English Language Teaching; Vol. 17, No. 9; 2024
ISSN 1916-4742 E-ISSN 1916-4750
Published by Canadian Center of Science and Education

Dissecting Neuromyths – Bridging the Gap between Education and Neuroscience in EFL Pedagogy

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Project Sources: This work is supported by Scientific Research Fund of Zhejiang Provincial Education Department (No. Y202248847).

Received: July 5, 2024 Accepted: August 3, 2024 Online Published: August 5, 2024

doi: 10.5539/elt.v17n9p1 URL: https://doi.org/10.5539/elt.v17n9p1

Abstract

This study investigates the prevalence of neuromyths among English as a Foreign Language (EFL) teachers and examines their general neuroscience knowledge (GNK). Neuromyths, often stemming from misinterpretations of neuroscience research, can lead to ineffective teaching practices. The research employs a mixed-methods approach, surveying 45 EFL teachers to assess their GNK and beliefs in common neuromyths, while considering variables such as gender, years of teaching experience, educational background, and exposure to neuroscience training. Additionally, a case study explores the practical integration of educational neuroscience concepts (ENCs) into EFL teaching.

The findings reveal a moderate level of GNK among participants, but a significant struggle in identifying neuromyths, particularly those related to learning styles and brain usage. Teachers with more teaching experience tend to hold stronger neuromyth beliefs. The case study demonstrates both the challenges and benefits of applying ENCs in EFL teaching, showing improvements in teaching strategies and student outcomes.

The study highlights the critical need to enhance neuroscience literacy among EFL teachers through targeted professional development programs. These programs should focus on debunking neuromyths and promoting evidence-based teaching strategies. The conclusions emphasize the importance of integrating neuroscience education into teacher training to improve teaching effectiveness and student learning. Future research should investigate the long-term impacts of such training and explore the application of neuroscience principles across various educational contexts.

Keywords: neuromyths, educational neuroscience, EFL teaching, professional development

1. Introduction

1.1 Research Background

Educational neuroscience is an emerging interdisciplinary field that integrates neuroscience, psychology, and pedagogy to study human education and its general laws. With its rapid development, many teachers are enthusiastic about applying neuroscience in education. However, due to a lack of interdisciplinary communication, insufficient neuroscience knowledge among teachers, and media misrepresentations, misconceptions about educational neuroscience, known as neuromyths, are constantly emerging. Studies and surveys have shown that neuromyths are prevalent among educators and are often associated with ineffective or unevaluated teaching approaches, thereby influencing students' learning outcomes (Dekker et al., 2012). Additionally, educational policies are increasingly swayed by neuromyths, potentially resulting in inefficient resource allocation and financial expenditures (Furey, 2020). Therefore, efforts to reduce the prevalence of neuromyths among educators are necessary.

The domain of English as a Foreign Language (EFL) teaching, with its unique set of challenges and pedagogical approaches, is not immune to the influence of neuromyths. The prevalence of such misconceptions among EFL teachers poses a significant challenge to the effectiveness of language instruction, as these unfounded beliefs can distort educational practices and hinder the adoption of evidence-based strategies crucial for language acquisition and cognitive development. Therefore, it is necessary to dissect neuromyths within the EFL teaching community and equip teachers with a solid understanding of neuroscience principles that can be effectively applied in their teaching practices, thereby contributing to the overall improvement of teaching effectiveness.

1.2 Research Questions

This study aims to answer three research questions through a survey and a case study:

(1) How well can EFL teachers distinguish between popular neuromyths and neuroscience knowledge?

(2) Do neuromyth beliefs relate to factors such as gender, affiliation, years of teaching experience, level of education, reading habits, and experience of neuroscience-related training or lectures?

(3) How can educational neuroscience concepts be incorporated into EFL teaching practices in a case study?

2. Literature Review

2.1 Neuromyths

The term "neuromyth" refers to a "misconception generated by a misunderstanding, a misreading, or a misquoting of scientifically established facts (by brain research) to make a case for the use of brain research in education and other contexts" (OECD, 2002). Neuromyths arise for various reasons, including insufficient interdisciplinary communication, the lack of systematic study of educational neuroscience by many educators, and the oversimplification or exaggeration of findings in media representations.

Five widely spread neuromyths include (Bailey, 2002; Düvel & Kopiez, 2017):

(1) Children learn better when they receive information in their preferred learning style (e.g., visual, auditory, kinesthetic styles).

(2) Differences in hemispheric dominance (left brain, right brain) can help explain individual differences among learners.

(3) We only use 10% of our brain.

(4) There are critical periods in childhood after which things can no longer be learned (0 to 3 years).

(5) Listening to classical music increases cognitive ability.

