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NEUROEDUCATION AND MENTAL HEALTH IN HIGHER EDUCATION: THE ROLE OF ADDICTIVE BEHAVIORS IN ACADEMIC PERFORMANCE. A BIBLIOMETRIC ANÁLISIS

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***ABSTRACT*:**

In the past two decades, the intersection of neuroscience, education, and mental health has given rise to an emerging field of research known as neuroeducation, which seeks to understand how brain processes influence learning and the academic performance of university students. Moreover, the increasing complexity of educational contexts has highlighted the need to integrate interdisciplinary perspectives that bring together psychology, pedagogy, and biomedical sciences. The present study aims to address the question: What trends emerge from the co-occurrence network of terms in the scientific literature on neuroeducation and mental health in higher education, and how are these trends related to the role of addictive behaviors in academic performance? To this end, a bibliometric co-occurrence network analysis was conducted on 2,213 terms defined by 4,258 authors. The results reveal four relevant clusters: Cluster 1: Neurobiological and genetic foundations of learning and mental health; Cluster 2: Neurocognitive processes and memory mechanisms in learning; Cluster 3: Neuroimaging and cognitive decline in the study of brain health; and Cluster 4: Psychoeducational interventions and digital technologies for mental health and learning. These findings open new research gaps, where scholars, through the application of quantitative techniques such as structural equation modeling, may generate novel constructs of knowledge

***Keywords**: Neuroeducation, Mental Health, Academic Performance, Bibliometrics, Python.*

INTRODUCTION

In recent decades, *neuroeducation* has emerged as an interdisciplinary field that integrates contributions from neuroscience, psychology, and pedagogy to better understand how the brain learns and how these findings can be applied in educational contexts [1]. In higher education, this approach has become a key tool for designing pedagogical strategies that address the cognitive and emotional needs of students, particularly in scenarios where the complexity of learning intersects with multiple psychosocial risk factors [2].

Mental health in the university setting constitutes a critical axis for students' well-being and *academic performance*. Exposure to situations of stress, anxiety, and depression has shown direct effects on motivation, working memory, and concentration capacity, thereby impacting academic achievement [3]. Recent studies have demonstrated that university students face increasing vulnerability to mental health disorders due to academic pressure, employment uncertainty, and changes in social dynamics [4].

Among the most relevant risk factors in this context, addictive behaviors such as problematic use of psychoactive substances, technological dependence, or excessive internet use pose a significant challenge for learning and social integration [5]. Research has shown that cannabis abuse is closely linked to mental health disorders and cognitive impairments, while internet addiction has emerged as a growing phenomenon that directly affects self-regulation and concentration in university students [6]. Likewise, compulsivity and deficits in inhibitory control have been identified as key factors in the development and persistence of addictions, with direct repercussions on academic performance [7].

Given this reality, it becomes essential to systematically analyze the relationship between neuroeducation, mental health, and addictive behaviors in higher education. A bibliometric approach enables the identification of trends,

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knowledge gaps, and patterns of scientific collaboration that reveal the magnitude of this issue and the academic responses generated over time [8]. This type of analysis not only facilitates a comprehensive understanding of the phenomenon but also lays the groundwork for designing innovative interventions that foster well-being and enhance academic performance within the framework of higher education.

Neuroeducation and Well-being in Higher Education

Neuroeducation has emerged as an innovative discipline that integrates knowledge from neuroscience and pedagogy to enhance learning processes in higher education. Its application seeks not only to optimize cognitive functions but also to promote the integral well-being of students, acknowledging that emotions, motivation, and mental health status are fundamental components of the educational process [9].

Academic well-being is closely linked to brain development and the cognitive capacities characteristic of the university stage. Late adolescence and early adulthood represent critical phases of neural plasticity, during which the brain undergoes changes that directly affect the acquisition of learning skills and emotional regulation [10]. While these transformations provide opportunities for the development of higher-order competencies, they also expose students to increased vulnerability to psychosocial risk factors.

Recent research has highlighted that interventions such as acute physical exercise have the potential to enhance cognitive functions and, consequently, improve academic performance [11]. These findings reinforce the premise that learning does not rely solely on formal instruction, but also on practices that strengthen both physical and mental health, in alignment with the principles of neuroeducation.

Similarly, the early identification of symptoms related to stress and anxiety is essential for implementing educational strategies that prevent declines in performance. Depression, which is highly prevalent among the university population, has been associated with difficulties in concentration, memory, and motivation dimensions that neuroeducation seeks to address through a comprehensive approach [12].

Finally, the importance of social support and positive educational environments has been underscored as a decisive factor for academic resilience [13]. By considering emotional well-being alongside learning, neuroeducation enables the construction of educational experiences that strengthen intrinsic motivation, self-regulation, and students' capacity to cope with the challenges inherent to higher education.

Mental Health and Risk Factors in University Students

The mental health of university students constitutes a central axis in understanding academic performance and persistence in higher education. Various studies indicate that the risk factors associated with psychological vulnerability range from interpersonal experiences to biological conditions that predispose individuals to the development of disorders [14]. These factors directly affect concentration, motivation, and memory, thereby generating a significant impact on learning.

Evidence shows that some risk conditions have an early origin. Prenatal exposure to alcohol, for example, has been associated with an increased risk of developing alterations in emotional regulation and cognitive function throughout life [15]. This finding underscores that mental health problems in higher education should not be understood solely as phenomena isolated to the university stage, but rather as part of broader developmental trajectories.

