Uleam UNIVERSIDAD LAICA ELOY ALFARO DE MANABÍ
SAPIENTIAE

THE NEUROSCIENTIFIC APPROACH IN TEACHING ENGLISH TO HIGH SCHOOL STUDENTS

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ABSTRACT

This research focuses on diagnosing the impact of the neuroscientific approach on English teaching with respect to academic performance and student motivation in secondary education. It employs a mixed-method approach to gather both quantitative and qualitative data on the neuroscientific approach in English language teaching. The study participants included seven English teachers and thirty-nine third-year high school students from a private educational institution in Chone, Manabí, Ecuador. The data collection instruments used for the diagnosis were literature review, a semi-structured interview administered to English teachers, a questionnaire, and a pre-test and post-test administered to the students. The research results indicate that the application of techniques derived from the neuroscientific approach significantly impacts student motivation and academic performance in language learning. Furthermore, it concludes that neuroscientific techniques such as personalized learning plans tailored to each student's needs, spaced repetition, and the use of adaptive learning technologies optimize the language acquisition process. This study will contribute to the existing literature and to future studies focused on the impact of neuroscience on education.

Keywords: Neuroscientific approach, techniques, English teaching, high school students.

EL ENFOQUE NEUROCIENTÍFICO EN LA ENSEÑANZA DEL INGLÉS A ESTUDIANTES DE BACHILLERATO

RESUMEN

Esta investigación se centra en diagnosticar el impacto del enfoque neurocientífico en la enseñanza del inglés en el rendimiento académico y la motivación de estudiantes de bachillerato. Emplea el método mixto para obtener datos cuantitativos y cualitativos del enfoque neurocientífico en la enseñanza del idioma inglés. Los participantes del estudio fueron siete profesores de inglés y treinta y nueve estudiantes de tercero de bachillerato de una unidad educativa privada de Chone, Manabí, Ecuador. Los instrumentos de recolección de datos utilizados para efectuar el diagnostico fueron revisión documental, una entrevista semiestructurada administrada a los docentes del área de inglés, un cuestionario, y un “pre-test” y “post-test” aplicado a los estudiantes. Los resultados de la investigación señalan que la aplicación de técnicas que surgen del enfoque neurocientífico repercute significativamente en la motivación y rendimiento académico de los estudiantes en su aprendizaje lingüístico. Además, se concluye

que las técnicas neurocientíficas como la adopción de planes de aprendizaje personalizados a las necesidades de cada estudiante, la repetición espaciada y el uso de tecnologías de aprendizaje adaptativo, optimizan el proceso de adquisición del idioma. La presente investigación contribuirá a la literatura existente y a nuevas investigaciones enfocadas en la incidencia de la neurociencia y la educación.

Palabras claves: Enfoque neurocientífico, técnicas, enseñanza del inglés, estudiantes de bachillerato.

INTRODUCTION

In the contemporary educational field, the teaching of English as a second language has evolved, to the point of being driven by innovative approaches such as neuroscience. When learning a new language, particularly English, it is important to use effective educational strategies and methodologies, and to understand the natural processes of the human brain to acquire information, which highlights the relevance of neuroscience in education (Mendez et al., 2018). This topic becomes pertinent due to the growing need for pedagogical strategies that facilitate language learning and at the same time motivate students in their linguistic learning, since motivation plays a central role in language education (Seven, 2020). A significant challenge in language teaching, especially for teachers, is finding methods that optimize English acquisition.

To achieve this, it is needed to take advantage of existing knowledge about the functioning of the brain and the processes of learning a second language. Therefore, from a theoretical perspective, this study relies on the approach of neuroscience and education. Emphasizing the importance of teachers adapting their pedagogical practices, aligning them with the cognitive and emotional processes of language learners.

There are previous studies that explore various neuroscientific techniques applied to language teaching, although most focus on different contexts or different educational levels, conducted by authors such as Mendez et al. (2018), Cearon and Feltes (2020), and Delport (2021).

This work contributes to the field of language teaching by providing relevant data on how techniques that arise from the neuroscientific approach directly affect the academic performance and motivation of high school students in the context of learning English.

