Neurodidactics and vocabulary acquisition in Cuban teacher trainees: Emerging trends

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This study deals with the emerging field of neurodidactics and its implications for vocabulary acquisition. More precisely, the article presents a bibliometric analysis of a dataset comprising 32 papers from 24 sources, spanning the period from 2011 to 2023. The data were acquired from Web of Science and analyzed using the R-Bibliometrix package. The study identifies research trends, emerging and interdisciplinary areas, as well as citation factors, providing also a brief overview of the current state of vocabulary acquisition in Cuban language teaching in general, and in teacher training in particular. It aims to offer a global perspective on neurodidactics and an overview of its impact on vocabulary learning in the Cuban higher education system. Additionally, it identifies research gaps and suggests avenues for future studies and educational innovations.

Keywords: *bibliometrics, neurodidactics, teacher training, vocabulary acquisition*

1. Introduction

Hippocrates, the most influential Greek academic of the 4th century B.C. considered the father of medicine, stated in the period of 460-379 B.C. that the brain was not only the organ of sensation but also intelligence (Ferreira 2012). Inspired by Hippocrates and his followers, research on neurodidactics began. This discipline dates back to 1988 when Friedrich and Preiss claimed that this new field has the potential to optimize the teaching-learning process through the implementation of neuroscientific contributions in the educational field (Fernández Palacio 2017). Neurodidactics is considered an invaluable approach because it engages learners, encouraging them to touch, do, experiment, play, and be involved in their learning. So far, it has been scientifically tested that the teaching and learning process will increase enormously if education is adapted to control the brain and not vice versa (Guachi et al. 2022). In addition, people utilize a holistic

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process when they learn something in which thinking, feeling, and acting are inextricably linked, mainly focused on experiences (Petlák and Schachl 2019). The labour of the new teachers is to develop each student's maximum potential by drawing on the brain's processes, which can be applied in education.

Considering the advantages that neurodidactics brings to education, teacher trainers in Cuba are interested in studying this discipline and have begun to implement it, although in a restricted manner due to the lack of in-depth research and the limited training of educators on this topic at all educational levels. This article aims to present the current state of vocabulary acquisition through neurodidactics in the world and in Cuban teacher trainees of Foreign Languages Major in Higher Education by identifying emerging trends and key experiences.

As part of a qualitative study, a search was carried out in April 2024 through a bibliometric analysis of the literature on the connection between neurodidactics and vocabulary acquisition in foreign language teaching. The purpose has been to uncover trends, patterns, and predominant areas of interest in the scientific literature, and to assess the current state of neurodidactics in the international scenario. Leveraging the Web of Science platform as a primary data source enables a comprehensive examination of academic production in this domain. The bibliometric analysis offers a general idea of existing research on neurodidactics and vocabulary acquisition in foreign language teaching, while also identifying potential areas for future research and educational practices. The search comprises the period from 2011 to 2023.

The goal of this study is not only to disclose the current state of research on neurodidactics but also to offer a scientific reference for future directions within this field. The international interest demonstrates its relevance to society and justifies the present study.

2. Literature review

Neurodidactics involves the strategic perception and enhancement of education, drawing upon an understanding of sensory preferences, brain structure, variations in brain hemispheres, responses to stress, learning styles, and diverse forms of memory. This method of education combines and links various views of traditional learning from fresh perspectives. It emphasizes education itself, the individual characteristics of learners, and their motivation to acquire knowledge. In essence, neurodidactics can be regarded as the scientific practice of organizing the educational process by employing the most up-to-date insights into the human brain (Apakina et al. 2020). From another point of view, neurodidactics refers to a

comprehensive approach that enhances the utilization of human and material educational resources by comprehending how the brain functions during the process of acquiring skills and knowledge. This field of study emerges from the fusion of educational neuroscience and the characteristics of specific subjects, whether they are disciplinary, interdisciplinary, or transdisciplinary (Barbosa 2021). In addition, neurodidactics is a new discipline with a huge impact in various academic fields, which is why it is currently undergoing such rigorous study. (Muchiut et al. 2022) specify that neurodidactics and neuroeducation are distinct concepts. Neuroeducation aims to establish a connection between neuroscience and education by applying neuroscience knowledge to the field of education. On the other hand, the uniqueness of neurodidactics lies in its practical application within the teaching domain, specifically in implementing neuroscientific knowledge in the classroom. Building upon the ideas expressed by (Muchiut et al. 2022), neurodidactics can be described as a discipline that combines insights from both neuroeducation and didactics. Its objective is to optimize teaching and learning processes by enhancing methods, strategies, and tools, thus contributing to the identification of the most effective approach to make pedagogical knowledge accessible considering advancements in neuroscience and how the brain learns (Muchiut et al. 2022). From another point of view, neurodidactics is a pedagogical branch embedded in neuroscience that offers a fresh perspective on education. It integrates cognitive sciences and neuroscience to create more effective didactic and methodological strategies. This discipline not only establishes a solid theoretical and philosophical foundation but also encourages enhanced brain development (increasing learning) in an easier and more comprehensible manner for educators (Cueva et al. 2024).

To sum up, different authors have researched the topic of neurodidactics and have defined it as an emerging field of recent theoretical development which presents some difficulties in its definition when it comes to distinguishing it from neuroeducation. It focuses on brain plasticity as a means of access to the educational process. To put it differently, neurodidactics is a field of pedagogy grounded on neurosciences that provides education with an innovative shift, defining it as the joint of neurosciences and cognitive sciences with education, promoting more efficient designs and methodological strategies as its main objective. All this, as well as the fact that it boosts learning, has been consensual among researchers since the emergence of neuroeducation and neurodidactics (Mora and Sanguinetti 1994; Guachi et al. 2022; Sousa 2010; Pedraza and Méndez 2023; Paz Illescas et al. 2019; Paniagua G. 2013; Apakina et al. 2020; Pérez Marrero et al. 2023; Pérez 2017; Hernández García et al. 2022).

