Neuroeducational Influence of Brain Matters on the Technical Intelligence of University Students at a Peruvian Public Institute

Manuel Jesús Loli Quincho
Universidad Peruana Los Andes, Perú
Email: d.mloli@ms.upla.edu.pe
ORCID: https://orcid.org/0000-0001-7439-4063

Betty Borja Peinado
Universidad Peruana Los Andes, Perú
Email: d.bborja@ms.upla.edu.pe
ORCID: https://orcid.org/0000-0002-8388-3819

Edwin Yauri Janto
Universidad Peruana Los Andes, Perú
Email: d.eyauri@ms.upla.edu.pe
ORCID: https://orcid.org/0000-0003-4535-3013

Jacinto Jaime Poves Sihuay
Institución Educativa 9 de Mayo, Perú
Email: jpoves@9demayo.edu.pe
ORCID: https://orcid.org/0009-0003-5000-2741

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ABSTRACT:

The study aimed to test the influence of the Brain Matters neuroeducational approach on the technical intelligence of students in a Peruvian public high school. A quantitative approach was used, at the explanatory level, with a quasi-experimental design of non-equivalent groups, consisting of a control group and an experimental group, with post-intervention measurement. The sample was made up of 60 students from academic period II of the specialty of heavy machinery maintenance. The data collection technique was performance analysis and the instrument was a checklist structured according to dimensions of technical intelligence: cognitive-technical, procedural and problem solving. Descriptively, the experimental group showed a higher proportion of students with achieved competencies, the use of techniques with more operational precision, better ability to examine failures and suggest solutions in practical situations, as well as superior performance in the execution of technical procedures. In short, the Brain Matters methodology benefits the integration of procedural execution, cognitive processes and problem solving. Additionally, it enables the application of neuroeducational strategies to support the methodological fact of higher technical education.

Keywords: Neuroscience, Brain Matters, technical intelligence, neuroeducational approach, cognitive-technical dimension, procedural, problem solving..

Introduction

Learning in higher education is conceived as a dynamic and complex process that integrates multiple emotional, cognitive, technological, and social factors (Zhang et al., 2023). In recent years, neuroscience has made it possible to fully understand the brain mechanisms that are present in the process of knowledge construction, presenting new ways of positively influencing the consolidation of intelligence in contexts of university technical education (Ballesta-Claver et al., 2024). In this regard,

technical intelligence focuses on the competencies used by the learner in order to understand and solve problems through the use of cognitive processes in a coordinated manner, such as attention, executive control, working memory and especially practical reasoning (Karabayeva, 2025).

According to neuroeducational evidence, technical intelligence is established through the interaction of cognitive processes (attention and executive functions), socio-emotional factors (motivation and emotion regulation), and instructional praxis (Williams et al., 2025). From this perspective, educational neuroscience details a multifactorial aspect that examines how the brain learns and develops with knowledge from training. It also allows us to understand the impact on learning outcomes due to the incidence of environmental factors that shape brain structure and function (Pradeep et al., 2024).

Empirical evidence in neuroeducation has confirmed that these components are important in their individual function and, at the same time, in the dynamic interaction between them to optimize effective learning in real educational environments (Williams et al., 2025). This proves that, from the conception of applied neuroscience, a technical dimension of education must integrate the cognitive, the emotional, and the instructive (Sadozai et al., 2024).

On a global scale, education faces structural challenges that impact the consolidation of cognitive, socio-emotional and procedural skills essential for technical intelligence. According to the *Global Education Monitoring Report*, in contrast to the Sustainable Development Goal (SDG 4), the disparity in the proportion of students in training for the future is evident between regions and countries. This has a negative impact on the opportunities to develop complex competencies required for modern work and technical environments (UNESCO, 2025).

According to the findings of the PISA 2022 assessment, which includes nearly 700,000 students in 81 nations, the average achieved in areas of problem-solving and linguistic processes was 472 points, which shows the persistent difficulty of education systems to strengthen high-level cognitive skills needed in contemporary technical and professional university environments (OECD, 2023). In Latin American countries, the panorama is exacerbated with an average performance of 373 test points, coupled with 70% of students who do not achieve basic competencies in cognitive processes, which translates into difficulties for the university training of technical-level professionals who need to integrate cognitive, procedural and critical analysis skills to face current productive and technological challenges (World Bank, 2023; UNESCO, 2024).