This study seeks to provide updated knowledge on the application of neuroscience in linguistic education and offer practical insights to enrich the educational

practices of teachers around teaching English. Besides, it is executed in the current context of secondary education, considering several factors that affect the teaching-learning process of English. With the purpose of filling this gap in the academic literature, the research aims to diagnose the impact of the neuroscientific approach in teaching English to high school students, focusing on research questions:

1. How do English teachers perceive the neuroscientific approach in teaching English to high school students?
2. What are the key techniques derived from the neuroscientific approach that improve English language teaching?
3. How does the neuroscientific approach of techniques influence the motivation and attitude of high school students toward learning the English language?
4. What is the effect of the neuroscientific approach on the academic performance of high school students in learning English?

LITERATURE REVIEW

Neuroscientific approach

Neuroscience is a multidisciplinary branch of biology that investigates the nervous system, combining various areas such as physiology, anatomy, molecular biology, among others, to understand how neurons and neuronal circuits work (Tambunsaribu, 2019). Besides, neuroscience provides both innovative ideas and practical guidelines to improve learning and development practices (Vorhauser, 2019). Neuroscience consolidates an understanding of the functioning of the nervous system in the generation and regulation of emotions, thoughts and behaviors, allowing us to recognize the influence of emotions in the teaching and learning process (Escobedo, 2023). Hence, neuroscience integrates various disciplines that deepen the understanding of the functioning of the nervous system and the importance of emotions in learning, with the aim of offering tools to improve educational practices and promote education towards a more human approach.

Advances in neuroscientific approach reveal how brains change during learning, allowing educators to integrate this knowledge into their educational practices (Chang et al., 2021). Neuroscience approach provides valuable insights that can inform educators about the theoretical foundations of both established and innovative teaching methods; by influencing their perspectives on learning, teachers can develop a mental framework for understanding the subtle psychological factors that may impact classroom practices (Mai, 2022). By incorporating insights from neuroscience, educators can improve their teaching

methods, better understand learning mechanisms, and enhance their effectiveness in the classroom.

Educational neuroscience

Neuroscience in education is an interdisciplinary field that seeks to incorporate knowledge about how the brain learns into teaching practices and educational policies (Gkintoni *et al.*, 2023). At its core, the fusion of neuroscience and education strengthens the path of educators, empowering them to design teaching approaches that resonate deeply with the intricate workings of the human mind, fostering an environment where each student's potential can truly flourish. (Owen, 2024)

Educational neuroscience explores the reasons behind the varying degrees of reward associated with different types of learning, the adaptability of the brain and its response to learning new skills at different stages of life, methods for improving learning capabilities, and the impact of technological resources in learning. (Uden, 2023)

Neuroscience and education can interact directly, focusing on the brain as a biological organ that must be in optimal condition for learning, or indirectly, as neuroscience informs psychological theory, which in turn influences educational practices, (Thomas *et al.*, 2019)

In short, the fusion of neuroscience and education empowers educators to incorporate teaching approaches that resonate with the intricacies of the human mind to generate an environment where each student's capabilities can thrive.

Neuroscientific approach in teaching English

The neuroscientific approach to teaching English is an innovative methodology that uses knowledge of the brain to develop educational strategies that improve academic performance and increase students' motivation when learning the language (Mendez *et al.*, 2018). The neuroscientific approach in teaching English is particularly aimed at creating a learning atmosphere that aligns with the natural rhythm and functioning of the language learners' brain, thus optimizing their skills and improving the language learning process. (Edjidjimo, 2022)

To conclude, the neuroscientific approach provides a modern methodology that harmonizes educational strategies with the spontaneous rhythms of the brain to improve academic performance and increase students' motivation in learning the English language.

METHODOLOGY

This study used a mixed method to evaluate how the neuroscientific approach affects the teaching of English to high school students, using both quantitative and qualitative data for a detailed and contextualized analysis, similarly what Risna et al. (2024) did in their research.

The research is of a descriptive-exploratory type aimed at describing and exploring the perceptions of English teachers about the use of neuroscientific techniques in teaching English, as well as the effects of said approach on the academic performance and motivation of students' high school in the acquisition of the English language (Ranganathan, 2019; Al-Khresheh, 2021). The research design was observational and transversal due to data was collected at a specific moment in time to analyze perceptions and effects of the participants (Ranganathan, 2019).

Sample

The sample was selected using the non-probabilistic convenience sampling method (Stratton, 2023), by selecting seven English teachers who teach at the high school level, and 39 third-year high school students from two parallels A and B, of which 22 are women and 17 are men between the ages of 16 and 18 belonging to a private educational unit in Chone, Manabí.