3. Materials and methods

Bibliometrics is the application of statistical and mathematical techniques to measure and examine the growth, dissemination, and influence of scholarly publications within the academic community. The field of bibliometrics originated in the previous century, with foundational work from figures such as Lotka and Bradford, after being renewed by other academics (Muritala, Sánchez-Rebull, and Hernandez 2020). The development of bibliometrics has led to its application across various domains. Bibliometric research comprises a range of analytical techniques, including citation and co-citation analysis, keyword connections, authorship, and co-authorship networks, among others (Zupic and Čater 2015). This approach aids in enhancing the rigour and minimise bias in literature reviews, complementing techniques such as structured qualitative reviews and meta-analysis. Bibliometric indicators and indices are significant in evaluating the success of academic performance and scientific research and thus, influence the progress and careers of researchers (Thompson and Walker 2015; Choudhri et al. 2015).

Data were gathered from the Web of Science (WoS) database to compile this article, from 2011 to 2023. The search query was constructed around the key concepts of "neurodidactics" and "vocabulary acquisition." Furthermore, several categories from the WoS database were selected based on their relevance to the research focus. They are as follows: Learning, Students, Education, Language, Teaching, Results, Methodology, Process, Training, Educational strategies, Neuroscience, Neurolinguistics, Skills, Inclusive education, Technology, Self-regulation, Children with special needs, ICT, ICT-supported teaching, Moodle.
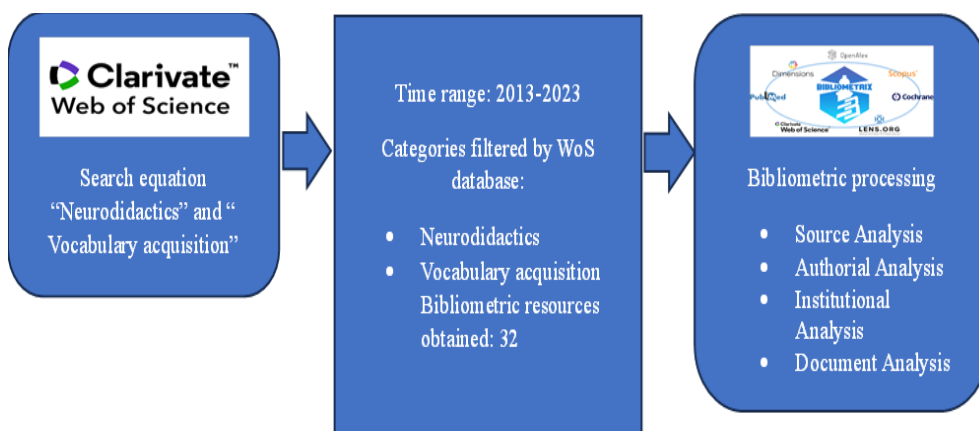

Figure 1. Bibliometric review methodology

The documents were sorted according to the *relevance* criterion, the data were exported in BibTex format to make it fit with various reference management tools and the R bibliometrix package. Criteria such as language were left unchanged. After applying these filters, 32 resources were selected. Figure 1 provides an overview of the methodology.

4. Findings and discussion

4.1. Neurodidactics in the world

This search was conducted in April 2024 and focuses on directing a bibliometric analysis of research on the connection between neurodidactics and vocabulary learning in foreign language teaching. As seen in Table 1, the analysis covers the period from 2011 to 2023, providing an up-to-date perspective on research trends in the field. A total of 32 documents from 24 different sources, including journals, books, and academic resources, were examined. The analysis reveals a notable annual growth rate of 17.6% in scientific production within this domain, indicating increasing interest and research activity over time, while the average age of analysed documents was 4.09 years, suggesting that most of the research in this area is relatively recent. The average quantity of citations per document was 0.5312, which can serve as an indicator of the impact and relevance of the research within the academic population. A total of 804 references were identified in the analysed documents, indicating a solid theoretical foundation for research in neurodidactics and vocabulary learning in foreign language teaching. A total of 13 Keywords Plus (additional keywords identified by Web of Science) and 109 author keywords were uncovered, shedding light on the topics and research methodologies. There were contributions from 91 authors in the analysed documents, with 8 documents written by a single author.

Notably, significant collaboration among authors was evident, with an average of 2.88 co-authors per paper and 12.5% of international co-productions. The predominant publication formats included articles (25), followed by conference papers (5), and reviews (2), indicating the diversity of publication formats used in research within this field.

