Original Article

Problem-based learning and its relationship to neuroscience in undergraduate university students

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Abstract

Problem-based learning and its relationship to neuroscience in undergraduate university students aim to describe the level of knowledge and the ways in which university students transmit the information obtained through neurodidactics in the educational process. To do this, the research is based on a quantitative approach, to establish, including the use of documentary and bibliographic methods, that students in university research centers focus on the use of Problem-Based Learning (PBL) to improve their academic performance. The relationship between PBL and neurodidactics is that this methodology ensures that academic preparation is in accordance with the real interests and needs of students, works on relevant situations of daily life in an interdisciplinary approach and promotes the creation of experiences, and useful and appropriate teaching methods to the context. Research shows that neuroscience-based data can help teachers better choose the most beneficial methods to stimulate students to actively learn, leading to sustained attention and focus.

Keywords: Problem-Based Learning, Neurodidactic, interdisciplinary, academic performance, useful teaching method.

1. Introduction

It is important to remember that most students entering college after high school are teenagers with different quali-quantitative grades than teachers at the same stage of life, and the educational requirements are unprecedented in the 21st century. The formal educational process at all levels poses considerable challenges typical of the new era, so the potential contribution of other scientific disciplines that can help improve the quality of learning must be considered. Neuroscience is an interdisciplinary field that studies everything related to the brain and nervous system (Araya and Espinoza, 2020).

Recent discoveries have gone beyond medicine to fields such as marketing, psychology, education, and more. The interdisciplinary nature of neuroscience allows for a comprehensive understanding of human behavior.

As Lozoya et al. (2018) explain, the relationship between education and neuroscience has been built since 2000 by the direct relationship between neural networks and learning. According to Herández et al. (2019), to implement adequate teaching it is necessary to understand the biochemical functions of the brain, since these processes at the cellular and tissue level are responsible for the creation of knowledge.

Therefore, it is possible to understand how the information received by the sensory organs is transmitted to the integration center by electrochemical processes through the path of entry and then a response is given.

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As research on cognitive function and its biological basis continues, the brain is made up of multiple neural networks that change and regulate themselves specifically with each experience.

During the learning process, each student feels and perceives sensory information individually and uniquely; each build, changes, and reorganizes its own network of neurons in the cerebral cortex, and each builds its own learning (Benavidez and Flores, 2019). This is an important link between neuroscience and education. Each person's unique characteristics and learning are closely related to the neural processes that occur in the nervous system and brain. As Espinoza et al. (2022) reveal, this relationship is increasingly strong and accepted in the world of education. The interest in improving the quality of learning is not limited to the contribution of neurosciences at the university level. Scientific support is also sought for pedagogical innovations used in university classrooms.

Pherez et al. (2018) and Figueroa and Farnum (2020), demonstrated that there is a need to explore the contribution of neuroeducation as a response to the demands of the new educational environment, where it is necessary to understand the neural aspects of learning. This integration of knowledge can support the role of the teacher by orienting teaching and learning strategies accordingly and allowing a deeper understanding of many aspects that intervene in the educational process and that are chronically decontextualized.

Language, voice, action, preference, creativity, ideas and emotions interact simultaneously in the interaction between teacher and student, forcing university education to take into account not only cognitive but also procedural aspects in the first place; emotionally, socially and axiologically, thus freeing itself from repetitive contents and responding satisfactorily to the educational needs of the 21st century.

Neuroscience emerged from neuroeducation and guides teaching practice through instructional strategies that integrate learning with the capabilities of the brain. These disciplines, such as neuroscience, are constantly developing and evolving, and it is the responsibility of teachers to integrate them as lesson plans and educational research evolve. Machado et al. (2013), proposed three neuroscientific principles: interaction, balance, and panoramic vision. The principle of interaction occurs when the learner shares all his sensory resources, is awake and in an active state of information processing. The principle of balance occurs when different regions of the brain are stimulated, resources that include both hemispheres (analytical and metaphorical) and the content chosen is collaborative and interdisciplinary. Holistic principles are realized when the interaction of cognitive and affective processes is carried out, self-esteem and multiple intelligences are valued and lifelong learning is developed (Cantú et al., 2017).

Neurodidactic strategies focus on creating meaning, maintaining engagement with other students, analyzing contextual concepts and situations, solving problems, applying content to the real world, creating new solutions, and developing thinking from proper management of emotions to metacognition. Araya and Espinoza (2020) affirmed that the contribution of neuroscience to educational activities can generate changes and developments in evaluation systems and educational practices. Pherez et al. (2018), suggest that teachers should consider neurological evidence to actively promote meaningful learning in students.