These examples highlight the deceptive nature of neuromyths. Neuromyths often retain a small amount of scientific knowledge, which helps sustain their circulation and gives them widespread influence and credibility, thus exempting them from scientific scrutiny and evading skepticism.

Studies have shown that neuromyths are pervasive and prevalent within the educational community (Ruiz-Martin et al., 2022; Craig et al., 2021; Carter et al., 2020; Ferrero et al., 2016; Zhang Ronghua et al., 2019). This can lead teachers to pass on ineffective learning strategies to their students, wasting the money, time, and effort of the education system and depriving teachers and learners of the opportunity to spend resources on more effective theories and methods. Additionally, neuromyths can lead to misconceptions and biases among educators about educational neuroscience, hindering the transformation and application of neuroscientific findings in the field of education (Howard-Jones, 2014).

2.2 Educational Neuroscience Concepts (ENCs)

Educational neuroscience aims to bridge the gap between neuroscience and education, offering valuable insights that can lead to more effective teaching strategies and policies grounded in a deeper understanding of how the brain learns (Goldberg, 2022). A brief list of educational neuroscience concepts (ENCs) includes:

1. Brain Plasticity: This concept refers to the brain's ability to modify its structure and function in response to environmental stimuli and experiences. Repeating response patterns strengthens specific neural pathways, changing the structure and function of relevant brain areas. However, this change requires consistent repetition of new response patterns to weaken old ones and form new neuronal pathways (Jolles & Jolles, 2021). The neural network hypothesis of learning and memory is based on this foundation.

2. Memory Formation: Memory formation consists of three main steps: encoding, storage, and reproduction. Encoding involves processing information to be learned and putting it into a form that the memory system can accept and use. Storage is the process of retaining information about actions, emotions, thoughts, and perceptions in a certain form. Reproduction involves extracting and making sense of the information stored in the memory system. The Hierarchical Relational Binding Theory (hRBT) is related to this concept (Tan, Amiel & Yaro, 2019).

3. The Role of Emotions in Learning: Emotions significantly influence learning by impacting cognitive functions like attention and memory (Fredrickson, 2001; Schunk, 2012; Dubinsky, Roehrig & Varma, 2022). They regulate attention by affecting attention span duration and creating biases towards emotional stimuli. Emotional events capture and hold attention more rapidly than neutral events during perceptual processing. Once registered, emotional information is more likely to be repeatedly thought about, finely retold, and selectively retrieved, enhancing memory consolidation.

Incorporating evidence-based ENCs into teaching practices yields significant benefits. ENCs empower teachers to gain deeper insights into their students' needs, particularly for students with challenges such as attention deficits, allowing for more effective, tailored strategies. ENCs also enhance teachers' ability to assess the scientific validity and practical effectiveness of their instructional approaches. Grounding instructional design in ENCs facilitates the application of neuroscience findings in educational settings, thereby enhancing teaching efficacy.

3. Methodology

3.1 Participants

The questionnaire targeted a diverse group of EFL educators, including in-service teachers, teaching assistants, and pre-service teachers from various educational settings in a Chinese city: primary schools, secondary schools, universities, and English language training institutes.

The author employed snowball sampling to recruit 45 participants for the study. The demographic breakdown was as follows: 11 male teachers (24.44%) and 34 female teachers (75.56%). In terms of educational sector, the composition included 6 primary school teachers (13.3%), 6 secondary school teachers (13.3%), 13 university teachers (28.9%), 7 teachers from English language training institutes (15.6%), and 13 pre-service teachers (28.9%). Regarding their educational qualifications, the participants included 5 with doctoral degrees, 19 with master's degrees, and 21 with bachelor's degrees. Experience in teaching was distributed as follows: 25 participants had taught for less than five years, 5 for five to ten years, 10 for ten to twenty years, and 5 for over twenty years.

All personal information involved in the design and distribution of the questionnaire was kept confidential, and each participant provided informed consent.

3.2 Questionnaire Design

3.2.1 Questionnaire Purpose

The questionnaire serves dual primary objectives: to assess EFL teachers' ability to differentiate between prevalent neuromyths and evidence-based neuroscience knowledge, and to determine whether beliefs in neuromyths correlate with factors such as gender, years of teaching experience, educational level, reading habits, and exposure to neuroscience-related training or lectures. Additionally, the questionnaire gauges EFL educators' attitudes towards integrating neuroscience into their teaching practices.

3.2.2 Questionnaire Structure and Content

The questionnaire consists of two sections with a total of 27 questions, designed to be completed in 10-15 minutes. Section one collects basic participant information through 7 single-choice questions, including gender, affiliation, years of teaching experience, educational background, reading habits, prior neuroscience training, and attitudes towards neuroscience. This data aims to identify correlations between these factors and participants' understanding of neuroscience.