An evolution of interest in the research is evident by the scientific production of the annual interpretation through valuable insights offered by several articles in the arena of neurodidactics and vocabulary acquisition in foreign language teaching over time. There is a gradual growth in scientific production from 2011 to 2023, even with fluctuations in certain years. The early years (2011-2013) show limited

production, with only 1 article in 2011 and none in 2012 and 2013, indicating an emerging interest in the topic. However, starting in 2014, there was an increase in production, followed by steady growth in later years. It is worth noting the significant increase in production from 2020 to 2023, with five articles in both 2020 and 2021, and a further increase to seven articles in 2023. This upward trajectory suggests increased research activity and a growing interest in the topic during this period.
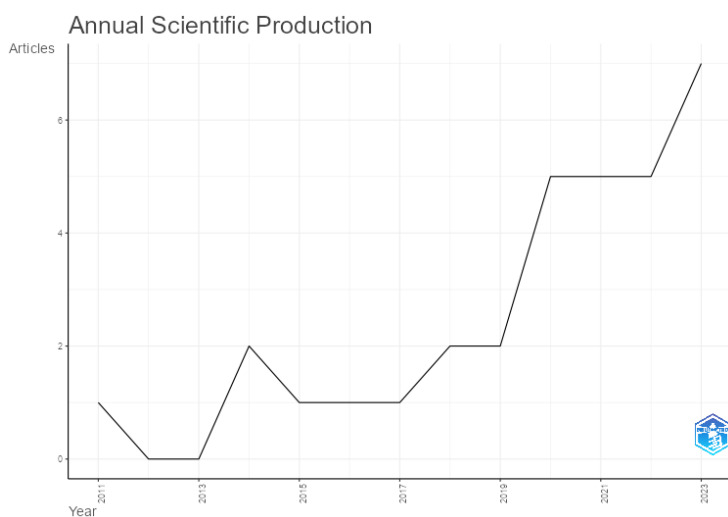

Figure 2. Annual scientific production

The analysis of the most cited documents, along with their citation metrics, provides insights into the impact and relevance of these papers in the arena of neurodidactics and vocabulary acquisition in foreign language teaching.

Citation analysis reveals varying levels of scholarly impact among recent publications in the field. Semprun de Villasmil's paper (2020) demonstrates the highest impact with a normalized citation score of 5, setting a notable benchmark. Following this, Alvarez Fernandiz (2022) has shown remarkable early influence with 2 citations, averaging 0.666 citations per year and achieving a normalized score of 2.5. Ferrer Planchart (2018) has maintained consistent scholarly attention with 7 citations, averaging 1 citation per year and a normalized score of 2, while Estupinan Guamani (2019) matches this normalized score of 2. In the moderate impact range, both Ibanez-Cubillas (2022) and Gonzalez-Caballero (2022) show promising early influence with normalized scores of 1.25 and similar citation patterns, while Kazmierczak's (2017) work has garnered 3 citations with an average of 0.375

citations annually. Von Otter's (2011) conference presentation maintains a normalized citation score of 1, indicating sustained but modest scholarly attention. Several other authors in the field have received single citations, suggesting emerging interest in their contributions, though their impact metrics remain to be established over time.

These papers demonstrate varying degrees of impact and relevance to the field, with some showing sustained interest over time and others having an immediate impact upon publication.

Table 2. Citation Factor

Paper	Total Citations (TC)	TC per Year	Normalized TC
FERRER PLANCHART SC, 2018, REV IBEROAM EDUC	7	1	2
KAZMIERCZAK D, 2017, EFFECTIVE DEVELOPMENT OF TEACHERS' SKILLS IN THE AREA OF ICT AND E-LEARNING	3	0,375	1
ALVAREZ FERRANDIZ D, 2022, TEXTO LIVRE	2	0,66666667	2,5
IRENE SEMPRUN DE VILLASMIL B, 2020, REV SAN GREGORIO	1	0,2	5
IBANEZ-CUBILLAS P, 2022, TEXTO LIVRE	1	0,33333333	1,25
GONZALEZ-CABALLERO F, 2022, ESPIRAL	1	0,33333333	1,25
ESTUPINAN GUAMANI MA, 2019, REV INCL	1	0,16666667	2
VON OTTER AM, 2011, EDULEARN11: 3RD INTERNATIONAL CONFERENCE ON EDUCATION AND NEW LEARNING TECHNOLOGIES	1	0,07142857	1

The word cloud visually represents the frequency of terms extracted from the dataset on neurodidactics and vocabulary acquisition in foreign language teaching, as found in the abstracts of the articles. Prominent terms such as 'learning', 'students', 'education', 'teaching', and 'neurodidactics' emerge as the most frequent, indicating their centrality within the research domain. In addition, terms such as 'education', 'language', 'teacher', and 'classroom' highlight the research focus on educational practices, language teaching, and classroom dynamics. In addition, terms such as 'research', 'study', 'results', 'process', 'methodology', and 'techniques' indicate an emphasis on empirical inquiry, methodology, and the study of learning processes and outcomes. Also, terms such as 'brain', 'neurodidactics', 'neuroscience', and 'neuroscientific' suggest interest in understanding language

teaching and learning from a neuroscientific perspective, and possibly exploring the neural mechanisms underlying these processes. The inclusion of terms such as 'training', 'skills', 'development', 'pedagogical', 'practice', and 'effective' underlines the focus on pedagogical approaches, skills development, and teaching practices within language education research. In addition, the presence of terms such as 'foreign', 'music', 'art', and 'technology' reflects the interdisciplinary landscape of the research, potentially exploring the intersection of language teaching with other fields previously mentioned. Overall, the word cloud provides a snapshot of the key themes and concepts prevalent in research on neurodidactics and vocabulary acquisition in language teaching. It provides valuable insight into the focus and priorities within the field, highlighting the multifaceted nature of language teaching research.