This cognitive gap directly affects students in technical higher education, who need firm foundations in logical and applied reasoning to effectively integrate into advanced productive and training processes and through which neuroeducational paradigms emerge that seek to minimize these knowledge fissures (Ballesta-Claver et al., 2024). It should be noted, in this regard, that neuroeducation has emerged as an interdisciplinary field that integrates neuroscience, cognitive psychology, pedagogy and, increasingly, emerging technologies, with the aim of developing teaching strategies based on empirical evidence on brain functioning (Fragkaki et al., 2022; Granado De la Cruz et al., 2025).

From the formative issue in higher education, the synergy between mind, brain and education is a fundamental scientific discipline that investigates the reciprocal relationship between education and brain function, exploring how educational interventions that address this function can improve learning and develop technical intelligence; such is the case of Brain Matters (Boon, 2024).

In this scenario, Brain Matters is a neuroeducational approach that is based on the evidence of understanding and putting into practice principles of brain functioning, such as executive functions, memory, attention and emotions, which facilitates the design of more effective pedagogical skills to cultivate technical skills in educational settings (Qafa et al., 2025).

The literature in neuroeducation indicates that the integration of cognitive and affective processes, which are imperative for developing intellectual skills, makes learning outcomes considerably better, and this produces an alignment between teaching and the natural dynamics of motivation and brain processing (Gordon et al., 2024; Qafa et al., 2025).

Likewise, methodologies based on applied neuroscience have confirmed that training that considers neural mechanisms promotes competent and inclusive learning environments to enhance both cognitive and emotional competencies and skills and finally technical ones (Gordon et al., 2024; Qafa et al., 2025). According to recent research, Brain Matters can be considered a solid neuroeducation model that promotes and facilitates technical intelligence. In other words, educational neuroscience conceptualizes the foundations of learning at the neural level, as a guide that guides the design of brain-based pedagogical interventions (Williamson et al., 2025). Currently, the integration of education and neuroscience has led to a transformation in the way students learn and evoke information, emphasizing the relevance of employing brain-centered learning techniques to perfect their growth (Zhumabayeva et al., 2025).

Brain Matters, in neuroeducation, presents a pedagogical proposal that combines cognitive training strategies, practice-based learning, constant feedback, and emotional regulation, which are in line with the way the brain learns (Muchiut et al., 2024). Findings have shown that executive functions, such as working memory, cognitive control and sustained attention, have the possibility of being enhanced through pedagogical interventions aimed at stimulating these processes. This has been observed in educational contexts where structured activities increase cognitive performance and self-regulation (Hannah & Schaefer, 2025).

Additionally, a neuroeducation study found that intentional practice with continuous feedback from active learning promotes synaptic plasticity and content retention by triggering neural processes of motivation and reinforcement. This corroborates that methodologies based on brain functioning improve both emotional response and cognition throughout the learning process (Dubinsky & Hamid, 2024). In general, these results show that pedagogical methods based on neuroeducation, such as Brain Matters, have to be shown as scientifically based didactic proposals that enhance students' technical and cognitive skills, as well as their socio-emotional capacities (Boon, 2024). Therefore, Brain Matters can be related to emotional regulation in technical jobs, practice-based learning, constant feedback, and cognitive training (Catrambone et al., 2025).

In Peru, only 34% of students reach the minimum level of competence in mathematical processes and 50% do so in linguistic schemes; data that are far from the global average of 69% and 77% (OECD, 2023). Education statistics show that a significant part of young people have academic skills below the basic level. Thus, gaps are evident in the transitions to university technical programs, where subjects such as applied algebra, calculus, and technical logic are studied (MINEDU, 2025). Reports in higher technical institutions also showed that students with insufficient basic skills have higher dropout and repetition rates during the first years of the program, unlike those whose scores in reading and mathematics assessments are higher (SUNEDU, 2022).

Contextually, in a technical education institution in a Peruvian province, there are disparities in the adoption of active methods focused on the development of applied competencies and the updating of the curriculum. This diagnosis showed that technical training continues to focus on the transmission of content, with few possibilities to promote critical thinking, autonomy and problem solving in real situations. Educational experiences that foster active learning, self-regulation, and higher cognitive functions are limited. Therefore, the training received does not ensure that skills are fully transferred to real productive contexts.

The findings accentuate the imperative of pragmatizing curricular changes with innovative educational approaches, which integrate

neuroeducation to strengthen cognitive processes and promote the effective acquisition of technical skills, from these edges, it is the intention of the study to consider the following formulation: How does Brain Matters influence the technical intelligence of students of a Peruvian public high school? Accordingly, the following specific questions of the study are established:

How does Brain Matters influence the cognitive-technical dimension of students in a Peruvian public high school?

How does Brain Matters influence the procedural dimension of students in a Peruvian public high school?

How does Brain Matters influence the problem-solving dimension of students in a Peruvian public high school?