Instruments and Data Collection Procedure

To collect both qualitative and quantitative data, four data collection instruments were implemented: a) interview, b) literature review, c) questionnaire, and d) tests.

Interview: seven teachers in the English area who teach at the high school level were interviewed. The participating teachers were interviewed through a semi-structured interview to obtain qualitative data on how they perceive the incorporation of neuroscientific techniques in teaching English to high school students. The interviews were guided by a series of questions and indicators such as: experience as an English teacher, familiarity with the neuroscientific approach, neuroscientific techniques used, benefits of the approach in teaching English, challenges in implementation.

Questionnaire: a questionnaire consisting of seven statements was applied to the participating students, designed to obtain qualitative data. Before administering the questionnaire, each of the statements, the definition of the neuroscientific approach in teaching the English language and the techniques of the approach and their benefits in linguistic learning were explained to the language learners. Students had to select one of three options: "agree," "neutral," or "disagree."

This data collection instrument was administered with the objective of collecting information on how the neuroscientific approach influences the motivation and attitude of high school students towards learning the English language.

Literature Review: the literature review was conducted using various academic sources such as Redalyc, Latindex, Scopus, SciELO, Dialnet, and Google Scholar. To search for information, terms like “neuroscience in education”, “neuroscientific techniques,” and “English language teaching” were used. The research focused on gathering information that would facilitate the identification of techniques derived from the neuroscientific approach applicable to English language teaching. However, techniques originating from neuroscience that have been applied in other subjects but have shown excellent results in terms of teaching and knowledge acquisition were also considered.

Tests: to obtain quantitative data, a pre-test and a post-test were applied to thirty-nine third-year high school students. The pre-test was administered before the intervention, whereas the post-test was administered after having introduced the techniques of the neuroscientific approach in teaching the English language. The two tests were made up of six sections: listening, speaking, reading, writing, grammar, and vocabulary. The application of the pre-test and post-test was focused on evaluating the effect of the neuroscientific approach on the academic performance of high school students in learning English. Each section of the tests consisted of specific questions that students had to answer. The total score for both tests was ten points, allowing a comprehensive evaluation of the participants’ academic performance in English.

To conduct this research, ethical considerations were considered, by guaranteeing the confidentiality and anonymity of the participants and the educational unit. Consent was obtained from the educational institution before the subjects were included in the study, ensuring that the data collected would be used exclusively for research purposes. The inclusion criteria for the practical intervention considered English teachers who use neuroscientific techniques in their teaching, teachers from the institution's English area, and high school students who participate in English classes regularly. On the other side, the exclusion criteria ruled out teachers and students who did not give their consent to participate.

The limitations of the study focused on the non-probabilistic selection of the sample, given that it was only possible to intervene in two pre-schools of a single educational institution, which may restrict the generalization of the quantitative and qualitative results obtained. Despite these limitations, the findings provide

valuable insight into the application of neuroscientific techniques in teaching English and their impact on student learning.

RESULTS

Results from the interviews with the teachers.

Experience as an English teacher:

• Teachers have varied experience ranging from one to more than 16 years teaching the English language.

• Participants reported that their professional training included bachelor's and master's degrees in English language teaching, as well as participation in pedagogical workshops.

• Teachers claim that teaching English is perceived as an enriching, rewarding experience and an opportunity to influence the personal, cultural, and academic development of the students.

Familiarity with the neuroscientific approach:

• Participants have varying degrees of familiarity with the neuroscientific approach in education, ranging from little knowledge to a very deep understanding of the topic.

• Some teachers apply principles of the neuroscientific approach intuitively, observing improvements in the motivation and academic performance of their students.

• There is general recognition of the importance of providing positive stimuli and engaging activities to keep students engaged and improve their learning.

• There is a growing trend in the use of the neuroscientific approach, which is changing the way teaching is understood and practiced.

Training in the neuroscientific approach:

• Some of the teachers have not received specific training on the use of neuroscientific techniques in teaching, which indicates a gap in teacher training in this area.

• Some participants mention having received little training, suggesting that although there is some knowledge, it is not sufficient for robust application of these techniques.

• Only two participants mentioned having taken specific subjects at university related to neuroscience, which has provided them with a solid theoretical basis to apply this knowledge in their teaching practice.

- The teachers who received training remark specific techniques, for instance, mindfulness, active pauses, and teamwork, which are applied in their teaching practice.