Section two presents 10 evidence-based statements on general neuroscience knowledge (GNK) and 10 statements reflecting popular neuromyths. The GNK statements cover topics such as brain function, synaptic plasticity, and memory formation, while the neuromyth statements are derived from a literature review. Each statement offers three response options: correct, incorrect, and don't know. Responses to the GNK statements measure participants' neuroscience literacy, while the neuromyths section assesses their susceptibility to misconceptions. Collectively, the responses provide an assessment of participants' grasp of educational neuroscience.

3.2.3 Validity and Reliability Considerations

The neuromyths section is informed by Dekker et al. (2012), examining the relationship between teacher demographics and neuromyth beliefs. The general neuroscience knowledge section is crafted with reference to the principles established by Chang et al. (2021), focusing on educational neuroscience concepts pertinent to practice, such as brain function, synaptic plasticity, memory formation, and attention cycles.

Content validity was ensured by expert review from educational neuroscience specialists and experienced EFL teachers. A pilot study with a small sample of EFL teachers was conducted to refine the items based on their feedback. Internal consistency was measured using Cronbach's alpha, with a value above 0.70 indicating good reliability. Test-retest reliability was also assessed to ensure stability over time. Exploratory factor analysis (EFA) confirmed that the items grouped appropriately into neuromyth beliefs and general neuroscience knowledge sections.

3.3 Data Collection and Analysis

The questionnaire data were collected over a period of two weeks using the online survey platform Wenjuanxing. Participants were assured of anonymity and confidentiality to encourage honest and accurate responses.

Descriptive statistics, including means, standard deviations, and frequency distributions were calculated to summarize the data. These statistics provided a clear overview of the participants' general neuroscience knowledge and their beliefs in neuromyths.

To explore potential differences in general neuroscience knowledge and beliefs in neuromyths based on demographic variables, a comparative analysis was conducted using cross-tabulations and mean comparisons. Key demographic variables included years of teaching experience, highest educational qualification, and reading habits, and professional development participation.

Pearson correlation coefficients were calculated to investigate the relationships between participants' general neuroscience knowledge and their beliefs in neuromyths. This analysis helped identify whether higher knowledge levels correlated with lower acceptance of neuromyths.

The data analysis was performed using Excel, ensuring accurate and reliable results. The findings were interpreted to draw meaningful conclusions about the current state of neuromyths in EFL teaching and to suggest implications for future teacher training programs.

4. Results and Discussion

4.1 Results

4.1.1 General Neuroscience Knowledge (GNK)

The analysis of participants' General Neuroscience Knowledge (GNK) revealed the following results. The mean score for GNK was 7.29 (SD = 3.40), indicating a moderate level of knowledge among participants. 71% of participants scored above 8, while 20% scored below 6. Table 1 shows the distribution of responses for the GNK section.

Table 1. GNK Statements

Statement	Agree (%)	Disagree (%)	Don't know (%)
1. Positive emotions extended attention span compared to neutral and negative emotions.	75.6	6.7%	17.8%
2. Representations of learning objects are made up of smaller units of information (e.g., visual, auditory, sensory, affective) that are processed and stored in distinct areas in the brain.	73.3%	2.2%	24.4%
3. Learning occurs through modification of the brain's neural connections.	62.2%	8.9%	28.9%
4. Emotions affect memory at various stages of memory processing.	64.4%	8.9%	26.7%
5. The brain is plastic. Brain can be modified by environment and experience, reshaping its structure and function in response to them.	71.1%	8.9%	20%
6. Safe learning environments provide opportunities for deeper learning.	80%	2.2%	17.8%
7. Rehearsal, application and self-evaluation lead to automaticity and mastery.	82.2%	0%	17.8%
8. Learning strengthens synapses. Remembering reactivates plasticity.	82.2%	0%	17.8%
9. Emotions affect learning through cognitive activities such as attention and memory.	75.6%	2.2%	22.2%
10. Brain pathways, while similar across individuals, are shaped by unique experience.	62.2%	4.4%	33.3%

As shown in Table 1, within the domain of general neuroscience knowledge, the lowest correct response rates were for Statement 3, "Learning occurs through modification of the brain's neural connections," and Statement 10, "Brain pathways, while similar across individuals, are shaped by unique experiences," both at 62.22%. Notably, Statement 10 also had the highest number of "don't know" responses. This suggests that a significant portion of the teachers surveyed may lack understanding of the brain's memory formation mechanisms and the influence of personal experiences on neural pathways.

4.1.2 Neuromyth Beliefs

The responses to neuromyth statements revealed varying degrees of belief in common neuromyths among participants. The mean score for neuromyth beliefs was 7.29 (SD = 2.50), suggesting a prevalent belief in certain neuromyths. Table 2 presents the frequency of responses to selected neuromyth statements.