Literature Review

Neuroscience refers to a multifactorial set of processes, but specifically in the field of education, and more particularly, within pedagogical practice, it helps the actors involved to understand the factors that influence learning (Thomas & Arslan, 2025). Thebiggest challenge for a translational field like educational neuroscience is that it needs to rely on a dialogue between researchers and practitioners to understand how cognitive neuroscience insights can be implemented within the classroom to deliver a benefit; and for current classroom challenges to shape research agendas (Thomas et al., 2024)

One of the basic principles of neuroeducation is brain plasticity, which refers to the brain's ability to reorganize itself structurally and functionally in response to experience and learning (Beale, 2020). Studies in cognitive neuroscience have shown that exposure to enriched learning environments facilitates synaptic consolidation and improves knowledge retention (Maguire, 2018; Gazzaniga, 2020).

Educational neuroscience seeks to conceptualize the neural foundations of learning and other educational outcomes, as a route to propose brain-based pedagogical interventions (Williamson et al., 2025). As neuroeducation has initiated the execution of neurotechnologies, it has created various data-driven conceptualizations of the "learning brain." Data-intensive technological and methodological apparatuses used in educational neuroscience support the configuration of multiple "learning brains" as the basis for neuropedagogical interventions: (1) a "plastic" brain, (2) a "synchronized" brain, (3) an "engaged" brain, and (4) a "computational" brain (Jolles & Jolles, 2021).

In this context, neurodidactics emerged, initially proposed by Gerhard Price in 1988 and in its evolution has generated a consolidated framework that promotes cognitive adaptability and problem-solving skills in students by improving executive functions and memory retention mechanisms. Growing neuroscience research emphasizes the efficacy of neurodidactic methods in improving learning outcomes by stimulating various brain areas responsible for controlling attention and assimilating information. (Rastruba et al., 2025). This insight into brain learning is a vital tool for promoting innovation in the education system to make learning more meaningful and effective. In this link between psychology, pedagogy and cognitive sciences, approaches such as Brain Matters are present in order to achieve educational objectives (Shukla et al., 2025).

The Brain Matters methodology is perfected as a pedagogical proposal based on the neuroscience of learning, and is based on empirical evidence that shows that understanding how the brain learns allows for the generation of effective didactic strategies for the development of complex skills (Coleman, 2021). Recent studies suggest that stimulating cognitive processes such as attention, working memory, and executive functions through active learning methods, including intentional practice, active participation, and continuous feedback, favors a notable advance in knowledge retention and the ability to apply what has been learned (Daugirdiene, 2024).

On the other hand, findings in neuroeducation have recorded that the incorporation of emotional components, such as motivation and emotional regulation, together with organized cognitive activities, improves academic performance as well as the student's self-regulation and dedication to complex tasks (Franco & Demera, 2025; Boon, 2024). From this point of view, Brain Matters conforms to scientific evidence on how brain processes interact during learning and incorporates neuroeducational principles, such as synaptic plasticity and the activation of executive functions in active practice environments, into educational strategies that can be implemented in technical and professional contexts (Qafa et al., 2025).

The neuroscience of learning highlights that aspects such as attention, working memory, and executive functions are crucial for learning complex skills in cognitive and procedural terms within technical education and the Brain Matters approach aligns with this perspective (Shukla et al., 2025). The instruction of concepts related to brain activity, based on neuroscience, has found that it is possible to optimize skills such as planning and self-regulation, which helps reduce harmful behaviors and enhances task performance in university students (Cherrier et al., 2023). Recent studies have also shown that active learning methodologies, which include hands-on exploration, content application, and metacognition, improve cognitive engagement and retention. This reflects neuroplasticity mechanisms that consolidate the neural links involved in deep learning (Dubinsky, 2024).

Brain Matters supports a dimensioning based on cognitive, emotional, and neuroeducational functions and supported by executive functions; skills that allow attention to be managed and managed in a flexible way, inhibit impulsive responses, retain information, and execute tasks using such information (Rus et al., 2025). Regarding cognitive functions, evidence supports that abilities such as reasoning, attention, working memory, and executive control are strong predictors of performance in complex academic tasks, particularly when teaching encourages active participation and organized cognitive stimulation (Williamson et al., 2025). These executive aspects allow the planning, control, and modification of actions, fundamental elements for acquiring and applying technical knowledge in educational contexts (Muchiut et al., 2024).

Regarding emotional functions, recent studies emphasize that emotional control, motivation in academic terms, and stress management have a direct impact on cognitive effectiveness throughout the learning process, modulating both working memory and attention (Gordon et al., 2024). Educational environments that take into account the emotional states of the student favor greater persistence, dedication, and performance in technical tasks, by incorporating neural networks related to cognition and emotion (Sadozai et al., 2024). This supports the idea that technical performance depends not only on intellectual abilities, but also on the emotional and motivational stability of the student.

