* Activities need to be organized and structured with regard to students' growth stage and their ability to

recall information. For example, begin with frequently used words and then gradually introduce irregular or sophisticated spellings in easy to-understand chunks.

- *Correctional-tolerant and Reflective Educational Activities:* Activities should encourage acceptable error-making and promote metacognitive thinking by using peer correction games, spelling newspapers, and "pick out the mistake" activities.
- *Collaborative and Interactive Activities:* The activities need to encourage discussion, sharing of knowledge, and peer interaction. The instructor can plan spelling competitions, use team word-formation activities, and use cooperative story writing.

4. Results

After ensuring the homogeneity of the two groups in all the variables before the experiment, the third researcher started the experiment and ended it with the post-administration of the spelling test. Statistical analyses of the test were done to arrive at the results of the study. In the following section, a discussion of the hypotheses is provided in order to investigate the results of the study.

– The First Hypothesis:

The independent samples t-test was conducted to test the hypothesis by comparing the mean scores of the two groups after the test was administered, as shown in the table (2).

Table (2): t-Test of the Difference Between the Mean Scores of the Experimental Group and the Control Group Students on the Post-administration of the Spelling Test.

| Test | Group | N | Mean | Std Deviation | Df | t | Sig.level | 2 η | In favor of | Effect size |
|------|--------------|----|-------|---------------|----|--------|-----------|----------|-------------|-------------|
| Post | Control | 36 | 11.11 | 3.59 | 70 | 12.801 | 0.01 | 0.08 | Exp. | large |
| | Experimental | 36 | 23.22 | 4.38 | | | | | | |

T-tabled value at (70) df. at (0.01) sig. level equals (2.390)

The results in the table (2) indicate the following:

The above table shows that there is a statistically significant difference at the 0.01 level between the mean scores of the experimental group (23.22) with a standard deviation of (4.38) and the mean scores of the control group (11.11) with a standard deviation of (3.59) on the post-administration of the test in spelling skills in favour of the experimental group, as indicated by the t-value (12.801), which is higher than the t-tabled value (2.390) with a degree of freedom of (70).

Eta square “ 2η ” of the spelling skills test was (0.8), which means that (80%) of the relative extent of change in level of spelling skills (the dependent variable) is attributed to the use of neuroeducation (the independent variable), and it shows that the effect size of the independent variable was large.

Thus, it can be safely said that t-test results were consistent with the hypothesis. Therefore, the first hypothesis was verified.

This indicated significant development in the level of spelling skills of the experimental group students who were taught using the neuroeducation strategies over the control group students who were taught using the regular way of instruction. This means that the neuroeducation strategies were beneficial and had a large effect on developing EFL spelling skills of the students.

The Second Hypothesis

To test this hypothesis, a paired-sample t-test was used to test the second hypothesis, i.e., to investigate the difference between the students’ mean scores on the spelling skills of pre- and post-administrations of the test.

Table (3): t-Test Results of the Experimental Group Pre- and Post-administrations Mean Scores on the Spelling Skills Test.

| Group | Test | N | Mean | Std. Deviation | Df | T | Sig. level | 2η | Effect size |
|--------------|------|----|-------|----------------|----|--------|------------|---------|-------------|
| Experimental | pre | 36 | 10.67 | 4.032 | 35 | 13.345 | 0.01 | 0.84 | large |
| | post | 36 | 23.22 | 4.389 | | | | | |

T-tabled value at (35) df. at (0.01) sig. level equals (2.457)

The results in the table (3) indicate the following:

Table (3) shows that there is a statistically significant difference at the 0.01 level between the mean scores of the pre-administration of the test (10.67) with standard deviation (4.032) and the post-test (23.22) with standard deviation (4.389) of the experimental group in spelling skills in favour of the post-administration. Moreover, the estimated “t” value between the mean scores of the experimental group pre- and post-administrations in the spelling skills test was (13.345), which was higher than t-tabled value (2.457) with (35) degree of freedom, and so the difference was significant at the level of (0.01).

Eta square “ 2η ” of the spelling skills test was (0.84), which means that (84%) of the relative extent of change in level of spelling skills (the dependent variable) is attributed to the use of the neuroeducation (the independent variable), and it showed that the effect size of the independent variable was large.