Currently, digital contexts have introduced new challenges for psychological health. Interventions aimed at reducing stress through digital programs have shown potential to decrease anxiety and improve emotional regulation among students [16]. However, constant access to virtual environments also increases exposure to situations of cognitive overload and technological dependence, which operate as emerging risk factors.

Another key aspect is cognitive decline, which is recognized as a risk associated with conditions such as depression, anxiety, or prolonged stress [17]. Among university students, this decline manifests as difficulties in sustaining attention, retaining information, and solving complex problems, directly affecting their academic performance.

Contributions from developmental neuroscience help explain how certain vulnerabilities become consolidated during youth, a stage in which the brain is still undergoing maturation processes related to self-regulation and

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impulse control. In this regard, physical activity has been identified as a protective factor that helps prevent anxiety and depression, thereby improving both mental health and academic well-being [7].

Taken together, these findings reflect that mental health in higher education is the result of a complex interaction between biological, psychological, and social risk factors, which can be mitigated through preventive strategies and institutional support programs.

Addictive Behaviors and Their Relationship with Academic Performance

Addictive behaviors represent a critical factor that directly interferes with the academic performance of university students. The impact of these behaviors is not uniform; there are individual variations in how students respond to the processes of addiction and recovery attempts, resulting in different trajectories in the academic domain [18]. These differences highlight the need to understand addiction not only as a clinical phenomenon but also as a determinant of educational and social opportunities.

Associative learning plays a central role in the consolidation of addictive behaviors, as repeated experiences of reward or relief reinforce patterns of consumption [19]. This dynamic has a direct counterpart in education, as it alters the brain circuits involved in memory, motivation, and decision-making functions that are essential for academic success.

Several studies have demonstrated the association between substance use and significant cognitive impairments, including deficits in attention, inhibitory control, and working memory [20]. Such deficits hinder academic performance, increase the likelihood of academic failure, and limit students' ability to achieve their educational goals.

The emergence of new substances, such as certain benzodiazepine-type drugs, represents an additional risk, as it broadens the spectrum of possible addictions and exposes students to cognitive and emotional consequences that remain insufficiently studied [21]. This phenomenon reflects the constant evolution of risks associated with substance use and underscores the need to update prevention strategies in higher education.

Finally, although some neuropsychiatric conditions, such as schizophrenia, are not addictions per se, they share vulnerability trajectories that affect self-regulation and learning capacity in young individuals [22]. This reinforces the notion that addictive behaviors should be addressed within a broader mental health framework, one that considers both the risks of substance use and the neurobiological predispositions influencing academic performance.

Intervention and Support Strategies in Higher Education

Universities face the challenge of addressing the growing mental health needs of their students through intervention strategies that combine scientific evidence with practical applicability. Advances in functional neuroimaging techniques have enabled the design of more precise programs for the detection and monitoring of cognitive and emotional alterations, thereby strengthening the foundation of psychological support plans within the academic setting [23].

A growing area of attention is the identification and treatment of conditions such as attention deficit hyperactivity disorder (ADHD), whose presence among university students affects concentration, self-regulation, and academic performance. The implementation of adapted educational strategies and psychotherapeutic support has shown positive results in improving performance and fostering the inclusion of these students [24].

Multidomain interventions that integrate physical, emotional, and cognitive components have demonstrated significant effectiveness in reducing symptoms of anxiety and depression, as well as in strengthening academic resilience [25]. Such programs are particularly useful in universities seeking to address the diverse needs of their student populations.

Complementarily, computational psychiatry has begun to provide tools for personalizing interventions through the analysis of individual data. These strategies allow for the anticipation of risks and the provision of targeted support, thereby contributing to the optimization of both prevention and treatment of mental health problems in university students [26].

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Finally, recent neurocognitive models have supported therapies focused on emotional regulation and self-reflection, which help students develop coping skills in the face of academic stress [27]. By integrating scientific advances with pedagogical practices, these initiatives strengthen the role of higher education not only as a promoter of learning but also as a driver of the integral well-being of future professionals.

Applications of the PRISMA Methodology in Neuroeducation and Mental Health and Their Link to Behaviors

The application of the PRISMA methodology has been fundamental in ensuring transparency and rigor in systematic reviews addressing the intersection between neuroeducation, mental health, and behaviors. In recent studies, this tool has facilitated the organization and analysis of available evidence on the ethical and social challenges derived from the early prediction of severe mental disorders, highlighting how such developments influence the understanding of behavior and the design of educational and clinical interventions [28].

Likewise, PRISMA has been applied in research on contemplative pedagogy, such as the incorporation of yoga in higher education, which has shown positive effects on mental well-being, self-control, and students' adaptation in contexts of high academic demand. These findings demonstrate how healthy behaviors can be strengthened through pedagogical strategies that are systematically integrated and documented [29].

Finally, reviews supported by PRISMA have also made it possible to evaluate multidomain interventions, such as the use of somatosensory digital dance games, linking physical activity, cognitive stimulation, and mental health. Such studies have reported improvements in cognition, quality of life, and behavioral regulation, confirming the relevance of rigorous methods to identify trends that connect neuroeducation with psychological well-being [25].

Interquartile Analysis and Its Relationship with Neuroeducation, Mental Health, and Behavioral Patterns

Interquartile analysis constitutes a key statistical tool for understanding variability and data dispersion in studies related to neuroeducation and mental health. By dividing the distribution into quartiles, this approach enables the identification of behavioral patterns and critical segmentations within heterogeneous populations, which is essential for the design of educational and therapeutic interventions. For example, research on the relationship between diet and psychological well-being shows inverse associations that can only be observed when evaluating interquartile ranges, as it is within these intervals that significant differences in individual exposure and response are identified [30]. Similarly, studies focused on mental health in trauma contexts demonstrate that subgroup analysis through interquartile methods facilitates the detection of risk and resilience factors that directly affect cognitive and academic performance. Thus, the application of this statistical technique goes beyond the numerical dimension, becoming an interpretive bridge between neuroeducation and mental health, and revealing how both adaptive and dysfunctional behaviors emerge and consolidate across different population levels [31].