Neuroscientific techniques used:

- Some teachers do not apply neuroscientific techniques.

- Some educators adopt personalized learning plans that fit the unique needs and abilities of each student, thus facilitating a more effective and meaningful educational process.

- Some teachers incorporate adaptive learning technologies and techniques, specially spaced repetition, based on neuroscience principles, to improve knowledge retention and adapt teaching based on each student's individual progress.

- The teachers who mentioned applying neuroscientific techniques select them considering the context and specific level of the students.

Benefits in teaching English:

- According to teachers, the application of neuroscientific techniques, particularly the promotion of neuroplasticity and multisensory learning, increases motivation and academic performance.

- Educators suggest that applying neuroscience techniques helps them better understand how individual scholars learn, which guides instruction focused on each student's cognitive and emotional abilities.

Challenges in implementation:

- Two participants highlight that there is a lack of knowledge and familiarity with neuroscience techniques.

- Teachers pointed out that sometimes students show resistance to leaving their comfort zone, which can limit their application.

- Neuroscientific techniques are not widely known or accepted by all those involved.

Results from literature review:

Table 1. Techniques of the neuroscientific approach according to literature review.

1	Spaced repetition
2	Multimodal learning
3	Emotionally supported learning surroundings
4	Adaptive learning technologies

5	Personalized learning plans
6	Alignment of school schedules with biological rhythms
7	Polymodal or multisensory learning
8	Adaptation of instruction methods to individual abilities
9	Synthesized learning system
10	Prediction and correction of mental development
11	Group learning

Source: Berlin & Cohen (2020); Kharwal et al. (2022); Melnyk et al. (2022); Edjidjimo (2022); and Owen, (2024).

As shown by Table 1, the techniques of the neuroscientific approach in language education are based on principles and findings from brain research to improve educational processes as states Owen (2024). Language educational techniques derived from the neuroscientific approach seek to improve the learning process through the application of principles derived from neuroscience, neuropsychology, and neurolinguistics, with the aim of making the educational process more effective and guaranteeing the full cognitive and personal development of students. (Melnyk *et al.*, 2022)

From the perspective of the author of this study, the techniques based on the neuroscientific approach presented in Table 1 are primarily aimed at enhancing the English language education process and ensuring the comprehensive development of students. Therefore, incorporating neuroscientific principles into language instruction enhances teaching effectiveness by nurturing both the cognitive and personal development of students.

Table 2. Motivation and attitude of students towards the neuroscientific approach to techniques.

No	Statements	Agree	Neutral	Disagree
1	Learning based on neuroscience techniques motivates me to participate in classes.	71,79	23,08	5,13
2	Synthesized learning system technique can improve my academic performance.	74,36	17,95	7,69
3	Acquiring English language is more interesting and relevant when techniques based on spaced repetition are used.	64,10	28,21	7,69
4	The multisensory learning technique makes me feel more confident in my linguistic ability.	66,67	23,08	10 ,26
5	Emotionally supportive learning environments allow me to better manage my language learning.	64,10	30,77	5,13

6	The application of multimodal learning techniques makes my attitude improve when learning English.	69,23	23,08	7,69
7	Adapting teaching methods to my individual abilities increase my understanding of the English language.	71,79	23,08	5,13

Table 2 reveals that high school students perceive the neuroscientific approach as helpful in their learning of language English. Notably, 71, 79% of participants that neuroscience-based techniques increase their motivation to participate in classes. Moreover, an impressive 74,36% believe that the synthesized learning system technique can improve their academic performance. That is, language students value the connection between neuroscience and their academic performance, considering it a principal factor in learning the English language.

Equally, 64,10% of high school students consider that learning the English language is more interesting and relevant when techniques based on spaced repetition are used. Nevertheless, 66.67% of language learners feel more confident in their linguistic ability under the multisensory learning techniques. As a result, although interest and confidence are crucial aspects of language learning, neuroscientific methods play a relevant role in their linguistic learning. In fact, 69.23% of students report that their general attitude improves when the teacher applies multimodal learning techniques in English class, highlighting the prominence of integrating emotional and cognitive knowledge into language teaching strategies.

Consequently, about 71.79% of high school students state that the neuroscientific approach improves their understanding of English. These findings, along with the fact that 64.10% think that emotionally supportive learning environments allow me to better manage their language learning, prominence the effectiveness of neuroscientific strategies in facilitating meaningful learning.