Table 2. Neuromyth Statements

Statement	Agree (%)	Disagree (%)	Don't know (%)
1. Some of us are "left-brained" and some are "right-brained" due to hemispheric dominance, and this helps explain differences in how we learn.	57. 8%	13.3%	28.9%
2. Children learn better when they receive information in their preferred learning style (e.g., the visual, auditory, kinesthetic styles)	80%	4.4%	15.6%
3. Exercises that rehearse co-ordination of motor-perception skills can improve literacy skills.	55.6%	17.8%	26.7%
4. We use only 10% of our brain.	46.7%	24.4%	28.9%
5. If pupils do not drink sufficient amounts of water (6–8 glasses a day), their brains shrink.	13.3%	55.6%	31.1%
6. Children must acquire their native language before a second language is learned. If they do not do so, neither language will be fully acquired.	26.7%	46.7%	26.7%
7. Listening to classical music increases reasoning ability.	28.9%	28.9%	42.2%
8. Learning problems associated with developmental differences in brain function cannot be remedied by education.	53.3%	15.6%	31.1%
9. The defining feature of dyslexia is reversing letters.	48.9%	11.1%	40%
10. There are critical periods in childhood after which certain things can no longer be learned.	26.7%	51.1%	22.2%

Table 2 reveals considerable variation in participants' responses to neuromyth statements. Out of the 10 statements, only two received more than 50% correct responses. The statement with the lowest correct response rate was Statement 2, "Children learn better when they receive information in their preferred learning style (e.g., visual, auditory, kinesthetic)," which was correctly identified as a neuromyth by just two participants (4.44%). The next lowest correct response rates were for Statement 9, "The defining feature of dyslexia is reversing letters," and Statement 1, "Some of us are 'left-brained' and some are 'right-brained' due to hemispheric dominance, and this helps explain differences in how we learn," with 11.11% and 13.33% correct responses, respectively.

A comparison between Table 1 and Table 2 reveals that, for the 10 statements on GNK, participants achieved a significantly higher percentage of correct responses than for the Neuromyths section. This indicates that most participants possessed a basic understanding of GNK concepts, such as the brain's plasticity. However, they seemed to lack knowledge of more nuanced details, which hindered their ability to accurately identify and refute misleading neuromyths.

4.1.3 Comparative Analysis

Comparative analysis was conducted to explore potential differences in general neuroscience knowledge (GNK) and beliefs in neuromyths based on various demographic variables.

Participants were divided into five groups based on their years of teaching experience: more than 20 years, 10 to 20 years, 5 to 10 years, 1 to 5 years, and less than 1 year. Table 3 presents the detailed mean scores and standard deviations for GNK and neuromyth beliefs across different groups based on years of teaching experience. The analysis revealed notable differences across these groups. Teachers with 10 to 20 years of experience had the highest mean GNK score (M = 8.3, SD = 1.49), indicating a higher level of neuroscience knowledge compared to other groups. Conversely, teachers with less than 1 year of experience had the lowest mean GNK score (M = 6.4, SD = 4.03), suggesting limited knowledge in this area. The belief in neuromyths varied significantly with years of teaching experience. Teachers with 5 to 10 years of experience had the lowest mean neuromyth belief score (M = 4.6, SD = 3.51), while those with more than 20 years of experience had the highest mean score (M = 9.6, SD = 0.55).

Table 3. Mean GNK and Neuromyth Belief Scores by Years of Teaching Experience

Years of Teaching Experience	Mean GNK Score (SD)	Mean Neuromyth Belief Score (SD)
More than 20 years	7.4 (4.34)	9.6 (0.55)
10 to 20 years	8.3 (1.49)	7.3 (2.16)
5 to 10 years	7.4 (4.22)	4.6 (3.51)
1 to 5 years	7.7 (3.00)	6.6 (2.60)
Less than 1 year	6.4 (4.03)	7.8 (1.94)

Differences in GNK and neuromyth beliefs were also observed based on participants' affiliations. College teachers had a mean GNK score of 7.0 (SD = 3.37), secondary school teachers had a mean score of 9.0 (SD = 1.26), primary school teachers had a mean score of 9.3 (SD = 1.03), training institution teachers had a mean score of 8.3 (SD = 1.60), and pre-service teachers had the lowest mean score of 5.3 (SD = 4.48). Regarding neuromyth beliefs, secondary school teachers exhibited the lowest mean score (M = 4.3, SD = 2.66), whereas pre-service teachers showed the highest mean score (M = 8.5, SD = 1.81) (see Table 4 for detailed data).

