Chapter

Higher Education: What does the Neurocognitive Evidence Say for Decision-Making and Complex Problem Solving?

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Abstract

Higher education aims to train suitable professionals for a globalized context and develop transversal skills that allow them to function successfully in society with the current demands. Higher education includes the entry of young people from 18, with professional careers lasting at least 4 to 5 years, graduating at approximately 23 years of age. Cognitive neurosciences show that brain maturation of the prefrontal lobe (associated with executive functions, such as decision-making, planning, and cognitive flexibility) is completed around 25 years of age, continuing with the myelination of the various processing networks. Thereby, raises the question of how to approach the resolution of complex problems that demand a battery of technical, procedural, attitudinal, and ethical implications, among others, in a brain that is still developing, still dealing with the regulation of its characteristic emotional states. At this stage of the life cycle. The chapter will allow us to reflect on the scaling of these competencies based on neuroscience to suggest methodologies that will enable, depending on the entry profile of the students, to address specific methods.

Keywords: higher education, neuroeducation, executive functions, problem solving, didactics

1. Introduction

Students who enter higher education are in emerging adulthood (from now on EA), a culturally constructed evolutionary period, ranging from 18 to 29 years of age, in which students are in the majority pursuing higher education in institutes or universities in most countries.

Five general characteristics of the stage in this period are defined, with an emphasis on EA [1]:

1. A period of exploration.

2. A term to build identity.

3. A period to feel between adolescence and adulthood.

It is in this educational stage where, from curricular planning, students must make decisions and solve complex problems associated with methodological, didactic, and evaluation strategies during this period. Based on this reality, the question arises, how to generate the scalability of the learning results related to these two points, understand and attend to the neurocognitive period in which our students find themselves? We know that the competency scalability models have been studied and defined, but do we know the methodological strategies that reliably determine the achievement of the indicators?

This research also seeks to visualize this biological and social issue in the same document to generate the approach to these questions about the methodological strategies used to achieve skills. It is independent of the scalability of the skill domain in which it is located, such as being a guide to understand the faith.

2. Emerging adulthood and executive functions

The executive functions (from now on, EF) are developed through sequencing and with intervals. Some processes are carried out earlier than others and in different periods of the life cycle [2]. During the EA process, the EF presents development, potentiation, and changes that facilitate the survival of the individual. The executive functions are fundamental for achieving goals since they coordinate and organize basic cognitive processes, such as memory and perception, required for purposeful behavior [3].

EF are composed of different abilities related to the brain's prefrontal areas. The development of these is extensive in the individual's life cycle, beginning in childhood until adulthood [4]; in this course, their effect takes place throughout childhood and adolescence, reaching a peak in early adulthood. In this way, the interaction between the individual and the environment influences prefrontal maturation, allowing the consolidation of the neural networks that support executive functioning [5]. These networks continue to develop until adulthood when our student is already growing in the world of work.

3. EF as complex cognitive functions

Admission to higher education and university life requires that students self-regulate behaviors and emotions, decision-making, planning, and design strategies to be protagonists of their training process. In addition, students migrate to another institution, with other requirements and adaptation needs arising. According to Luria [6], for the development of EF, the maturity of the prefrontal lobe is required to develop even the monitoring of their learning [7]. This is how higher education students in the EA period do not have the full development of their EF and face a series of biopsychosocial factors that impact their understanding and interpretation of the world.

Various investigations focus on the differences in academic performance according to the degree of development of cognitive functions, evidencing that individuals who have difficulties in their development decrease their performance in tests that require working memory, planning, and monitoring [8]. However, most of this evidence is carried out in children, with the most remarkable diversity in neurocognitive

development due to various biopsychosocial variables that make it more quantifiable. Furthermore, these highly complex cognitive functions develop as the individual grows and is exposed to challenges that allow them to respond in search of survival.

This point is highly relevant since young people who still need to gain the skills of emotional or thought regulation will find it challenging to achieve a transcendental process in higher education that is significant for their professional development [9]. Once these self-regulation skills have been developed, we could think about the success of problem-solving and, as the management of disciplinary and interdisciplinary concepts progresses, the correct escalation to the resolution of complex problems.