Thus, it can be safely said that t-test results were consistent with the second hypothesis. Therefore, the second hypothesis was verified.

The findings in table (3) showed that the “t” estimated value was higher than the t-tabled value (2.457) in the post-administration of the spelling test. This means that there was significant difference at the level of (0.01) between the pre- and the post-administrations mean scores of the experimental group. That means that the neuroeducation strategies were able to develop the students’ spelling skills.

In addition, the effect size of the neuroeducation strategies was counted (0.84), which was large. So, the activities had a large effect size on developing the spelling skills. Thus, the second question was answered.

4.1 Discussion of the Results

Comparing both the control and the experimental group students' mean scores on the post-administration of the English language spelling test, the estimated "*t*" value (12.801) was highly significant at the (0.01) level. Moreover, the calculated effect size of the proposed program on the experimental group students' overall spelling performance was about (0.84) in table (3). Therefore, it can be inferred that the neuroeducation had a large effect on the experimental group students' overall spelling performance on the posttest. Also, when compared to that of the control group students' performance who received regular instruction, the effect on the experimental group's performance was large (0.80) in spite of their being of the same level on pre-administration of the same test before the experiment.

When comparing both the experimental group students' mean scores on the pre- and post-administrations of the spelling test, the estimated "*t*" value (13.345) was significant at the level of (0.01). This indicates that the gain in their English spelling in favour of the post-administration of the test is due to the neuroeducation strategies.

These results are in accordance with results of studies of Mustafa (2004), Aguilera (2018), and Taylor (2023), as they all attest to the importance of using different approaches and theories such as neuroeducation, on developing and improving English language spelling.

Finally, some factors might have helped in developing learners' spelling skills and arriving at these positive results such as:

1. Using activities based on neuroeducation.
2. Using group work and pair work (cooperation rather than competition) among learners. Learners were permitted to participate in the discussions freely without being shy, which aided greatly in improving their spelling skills. Through group or pair work, learners were motivated and enthusiastic to go on with this.

3. Ensuring a friendly, free, and interactive environment during the proposed spelling activities helped students become relaxed and more motivated to participate in them.

4. Activating the learners and helping them practise all the sub–skills.

5. Using authentic materials that attract learners' attention motivated them to continue their tasks willingly.

4.2 Conclusions:

Based on the study's findings, the following conclusions can be drawn:

- Mastering English spelling remains a tough hurdle for intermediate–stage school learners, but with consistent practice and effective learning strategies such as neuroeducation, progress is absolutely achievable. This study has shown that neuroeducation strategies can substantially enhance spelling skills among EFL Iraqi learners. Educators may encourage deeper participation and superior language acquisition by integrating instructional strategies with the way the brain normally processes and retains information.
- The findings underline the significance of implementing brain–based strategies into language instruction. The instructors are advised to employ multisensory and neurologically stimulating strategies that can assist learners to develop spelling skills in a more comprehensive and brain–compatible ways.
- Clear principles in English spelling instruction offer a structured approach that enhances phonemic awareness, pattern recognition, and error reduction. This clarity fosters learners' confidence and supports long–time retention of accurate spelling.
- Bringing together neurology and instruction gives and opens a prospective pathway forward for eliminating enduring issues in teaching English as a foreign language. Comprehending how the human brain thinks and works best helps educators teach learners not merely to spell

correctly but additionally to become more confident and independent language learners.

4.3 Recommendations

Based on the results and conclusions of this study, the following recommendations are suggested:

– Instructors need to be trained to know about neuroeducation and how they make use of it in their teaching. They should implement neuroscience-based principles such as spaced repetition, auditory-visual comprehension, and emotive significance in spelling teaching to enhance learning outcomes.