Figure 3. Word cloud

The co-occurrence network provides a comprehensive overview of the key issues, concepts, and relationships within the field of neurodidactics and vocabulary acquisition in foreign language teaching, highlighting its interdisciplinary nature and its emphasis on neuroscientific principles, pedagogical practices, and integrative approaches to language teaching.
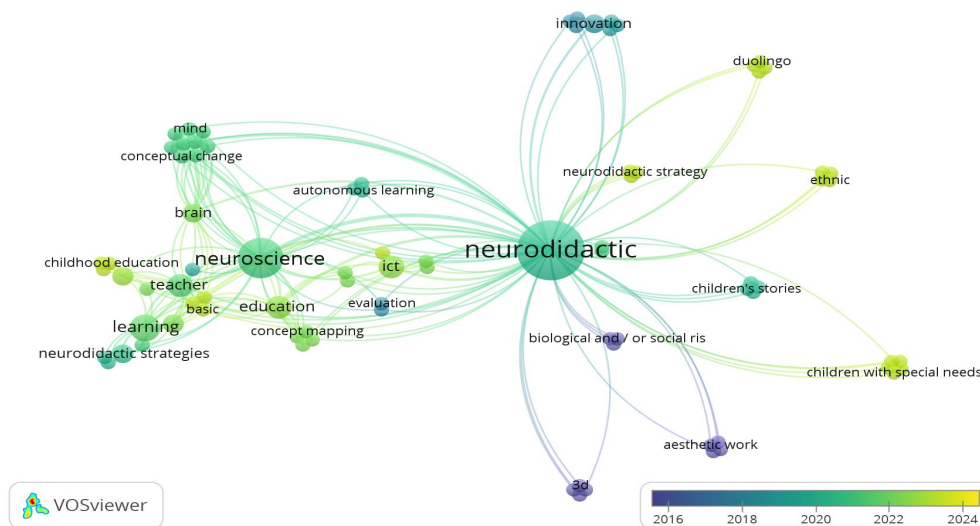
Figure 4. Co-occurrence Network

To conclude, the bibliometric analysis provides a broad summary of the research landscape on neurodidactics and vocabulary acquisition in the context of foreign language teaching. The main trends, patterns, and areas of interest are highlighted in this analysis, shedding light on the evolution and impact of research in this interdisciplinary field. The study of annual scientific production shows a gradual increase in interest and research activity over time, with fluctuations observed in certain years. This evolution reflects the growing importance attached to neurodidactics and vocabulary acquisition in language teaching, as evidenced by the increased research activity in recent years. In addition, the analysis of the most cited documents provides insights into the impact and relevance of key papers in the field. These documents cover a range of topics, from pedagogical approaches to neuroscientific concepts, highlighting the interdisciplinary environment of research in this field. In addition, the inclusion of terms such as 'art', 'inclusive education', and 'technology' emphasizes the interdisciplinary nature of the research, exploring the links between neurodidactics and many other fields such as arts education, technology integration, and inclusive teaching practices.

More generally, bibliometric analysis provides important insights into the present state of research on vocabulary acquisition and neurodidactics in foreign language teaching. Analysing and synthesising the range of literature in this field allows for a deeper grasp of the opportunities, challenges, and emerging trends that are shaping language teaching research and practice.

The database obtained from the Web of Science Platform was studied using the R language software package Bibliometrics[2] (accessed on April 13) and the VOS Viewer[3] (accessed on April 14, 2024).

4.2. Neurodidactics in Cuban teacher education

Strengthening teacher training is one of the main concerns of the Education 2030 project or Incheon Declaration. It suggests the need to innovate teaching and learning methods and content that meet the needs of all learners, educated by trained teachers (Fernández–González 2016). Due to this global need, researchers from all over the world are focused on the continuous improvement of quality in education. Cuba is also immersed in this research to put it into practice in all its educational institutions.

In 2013, the Ministry of Higher Education (MES) highlighted the importance of foreign languages, especially English, emphasizing that it is crucial for success. Since then, this message has been reinforced through various policies and resolutions.

The Ministry of Higher Education aims to improve the teaching process of English in Cuban universities, recognizing the need to reform this process to achieve a higher quality of English language proficiency among graduates. Consequently, this will have a greater impact on the socio-economic and cultural development of the country and its relations with other nations (MES 2017, 5). In 2016, the Cuban Ministry of Higher Education approved the application of the "E" curriculum in all the country's universities, with requirements for more complete training and greater flexibility in the design of the disciplines in the different majors. In this sense, the Pedagogical Major in Foreign Languages considers the teaching process from the point of view of change and creative learning. Moreover, based on the assumed professional profile, the degree course is characterised by the development of cognitive-communicative and linguodidactic competencies from an intercultural and problematic perspective, as a crucial requirement for the formation of more skilled foreign language teachers in their practical actions (Alberteris, Montejo, and Rodríguez 2019).

It is customary to expect that by the end of the first two years of study, students should know how to research, mediate in disciplinary communities, read, and produce texts based on the discourses that frame these disciplines. Conversely, students have serious problems in speaking, reading, and producing the kinds of

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[2] Bibliometrix. https://www.bibliometrix.org/home/
[3] VOSviewer version 1.6.20. http://www.vosviewer.com/

texts specific to the disciplines they are studying (Alberteris, Montejo, and Rodríguez 2019).