In this sense, Rico and Puentes (2016), affirm that teachers who use neuroscience strategies become agents that modify the structure and electrochemical activity of the brain through new and interesting learning. Practical strategies are a set of creative stimuli that teachers plan to deliver content and respond to the interests of students and the particularities of the educational environment. Social and emotional strategies involve connecting the emotional components of teachers and students. These strategies provide a stronger commitment to active learning and experience. Systems strategies include activities that enhance research, analysis, and knowledge creation through logical processes and are supported by operational, social, and emotional strategies.

Based on the problem, the main objective of this study was to describe the level of knowledge and the ways in which university students transmit the information obtained through neurodidactics in the educational process.

2. State of the Art

The use of neurodidactic strategies involves focusing on how students learn. Freiberg et al. (2017) show that learning styles refer to specific ways in which students attribute knowledge and make it their own. Emotions are another important aspect of learning in 21st century schools and universities. Positive emotions have been shown to stimulate the production and release of dopamine, a neurotransmitter involved in many mental, cognitive, and emotional processes, but primarily responsible for the feeling of pleasure and relaxation.

According to García Retana (2012), when students enjoy or experience pleasant situations in the classroom, it translates into benefits for cognitive performance and learning. Emotions identify the stimuli to which attention is directed, allowing us to send information to memory for subsequent retention and influence behavior.

Positive emotions link learning, joy and happiness Mayorga et al., 2022). Therefore, neurodydatic strategies differ from traditional teaching methods in that they bring new experiences to the classroom, consider the development and learning needs of students' brains, and allow for lifelong learning experiences. As the opportunities offered by universities increase, these institutions want to know whether students accept or recommend the experiences they offer (Morelato et al., 2019).

In this way, it is important to understand what the student community thinks about professional activities and offerings. Student satisfaction depends on many experiences inside and outside the classroom. This is a multidimensional process that requires multifaceted analysis.

According to García and Carrizales (2021), academic satisfaction includes mental health and enjoyment of the academic experience, which are closely related to student participation and graduation. With academic success, so do students. The authors propose that to understand student satisfaction, the role of teachers must be considered as variables that directly affect them, in turn they argue that staff, faculty, professional opportunities, university infrastructure and prestige are the most important factors that influence student satisfaction.

Thus, different aspects of teaching mainly determine satisfaction. Surdez et al. (2018), consider that the quality and personalization of teaching are factors that directly influence the satisfaction of university students. Rodríguez et al. (2020) point out that student satisfaction is influenced by the role of teachers and the quality of teaching. Álvarez et al. (2015) argue that satisfaction with the learning process influences identification with institutions; and that satisfaction in a university environment is related to what happens in the classroom and attention to students.

The analysis of academic satisfaction by González-Peiteado et al. (2017) is a good way to see if teachers are meeting student expectations. Surdez et al. (2018) suggested that teachers' assessment of student satisfaction can improve the learning process. Luque Vilca et al. (2022) concluded that the level of satisfaction is reflected in positive assessments of the university, the faculty and the immediate environment.

In general, we believe that immediate academic achievement, considered a quantitative trait, can be understood as a reflection of success if teachers consider cognitive, affective and ecological aspects in the evaluation process and throughout the curriculum.

Martín Pavón et al. (2018) showed that one of the institutional factors of academic performance is the teacher-student relationship. The authors explain that this interaction sets expectations for the affective and pedagogical relationships that students form with teachers, and these relationships influence academic performance. Feliz et al. (2022), report that teaching strategies are strongly related to academic performance. Likewise, Pamplona et al. (2019) show that, among other variables, the didactic strategies used by teachers are an important part of understanding the academic performance achieved.

Arenas (2017), determines that didactic strategies that support different learning styles allow students to identify their preferences, promote skills development and improve academic performance. Therefore, metacognition is a determinant of academic performance, where good satisfaction leads to good academic performance and vice versa.

3. Methodology

This study is based on descriptive and methodological evaluations, since the results of critical thinking in an educational context come from problem-based learning with the aim of creating or expanding knowledge. Knowledge and literature will be considered as the only academic references that support and validate the context of this study (Pérez and Rodríguez, 2017).

In addition, secondary data sources were examined in accordance with the Principles for Reporting Materials for Systematic Reviews and Meta-Analyses (PRISMA) (Urrutia and Bonfill, 2010). For the purposes of this article, a systematic review of the literature was carried out, considering the following inclusion criteria:

i. Examine effective scientific papers in which students' abilities are analyzed in an academic context relevant to the development of problem-based learning and its relationship to neurodidactics.

ii. Active methodologies associated with problem-based learning, represented by a sample of 25 scientific sources collected from the Scopus, Web of Science and Ebsco databases, for the period from 2015 to 2022

4. Results and discussion

Neuroscience should be considered not only as a discipline, but also as a set of sciences with the theme of cognition and emotions, with special attention to the connection between brain activity and the behavior and learning of students of the first cycles of the university. According to Araya and Espinoza (2020), the overall goal of neuroscience is to understand how the brain produces the characteristics of human behavior.