In brief, the data in Table 2 suggest that high school students reported agreeing that neuroscientific techniques increase their motivation and attitude by improving both their understanding and confidence in using the often boring and boring English language. tedious, according to what the author could perceive when applying the questionnaire

Table 3. Academic performance of high school students.

		No	Min	Max	Mean	Standard Deviation	Mean Difference	P-value	Cohen's d
1	**Pre-Test**	39	5,40	8,70	7,08	0,69	1,31	0,001	2,11
2	**Post-Test**	39	7,80	9,90	8,39	0,80			
	Valid N	39							

Table 3 presents quantitative data on the academic performance of thirty-nine high school English students, before and after applying techniques based on a neuroscientific approach in teaching the English language. Before the intervention, the average scores ranged between 5.40 and 8.70 in the pre-test; on the contrary, after the intervention, in the post-test, the scores improved, with a "Mean" of 8.39 and a range of 7.80 to 9.90.

This data suggests a considerable improvement in academic performance after the implementation of the neuroscientific approach. Statistical analysis shown a major difference between the pre-test and post-test scores, supported by a p-value of 0.001. Likewise, the effect size, represented by Cohen's d, is considerable, with a value of 2.11. Subsequently, a substantial and practical effect of the neuroscientific approach in improving students' academic performance in learning English.

To sum up, the quantitative data obtained from academic tests (pretest and posttest) shown in Table 3 can be interpreted as evidence that the neuroscientific approach is a valuable tool for teachers and students of English because the techniques provided by this approach improve the academic performance of high school students. The numerical results reflect that when educators plan and implement their lessons using this approach, they can effectively help students acquire a second language, especially the English language.

DISCUSSION

The quantitative and qualitative results obtained provide valuable information on the application of techniques based on the neuroscientific approach in teaching the English language.

Although not all teachers who participated in this study are familiar with or have received sufficient training in the neuroscientific approach in their professional training, as shown in table 1, schoolteachers them mentioned having applied these techniques unconsciously. Those teachers who are not familiar with the approach indicated that, despite their ignorance, they have used several of these strategies without realizing it.

On the contrary, teachers who do have a deep knowledge of the neuroscientific approach indicated that they apply techniques such as the adoption of personalized learning plans that adapt to the unique needs and abilities of each student, the use of adaptive learning technologies and techniques, and spaced repetition in their English classes, which have given satisfactory results in teaching

the English language, these results are in line with the research of Jolles and Jolles (2021).

Likewise, the results in table 2 suggest that many high school students agree that synthesized learning systems, rhythmic repetition, multisensory learning, emotionally supportive learning environments, and multimodal learning, etc. are important both to increase their motivation and attitude to improve their academic performance in the linguistic acquisition of the language, which was evident in their responses since approximately between 64.10% and 74.36% reported agreeing that the application of this type of techniques will allow them to improve their language skills, these findings coincide with the research of Gazioğlu and Karakuş (2023) and Syahputri (2019).

The results of this study reveal that students exposed to neuroscience-based teaching techniques, particularly multisensory learning and the use of educational technology, improved their academic performance in English language acquisition, as shown in Table 3 obtained a "Mean Difference" of 1.31 when contrasting the pre-test and post-test, these results are like those obtained by Hammami (2023), Edjidjimo (2022) and Delport (2021).

This study proposes an innovative approach aimed at combining two areas, language education and neuroscience, by using knowledge of the brain to introduce pedagogical techniques that positively transform the way in which learners acquire a second language, by providing teachers with a vast collection of techniques that can be adapted to the needs of students. However, this research presents weaknesses such as limited knowledge and mastery of the neuroscientific approach; although it is innovative and useful, some teachers and students are reluctant to formally incorporate it into education, making the effective application of the approach difficult.

For future implications of this approach, it is suggested that teachers and students be train about the possible practical benefits of neuroscience in the educational area, since it can not only be applied in English language instruction but also in all areas of the academic field.

To conclude, this research provides convincing evidence that neuroscience approaches can greatly improve the teaching of English to high school students, as the findings highlight the importance of integrating neuroscience techniques into education to increase students' language learning potential. Regarding implementing these practices, it can facilitate language acquisition and promote student motivation and language learning.