Why is emotional regulation so relevant? What happens when this function needs to be adequately developed? Emotional regulation positively impacts the training process, determining that the student can redirect ideas, behaviors, and knowledge since the attentional circuits remain alert to the task. Still, at the same time, they are eager for more information from the environment, filtering what is essential to the process. This does not happen when the student is in an unregulated stressful and emotional state, which promotes the activation of the amygdalin zone and primary responses, such as fight, freeze, or flight, which hinders the teaching-learning process in the entire context.

The question arises as to how we develop this crucial executive function before promoting skills of high metacognitive value, such as solving complex problems. Under this prism, the need to reinforce self-knowledge and the recognition of emotions becomes crucial in developing transversal competencies as part of the navigation chart toward solving complex problems. This is reinforced by the fact that from 2020 to date, most of our students have been connected to screens, which have various impacts already known by cognitive neurosciences, one of which is crucial in post-development.

Pubertal are mirror neurons and social cognition. Understanding this as a humanizing function of anthropological value is part of the subjective and intersubjective construct of social construction and, therefore, of solving problems with collective impact.

As a pedagogical strategy, the empathic approach assumes that the educational phenomenon implies emotional transfer, and not only conceptual recognition of the other, but also considering observational learning to enable formative processes in the context of recognizing the other in their existence. Research suggests that this process also impacts verbal and nonverbal language expression and, at the brain level, promotes insular activation of emotional interoceptive mapping.

Recalling these EA, we know that in this population, there is a state of sleep debt that impacts student performance and an irregular sleep-wake cycle that affects metabolic and hormonal circadian processes that impact memory the next day [10, 11].

This set of antecedents and the absence of pedagogical strategies that impact the developing neurocognitive processes worsens the academic performance indices and exacerbates the dropout rates in higher education—in the long term, generating more significant frustration in the young population and, with this affecting the mental health of a significant percentage of the population.

4. Resolution of complex problems and decision-making

Problem-solving is part of systems thinking; it must be operational to understand and model the solution. This problem-solving determines the mobilization of a wide

range and diversity of knowledge and skills. Since there are divergences in implemented methodologies to solve problems and challenges, the student is expected to be provided with a thought structure that can be adapted to each process. At this point, decision-making begins as a fundamental part of FE.

However, the evidence suggests facilitating or inhibiting the processes, depending on the degree of emotional regulation that the individual possesses.

There is great diversity in how people regulate their thoughts and actions. Despite this, the mechanisms underlying these differences in autoregulatory processes are unknown [12]. Various studies make it possible to define and determine that the development of these EF in children and adolescents can be enhanced since the differences are evident. However, it is difficult in young or AD individuals because standardized tests do not allow for intersubjective analysis or measurement of the stress level experienced by the individual with whom they are initially tested.

Under psycho-pedagogical models and learning theories, questions related to this topic can be answered, but are the theories comparable in adult individuals? The more likely it is that each stimulus in the environment promotes the development of new connections. But what kind of stimuli? For example, can an individual with low self-concept or empathy development, and therefore, low social skills promote adequate emotional self-regulation as central EF.

We know that reading favors attention, cognitive flexibility, monitoring, and semantic memory; writing allows the development of planning, inhibitory control, and follow-through (when evaluating spelling); and mathematics participate in working memory and logical thinking. However, in our higher education classrooms, we have digital native students who do not use manual writing, do not need spell checking since it is automated, and many mathematical processes are solved with technology.

When new questions arise, it is then to generate processes and transformation of the school and of higher education that allow student-centered learning to capture and take charge of the profiles and abilities of the new generations. Moreover, when we indicate skills, we refer to skills of the technical dimension (knowledge or knowledge), the methodological (know-how or the ability to apply knowledge), the participatory (knowing how to be), and mainly, the personal (knowing how to be and know how to live together).

It is then part of the social and ethical responsibility of teachers and institutional policies to understand that higher education institutions not only train professionals but also train people who must be agents of social change.