Brain-friendly instructional design is a real challenge to the university educational process. The challenge is to create a new paradigm that combines natural learning with the latest technology. Analyze gaps between current teaching practices and best learning practices. The answer is not why it can't be done, but how it can be done.

4.1 Neurodidactic strategies and learning styles

On the one hand, while neurodidactic strategies consider learning styles, promote skill development, and improve academic performance (Estrada, 2018), the planning process is not sufficient to ensure their success. The planning of the strategies is based on the decisions of the teachers about the emotional preferences and intensities, as well as the importance of the activities in the achievement of the objectives. Teachers who are not aware of these aspects will not be able to take full advantage of the potential offered by strategies in problem-based learning, so it insists on the contribution of neurosciences to teacher-student training

On the other hand, relevant and emotionally rewarding experiences help students to better develop knowledge that can be translated into better conceptual and procedural skills and to respond appropriately to teachers' questions or challenges to pass the assessment. The emotional intelligence that comes from enjoying learning experiences seems to promote academic performance. However, causality cannot be established; according to Berger et al. (2014), academic performance and satisfaction are mutually reinforcing.

Among the types of neurodidactic, systemic and social-emotional strategies are most strongly associated with academic performance. This may mean that educational programs that focus on inquiry, social interaction, and positive emotions are related to knowledge creation and learning.

Although evidence is presented, causality cannot be demonstrated, since according to Márquez et al. (2019), academic performance is an aspect of academic life in which various factors influence. These factors include personal determinants (cognitive skills, motivation, learning strategies, academic self-concept, self-efficacy, classroom participation, competence, previous academic education, mental health, job satisfaction), social factors (social status, family, environment, educational level of parents, socioeconomic reality and demographic characteristics) and institutional (form of admission, academic difficulties, status of the institution, environment of study). Therefore, it is not possible to establish a direct correlation between the two variables.

These findings serve as an introduction to reflection on the educational services offered to all students, not only certain groups, should participate in educational activities that sufficiently promote learning and satisfy their desires, that is, at all stages of university education. All teachers use pseudoscientific strategies designed to enhance learning. As mentioned above, the present study was documentary. However, quasi-experimental and longitudinal studies are recommended to further investigate the effects of neurodidactic strategies on academic satisfaction and performance.

4.2 Dynamic learning and integration of neuroscience

The analysis of the findings in the indicators of development and potential of students confirms what Araya and Espinoza (2020) said, revealing that the functioning of certain parts of the brain and the creation of new connections related to learning are experiential neural systems of learning and teaching. In this sense, it has been proven that where learning is dynamic, by the integration of neuroscience and education, it is reflected in motivation, positive thoughts and above all in the behavior of students. Beyond what the results reflect, understanding the brain can improve understanding of students' needs, just as emotions during learning are related to a wide range of instruction in a variety of contexts and physiological settings.

So it is with motivation, as learning is facilitated by a student in synergy with the passion for professional development in higher education. The above contributions are also consistent with BBC News World (2015), who argues that knowledge of the brain allows the heart to find a way to connect with the human conscious and subconscious so that transformative adaptations of personality are modulated by emotions and motivation to learn. Therefore, creative disciplines include neurostimulation, and creativity, which is one of the focus areas of innovative development.

While this is true in statistics, it becomes clear how the structure of thinking and control facilitates the adaptation of the environment to needs and encourages action with ingenuity or fluid immediacy. Similarly, Méndez and Ghitis (2015) show how creativity arises from neuro-executive function facilitated using pedagogical methods and the harmonious management of the environment; in such a way that it reaches the optimal development of cognitive skills in the university.

4.3 Neuroscience, cognition and emotion: thinking and teaching practice

Benavidez and Flores (2019), propose a set of principles and propositions that neuroscience uses to improve student learning. The first requirement to take into account is that the student is an active, assertive and reasoned participant. Each student's interests and needs, emotions and exploration, reasoning and understanding should be addressed. The authors suggest cooperative learning, the use of Information and Communication Technologies (ICT), flexibility of methods and a change in traditional classroom styles.

According to Calzadilla and Clemente (2017), neuroscience consists of two basic components: cognition and emotion. As for the cognitive part, neuroplasticity is important. On an emotional level, various factors that can disturb the learning process are considered, highlighting the mood of students and teachers, their relationships, motivation, the creation of a comfortable emotional climate, as well as the understanding and management of personal feelings or interests.

The current education system has traditionally focused on the active role of the teacher and only on the passive role of the student. Neuroscience engages students and encourages them to experiment, touch, play, and participate in their learning. In short, it is not the brain that needs to adapt to the learning process, but the learning that adapts to how the brain works. It is essential to emphasize an education based on empirical evidence, not on intuition or good practices. In this sense, neuroeducation helps build a bridge between neuroscientific research and educational practice (Gago and Elgier, 2018).