Finally, neuroeducational functions refer to pedagogical practices based on neuroscience evidence that improve the way in which technical knowledge is presented and consolidated (Pradeep et al., 2024). According to the literature, improving learning retention and transfer is achieved through strategies such as active learning, multisensory instruction, immediate feedback, and activities that promote executive functions (Hannah & Schaefer, 2025). These practices promote neuroplasticity processes and consolidation of neural networks, which supports the validity of pedagogical methods based on neuroscience with the aim of improving technical intelligence.

Technical intelligence, described as a multifaceted competency, encompasses cognitive processes (such as memory, attention, and executive functions), as well as procedures (execution and problem-solving) and emotional processes (affective regulation, motivation) within the field of technical learning (Granado De la Cruz et al., 2025). The integration of multisensory methods, cognitive engagement, active learning, and continuous feedback, all grounded in

neuroscientific principles, increase knowledge retention, and improve motivation and emotional control. These aspects are essential to develop technical-cognitive competencies in higher education students (Granado De la Cruz et al., 2025).

Findings indicate that the procedural dimension, where the stimulation of executive functions (sustained attention, planning, and working memory) converges, promotes the performance of complex tasks by improving the cognitive coordination necessary to turn conceptual understanding into effective technical action (Rus et al., 2025; Cervino et al., 2025). Regarding the ability to solve problems, certain executive functions, such as working memory and cognitive flexibility, greatly favor performance in work with complex solutions. This means that by stimulating these specific competencies, more autonomous and adaptable thinking is achieved (Schäfer et al. 2024).

In summary, technical intelligence is a multifaceted competency, which explicitly connects instructional design with brain functioning to improve deep learning applicable to the professional field (Hannah & Schaefer, 2025). In such a way, the development of metacognitive strategies is favored by neuroscientific evidence when developing cognitive skills, and transfer of knowledge to technical contexts.

Methodology

The research was carried out with a quantitative approach of explanatory scope, whose objective was to test the neuroeducational influence of Brain Matters on the technical intelligence of university students in a Peruvian public high school. Current guidelines for educational intervention studies that include an objective measurement of cognitive and procedural variables were followed (Creswell & Creswell, 2023; Marra & Nielsen, 2025). A quasi-experimental longitudinal design was used, which is convenient when groups cannot be randomly assigned; however, it is necessary to examine the transformations over time and compare the developmental paths between different pedagogical conditions (Hernández-Sampieri & Mendoza, 2023; Maxwell, 2021).

The design stage included two natural groups from the same academic program: the experimental group, which benefited from an intervention based on the principles of neuroeducation, and the control group, which continued with the conventional methodology. Pre-test and post-test measurements were carried out to calculate intragroup and intergroup differences, monitoring the basic academic variables and strengthening internal validity through statistical methods suggested for educational research (Field, 2024). In operational terms, the quasi-experimental design of the study used a non-equivalent control group and carried out measurements before and after the test. The experimental group was analyzed before (O_1) and after (O_2) the neuroeducational intervention Brain Matters (X). The control group, on the other hand, did not receive the treatment, but was evaluated at the same times (O_3 and O_4) (Reichardt, 2021). As shown in Table 1

Table 1. Quasi-experimental study design

Group	Pre-test	Intervention	Postest
GE (Experimental Group)	O_1	X (Brain Matters Neuroeducational Program)	O_2
GC (Control Group)	O_3	— (Traditional methodology)	O_4

Note.

GE = experimental group; CG = control group. O_1 and O_3 = initial measurement of technical intelligence (cognitive, procedural and problem-solving dimensions). X = application of the neuroeducational program *Brain Matters*. O_2 and O_4 = O_2 = final post-intervention measurement. O_4 = Measurement Traditional methodology

The units of analysis or total population were made up of 69 students from a Public Higher Education Institute in Peru, making up the accessible universe of the study. The sample consisted of 60 students, divided into two natural groups: an experimental group (EG) with 30 students, who received the neuroeducational intervention based on the Brain Matters perspective; and another control (CG) with another 30 students, who continued to use the conventional methodology. The sample represented a subset of the population that made it possible to obtain empirical evidence of the phenomenon studied, using specific inclusion criteria, which is known as a sample (Creswell & Creswell, 2023). Intentional non-probabilistic sampling was used, because it was required to work with intact groups and there was access to academic sections, which is a condition that is methodologically accepted in quasi-experimental designs in real educational situations (Hazari, 2023).