Therefore, the present study seeks to answer the question: What trends emerge from the co-occurrence network of terms in the scientific literature on neuroeducation and mental health in higher education, and how are these trends linked to the role of addictive behaviors in academic performance?. It proposes the following hypothesis:
H1: The analysis of the co-occurrence network of terms will make it possible to determine the trends related to neuroeducation and mental health in higher education, as well as the role of addictive behaviors in academic performance.

The proposed hypothesis asserts that the analysis of co-occurrence networks can reveal trends concerning neuroeducation and mental health in higher education, alongside the impact of addictive behaviors on academic performance. This claim is supported by the review of abstracts analyzed, which reflect a growing scientific concern with integrating findings from cognitive neuroscience and psychology into the university context, with particular emphasis on factors influencing students' psychological well-being and academic achievement.

First, the literature demonstrates that the link between mental health and learning processes constitutes an expanding area of interest, addressing issues ranging from the influence of psychosocial stress and anxiety to the impact of addictions on memory, concentration, and higher cognitive functions. These connections suggest that academic performance cannot be analyzed in isolation, but rather in interaction with emotional, behavioral, and contextual variables. This reinforces the relevance of applying bibliometric methodologies capable of mapping such complex relationships.

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Furthermore, studies in this field emphasize the incorporation of neuroscientific and technological methodologies for the study of cognition, such as neuroimaging techniques, neural network analysis, and machine learning models. These approaches not only enrich the field of neuroeducation but also broaden the possibilities for identifying patterns associated with the effects of addictive behaviors on student performance. The co-occurrence of terms related to neural plasticity, memory, and psychological disorders further underscores the need for an integrative analysis capable of detecting representative thematic clusters.

Another recurring aspect in the literature is the interdisciplinary nature of the field, where psychology, education, medicine, and digital technology converge. The diversity of terms employed (mental health, well-being, addictions, learning, neuroplasticity, educational intervention) provides fertile ground for the application of co-occurrence network analysis, which can organize this heterogeneity into clear conceptual axes and emerging trends. This is essential for understanding how addictive behaviors interact with mental health and affect academic performance in higher education.

In summary, the justification of the hypothesis lies in the fact that co-occurrence analysis not only enables the systematization and visualization of accumulated knowledge, but also helps identify research gaps and underexplored thematic connections concerning neuroeducation, mental health, and addictive behaviors. In this way, bibliometric analysis emerges as a relevant and necessary tool for uncovering trends, conceptual dynamics, and emerging areas in a multidisciplinary field that is currently consolidating.

METHODOLOGY

Document Selection

Following the best practices established in the PRISMA methodology flowchart (see Figure 1), two databases were selected as sources of references, as they allow for the extraction of most bibliometric measures. Corresponding search equations were designed for each source (see Table 1).