After an extensive bibliographic review, it was found that in Cuba there is an institutional project called *Sense and Meaning in Heteroglossia*: a collaborative project in the western part of the country, included in the Faculty of Spanish for Non-Spanish Speakers (FENHI). Its objective has been to design a strategy, based on neurodidactics, that favours the improvement of communicative competence in the teaching-learning process in the Spanish for non-Spanish speakers' course offered at FENHI (Hernández García et al. 2022). The Faculty of Early Childhood Education of the University of Holguin has a research group called *The Neurodidactic Formation of the Professional of Initial and Basic Education*. This work deals with the search for solutions and integrates a series of publications that are part of the research of this group. The leading objective of this job is to analyse the arguments and bases for the integration of neuroscience in teacher training (Pérez 2017). Special education in Cuba also contributes to the field of neuroscience. This subject has been dedicated to a project known as *The Human Brain Mapping Project*, which is the first of its kind to be developed in a Third World country and one of the two projects that include electroencephalography and anatomical neuroimaging. This Cuban project proposes to create the Cuban Atlas of the Human Brain, from birth to old age, as a normative tool to define areas of brain normality. It creates tools for active screening and early diagnosis of different pathologies and is also working on the creation of quantitative tools to improve clinical trials in neuroscience. This project aims to use brain mapping to study learning disorders, mild cognitive disorders, and diseases (Martínez, Chávez, and Calzadilla 2019).

The fieldwork carried out for data collection revealed that another project is being implemented in the province of Santiago de Cuba; this one also focused on neurodidactics, but this time in a kindergarten with children from 3 to 5 years old. In another vein of information, the bibliometric analysis shows that international research tendencies in neurodidactics and vocabulary acquisition are handled by interdisciplinary approaches that combine pedagogy and neuroscience. Key issues turn around neurocognitive processes, effective pedagogical strategies for vocabulary acquisition, and language learning. Neuroscience principles are strongly emphasised, with studies focusing on how the brain absorbs language and the role of some methods such as self-regulation and active learning in developing vocabulary acquisition. Keywords such as 'neurodidactics', 'brain', and 'learning strategies' suggest a profound exploration of cognitive processes. There is also an increasing interest in technology in education, focused on terms such as 'ICT-

supported teaching', 'methodologies', and 'Moodle'. This shows a modern, technology-enhanced pedagogical tendency.

Despite the substantial attention internationally paid to the acquisition of vocabulary as part of language learning, bibliometric analysis does not draw attention to teacher education students in point. Most studies seem to focus on common learners or specific areas, but not particularly on teacher education.

On the other hand, in Cuba, although neurodidactics is integrated into teacher training, the focus seems to be more on practical efforts in communicative competence and teacher development, particularly in early childhood and special education. *The Sense and Meaning in Heteroglossia* project connects neurodidactics with improving Spanish communicative competence, with minimal emphasis on neuroscientific bases and more on language use in context. (Hernández García et al. 2022).

The Human Brain Mapping project facilities on neuroscientific principles but focuses on brain mapping for clinical and educational purposes, such as the diagnosis of learning disorders, rather than direct application in the classroom. At the same time as international research places substantial emphasis on neuroscientific mechanisms in language acquisition, Cuban research while integrating neuroscience, seems more focused on practical results such as language development and communicative competence. There is less direct attention on acquiring foreign language vocabulary in teacher trainees at pedagogical centres. Cuban projects converge heavily on collaborative research and applied strategies to improve educational practice. For example, the Neurodidactic Formation project in Holguín emphasises the integration of neuroscience into early childhood and basic education but does not focus on comprehensive experimental neurocognitive studies (Martínez, Chávez, and Calzadilla 2019).

The research landscape in Cuba reflects an evident lack of direct focus on vocabulary acquisition among foreign language teacher trainees. Although projects such as *Sense and Meaning in heteroglossia* and *Neurodidactic training* address aspects of language learning, no research has been developed that focuses specifically on optimising vocabulary learning for prospective teachers, despite the relevance of vocabulary for their communicative competence.

Although there are several neurodidactic-related projects, there is no evidence of prior research on vocabulary acquisition specifically for teacher trainees in the Foreign Languages major in Cuban Higher Education. For these reasons, a new approach to teaching through neurodidactics could be the solution, where the student plays the central role, driven by the acquisition of vocabulary, based on the systematic use of the four language skills, so that the students' progress is from a linguistic-communicative perspective.

5. Neurodidactic strategies for the 21st century: New trends in vocabulary learning

Comprehensive teacher education for inclusive and equitable education is a global concern, as highlighted in various international conferences organized by *UNESCO*, such as the *Conference on Higher Education for Latin America and the Caribbean (2008)* and the *World Conference on Higher Education (2009)*. In the Education 2030 goals, *UNESCO* sets key targets that address this issue, such as Target V, which aims to ensure inclusive, equitable, and quality education. In addition, Target XIV highlights the need for relevant teaching methods and content, delivered by well-trained and motivated teachers, using appropriate pedagogical approaches to meet the needs of all learners (Unesco, 2015).

Neurodidactics has had a major impact on education today by promoting teaching practices that are more inclusive, effective, and tailored to individual needs, which has positively transformed teaching and learning methods (Cueva et al. 2024). In the same article, Cueva et al. (2024) quote Sousa (2016) who argues that the application of neuroscience in the classroom provides valuable insights into how students process and retain information. According to recent studies, neuroscience-based approaches can optimize teaching by identifying the brain processes involved in learning and creating personalized strategies that match each student's cognitive abilities. According to (García 2022), neurodidactics is based on four fundamental certainties that have been extensively researched and tested. These certainties provide a solid framework for understanding the relationship between neuroscience and education and offer a scientific basis for pedagogical strategies in the classroom. They are as follows: In neuroplasticity, while given the right stimulation, the brain can adapt and change throughout life, forming new neural connections. Equally, mirror neurons are a group of neurons in the brain, that are activated when we observe other people acting. This activation allows us not only to imitate their behavior, but also to understand the emotions and experiences of those around us, facilitating empathy and social interaction. Another important role is played by emotions, for the brain to learn effectively, it needs to experience emotions. Learning associated with emotions tends to be deeper and longer lasting. In addition, factors such as novelty, surprise, curiosity, and creativity intensify emotions and thus contribute to higher quality and longer-lasting learning. On the other hand, through multisensory learning the brain improves its ability to learn when activated through all five senses, i.e. when information is not received through just one sense.