Many authors argue that we face significant professional challenges. The authors consider it to be a behavioral issue. Instead of cognitive mechanisms and processes, we focus on visible, measurable, and controllable manifestations of knowledge. Because the teaching exercise cannot comprehend internal brain processes, it focuses on external objects or events (stimuli) and behaviors that arise from

unknown cognitive processes (responses).

The foundation of the profession is closer to the curriculum than to scientific knowledge. We can predict what will happen in the classroom, but we don't know why. Focusing on external behavior can lead to inappropriate results. We do not understand the key mechanisms that govern teaching and learning, such as emotion, attention, focus, thinking, and memory (Salas, 2003). On the other hand, behavioral research can lead to partial diagnosis and treatments of many complex learning behaviors, such as dyslexia, attention, motivational and amnesic disorders.

So we are at a crossroads; we can continue to focus on observing external behavior or seeking a scientific understanding of the mechanisms, processes, and errors that affect the performance of complex learning tasks. Now, understanding the mechanisms and processes of the brain adds an exciting dimension to our way of thinking about the profession. Only through our research expertise and professional mistakes can we begin to discover useful applications of brain theory. However, significant advances in brain theory and research suggest that pedagogical praxis and the didactic situation fostered by educators should take brain research seriously and coin the term neuroscience in the university curriculum.

This means changing our thinking and practice based on what we know about learning in the brain. Currently, there is a discourse in education that teachers should not rush to join the bandwagon of intellectual education. We just have to wait. We hope that pseudoscientists will tell us how to use all this new research on the brain in the classroom. However, as learning guides, we must directly address the issues that concern us most.

4.4 Problem-based learning and its application in neuroscience

No definitive study will ever be found showing that brain-based learning is better. Meneses (2019) also emphasizes this cautious approach to neuroscience research, where enthusiasm and interest in neuroscience research are in synergy. It is clear that problem-based learning plays a role in improving students' academic performance, while improving their numeracy skills, for example. As the evidence shows, it is effective for reading comprehension because it is based on a method that requires each student to participate in reading (Hurtado and Salvatierra, 2020).

Similarly, Ortega and Carrascal (2018) highlight the integration of the teaching of economics and finance with the teaching of algebra using problem-based learning educational strategies and this has had a significant impact on the development of competencies in economics and finance. In contrast, Albarrán and Diaz (2021) applied a positive intervention approach to medical students to support the development of verbal reasoning, argumentative analysis, and critical thinking skills related to probability and uncertainty. The results are used as a teaching method for the development of emotional intelligence in university students (Lozano-Ramírez, 2020).

Cangalaya (2020), Mackay-Castro et al. (2018) The ability to think critically about research leads to more accurate results and outcomes. Lozano-Ramírez (2020) explains that problem-based learning helps undergraduate students in professional education because it supports their learning process by analyzing and reflecting on problems.

The same study described it as a technology that teachers rarely use in the classroom. Similarly, Betancourth-Zambrano et al. (2019) explain that programs and methods should be implemented in higher education to motivate students to develop critical thinking and learn a reflective attitude towards solving problems related to social education. This has been proven in the extensive literature, where problem-based learning has been implemented in various methods and disciplines, improving learning and developing students' critical thinking.

The findings encourage the development of didactic strategies based on the teaching of critical thinking as a contribution to Latin American education. The results, combined with critical thinking, show that students have reached a certain level of performance.

5. Conclusion

Perhaps one of the most powerful functions of the brain is the ability to work on multiple levels in multiple ways at once. Thought, emotion, imagination, character and physiology work simultaneously and interactively, as the entire system interacts and exchanges information with the environment. In addition, some features of the brain appear as a system that can only be perceived or understood when individual parts of the brain are studied.

Although one aspect of consciousness is consciousness itself, most of our learning occurs unconsciously, meaning that sensory experience and information are processed below the level of consciousness. Then the understanding may not be on the course, but after hours, weeks or months. Teachers should organize student activities to facilitate their unconscious post-experimental process. Teaching has largely become helping students make the invisible visible.

However, neuroscience is specific to a certain type of learning, but this whatever it is, it must be meaningful. The most important goal of neuroscience research is to provide a mechanistic understanding of the behavior of the whole organism, beyond being. Self-taught works on a mechanistic and reductionist level. But it also includes cognitive mechanisms, functions, or behavior. These include cognitive psychology, linguistics, physical anthropology, philosophy, and artificial intelligence.

Advances in neuroscience have confirmed the theoretical positions developed over the years in developmental psychology, such as the importance of early developmental experiences. What is new is a compilation of evidence from

various scientific fields. The details of learning and development combine to provide a more complete picture of how intellectual development occurs, the result being problem-based learning.

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