Participants who regularly read scientific books, journals, or magazines had lower mean GNK scores (M = 4.5, SD = 5.26) compared to occasional readers (M = 8.2, SD = 2.40) and non-readers (M = 5.5, SD = 4.25). The belief in neuromyths was higher among non-readers (M = 8.8, SD = 1.62) compared to regular readers (M = 6.8, SD = 4.27) and occasional readers (M = 6.9, SD = 2.36) (see Table 4 for detailed data).

Differences in GNK and neuromyth beliefs were also examined based on gender. Male participants had a mean GNK score of 7.5 (SD = 3.75), while female participants had a mean score of 7.2 (SD = 3.33). In terms of neuromyth beliefs, male participants had a mean score of 5.5 (SD = 3.39) compared to female participants who had a mean score of 7.9 (SD = 1.84) (see Table 4 for detailed data).

Participants who had prior training in neuroscience had significantly higher mean GNK scores (M = 8.3, SD = 2.58) compared to those without such training (M = 6.8, SD = 3.68). Additionally, those with prior training had lower mean neuromyth belief scores (M = 6.1, SD = 3.13) than those without training (M = 7.9, SD = 1.93) (see Table 4 for detailed data).

Table 4. Mean Scores and Standard Deviations for GNK and Neuromyth Beliefs across Demographic Variables

Demographic Variable	Group	Mean GNK Score (SD)	Mean Neuromyth Belief Score (SD)
Affiliation	College	7.0 (3.37)	7.8 (2.62)
	Secondary school	9.0 (1.26)	4.3 (2.66)
	Primary school	9.3 (1.03)	7.8 (2.32)
	Training institution	8.3 (1.60)	6.1 (0.90)
	Pre-service	5.3 (4.48)	8.5 (1.81)
Reading habits	Regular readers	4.5 (5.26)	6.8 (4.27)
	Occasional readers	8.2 (2.40)	6.9 (2.36)
	Non-readers	5.5 (4.25)	8.8 (1.62)
Gender	Male	7.5 (3.75)	5.5 (3.39)
	Female	7.2 (3.33)	7.9 (1.84)
Exposure to prior training on neuroscience	Yes	8.3 (2.58)	6.1 (3.13)
	No	6.8 (3.68)	7.9 (1.93)

The survey also finds that the majority of participants (64.4%) believed that educational neuroscience is beneficial for EFL classroom practice, while a significant minority (31.1%) remained uncertain about its utility, and only two participants viewed it as unhelpful. This consensus indicates a positive attitude among most EFL educators towards integrating educational neuroscience into their teaching practices. However, two-thirds of the participants had not previously been exposed to training or lectures on neuroscience, suggesting that interdisciplinary knowledge transfer between educational neuroscience and EFL teaching is currently limited. This highlights the need for greater dissemination of neuroscientific knowledge within the EFL community.

4.2 Discussion

4.2.1 Interpretation of Findings

This study explored general neuroscience knowledge (GNK) and neuromyth beliefs among EFL teachers. The moderate negative correlation between GNK and neuromyth beliefs ($r = -0.414$) indicates that higher neuroscience knowledge is associated with lower acceptance of neuromyths. This finding aligns with previous research (Howard-Jones, 2014; Bissessar & Youssef, 2021; Rousseau, 2021), emphasizing the importance of enhancing teachers' neuroscience literacy to reduce the spread of neuromyths.

The overall GNK scores suggest that while participants possess a foundational understanding of neuroscience, there are noticeable gaps. This may be attributed to the varying levels of access to professional development and updated educational resources. The higher GNK scores among certain groups, such as those with 10 to 20 years of teaching experience, indicate that mid-career educators might have more opportunities for professional growth.

Despite moderate GNK, the prevalence of neuromyth beliefs highlights a critical issue in the education sector. The persistence of these myths could be due to the widespread dissemination of inaccurate information and the lack of effective professional development programs that address these misconceptions (Lindell & Kidd, 2011).

4.2.2 Comparative Analysis of Demographic Variables

The study found significant differences in GNK and neuromyth beliefs based on years of teaching experience. Teachers with 10 to 20 years of experience had the highest GNK scores, possibly reflecting their ongoing professional development. In contrast, those with less than 1 year of experience exhibited the lowest GNK scores, likely due to their limited exposure to neuroscience education. Interestingly, teachers with more than 20 years of experience had the highest neuromyth belief scores, suggesting that veteran teachers could be influenced by entrenched misconceptions from their early teaching years, potentially explaining their reduced ability to discern neuroscientific knowledge (Howard-Jones, 2020).

Affiliation played a significant role in the variation of GNK and neuromyth beliefs. College teachers had lower GNK scores compared to secondary and primary school teachers, which might be due to different professional development opportunities or curricular focus. Pre-service teachers had the highest neuromyth belief scores, indicating a critical need for incorporating neuroscience education into teacher training programs (Carter et al., 2020; Ching et al., 2020).