5. Higher education and its possibility of transforming

We know that solving complex problems requires developing critical thinking, so that students in an environment bombarded with information can discriminate valuable data from those that are not useful while using creativity to find solutions. However, these teaching-learning ecosystems must be consistent with the individual's neurobiological stage of development.

It is, therefore, necessary to provide students with tools to perform successfully in life and skills related to adaptability and resilience in the face of changes currently taking place at a political, scientific, economic, cultural, and social level. The achievement of critical skills to achieve these objectives determines broadening the training horizons far beyond what happens within the university, either virtually

or face-to-face, expanding the limits of strictly curricular training and favoring interdisciplinarity.

In addition, it is essential to highlight how transversal skills are understood and how they are being developed in the curriculum and within the hidden curriculum, which nourishes and reinforces dominant ideas and belief systems in each institution. Therefore, it underlies all educational experiences. This concept encompasses the interpersonal relationship of teachers, the expectations and trust they have with students, taking into account affectivity, interest, empathy, and other relevant soft skills. It must be gradually transferred to higher education to generate contention and joint construction of knowledge. Therefore, it refers to the immersion of the dialogue in the formative process of higher education, facilitated by the teacher [13].

It is how students must have tools to achieve decision-making in safe contexts and be prepared for it to gradually adapt to the changes that will occur once they go out into the world as professionals in various areas.

The need arises to have guidelines that guide the student and facilitate the adaptation process to arouse their curiosity and motivation and inspire that the process is genuinely transformative and that the educational process extends beyond the traditional classroom.

For these guidelines to have an impact, our focus must be on the teachers, professors, and collaborators, who participate in the educational process, creating an ecosystem that promotes natural and significant change. Furthermore, an ecosystem that promotes systemic thinking is given because global transformations related to the arts, science, and technology permeate society as a unit. Therefore, it is also urgent to rethink and observe the emerging and coexisting phenomena, so that through the educational process, it is an interconnected and interrelated network that impacts the lives of individuals at all its edges and can be analyzed.

Systemic thinking through methodological strategies, which must be connected with the socio-emotional skills of students in EA, gradually promoting all EF, where the student feels safe and protected, and giving room for error as a crucial methodology in teaching. Feedback on the didactic and evaluation process.

6. Methodological proposals

In this analysis, it will be crucial to use strategies that allow the development of research and creation and where the student feels safe from making a mistake as a fundamental part of the training process. On the other hand, training instances where students emotionally connect promote social interaction, cognition, and self-concept. Furthermore, finally, didactic strategies, where the student is not only the protagonist or an active participant in his training process but also projects himself in the first person when creating the memories to activate the attentional networks continuously.

It is suggested to consider the following:

- Escalation of competencies declared and known by the student.
- Didactic strategies, where the student intervenes as a protagonist.
- Evaluative strategies, according to the didactic strategy.
- Leave space for error

- Leave protected times for facilitation and feedback by peers and by the teacher.
- Establish great dilemmas and challenges spaced in "trigger challenges" that allow progress toward the final goal.
- That the challenges impact society or the collective in such a way that they are transformative for students, and allow them to give meaning to what they do.
- Provide tools for students to contact the referents in the various areas necessary for resolving specific problems.

	Problem-based or project-based learning PBL	**Challenge-based learning CBL**	**Inquiry or artistic creation-based learning icBL**	**Service learning**	**Simulation-based learning**
Knowledge (Verbs Associated with)	Recovery comprehension analysis app	Comprehension analysis app metacognition self-regulation	Comprehension analysis app metacognition self-regulation	Comprehension app metacognition self-regulation	All taxonomy will depend simulation type
Learning strategy description	Students exposed to situation known and a solution is demanded or its implementation within a framework stipulated. fictional or real	Students exposed to situation known and a real solution is demanded or concrete and contextualized action.	Students exposed to manufacturing situation of a guided investigative process and/or creation artistic curated that demands conclusions of the process or execution of work.	Students perform disciplinary interventions, multidisciplinary or interdisciplinary, and with this are linked to society.	Students face situations of simulation solving a Simulated situation.
Learning strategies examples	Math problem-solving. Generation of design projects. Robotics/home automation projects. Elaboration of models. Fictitious cases in human or animal health.	Resolution of real problems in real context. Design Thinking Challenges Real cases of human or animal health. Real cases that impact some SDG. Collaborative online. International learning.	Disciplinary investigations. Interdisciplinary research. Artistic creation in all fields.	Field interventions. Social voluntary jobs.	Clinical simulation. Modeling software. Decision-making. Role plays. Business games.
Teacher role	Facilitator or guide	Coach or consultant	Coinvestigator or Cocreator	Tutor	Facilitator and modeler