Figure 1. Flujogram PRISMA

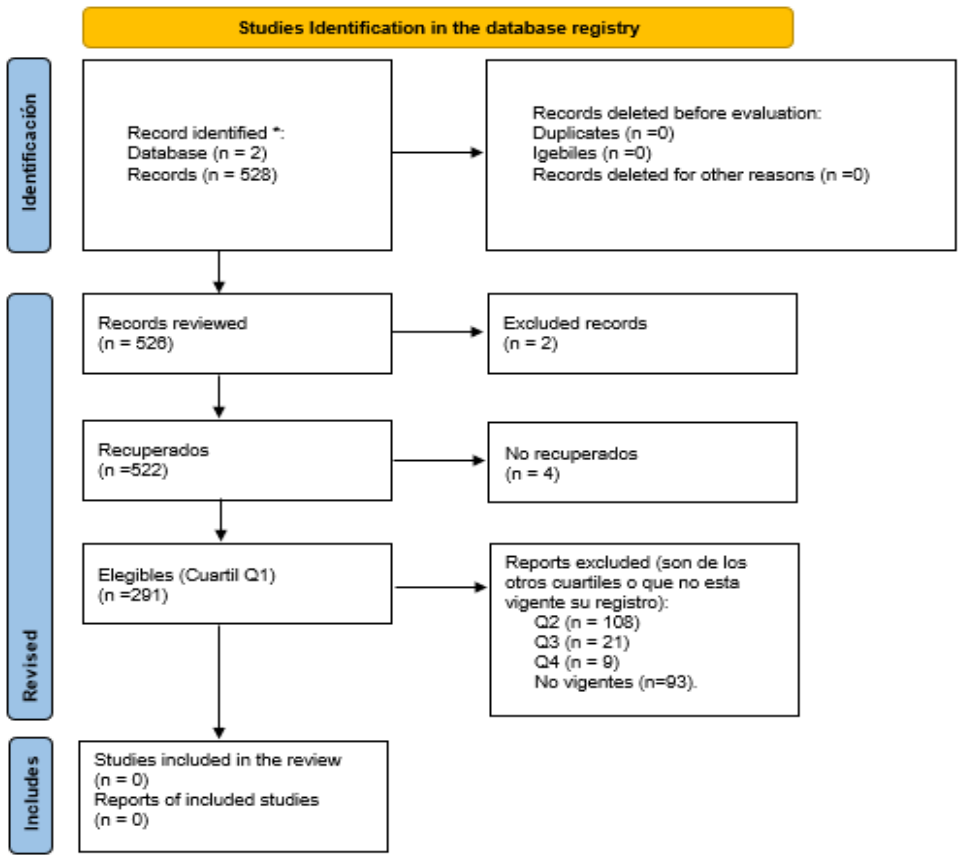

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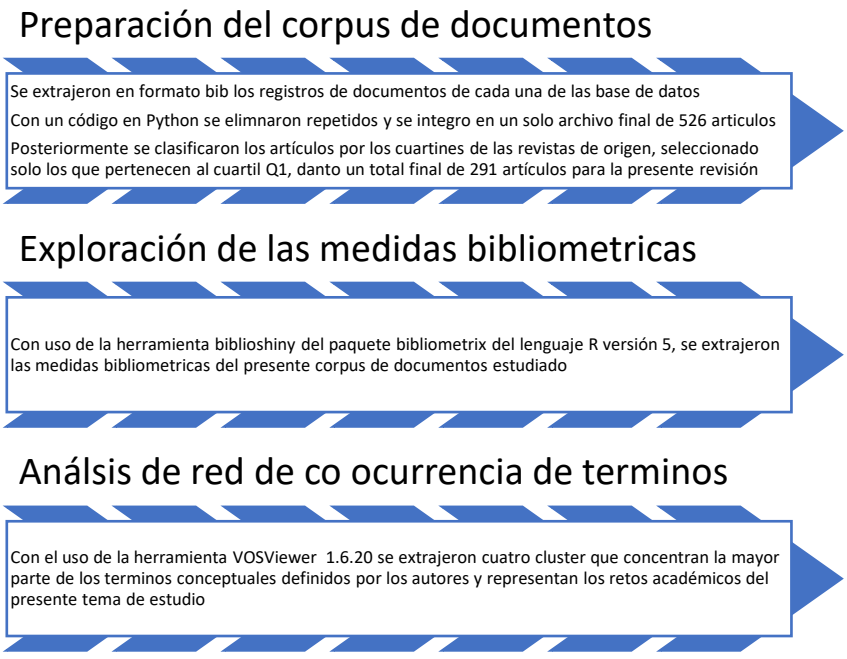
Table 1. Search equation

Data base	Search Equation	Total
Scopus	TITLE-ABS-KEY (("neuro education" OR "neuroeducation" OR "neuro-education" OR "neuroscience education" OR (neuroscience AND education) OR (neuro AND education)) AND ("mental health" OR "psychological wellbeing" OR "emotional health" OR "addictive behavior*" OR "addiction" OR "substance abuse" OR "internet addiction" OR "gaming disorder" OR "alcohol use" OR "drug use") AND ("higher education" OR university OR College OR Academy OR Institute OR "ommunity College") AND (performance OR "academic achievement" OR "learning outcomes")) AND (LIMIT-TO (DOCTYPE , "ar"))	22
Web Of Science	("neuro education" OR "neuroeducation" OR "neuro-education" OR "neuroscience education" OR (neuroscience AND education) OR (neuro AND education)) (All Field) AND ("mental health" OR "psychological wellbeing" OR "emotional health" OR "addictive behavior*" OR "addiction" OR "substance abuse" OR "internet addiction" OR "gaming disorder" OR "alcohol use" OR "drug use") (All Field) AND ("higher education" OR university OR College OR Academy OR Institute OR "ommunity College") (All Field) AND (performance OR "academic achievement" OR "learning outcomes")) Document Type: Article	506
	Summary	528

Bibliometric Analysis

For the bibliometric analysis, the following workflow was established (see Figure 2):

Figure 2. Workflow of bibliometric análisis



RESULTS

Analysis of the Main Bibliometric Indicators

The bibliometric analysis of the topic *Neuroeducation and Mental Health in Higher Education: The Role of Addictive Behaviors in Academic Performance* covers a period of more than two decades, from 2003 to 2025 (see Figure 3), which makes it possible to observe the evolution of scientific production in this field. During this period,

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288 documents were identified, published across 123 sources, primarily scientific journals. In fact, the annual growth rate is 13.43%, evidencing a progressive interest of the scientific community in addressing the relationship between neuroscience, higher education, mental health, and addictive behaviors (see Figure 4A).

With respect to publication impact, the average number of citations per document (0.3056) is relatively low. This may be explained by the novelty and specialization of the topic (see Figure 4B), as well as by the diversity of methodological and contextual approaches through which it has been addressed. The average age of documents (6.85 years) confirms that much of the available literature is in a recent stage of consolidation, which opens opportunities for future research to deepen the field and increase citation levels. The total of 15,184 references included in the analyzed studies demonstrates that, despite the low citation rates, there exists a robust theoretical and methodological foundation that has nourished scientific production (see Figure 4A).

Regarding the content of the documents, 1,061 Keywords Plus and 2,213 author keywords were registered, indicating a wide diversity of conceptual and terminological approaches (see Figure 4D). This suggests that the field is still in the process of semantic delimitation and thematic consolidation, with authors employing different labels to describe similar phenomena. Such dispersion broadens the spread of publications but also reflects the multidisciplinary richness that characterizes neuroeducation and mental health applied to higher education.

The analysis of authorship and collaboration reveals a highly collective field: a total of 4,258 authors were identified, with an average of 18.8 co-authors per document, reflecting large-scale research network dynamics (see Figure 4C).