By internalizing the fundamental certainties of neurodidactics that reinforce the importance of social and emotional learning, brain plasticity, and motivation, it is possible to identify a set of strategies, methodologies, and techniques that not

only optimize the acquisition of knowledge but can also be effectively implemented by teachers through technological tools and innovative approaches with the intention of strengthening students' learning in different educational contexts. What follows is a diverse proposal that puts into practice approaches that integrate technology, memorization strategies, and socio-emotional aspects.

As explained in the previous paragraph, technology is also used in language teaching, digital games for language learning can support the development of the four core language skills, they also increase vocabulary and improve grammatical competence. Studies of learning outcomes from digital games have covered several areas, including cognitive outcomes, such as learning performance; behavioral outcomes; and affective or motivational outcomes, sometimes both. Motivational outcomes are often considered a category within affective outcomes, in line with Bloom et al.'s (1984) taxonomy of educational goals. Digital games have also been found to increase exposure to the target language and to encourage greater learner engagement in the learning process (Vnucko and Klimova 2023).

In addition, Mobile-assisted language learning (MALL) has received increasing attention in language learning research (Burston and Giannakou 2022). In particular, MALL has been highlighted as an effective teaching method for second-language vocabulary learning (Lin and Lin 2019), because it provides learners with numerous opportunities to interact, use the language in everyday communication situations, and engage in diverse cultural experiences (Stockwell 2022). Research on the use of technology for vocabulary learning suggests that the use of mobile devices and related technologies tends to improve outcomes compared to traditional materials (Xodabande et al. 2022). Moreover, the incorporation of digital technologies in vocabulary learning has been linked to increased enjoyment, motivation, collaboration, and interaction among learners, as well as improved student performance (Hao, Wang, and Ardasheva 2021). MALL is also seen as a tool that allows students to overcome the physical limitations of the classroom, thereby extending learning opportunities (Hao, Wang, and Ardasheva 2021).

On the other hand, effective memorization techniques are emergent in the field of teaching and highly used to develop vocabulary, i.e. Learning in context: vocabulary learning is most effective when words are learned in meaningful contexts rather than through simple repetition. Rather than memorizing isolated words, aim to understand their meaning within sentences, paragraphs or real-life scenarios. Reading widely introduces a wide range of vocabulary in different situations, which helps both retention and comprehension. Using new vocabulary in context also reinforces its meaning and use. Another very useful technique is Mnemonics are tools that help memory by linking new information with familiar ideas or images. One can create mnemonics such as acronyms, rhymes or mental

pictures to help you associate new vocabulary with familiar ideas or visualizations. For example, to remember the word "gregarious", imagine a friendly group of people laughing and talking. Similarly, making associations between words and their meanings can help to consolidate new vocabulary. You can organize words into clusters or semantic maps by linking them by meaning, usage or theme. For example, linking "verbose" (meaning wordy) with synonyms such as "loquacious" or "prolix" strengthens the understanding of word relationships. Furthermore, spaced repetition involves reviewing vocabulary at intervals that gradually increase over time, improving retention through systematic review. Tools such as flashcards or spaced repetition apps can help to plan review sessions that match the forgetting 'curve', or the natural tendency to lose information over time. By spacing out your practice, you strengthen your memory and minimize forgetting (Jo'raqulov and Urazov 2024).

As (Durlak et al. 2011) observe, Social and Emotional Learning (SEL) programs that are led by educators have been demonstrated to yield beneficial outcomes for students. Moreover, (Shelemy, Harvey, and Waite 2020) posit that the efficacy of these outcomes is contingent upon the SEL competencies of the educators in question. This conclusion is supported by research from (Goroshit and Hen 2016), who found that educators with strong social and emotional learning (SEL) skills are able to foster SEL growth in their students. Furthermore, studies by (Poulou 2017) indicate that educators with well-developed social and emotional learning (SEL) abilities contribute to a supportive classroom environment and enhance students' academic performance.

One of the most applied techniques of Social Emotional Learning is active participation, it is actively engaging with vocabulary through interactive activities such as games, quizzes or conversations can increase retention. Join language exchanges, study groups, or use language learning apps that offer practice exercises that allow you to use vocabulary in real-time contexts. Such engagement not only improves memory, but also increases fluency and confidence with new words (Jo'raqulov and Urazov 2024). Likewise, cooperative and collaborative learning, while similar, differ in their approaches. In cooperative learning, tasks are typically divided among group members who work independently on their portions, while collaborative learning emphasizes collective problem-solving through interaction among members. This approach requires students to adapt their thinking processes to work effectively with others (Curtis and Lawson 2001). Furthermore, collaborative learning aligns with interpretivist principles, which focus on individuals' efforts to make sense of the world and respond accordingly (Bruffee 1993). In collaborative settings, students work in groups towards shared goals, with each member holding equal responsibility for the outcome (Gokhale 1995).

To conclude, the integration of neurodidactic methodologies with social and emotional learning techniques and technology represents a substantial advancement towards a more effective, engaging, and inclusive educational approach. These methods not only facilitate the comprehension and retention of vocabulary, but also address the specific needs of individual students, thereby promoting meaningful and enduring learning. The implementation of these techniques provides a robust foundation for addressing the challenges of contemporary education and achieving learning objectives in the holistic development of students.