Participants who regularly read scientific literature had lower neuromyth belief scores, underscoring the importance of continuous learning and professional development. However, their GNK scores were not significantly higher, suggesting that while regular reading helps dispel myths, it may not substantially increase overall knowledge without targeted training (Macdonald et al., 2017).

Gender differences in GNK and neuromyth beliefs were evident, with male participants showing slightly higher GNK scores and also lower neuromyth belief scores compared to female participants. This finding aligns with research that highlights the importance of gender-sensitive approaches in educational training (Ananga, 2021).

Participants with prior neuroscience training exhibited significantly higher GNK scores and lower neuromyth belief scores, highlighting the effectiveness of targeted training programs. This reinforces the need for professional development that focuses on current neuroscience research and its educational implications (Ruiz-Martin et al., 2022).

4.2.3 Implications for EFL Teaching

The results have several important implications for EFL teaching and teacher education. The moderate GNK scores and prevalent neuromyth beliefs underscore the need for targeted professional development programs. These programs should focus on debunking common neuromyths and enhancing teachers' understanding of educational neuroscience.

Effective professional development approaches include providing teachers with access to accurate and up-to-date neuroscience research through evidence-based training, such as workshops and seminars led by neuroscience experts (Tan, Amiel & Yaro, 2019). Such initiatives have shown promise in elementary EFL classrooms in a Colombian university and some high school EFL classrooms in Shandong, China. (Barbosa, 2021; Sun & Wang, 2024)

Additionally, encouraging teachers to develop critical thinking skills can help them evaluate the validity of new information. This can be achieved through reflective practices and discussions on current research findings. Establishing collaborative learning communities where teachers can share knowledge and experiences can foster a culture of continuous learning and skepticism towards unsupported claims.

Incorporating neuroscience-informed strategies into EFL teacher education curriculum design can improve teaching practices (Tardif, Doudin & Meylan, 2015). For instance, understanding the principles of brain plasticity can help teachers create more effective language learning experiences.

Educational policymakers should consider integrating neuroscience education into teacher training programs. By doing so, future teachers can be better equipped to critically evaluate and apply neuroscience findings in their teaching practices.

By integrating these professional development approaches, EFL educators can be better prepared to apply neuroscience principles in their teaching and critically assess the validity of neuromyths, ultimately leading to improved teaching practices and educational outcomes.

5. Case Study: Integrating ENCs into EFL Teaching

5.1 Teaching Strategies Based on ENCs

Integrating multimodal teaching within the curriculum exemplifies an effective strategy derived from ENCs, particularly those related to memory formation and the Hierarchical Relational Binding Theory. This approach leverages the brain's capacity to process and store information from various sensory modalities, enhancing the creation of robust memory representations. By engaging multiple types of information units—visual, auditory, sensory, and affective—the multimodal strategy strengthens neural connections and the potential for recall (Tan, Amiel & Yaro, 2019). A multi-sensory learning model not only supports the formation of retrievable information units but also significantly deepens students' memory and improves their overall learning capabilities (Yunus et al., 2022).

Exploring the cognitive underpinnings of memory, Cognitive Memory Theory and the Levels of Processing Theory offer valuable insights that can be directly applied within teaching strategies based on ENCs. These theories emphasize the importance of how information is processed and stored, distinguishing between short-term and long-term retention. By understanding that memory effectiveness is linked to the depth of processing rather than simply the amount of time spent on review (Schmitt & McCarthy, 2011), EFL educators can design instruction that promotes deeper levels of cognitive engagement. This approach not only enhances the memorability of the material but also fosters a more comprehensive understanding, ultimately improving educational outcomes.

Emphasizing affective regulation as a cornerstone of teaching strategies based on ENCs, the integration of emotional factors into the learning process is paramount for enhancing cognitive engagement and learning outcomes. The mechanisms of attention and reward significantly influence the learning rate, with neuromodulatory systems releasing chemicals like acetylcholine that signal the importance of specific experiences across the brain. Recognizing the impact of these mechanisms, it is crucial for EFL teachers to foster a positive affective state among students. This can be achieved by designing compelling scenarios at the beginning of lessons to capture students' interest or by encouraging positive interactions throughout the learning process (Dubinsky, Roehrig & Varma, 2022).

5.2 Lesson Design

This section presents a lesson example from Unit 1, "Lights, Camera, Action!" in the Compulsory Study 2 textbook for general high school English. The lesson illustrates the practical application of Educational Neuroscience Concepts (ENC) in unit teaching.