Taken together, these metrics portray a field in full expansion, sustained by academic collaboration, thematic diversity, and the progressive consolidation of a scientific community interested in linking neuroeducation with mental health and addictive behaviors in higher education contexts. However, the low levels of citation and the absence of international co-authorship highlight the need to strengthen the global visibility of scientific production through strategies of internationalization, conceptual standardization, and the creation of inter-institutional research networks.

Figure 3. bibliometric Measures

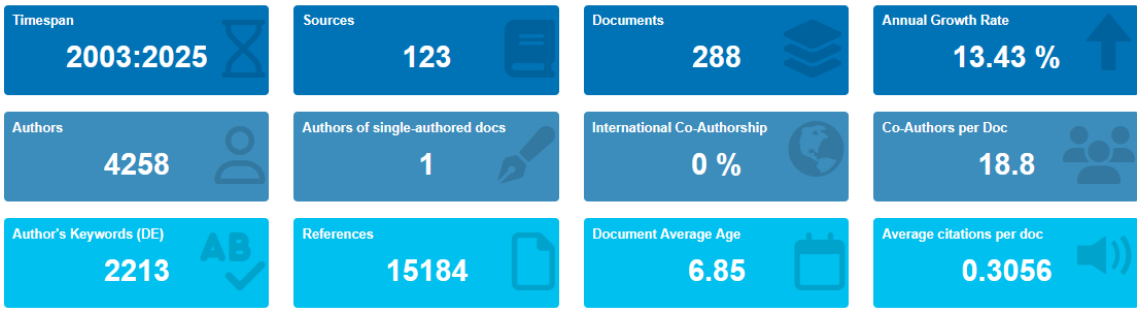
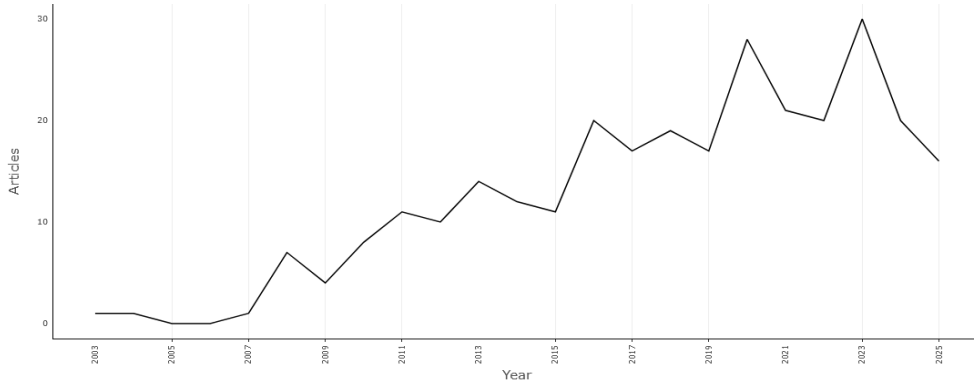


Figure 4. Tendencias de producción científica

A)



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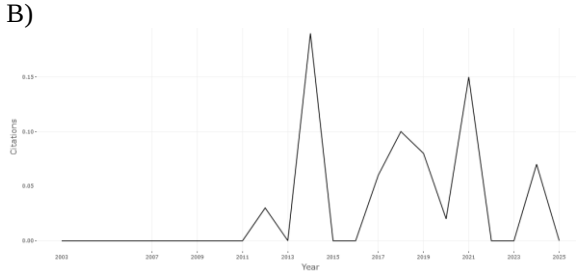
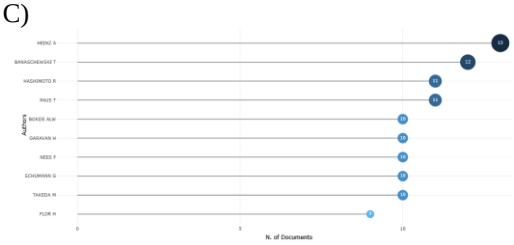
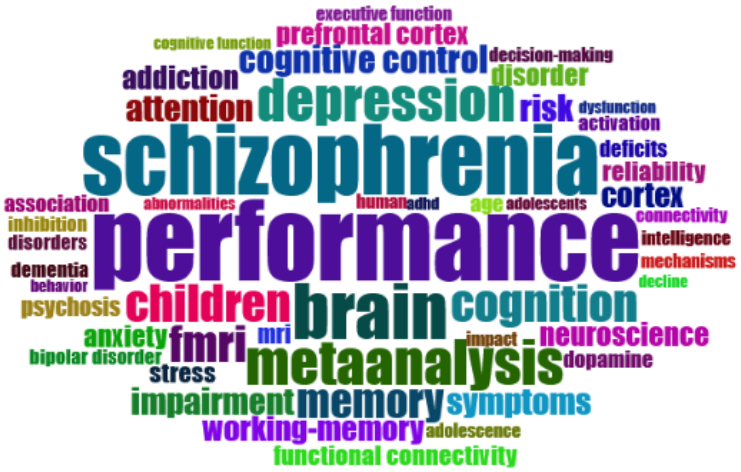
B)



C)



D)



Note: A) Annual Scientific Production. B) Average Citations Per Year C) Most Relevant Authors D) WordCloud

Analysis of Conceptual Term Co-Occurrence

From the analysis of the 2,213 conceptual terms defined by 4,258 authors, four clusters were extracted that concentrate the majority of the terms (see Figure 5). The first cluster was designated **Neurobiological and Genetic Foundations of Learning and Mental Health.** The second cluster was identified as **Neurocognitive Processes and Memory Mechanisms in Learning.** The third cluster was named **Neuroimaging and Cognitive Decline in the Study of Brain Health**. Finally, the fourth cluster was associated with **Psychoeducational Interventions and Digital Technologies for Mental Health and Learning**. The following section presents a literature review of the articles related to each of these clusters.