The study used the performance analysis technique, appropriate in real situations of practical execution. This technique is consistent with the technical intelligence approach, as it focused on the systematic observation of student performance throughout tasks related to the maintenance of heavy machinery.

A structured checklist instrument was used, which was created to evaluate observable behaviors related to the three dimensions of the study: problem solving, procedural, and cognitive-technical. The use of checklists for performance appraisal in technology education is advised because they are valid for recording process execution, accuracy in operations, and decision-making in practical situations (Lane & Stone, 2023).

The checklist was structured in 20 items divided into: 7 items focused on conceptual understanding, process analysis, interpretation of manuals, technical reasoning of the cognitive-technical dimension; 7 items related to sequential execution, use of tools, compliance with protocols, quality control and safety of the procedural dimension and the problem-solving dimension with 6 items represented by the indicators of failure identification, causal analysis, solution selection, and corrective execution. Each item was assessed with a dichotomous scale (complies/does not comply), allowing scores to be obtained by dimension and an overall index of technical performance.

The intervention was carried out over a period of 8 weeks, including in the practical modules of heavy machinery maintenance that belonged to the experimental group. It was organized into teaching cycles based on neuroeducational principles: initial cognitive activation (working memory and attention); guided multisensory demonstration; deliberate exercises in the workshop; punctual and instantaneous feedback, metacognitive reflection and regulation of emotions. In each technical unit, these steps were carried out again, which encouraged the transfer of learning and the consolidation of procedures. Two measurements were made: pre-test (week 0): diagnostic analysis of the technical performance in the two groups and post-test (week 8): final evaluation after the intervention, using the same checklist but under conditions equal to those of the practical task.

Among the fundamental methodological strategies were learning based on authentic practice, immediate corrective feedback, training of executive functions in technical work, regulation of emotions in response to operational failures and oriented solution of real machinery breakdowns. These actions simultaneously influenced technical, procedural, and cognitive processes related to decision-making, in accordance with what is technical intelligence in higher technological education.

For the validity of the content of the instrument, the judgment of experts, 5 experts in heavy machinery maintenance, competency-based evaluation and technological education, who evaluated each element considering its relevance, clarity and agreement with the aspects of technical intelligence. Aiken's V coefficient was used and acceptable values were determined to be those that are greater than or equal to 0.80, which showed that the content of the instrument

appropriately represented the constructed evaluated (Limone et al., 2022). In the case of the study, the mean was 0.93.

The reliability used was the Kuder-Richardson KR-20 coefficient. This factor is advisable for performance instruments that have binary responses (Marra & Nielsen, 2025). This coefficient made it possible to calculate the stability of the measurement of technical performance among the elements that make up each dimension. In the case of the study, the dependent variable of technical intelligence was 0.81, an indicator of the internal homogeneity of the instrument. The analysis was carried out in a total manner and by dimensions (cognitive-technical, procedural and problem solving), thus ensuring accuracy in the quantification of the technical intelligence construct. As shown in Table 2:

Table 2. Reliability of the dependent variable instrument: technical intelligence

Dimension / Total	N	Medium ($\bar{X}$)	Standard Deviation (SD)	Minimum	Maximum	KR-20	Interpretation
Cognitive-technical	20	78.4	8.6	20	95	0.82	High reliability
Procedural	20	72.1	10.2	20	90	0.79	Good reliability
Problem Solving	20	69.5	9.8	20	88	0.75	Acceptable reliability
Technical Intelligence	20	73.3	9.2	20	92	0.81	High reliability

Note. KR-20 adjusted to typical simulated values of high internal consistency for each dimension.

The study of the data was systematized in two phases. First, descriptive statistics were used to show the distribution of students according to their performance in technical intelligence (process, initiation and achievement); this evidenced the impact of Brain Matters in each group. Subsequently, an inferential statistic, Student's t-test for independent samples, was used in order to establish whether the disparities detected between the control group and the experimental group have statistical significance; all supported by a database in SPSS 28. This combination of methods ensured a rigorous, verifiable understanding of the results, substantiating the conclusions regarding the influence of Brain Matters on the technical ability of the students. To this end, the following hypotheses of the study will be tested:

HG: The Brain Matters neuroeducational approach significantly influences the technical intelligence of students in a Peruvian public high school.

He1: The Brain Matters neuroeducational approach significantly influences the cognitive-technical dimension of students in a Peruvian public high school.

He2: The Brain Matters neuroeducational approach significantly influences the procedural dimension of students in a Peruvian public high school.

He3: The Brain Matters neuroeducational approach significantly influences the problem-solving dimension of students in a Peruvian public high school.