CONCLUSIONS

English teachers have varied perceptions about the use of neuroscientific techniques in teaching English to high school students. While a portion of educators recognize and value the potential benefits, such as increased motivation and academic achievement, others face significant challenges due to a lack of specific training and resistance to change on the part of students. The lack of knowledge and widespread non-acceptance of these techniques represent significant obstacles for both teachers and learners.

Despite this, the intuitive application of neuroscientific principles by certain teachers indicates a positive trend that could be strengthened with more extensive and specific training in the field of educational neuroscience. Future research could focus on developing strategies to overcome these barriers and expand the understanding and acceptance of neuroscience techniques in language education. The evidence from the literature review reveals that the main techniques of the neuroscientific approach in English language teaching include spaced repetition, multimodal learning, emotionally supportive learning environments, adaptive technologies, personalized learning plans, and the alignment of school schedules with students' biological rhythms.

Additionally, techniques such as polymodal or multisensory learning, the adaptation of instructional methods to individual abilities, and the prediction and correction of mental development are also fundamental. According to the literature review, these techniques, grounded in neuroscience, aim to enhance the effectiveness of the English language education process and ensure the comprehensive cognitive and personal development of students.

The neuroscientific approach to teaching techniques has a profound impact on the motivation and attitude of high school students towards learning English, given that the data shows that many students perceive an increase in their motivation, academic performance, and linguistic confidence. when these techniques are applied. Personalizing teaching methods to suit individual abilities and using emotionally supportive learning environments are associated with better language learning management. Therefore, it is suggested to explore the applicability of these findings in a variety of educational contexts.

The findings of the study show that the application of techniques based on neuroscience in the teaching of the English language increases the academic performance of language learners, as evidenced by the quantitative data indicating substantial improvements in students' scores between the beginning and

of the study, supported by a considerable effect size and a relevant level of statistical significance.

From an educational perspective, these results highlight the importance of integrating methods and strategies derived from neuroscience into pedagogical practice to improve second language learning. Accordingly, it is essential to address the identified limitations, such as skepticism towards the approach, to advance the understanding of these results and establish broad evidence on the sustained benefits of this educational approach.

REFERENCIAS BIBLIOGRÁFICAS

Al-Khresheh, M. H. (2021). Reconceptualising the Elements of Effective English Language Teaching through the Lens of Pandemic Induced Online Teaching: An Exploratory Study of Jordanian EFL Teachers' Perceptions. Asian EFL Journal Research Articles, 28(2), 61-97. https://www.researchgate.net/publication/351379339_Reconceptualising_the_Elements_of_Effective_English_Language_Teaching_through_the_Lens_of_Pandemic_Induced_Online_Teaching_An_Exploratory_Study_of_Jordanian_EFL_Teachers'_Perceptions

Berlin, R., & Cohen, J. (2020). The Convergence of Emotionally Supportive Learning Environments and College and Career Ready Mathematical Engagement in Upper Elementary Classrooms. Sage Jounarls, 6(3), 1-20. doi:10.1177/2332858420957612

Cearon, I. F., & Feltes, H. P. (2020). Neuroscience role in the foreign language teaching and learning. Ciências .e Cognição, 25(1), 43-60. https://www.researchgate.net/publication/348663479_Neuroscience_role_in_the_foreign_language_teaching_and_learning

Chang, Z., Schwartz, M. S., Hinesley, V., & Dubinsky, a. J. (2021). Neuroscience Concepts Changed Teachers' Views of Pedagogy and Students. Sec. Educational Psychology, 12. doi:10.3389/fpsyg.2021.685856

Delport, D. (2021). The Impact of Math Manipulatives as a Multisensory Teaching Technique on Students' Statistics Performance At A South African University. Journal of Mathematics Education, Science and Technology, 6(2), 186-206. doi:10.30651/must.v6i2.10168

Edjidjimo, A. J. (2022). Teaching English to the Rhythm of the Brain. JONED. Journal of Neuroeducation, 34-52. doi:10.1344/joned.v3i1

Escobedo, Y. V. (2023). Neurociencia y Educación: una combinación perfecta para el éxito académico. Revista Científica Arbitrada Multidisciplinaria PENTACIENCIAS, 5(5), 379–385. doi:10.59169/pentaciencias.v5i5.746

Gazioğlu, M., & Karakuş, N. (2023). The impact of multisensory learning model-based tale-telling on listening skills and student opinions about it. Frontiers in Education, 8. doi:10.3389/feduc.2023.1137042