Cluster 1: Neurobiological and Genetic Foundations of Learning and Mental Health

This designation articulates the relationship between neuroeducation and mental health from a solid scientific basis, highlighting how biological and genetic predispositions influence behavior, learning, and the risk of developing addictive behaviors or academic performance problems (see Figure 6A).

Cluster 1: *Neurobiological and Genetic Foundations of Learning and Mental Health* integrates a body of evidence that underscores the decisive influence of brain processes and hereditary factors on cognitive and emotional development. Various studies have demonstrated that neurochemical regulation particularly through neuropeptides such as oxytocin contributes to strengthening empathy, impulse control, and the consolidation of social bonds, elements that directly affect learning and psychological stability [32]. Similarly, research conducted in populations with comorbidities such as HIV and alcohol abuse reveals that the interaction between biological conditions and lifestyle habits modifies cognitive performance and, consequently, academic and social adaptation [33].

Another fundamental aspect is the role of biomarkers and genetic testing in the early detection of neuropsychological alterations. The assessment of psychometric and laboratory variables has made it possible to identify abnormal patterns associated with developmental disorders and risks of cognitive decline, providing key tools for preventive intervention [34], [35]. In this sense, genes such as *dysbindin* have been linked to specific

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vulnerabilities that affect working memory and emotional regulation, thereby confirming the importance of integrating genetics into the study of learning and mental health [36].

Taken together, this cluster demonstrates that neurobiology and genetics cannot be analyzed in isolation, as their interaction shapes the foundations upon which learning processes and mental health trajectories are built. The convergence of clinical, molecular, and educational approaches opens the possibility of designing more personalized and effective strategies aimed at strengthening both academic performance and overall well-being.

Cluster 2: Neurocognitive Processes and Memory Mechanisms in Learning
Within the framework of the topic *"Neuroeducation and Mental Health in Higher Education,"* this cluster represents the dimension of how the brain organizes, processes, and consolidates information, and how these mechanisms are vulnerable to risk factors (stress, fatigue, psychosocial contexts) that affect academic performance (see Figure 6B).

The study of neurocognitive processes and memory mechanisms constitutes a central axis in understanding human learning. Scientific evidence demonstrates that alterations in functions such as attention, verbal and visual memory, as well as executive skills, can significantly influence academic performance and adaptation to new cognitive tasks [37]. These functions are particularly sensitive to neuropsychological and emotional factors, as observed in populations with late-onset depression, where deficits in memory and visuospatial functions have been reported, compromising the consolidation of learned information).

Furthermore, recent research has identified the prevalence of behaviors and habits that affect cognitive functioning, such as substance use, which impacts memory performance and the efficiency of information retrieval processes [38]. Other studies emphasize the influence of physiological variables on neurocognitive performance, such as calcium and vitamin D regulation, which are associated with synaptic plasticity and memory consolidation at different stages of life [39].

Complementarily, the analysis of neurodegenerative diseases such as spinocerebellar ataxia type 3 shows that genetic disorders also substantially alter working memory and the capacity for progressive learning, highlighting the importance of biological factors in cognitive processes [40]. Taken together, these findings position Cluster 2 as a field in which biological, behavioral, and clinical aspects converge, contributing to an integrated understanding of how memory mechanisms sustain and condition human learning.

Cluster 3: Neuroimaging and Cognitive Decline in the Study of Brain Health
This cluster brings together terms related to the diagnosis, progression, and analysis of neurodegenerative diseases such as Alzheimer's, along with advanced neuroimaging tools (MRI, EEG, voxel-based morphometry, machine learning, segmentation) that enable the quantification of structural and functional changes in the brain (see Figure 6C).

The bibliometric analysis of Cluster 3 shows that neuroimaging has become an essential resource for understanding the processes of cognitive decline and their impact on brain health. Research indicates that modifiable lifestyle factors such as physical activity, social participation, and intellectual engagement are associated with differentiated trajectories of cognitive aging. Using advanced statistical techniques and neuroimaging, evidence has demonstrated that these dimensions contribute complementarily to the maintenance of cognitive functions, whereas mental health does not always present a significant effect in this context [41].

Another central aspect is the prevalence of psychiatric comorbidities that accelerate cognitive decline in older adults. Studies on late-onset depression report significant impairments in verbal and visual memory, verbal fluency, and visuospatial skills, confirming the vulnerability of this population to multiple cognitive deficits. Neuroimaging in such cases allows the identification of specific patterns of brain impairment, providing an objective basis for differential diagnoses and targeted treatments [38].

In addition, research has shown that difficulties in the social and occupational reintegration of psychiatric patients are closely linked to cognitive decline. Barriers such as fear of performance or transitioning into regular work environments reinforce the importance of neuroimaging as a tool to monitor clinical progress and response to cognitive-behavioral therapies, thereby contributing to the optimization of psychosocial rehabilitation [42].

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In parallel, other studies have explored how certain addictions and consumption habits (such as tobacco and alcohol) influence cognitive decline. These findings, when combined with neuroimaging techniques, enable the analysis of neurotoxic effects and differential vulnerability based on gender, education, and health status, expanding the understanding of cumulative risk factors in the aging brain.

Taken together, Cluster 3 confirms that the integration of neuroimaging and cognitive analysis provides a comprehensive perspective for understanding the mechanisms underlying brain deterioration. This convergence not only offers empirical evidence to predict cognitive trajectories but also opens the possibility of personalized preventive interventions, including cognitive stimulation programs, healthy lifestyle habits, and psychosocial support. Thus, neuroimaging emerges as a strategic axis for addressing the multidimensional challenges of brain health across the life cycle.