6. Conclusions

For the international academic community and in Cuba, neurodidactics is an emerging field of research that has engaged many academics because of its interdisciplinary approach, combining neuroscience and education. Although significant advances have been made in understanding how the brain learns and processes information, most research has focused on general areas of learning, memory, neuroplasticity, cognitive development and the application of neuroscientific principles to teaching in the broad sense. In Cuba, several institutional projects have approached neurodidactics from different angles. For example, the project *Neurodidactic training of primary and secondary education professionals* has addressed pedagogical training based on neurodidactic principles and the project *Sense and meaning in heteroglossia* has studied the construction of knowledge in multilingual contexts. In addition, the *Human Brain Mapping project* has provided advanced knowledge on the functioning of the brain in different educational contexts. Despite the wealth of these studies, none has focused specifically on vocabulary acquisition in foreign language teaching.

In summary, although neurodidactics has been extensively researched both internationally and in the Cuban context, there is a lack of studies that directly relate these advances to vocabulary acquisition in foreign language teaching. This suggests an important research gap, which provides opportunities for future studies to address this area more specifically and in-depth.

References

Alberteris, Orlando, Manuel Montejo, and Maylín Rodríguez. 2019. "Contradictions In The Process Of Enculturation In Foreign Language Disciplines In The Cuban University Context." *Journal Pertinencia Académica* 3(4): 1–21.

Apakina, Liudmila, Vladimir Denisenko, Anastasia Denisenko, Alexander Chistyakov, and Alexandra Zetkina. 2020. "Neurodidactics in Foreign Languages Teaching (for Example in Russian as a Foreign Language)." *Journal of Advanced Pharmacy Education & Research* 10-(1-2020)206.

Barbosa, Edwin Y. 2021. "A Neurodidactic Model for Teaching Elementary EFL Students in a College Context". *English Language Teaching* 14(3): 42.

Burston, Jack and Konstantinos Giannakou. 2022. "MALL Language Learning Outcomes: A Comprehensive Meta-Analysis 1994–2019." *ReCALL* 34 (2).

Bruffee, Kenneth A. 1993. *Collaborative Learning: Higher Education, Interdependence, and the Authority of Knowledge.* Johns Hopkins University Press, 2715 N.

Choudhri, Asim F., Adeel Siddiqui, Nickalus R. Khan, and Harris L. Cohen. 2015. "Understanding Bibliometric Parameters and Analysis." *Radiographics: A Review Publication of the Radiological Society of North America, Inc.* 35(3): 736–746.

Cueva, Elian Jamil Hernández, Walter Darío Ramón Namcela, Karen Rosibel Ramírez Veintimilla, Claudia Estefanía Jiménez Jara, and Adelaida Del Rocio Lima Morocho. 2024. "Neurodidactic Strategies Used by Teachers to Strengthen the Teaching and Learning Process in Basic Education." *Ciencia Latina Revista Científica Multidisciplinar* 8 (1): 1389–1411.

Curtis, David and Michael Lawson. 2001. "Exploring Collaborative Online Learning." *J Asynchron Learn Netw* 5 (February).

Durlak, Joseph A., Roger P. Weissberg, Allison B. Dymnicki, Rebecca D. Taylor, and Kriston B. Schellinger. 2011. "The Impact of Enhancing Students' Social and Emotional Learning: A Meta-Analysis of School-Based Universal Interventions". *Child Development* 82 (1): 405–432.

Fernández Palacio, Ana. 2017. "Neurodidáctica e Inclusión Educativa." *Publicaciones Didácticas* 80 (1): 262–266.

Fernández–González, Noelia. 2016. 'UNESCO (2015). "Replantear la educación ¿Hacia un bien común mundial?" *Journal of Supranational Policies of Education*, no. 4 (July).

Ferreira, Tarcisio Jose de Melo. 2012. *Neurociencia + Pedagogía = Neuropedagogía: repercusiones e implicaciones de los avances de la Neurociencia para la práctica educativa*. Master Thesis, Universidad Internacional de Andalucía.

Guachi, Luis Carlos Quilligana, Byron Roberto Pilamunga Yansapanta, Tatiana Mishel Santacruz Heredia, and Paúl Stalin Espinoza Beltrán. 2022. "La neurodidáctica: una nueva perspectiva de los procesos de enseñanza-aprendizaje." *Polo del Conocimiento* 7 (6): 1266–1282.

García, Melanie González. 2022. "La educación del siglo XXI. Claves para la personalización del aprendizaje a través de la neurodidáctica." *Padres y Maestros / Journal of Parents and Teachers*, no. 389 (March): 36–42.

Gokhale, Anuradha A. 1995. "Collaborative Learning Enhances Critical Thinking." *Journal of Technology Education* 7 (1).

Goroshit, Marina and Meriav Hen. 2016. "Teachers' Empathy: Can It Be Predicted by Self-Efficacy?" *Teachers and Teaching* 22 (7): 805–818.

Hao, Tao, Zhe Wang and Yuliya Ardasheva. 2021. "Technology-Assisted Vocabulary Learning for EFL Learners: A Meta-Analysis." *Journal of Research on Educational Effectiveness* 14 (3): 645–667.

Hernández García, Sandra Meilen, Rómula Llanes Barbuzano, Sandra Meilen Hernández García, and Rómula Llanes Barbuzano. 2022. "Neuroscience, language didactics and awareness of the other." *Journal Varona. Revista Científico-Metodológica*, no. 75 (December).

Jo'raqulov, Amirjon and Mexroj Urazov. 2024. "Effective Approaches for Memorizing and Maximizing Vocabulary". *Conference Proceedings: Fostering Your Research Spirit*, May, 814–816.