Table 1.
Proposal of methodological strategies.

	Process	**Product/result**	**Self-learning self-appraisal**	**Peer evaluation**
Example	Portfolios Observation Forms Satisfaction Questionnaires Rubric	Checklists Matching Guidelines Document analysis Demonstrations or tests	Questionnaire that guides Reflection Base on Portfolio or Rubric	Questionnaire that guides Reflection Base on Portfolio or Rubric

Table 2.
Proposal of evaluative strategies.

- Guide the investigative process.
- Systematize the process through specific indicators that allow us to monitor and simultaneously continue.
- That the student knows that the teacher or facilitator trusts his potential.

Strategies are recommended that, through their standardization of processes, not results, allow feedback to the teacher with greater precision, such as design thinking and even mindfulness, when working with emotional intelligence and self-regulation.

We propose the following tables of methodological strategies (**Table 1**) and evaluation strategies (**Table 2**).

Regardless of the methodological strategies, we can propose, we cannot leave the well-being of students aside as a fundamental part of their understanding of the world, the development of resilience, and self-concept. It is the basis of the importance of education for humanity. Well-being is not only the result of it, but it is necessary to conceive it in the process of it. Well-being and education must go together; these are alchemies of the life of the human being in each stage of his development, and all experience is vivid in his interpretation of reality. Generating a training process that promotes positive psychological states, such as resilience associated with well-being, improves performance in work and academic environments [14].

It could be part of micro-curricular or extracurricular interventions or immersed in the hidden curriculum we mentioned earlier.

They are ensuring that the strategies are formative and summative, according to the methodology and didactics used, and that allows continuous feedback to students.

7. Conclusions

The EA is determined in a stage of neurodevelopment, where even executive functions are strengthened, depending on emotional management influenced by the biopsychosocial context of this life cycle age. That is why generating strategies that facilitate, guide, and improve decision-making with a defined path and promote the resolution of complex problems in a controlled environment will allow the student greater comfort at the time of the training process and security. Understand that there is room for error and feedback on this scaling of abilities and skills.

Regarding the mechanisms that will allow the enhancement of the competencies associated with the resolution of complex problems, there are not only

methodological ones (for which we identified the main development guidelines) but also some processes that would allow students to enhance the development of their skills. This is because it improves their well-being, and thus, reduces the risk of mental health disorders.

It would be prudent for curriculum development activities to mix interdisciplinary activities. This could be associated with methodologies of problem-solving processes, project generation, challenge-based learning, research, service learning, and simulation; but is necessary that allows the student to correctly manage their time to favor protective environments of well-being, motivation, and inspiration toward the goal. This is not new; what we can rescue is that it is known that there is evidence, as previously highlighted, of the hours of rest and sleep and their relationship with the circadian hormonal cycles; however, the schedules in most of the academic programs begin first thing in the morning. These programs were formulated for the teacher, forgetting, in a certain way, that it is the teacher who is the one who facilitates and the student who generates knowledge.

We have many opportunities to make a change that means more than curricular or methodological differences.

Acknowledgements

Thanks to the Universidad Mayor for constantly promoting an improvement in the training process of its students.

Thanks to Saint Rose School for supporting the achievement of this publication, which also promotes a constant change in the training strategies of young people of diverse cultural imprints to generate a transformative educational process that manages to expand outside the classroom.

Conflict of interest

The authors declare no conflict of interest.

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