– New techniques and activities for enhancing English spelling should be explored and exploited. Instructors can implement the following suggested techniques to instruct learners on homophones:

a) *Revisit, Explain, Use Technique* (REU): The plan requires the instructor to prompt learners to explain their prior knowledge of homophones, emphasizing that homophones are words with identical pronunciation but different spelling and meaning, for example, presenting frequently confused homophones such as *their/there* and *your/you're*. Here, learners are encouraged to share mnemonic devices they recall from previous years to support accurate spelling.

b) *Instruct, Model, Define Technique* (IMD): The instructor focuses on teaching homophone pairs through explicit modelling and clear definition. He introduces learners to select homophone pairs in which one word functions as a verb, such as *passed/past*, *allowed/aloud*, and *guessed/guest*. The learners should be encouraged to identify the verb in each pair, noting morphological cues such as the "-ed" suffix. The instructors can provide explicit instruction on distinguishing between verb-noun pairs, including *advice/advise*, *practice/practise*, and *licence/license*. He can also clarify the orthographic convention whereby nouns typically end in "-ce" and verbs in "-se". Additionally, contrast

affect (commonly a verb, e.g., *affect*, *affected*) with effect (primarily a noun, e.g., *effect*, *effective*) to reinforce grammatical and semantic distinctions.

c) *Practice, Explore, Investigate Technique* (PEI): The technique describes an educational game designed for learners to practise homophone pairs. Learners are instructed to copy a word grid onto individual cards, which are then placed face down on the table. Learners take turns flipping two cards; if a homophone pair is revealed, the learner may keep the pair only if they can accurately explain the difference in meaning between the two words. At the end of the game, the winner reads aloud their collected pairs, identifies whether each word is a noun or a verb (or uses it in a sentence), and challenges other learners in the group to write the correct spelling of each word.

4.4 Suggestions for Further Research

In the light of the findings of the present study, the following studies are suggested:

- The effect of neuroeducation on developing speaking skills for secondary–stage school students.
- While the study presents valuable information, it is constrained by its sample size and spatial scope. Further research might look to the cumulative effects of neuroeducation strategies across different age groups and linguistic settings to verify and build on the above results.
- The effectiveness of using neuroeducation strategies in teaching EFL on the achievement of secondary–stage school students

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Appendix (A)

The Initial Form of the Spelling Skills Checklist (SSC)

| NO | EFL Spelling Skills |
|----|-------------------------------------------------------------------------------------------|
| 1 | Learn the phonemic code. |
| 2 | Establish new ways to learn and spell new vocabulary. |
| 3 | Find the spelling and punctuation mistakes. |
| 4 | Underline the incorrect words. |
| 5 | Create their own difficult-to-spell lists. |
| 6 | Unscramble a group of words to build a sentence. |
| 7 | Memorize specific and tricky spelling. |
| 8 | Re-write the words in a sentence. |
| 9 | Master the spelling of troublesome words. |
| 10 | Identify and use the rules of spelling correctly. |
| 11 | Re-arrange the anagrams. |
| 12 | Identify the correct homophones or words that sound the same but have different meanings. |

The Final Form of the Spelling Skills Checklist (SSC)

| No | EFL Spelling Skills |
|----|---------------------------------------------------|
| 1 | Memorize specific and tricky spelling. |
| 2 | Identify and use the rules of spelling correctly. |
| 3 | Identify the misspelt words. |
| 4 | Rearrange the anagrams. |
| 5 | Produce and write new vocabulary correctly. |
| 6 | Master the spelling of troublesome words. |

Appendix (B)**A Pre–posttest on Spelling for First Intermediate–Stage Students**

Name:

Time: 45 Min

Class:

Q1/ Write a suitable word that begins with the letter provided: (5 Marks)

- 1- Open the **w**....., please.
- 2- I've filled the bath with very hot **w**..... .
- 3- We are **h**..... . My mam has made sandwiches.
- 4- Sami was flying his small **p**..... .
- 5- I'm **th**..... because it's hot.

Q2/ Fill the gaps with a word to replace the picture provided: (5 Marks)

1- I hope to visit a cold, snowy country one day. I want to make a



.....



2- I don't like, but I like peas.



3- My father is very tall and he has



4- Don't leave in the car.



5- He was driving his car high up in the

.

Q3/ Write the correct spelling for the following picture: (5 Marks)



1- sthityr..... .



2- shseaells..... .



3- easwter..... .



4- oheliecptr..... .



5- abmnaulce..... .

Q4/ Find five words from the letters of the Boggle: (5 Marks)

a t o m b
o s i p a
w e t o n
e a g l e

.....
.....

Q5/ Circle the correct spelling: (5 Marks)

- 1- hglau gaulh laugh aulgh
- 2- weather therwea waethre wtheaer
- 3- borow borrow boorw bowror
- 4- fresot fsoret froste forest
- 5- Photo pohto tphoo hpoo