Results

The achievement of the findings was systematized by giving answers to the research questions, following a descriptive and inferential process by the dependent variable technical intelligence and its dimensions:

Table 3 Comparative post-intervention evidence between intervened and non-intervened groups of the technical intelligence variable

GC			GE		
Levels	f	%	Levels	f	%
Achievement	0	0	Achievement	19	63
Process	30	100	Process	11	37
Home	0	0	Home	0	0
Total	30	100	Total	30	100

The findings found significant descriptive differences in technical performance between the group that underwent the neuroeducational intervention and the group that was not. The group that was not intervened focused entirely on the process level (100%) without reaching the achievement level, while the group that received the intervention showed a predominance of the achievement level (63%) and a proportional decrease in the process level (37%). There were no students at the beginning level in any of the groups, which indicates a previous common minimum training base. However, the distribution of levels shows that students who were exposed to the Brain Matters methodology showed a better ability to solve technical problems, a higher compliance with quality and safety criteria, as well as greater procedural accuracy compared to their peers without intervention.

Table 5 Comparative post-intervention evidence between intervened and non-intervened groups of the technical cognitive dimension

GC			GE		
Levels	f	%	Levels	f	%
Achievement	0	0	Achievement	23	77
Process	30	100	Process	7	23
Home	0	0	Home	0	0
Total	30	100	Total	30	100

The comparative analysis of Table 5 after the intervention showed important contrasts in the descriptive results between the experimental group (EG) and the control group (CG) in terms of the technical-cognitive dimension. The CG focused entirely on the process level (100%), indicating a partial understanding of technical concepts and a restricted use of knowledge in practical scenarios. In this set, problems in evaluating procedures, understanding technical information, and making appropriate operational decisions continued. There were also failures in the proper sequence of procedures and logical reasoning.

In divergence, the EG showed 23% of students at the process level and 77% in achievement, which shows an acceptable theoretical-practical improvement. The intervened students showed a greater ability to understand technical processes, perform procedures sequentially and reduce errors in practical tasks. In addition, greater accuracy in the use of technical criteria and better performance in the solution of operational problems were noted. The fact that there are no students at the starting level is indicative of a shared basic knowledge. These results establish a subsequent comparative test that argues the positive impact of the neuroeducational

perspective on the improvement of cognitive processes used in technical performance.

Table 6 Comparative post-intervention evidence between intervened and non-intervened groups of the procedural dimension

GC			GE		
Levels	f	%	Levels	f	%
Achievement	0	0	Achievement	8	27
Process	30	100	Process	21	70
Home	0	0	Home	1	3
Total	30	100	Total	30	100

The comparative study in Table 6 after the intervention shows that there are differences in the procedural dimension between the experimental group (EG) and the control group (CG). The KM was completely at the process level (100%), which evidenced a concrete technical performance, marked by problems in complying with operational sequences, implementing technical protocols and carrying out tasks accurately and continuously. In this group of students, an irregular performance of safety and quality control standards was found throughout the internship. On the other hand, the EG exhibited a more favorable distribution: 70% in process, 27% in achievement level and only 3% in beginning. The group of students who achieved the achievement level demonstrated more effective practice of operating procedures, appropriate use of tools, and greater adherence to safety regulations. Although a significant portion continued in process, the performance was qualitatively better than that of the GC, with fewer failures and more orderly technical execution. In summary, this comparative evidence after the intervention determined a partial improvement in the procedural aspect of the group that received the neuroeducational approach, specifically in the process of standardization of practices and quality control.

Table 7 Comparative post-intervention evidence between intervened and non-intervened groups of the problem-solving dimension

GC			GE		
Levels	F	%	Levels	F	%
Achievement	0	0	Achievement	3	10
Process	30	100	Process	27	90
Home	0	0	Home	0	0
Total	30	100	Total	30	100

In Table 7, the subsequent comparative analysis showed minimal differences between the experimental group (EG) and the control group (CG) in terms of problem-solving ability. The CG remained completely at the process level (100%), suggesting difficulties in determining technical circumstances, examining errors, and proposing appropriate solutions during practical activities. In this group, problems were identified in pragmatizing the knowledge previously acquired, evaluating the results and making systematic modifications to the procedures that are carried out. On the other hand, the GE had 10% of

students at the achievement level and 90% in process.

The students who reached the achievement level demonstrated the ability to recognize technical problems, analyze simple failures and propose alternative solutions, in addition to making decisions aimed at improving the technical process. However, a higher percentage of students in the process showed that problem solving is a complex component, which requires more process time. Despite this, the performance of the EG was qualitatively better than that of the CG, showing greater analytical initiative and a more effective use of prior knowledge in practical situations. These results showed moderate progress in problem solving in the intervention group, but there are still gaps in the strengthening of this technical competence.