The lesson content is structured around the textbook, encompassing vocabulary, two reading passages, a related knowledge supplement (video), speaking practice, and textbook tasks. The teaching objectives are categorized into three types:

Knowledge Objectives: Focus on vocabulary and grammar. Students will master the unit's vocabulary and associated collocations and understand and apply subject-verb agreement concepts.

Skill Objectives: Enhance students' reading and speaking abilities. Students will comprehend the main ideas and details of the reading passages, recognize organizational patterns, and express personal preferences regarding different movie genres, discussing their reasons. Additionally, they will learn to deliver engaging and informative speeches.

Additional Objectives: Educate students about film production and enhance their skills in film appreciation, such as analyzing emotional expressions in films.

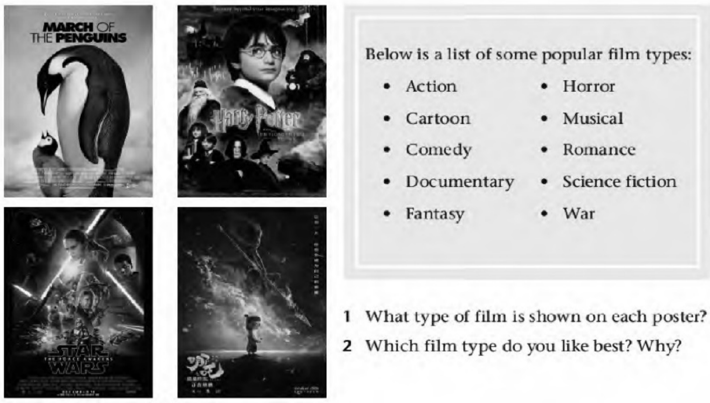

Figure 1. Welcome to the Unit Section

5.2.1 Teaching Session One: Lead-in

The teacher begins the lesson by using images from the textbook to pique students' curiosity about the unit's theme. The "Welcome to the Unit" section (Figure 1) invites students to describe various film genres depicted in the images. The teacher encourages an open discussion about the benefits and drawbacks of watching films, serving as a warm-up activity to engage students and practice their oral communication skills.

5.2.2 Teaching Session Two: Passage Reading

The next section of the textbook features a reading passage on film production, which may be challenging for students without relevant background knowledge. The teacher can introduce video materials to facilitate comprehension. For instance, when covering sound production, the teacher might screen a video titled "Learn about Foley and Foley Artists" to provide an introductory understanding of sound production processes. This multimodal teaching method enhances students' memory and comprehension.

During the reading explanation, the teacher can use mind mapping and retelling techniques to deepen memory. Students first identify the main idea of the article, structure it, and create a mind map (e.g. Figure 2). Then, they retell the reading passages based on their mind maps. This process helps encode and process information at a deeper level. Additionally, vocabulary explanations aid students in memorizing words through situational memory and contextual associations.

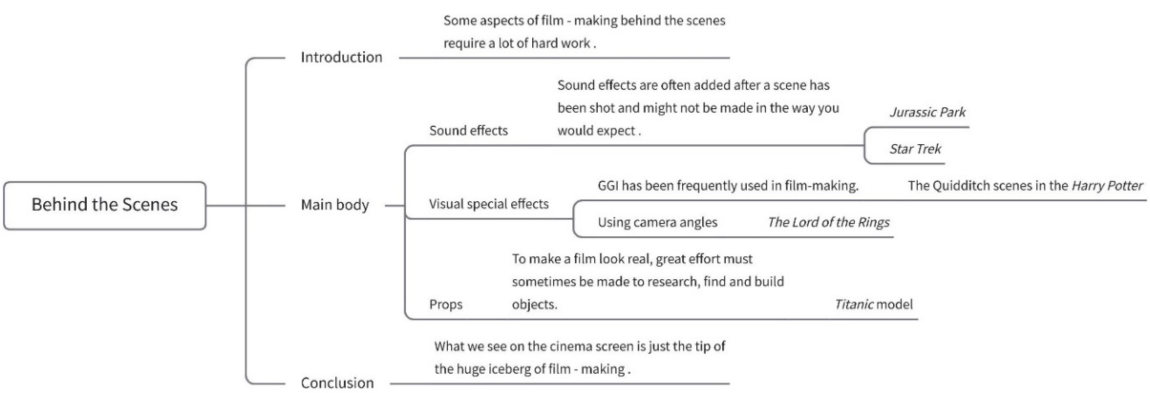

Figure 2. Mind Mapping

In the Extended Reading Section, the passage introduces the main content of “Forrest Gump” and its protagonist. After interpreting the passage, the teacher guides students to watch corresponding video clips and critique the movie using evaluation standards (Figure 3). This combination reinforces memory through multimodal teaching.