Lin, Jen-Jiun and Huifen Lin. 2019. "Mobile-Assisted ESL/EFL Vocabulary Learning: A Systematic Review and Meta-Analysis." *Computer Assisted Language Learning* 32 (8): 878–919.

Martínez-Cepena, Mayelín, Nadia Chávez, and Oscar Calzadilla. 2019. "Characterization of the Integration of Neuroscientific Knowledge in the Study Plans Licensed at Education Specialties". Available at http://repositoriodigital.uct.cl/handle/10925/4287

MES. 2017. *Documento Base Sobre El Perfeccionamiento de La Enseñanza Del Inglés*. Available at https://educa.edu.cu.

Muchiut, Álvaro Federico, Paola Vaccaro, Silvana Cochatok Díaz, Romina Roskiewich, Ariel Horacio Passamani, Sixto Emmanuel Sosa, and Belén Vallejos. 2022. "Evaluation of executive functions through rubrics. An experience from neurodidactics with high schoolstudents." *Journal of Neuroeducation* 3 (1).

Muritala, Babajide, María-Victoria Sánchez-Rebull, and Ana Hernandez. 2020. "A Bibliometric Analysis of Online Reviews Research in Tourism and Hospitality." *Sustainability* 12: 9977.

Paniagua G, María Nela. 2013. "Neurodidactica: Una nueva forma de hacer educación". *Fides et Ratio - Revista de Difusión cultural y científica de la Universidad La Salle en Bolivia* 6 (6): 72–77.

Paz Illescas, Carlos Emilio, Mónica Patricia Acosta Gaibor, Rosa Erlinda Bustamante Cruz, and Carlos Emilio Paz Sánchez. 2019. "Neurociencia vs. Neurodidáctica en la evolución académica en la Educación Superior." *Didasc@lia: Didáctica y Educación* 10 (1): 207–228.

Pedraza, Sully Johanna Calixto and Luz Stella Ahumada Méndez. 2023. "Neuro didáctica como propuesta para mejorar los procesos de aprendizaje." *Ciencia Latina Revista Científica Multidisciplinar* 7 (3): 4837–4851.

Pérez Marrero, Noelia de las Mercedes, Sonia Aurora Ponce Reyes, Fidel Ramón Gonzales Quincho, Noelia de las Mercedes Pérez Marrero, Sonia Aurora Ponce Reyes, and Fidel Ramón Gonzales Quincho. 2023. "Neuro didactic training of teachers from the integration of the knowledge neuroscientist and the employment of the ICT." *Luz* 22 (3): 188–201.

Pérez, Oscar Ovidio Calzadilla. 2017. "La integración de las neurociencias en la formación inicial de docentes para las carreras de la educación inicial y básica: caso Cuba". *Actualidades Investigativas en Educación* 17 (2).

Petlák, Erich and Hans Schachl. 2019. "Neurodidactics and Its Perception by Teachers in Slovakia." *The New Educational Review* 57: 161–172.

Sousa, David A. 2010. *Mind, Brain, & Education: Neuroscience Implications for the Classroom*. Solution Tree Press.

Poulou, Maria S. 2017. "Social and Emotional Learning and Teacher–Student Relationships: Preschool Teachers' and Students' Perceptions". *Early Childhood Education Journal* 45 (3): 427–435.

Shelemy, Lucas, Kate Harvey, and Polly Waite. 2020. "Meta-Analysis and Systematic Review of Teacher-Delivered Mental Health Interventions for Internalizing Disorders in Adolescents." *Mental Health & Prevention* 19 (September): 200182.

Sousa, David A. 2016. *How the Brain Learns*. 5th edition. Thousand Oaks, California: Corwin.

Stockwell, Glenn. 2022. M*obile Assisted Language Learning: Concepts, Contexts and Challenges.* Cambridge: Cambridge University Press.

Thompson, Dennis F. and Cheri K. Walker. 2015. "A Descriptive and Historical Review of Bibliometrics with Applications to Medical Sciences." *Pharmacotherapy* 35 (6): 551–559.

UNESCO. (19-22, mayo, 2015). *Incheon Declaration: Education 2030: Towards inclusive and equitable quality education and lifelong learning for all*. Incheon, Corea: Unesco.

Vnucko, Gregor and Blanka Klimova. 2023. "Exploring the Potential of Digital Game-Based Vocabulary Learning: A Systematic Review." *Systems* 11 (2). Multidisciplinary Digital Publishing Institute: 57.

Xodabande, Ismail, Yasaman Iravi, Behzad Mansouri, and Hoda Matinparsa. 2022. "Teaching Academic Words with Digital Flashcards: Investigating the Effectiveness of Mobile-Assisted Vocabulary Learning for University Students." *Frontiers in Psychology* 13 (June). Frontiers.

Zupic, Ivan and Tomaž Čater. 2015. "Bibliometric Methods in Management and Organization". *Organizational Research Methods* 18 (July): 429–472.

Appendix

Table 1. Key findings from the bibliometric study

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	2011:2023
Sources (Journals, Books, etc.)	24
Documents	32
Annual Growth Rate %	17.6
Document Average Age	4.09
Average citations per doc	0.5312
References	804
DOCUMENT CONTENTS	
Keywords Plus (ID)	13
Author's Keywords (DE)	109
AUTHORS	
Authors	91
Authors of single-authored docs	8
AUTHORS COLLABORATION	
Single-authored docs	8
Co-Authors per Doc	2.88
International co-authorships %	12.5
DOCUMENT TYPES	
article	25
proceedings paper	5
review	2