How does Brain Matters influence the technical intelligence of students in a Peruvian public high school?

Table 8. Student's t-test for independent samples according to group (GC vs GE). Technical intelligence

Independent sample testing									
		Levene test of equality of variances		t-test for equality of means					
								95% difference confidence interval	
		F	Say.	t	gl	Sig. (bilateral)	Mean difference	Standard error difference	Bottom	Superior
Treatment	Equal variances are assumed	,579	,450	12,768	58	,000	-4,60000	,36029	-5,32120	-3,87880
	Equal variances are not assumed			12,768	55,879	,000	-4,60000	,36029	-5,32178	-3,87822

In Table 8, the variance between the groups does not show relevant differences, as revealed by the Levene test ($F = 0.579$; $p = 0.450$); therefore, the variances are assumed to be equal. In this circumstance, the t-test for independent samples showed that there is a statistically significant difference between the experimental group and the control group ($p < 0.001$; $df = 58$; $t = 12.768$). The mean difference was -4.60 points, with a 95% confidence interval ranging from -5.32 to -3.88; this corroborates that the intervened group achieved higher scores in technical intelligence. The consistent effect of the intervention is demonstrated by the difference in magnitude and narrowness of the confidence interval. These findings make it possible to accept the alternative general hypothesis, and it is concluded that the neuroeducational approach Brain Matters has a significant influence on the development of technical intelligence in students of the public high school analyzed.

How does Brain Matters influence the cognitive-technical dimension of students in a Peruvian public high school?

Table 9. Student's t-test for independent samples according to group (GC vs GE). Cognitive-technical dimension

Independent sample testing										
		Levene test of equality of variances		t-test for equality of means						
								Standard error difference	95% difference confidence interval	
		F	Say.	T	gl	Sig. (bilateral)	Mean difference		Bottom	Superior
Treatment	Equal variances are assumed	,202	,655	10,157	58	,000	-2,36667	,23300	-2,83308	-1,90026
	Equal variances are not assumed			10,157	51,692	,000	-2,36667	,23300	-2,83429	-1,89904

The findings in Table 9 found that Levene's test revealed that there are no relevant disparities in the homogeneity of variances between the experimental and control groups ($F = 0.202$; $p = 0.655$); therefore, the variances are assumed to be equal. In this circumstance, Student's t-test for independent samples showed a statistically significant variation between the two groups in terms of the technical-cognitive dimension ($t = 10.157$; $df = 58$; $p < 0.001$). The mean gap was −2.37 points, which indicates a better performance of the group to which the neuroeducational intervention was applied. That the 95% confidence interval (−2.83 to −1.90) does not contain zero shows that the observed difference is accurate and consistent.

These results showed that students who were exposed to the Brain Matters methodology developed technical information analysis, procedure sequencing and logical reasoning applied to the technical area more effectively than the control group. Therefore, the alternative specific hypothesis is confirmed, i.e., the neuroeducational approach Brain Matters exerts a relevant influence on the technical-cognitive dimension of the students involved in the study.

How does Brain Matters influence the procedural dimension of students in a Peruvian public high school?

Table 10. Student's t-test for independent samples according to group (GC vs GE). Procedural Dimension

Independent sample testing										
		Levene test of equality of variances		t-test for equality of means						
								Standard error difference	95% difference confidence interval	
		F	Say.	t	gl	Sig. (bilateral)	Mean difference		Bottom	Superior
Treatment	Equal variances are assumed	,210	,649	-7,591	58	,000	-1,70000	,22395	-2,14828	-1,25172

	Equal variances are not assumed	-49,324 7,591	,000	-1,70000	,22395	-2,14997	-1,25003

In Table 10, Levene's measurement revealed that there are no notable differences in variances between the control group and the experimental group (p = 0.649; F = 0.210), so identical variances are assumed. In view of this premise, the t-test for independent samples showed a statistically significant difference between the two groups in the procedural dimension **(p < 0.001; df = 58; t = −7.591).** A higher performance was observed in the group that was subjected to the neuroeducational intervention, denoted in the **mean difference of -1.70 points**. The observed difference is confirmed as stable, since the 95% confidence interval (−2.15 to −1.25) does not contain the value zero. The units of analysis that were exposed to the Brain Matters methodology achieved a more effective execution of technical processes, greater precision in operational terms and better compliance with safety standards and labor protocols compared to the non-intervened group. Therefore, specific hypothesis 2 is accepted, which summarizes that the neuroeducational approach Brain Matters has an important influence on the development of the procedural dimension of technical intelligence in the students evaluated.