Dimensions	Contents	Feelings / Themes
Dialogue		
Expression		
Action		
Music		
Surroundings		
Plot		

Figure 3. Film Appreciation Dimension Table

5.2.3 Teaching Session Three: Vocabulary Learning

Following the second session, students are introduced to the unit’s vocabulary. The teacher can use classroom activities to reinforce memory. The unit presents 72 new words related to the film theme. Word association exercises, using charts and graphs, help link and categorize vocabulary. For example, "type" pertains to film genres like “comedy,” “documentary,” “fantasy,” and “romance.” Creating word charts facilitates memorization.

The teacher can also elucidate root words and suffixes to aid memorization. For example, the root “re-” signifies “back” or “backward,” as in “revise,” “regard,” “recollect,” and “recommend.” Grouping words with common roots enhances memory processing.

5.2.4 Teaching Session Four: Grammar Learning

The grammar focus is subject-verb agreement. The teacher explains that language serves as a communication tool, and in English, precision necessitates that each speech element conveys information effectively. That is why the “s” added to the third person singular verb signals a subject change. This explanation aids memory and application.

The teacher illustrates subject-verb agreement using examples, such as “My favorite fruit is apples.” The singular “is” reflects the singular subject “my favorite fruit,” while “apples” is plural because it refers to all fruits of that kind. Concrete examples promote easier understanding and memory retention.

5.2.5 Teaching Session Five: Speaking Practice and Dubbing

The teacher screens classic film clips featured in the unit, aligning with Parts A and B of the Project Section. This helps students understand film dubbing. Students select a film clip and undertake a dubbing task through cooperative learning, presenting their dubbing in the classroom.

Dubbing activities maintain a positive learning mood, inspiring students through emotional content. The teacher assesses presentations using “peer group evaluation,” considering cooperation, accuracy, fluency, emotion, and overall effect. This method enhances teacher-student interaction and aids in forming contextual memories.

6. Conclusion

6.1 Major Findings

This study has explored the prevalence of neuromyths among EFL teachers and investigated the potential of integrating Educational Neuroscience Concepts (ENCs) into EFL teaching practices. The key findings are summarized as follows.

First, the study revealed a significant prevalence of neuromyths among EFL teachers. Many teachers held misconceptions such as the belief in preferred learning styles (visual, auditory, kinesthetic) and the idea that we only use 10% of our brain. This highlights the need for better dissemination of accurate neuroscience information within the EFL community.

Second, while participants demonstrated a moderate level of general neuroscience knowledge (GNK), there was a noticeable gap in their ability to distinguish between accurate neuroscience concepts and neuromyths. This gap suggests that current professional development programs may not adequately address the intricacies of neuroscience in education.

Third, the study found that beliefs in neuromyths were influenced by various factors, including years of teaching experience, educational background, and reading habits. For example, teachers with more than 20 years of experience exhibited a higher belief in neuromyths compared to those with less experience. Additionally, participants who regularly engaged with scientific literature showed lower belief in neuromyths.

Finally, the case study demonstrated that incorporating ENCs into EFL teaching practices can enhance learning outcomes. Strategies such as multimodal teaching and emphasizing affective regulation were found to be effective in improving students' memory and engagement.

6.2 Limitations

Several limitations of this study should be acknowledged. For one thing, the sample size of 45 participants, recruited through snowball sampling in a single city, limits the generalizability of the findings. Future studies should aim for larger and more diverse samples to validate these results. For another, the reliance on self-reported data may introduce biases, as participants might overestimate or underestimate their knowledge and beliefs. Future research could incorporate more objective measures to assess teachers' neuroscience knowledge and neuromyth beliefs. Lastly, the study focused on a limited set of neuroscience concepts and neuromyths. Expanding the scope to include a broader range of topics could provide a more comprehensive understanding of teachers' knowledge and misconceptions.

6.3 Future Research Directions

Building on the findings and addressing the limitations, future research could explore the following directions.

First, conducting longitudinal studies to track changes in teachers' neuroscience knowledge and neuromyth beliefs over time, particularly following targeted professional development programs, could provide insights into the effectiveness of such interventions.

Second, developing and evaluating specific professional development programs designed to reduce neuromyth beliefs and enhance the application of ENCs in EFL teaching practices would be valuable. These studies could assess the impact of these programs on both teacher knowledge and student outcomes.

Third, investigating the prevalence of neuromyths and the effectiveness of ENC-based teaching strategies across different cultural and educational contexts would help identify universal and context-specific challenges and solutions.

Finally, exploring how emerging technologies, such as artificial intelligence and virtual reality, can support the integration of ENCs into EFL teaching practices could offer innovative approaches to enhancing learning experiences.

By addressing these research areas, the field can continue to bridge the gap between neuroscience and education, ultimately leading to more effective teaching practices and improved learning outcomes for students.

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