Cluster 4: Psychoeducational Interventions and Digital Technologies for Mental Health and Learning
This cluster integrates concepts of clinical and preventive mental health (anxiety, depression, distress, well-being, eHealth, e-mental health apps) with educational and therapeutic strategies (cognitive-behavioral therapy, psychoanalysis, early interventions, social and emotional learning, neuroscience-informed education). At the same time, it encompasses the growing relevance of digital and mobile technologies (apps, online interventions, UTAUT, user acceptance) applied to mental health in educational contexts, as well as their implementation among students and professionals in training (medical students, medical curricula, interdisciplinary education) (see Figure 6D).

Cluster 4 reflects the convergence between psychoeducational interventions and the use of digital technologies as support tools for mental health and learning processes. Recent research highlights the importance of training environments within academic laboratories, where the integration of digital resources facilitates the acquisition of competencies and adaptation to high cognitive demand contexts [43]. Likewise, emerging disciplines such as sports science have demonstrated that the use of technological platforms contributes not only to physical performance but also to strengthening motivation and psychological well-being, thereby confirming the educational potential of these environments [44].

Another key contribution stems from evidence on habits and lifestyles, showing that participation in social and cognitive activities is associated with better mental health and reduced cognitive decline. These dynamics, supported by digital technologies, enhance stimulation strategies and allow for the monitoring of individual progress over time [41]. Complementarily, studies on substance use in educational and healthcare contexts have emphasized the need for innovative psychoeducational programs capable of integrating digital platforms for the prevention and early management of risk behaviors [38].

Taken together, this cluster demonstrates that the combination of psychoeducational interventions and digital technologies constitutes a strategic approach to promoting mental well-being and improving learning processes across diverse settings. The incorporation of interactive environments and digital monitoring tools opens new possibilities for the personalization of educational and therapeutic programs, thereby consolidating an interdisciplinary research field with broad social impact.

Figure 5. co occurrece Network

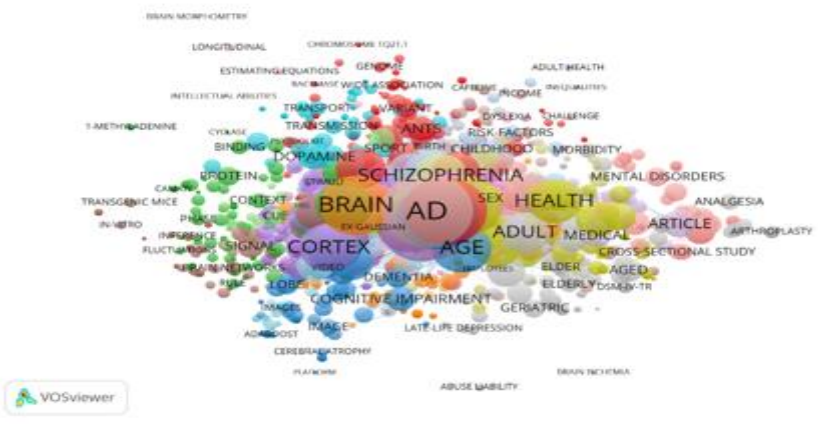

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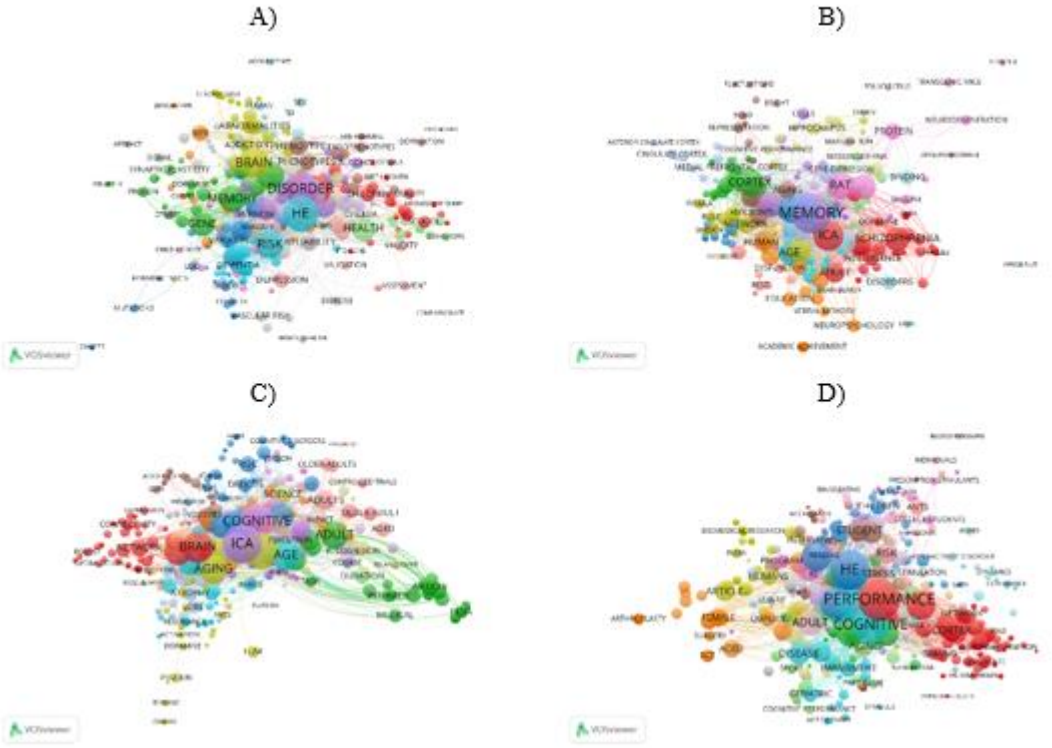
Figure 6. Clusters