Gkintoni, E., Dimakos, I., Halkiopoulos, C., & Antonopoulou, H. (2023). Emerging Science Journal. Contributions of Neuroscience to Educational Praxis: A Systematic Review, 146-158. http://dx.doi.org/10.28991/ESJ-2023-SIED2-012

Hammami, M. B. (2023). Utilizing Neuroscience Research To Enhance Learning Strategies And Optimize Curriculum Design. International Journal of Advanced Research 11(09), 797-811. doi:10.21474/IJAR01/17588

Jolles, J., & Jolles, D. D. (2021). On Neuroeducation: Why and How to Improve Neuroscientific Literacy in Educational Professionals. Frontiers in Psychology. doi:10.3389/fpsyg.2021.752151

Kharwal, A., Umrotkar, N., Godambe, V., Kolekar, U., & Badgujar, V. (2022). Spaced Repetition Based Adaptive E-Learning Framework. Progresses in Artificial Intelligence & Robotics: Algorithms & Applications. ICDLAIR 2021. Lecture Notes in Networks and Systems, vol 441. Springer, Cham., 26-34. doi:10.1007/978-3-030-98531-8_3

Mai, V. T. (2022). A Neuroscientific Approach to Understanding Listening Comprehension in EFL Contexts. AsiaCALL Online Journal, 13(1), 73-81. doi:http://eoi.citefactor.org/10.11251/acoj.13.01.004

Melnyk, O., Petryk, O., Lysohor, L., & Pavlyk, O. (2022). Current Approaches to Organizing the Educational Process in Primary School: a Neuroscientific Approach. BRAIN BROAD RESEARCH IN ARTIFICIAL INTELLIGENCE AND NEUROSCIENCE 13, 1-21. doi:10.18662/brain/13.1Sup1/299

Mendez, P. J., Carabajo, I. R., & Vergara, K. Z. (2018). Neuroscience in the teaching of English. Pro Sciences Revista de Producción Ciencias e Investigación 2(13), 3-10. http://dx.doi.org/10.29018/issn.2588-1000vol2iss13.2018pp3-10

Owen, J. (2024). Neuroscience of Education in the Classroom. ResearchGate. https://www.researchgate.net/publication/380728488_Neuroscience_of_Education_in_the_Classroom

Ranganathan, P. (2019). Understanding Research Study Designs. Indian Journal of Critical Care Medicine. doi:10.5005/jp-journals-10071-23314

Risna, Dewi, L., & Suparjoto, E. (2024). Need Analysis Of EGRA Training With Neuroscience Approach For Teachers As A Foundation For Improving Basic Literacy Of Early Grade Students. Educational Administration: Theory and Practice, 30(6), 3049-3054. doi:10.53555/kuey.v30i6.5961

Seven, M. A. (2020). Motivation in language learning and teaching. African Educational Research Journal, 8(2), 62-71. doi:10.30918/AERJ.8S2.20.033

Stratton, S. J. (2023). Population Sampling: Probability and Non-Probability Techniques. Prehospital and Disaster Medicine 38(2), 147-148. doi:10.1017/S1049023X23000304

Syahputri, D. (2019). The Effect of Multisensory Teaching Method on The Students' Reading Achievement. Budapest International Research and Critics in Linguistics and Education 2(1), 124-131. doi:10.33258/birle.v2i1.192

Tambunsaribu, G. (2019). A Neuroscience Implementation in Learning English tobe for English Learners in Indonesia. Jurnal Penelitian Komunikasi, 1(1), 86-94. http://repository.uki.ac.id/2112/1/ANeuroscienceImplementation.pdf

Thomas, M. S., Ansari, D., & Knowland, a. V. (2019). Annual Research Review: Educational neuroscience: progress and prospects. Journal of Child Psychology and Psychiatry 60:4, 477–492. https://doi.org/10.1111/jcpp.12973

Uden, L. (2023). Why Neuroscience is Important for Teaching and Learning. Open Access Journal of Education & Language Studies 1(1), 1-3. https://juniperpublishers.com/oajels/pdf/OAJELS.MS.ID.555554.pdf

Vorhauser, S. (2019). The Neuroscience Of Learning & Development Pageup People White Paper. PageUp People, 18. https://www.pageuppeople.com/wp-content/uploads/2012/06/Neuroscience-of-Learning-and-Development1.pdf