Note: A. Neurobiological and Genetic Foundations of Learning and Mental Health B. Neurocognitive Processes and Memory Mechanisms in Learning C. Neuroimaging and Cognitive Decline in the Study of Brain Health D. Psychoeducational Interventions and Digital Technologies for Mental Health and Learning

DISCUSSION

The bibliometric analysis highlights a field in consolidation, characterized by dynamism in scientific production and conceptual diversity around neuroeducation, mental health, and addictive behaviors in higher education. The results show sustained growth in publications since 2003, with an annual rate of 13.43%, confirming the progressive interest of the academic community in the articulation of these topics. However, the low average number of citations per document (0.3056) suggests that, despite the increasing volume of research, further efforts are required to strengthen the visibility and impact of published work, as well as to consolidate international collaboration networks that promote knowledge transfer.

In this regard, the terminological dispersion observed in the more than 2,200 author keywords reflects both a strength and a weakness of the field: on the one hand, it demonstrates the interdisciplinary richness that enables phenomena to be addressed from biological, cognitive, clinical, and educational perspectives; on the other, it hinders the consolidation of a common language that would facilitate the comparison and replication of results. This underscores the need to advance toward conceptual standardization processes that provide greater cohesion for future studies.

The co-occurrence analysis of terms identified four main clusters that together offer an integrative view of the field. The first, focused on neurobiological and genetic foundations, highlights how biological predispositions influence mental health and academic performance, underlining the importance of integrating genetics and biomarkers into educational and preventive interventions. The second cluster, related to neurocognitive and memory processes, evidences the vulnerability of executive and mnemonic functions to risk factors such as stress, fatigue, or addictions, which directly affect academic performance and learning capacity.

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The third cluster underscores the importance of neuroimaging as a key tool for understanding cognitive decline and structural brain changes, both in normal aging and in contexts of psychiatric comorbidity. This approach not only enables more precise diagnoses but also opens the door to personalized interventions aimed at preserving brain health. Finally, the fourth cluster emphasizes the convergence between psychoeducational interventions and digital technologies, highlighting their role in prevention, care, and support for mental health in educational contexts. This last aspect is particularly relevant, as it shows how digitalization and interactive tools enhance new support strategies, expanding the reach of prevention programs and strengthening student resilience.

Taken together, the findings suggest that the field of neuroeducation and mental health in higher education is in an expansion phase but faces challenges related to consolidating a conceptual and methodological identity. The trend toward multidisciplinary collaboration is a strength that should be leveraged to promote comparative research, develop evidence-based interventions, and foster integration between disciplines such as neuroscience, pedagogy, clinical psychology, and educational technology. In this way, a horizon of opportunities emerges, in which strengthening internationalization, adopting emerging technologies, and creating global academic networks will be decisive for consolidating this field as a benchmark for improving learning and well-being in higher education.

CONCLUSIONS

The bibliometric mapping confirms that the intersection between neuroeducation, mental health, and addictive behaviors in higher education is a young yet rapidly expanding field, characterized by sustained growth in scientific production (2003–2025) and strong academic collaboration. The co-occurrence network of terms made it possible to identify four thematic axes structuring the research agenda: (1) neurobiological and genetic foundations of learning and mental health; (2) neurocognitive processes and memory mechanisms; (3) neuroimaging and cognitive decline; and (4) psychoeducational interventions enhanced by digital technologies. Together, these clusters delineate a coherent conceptual framework that links biological and cognitive mechanisms with educational outcomes, as well as the negative or protective moderating role of behaviors and habits.

The findings support the central hypothesis: co-occurrence analysis is well suited to reveal trends and gaps, and to clarify how addictive behaviors are associated with academic performance through executive functions, attention, and memory. Nevertheless, the low average citation rate and terminological dispersion indicate a stage of consolidation: it is urgent to move toward greater conceptual and methodological standardization, as well as to strengthen internationalization and comparability across studies. The rigorous application of PRISMA in reviews and the use of statistical tools such as interquartile analysis contribute to this consolidation by ensuring transparency, delineating biases, and capturing relevant heterogeneities among subgroups.

In terms of implications, the field converges on two strategic lines. On the diagnostic-explanatory side, the integration of neuroimaging with cognitive and psychosocial metrics enables the profiling of risk trajectories and the protection of brain health throughout the educational cycle. On the intervention side, psychoeducational programs especially those incorporating digital tools, continuous monitoring, and principles of social-emotional learning show potential to mitigate anxiety, depression, and problematic use of technologies or substances, with expected benefits in motivation and performance.

Looking ahead, the following are recommended: (i) multicenter longitudinal studies that integrate biomarkers, cognitive metrics, and academic outcomes; (ii) controlled trials of digital and multidomain interventions with standardized reporting of adherence and effects; (iii) FAIR data frameworks to facilitate replication and meta-analysis; and (iv) ethical agendas to regulate the responsible use of neurocognitive data in educational contexts. For higher education institutions, practical translation involves comprehensive policies that combine early detection, mental health literacy, self-regulation training, and curriculum design sensitive to cognitive load.

In sum, the field today possesses a sufficient conceptual and methodological framework to take a qualitative leap: from fragmented description to integrated ecosystems of evidence, capable of transforming pedagogical practices and student support services on the basis of solid, open, and comparative science.

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