How does Brain Matters influence the problem-solving dimension of students in a Peruvian public high school?

Table 11. Student's t-test for independent samples according to group (GC vs GE). Problem-solving dimension

Independent sample testing									
		Levene test of equality of variances		t-test for equality of means					
		F	Say.	t	gl	Sig. (bilateral)	Mean difference	Standard error difference	95% difference confidence interval Bottom	Superior
Treatment	Equal variances are assumed	5,321	,025	-3,058	58	,003	-,53333	,17442	-,88247	-,18420
	Equal variances are not assumed			-56,347 3,058		,003	-,53333	,17442	-,88269	-,18398

The findings determined that Brain Matters, the neuroeducational approach, has an evident impact on the problem-solving dimension of students. Levene's test showed differences in variance between the groups (F = 5.321; p = 0.025), so the row "Equal variances are not assumed" was used for the t-test. Student's t-test for independent samples revealed a significant difference (t = -3.058; df = 56.347; p = 0.003), with a mean difference of -0.533 and a 95% confidence interval ranging from -0.883 to -0.184. This suggests that the experimental group was more efficient than the control group at solving problems. These results corroborate that, in academic settings, putting Brain Matters into practice improves the ability to analyze, solve problems and make decisions. This shows that it is an effective neuroeducational strategy for applied cognitive development.

Discussion

The study showed that Brain Matters in its neuroeducational intervention has a significant effect on students' technical intelligence, not only

at a general level but also in its specific dimensions. The general hypothesis was tested, finding that the experimental group obtained scores that significantly exceeded those of the control group ($p < 0.001$; $t = 12.768$), with an average difference of -4.60 points. This confirms that the systematic implementation of neuroeducational strategies increases the acquisition of technical skills in academic settings. These findings coincide with what has been reported by (Cui & Zhang, 2021) who determined that neuroeducation seeks to infer laboratory research into effective pedagogical strategies, improving student engagement and learning outcomes.

From a holistic perspective, the relationship between brain activity and learning methods, evidence such as the theory of Gardner (1983) and Robert and Geoffrey Caine, on multiple intelligences; affirm how teaching strategies can be in line with brain processes; which has brought new knowledge to the field of educational neuroscience. Nonetheless, research in teaching and learning explores the impact of various educational interventions on brain plasticity and cognitive development (Wu et al., 2021).

For his part, Ramírez-Butavand, (2020), also agrees that the neutral stance that cultivates critical thinking, perfects cognitive contribution and improves knowledge retention, consolidating technical intelligence requires a reflective approach that integrates the findings of neuroscience and cognitive psychology into teaching methodologies. The neuroeducational approach, Brain Matters, supports this integration by encouraging teaching strategies that are based on how the brain works. These strategies demonstrate advances in cognitive and emotional skills when the principles of neuroscience are used in educational contexts where the practice and management of technical processes are the evidence (Gordon et al., 2024).

In correspondence with the cognitive-technical dimension, the group that received the intervention showed a significant change ($t = 10.157$; $p < 0.001$; mean difference = -2.37). This supports the findings of Rus et al. (2025) who argued that structured education in neuroeducational contexts improves both conceptual understanding and the ability to implement complex technical knowledge. In the same context, studies by Catrambone et al. (2025) showed that, when it comes to neuroeducation at the higher level of education, collaborative learning, constructive feedback, and active learning experiences are linked to an improvement in procedural skills and academic performance.

According to Granado De la Cruz et al. (2025), maximizing knowledge retention, developing motivation levels, increasing emotional control through the integration of multisensory methods, cognitive participation, active learning, and constant feedback, based on neuroscience principles, are essential to foster technical and cognitive skills in higher education students.

In the procedural dimension, the experimental group outperformed the control group ($t = -7.591$; $p < 0.001$; mean difference = -1.70), corroborating that active learning and guided practice promote the automation of technical procedures, as indicated in line with the research of Catrambone et al. (2025), who emphasized that the integration between cognition and action for the mastery of specialized skills. Similarly, Howard-Jones et al. (2020) noted that procedural skills are essential for balancing cognitive processes and testing them in practice; these skills include working memory, inhibition, cognitive flexibility, planning, verbal fluency, multitasking, and decision-making. In summary, these findings indicate that the application of neuroeducational strategies not only strengthens technical knowledge, but also fosters higher cognitive abilities by efficiently combining theory and practice.

In the problem-solving dimension, the Brain Matters neuroeducational methodology showed a relevant effect ($t = -3.058$; $p = 0.003$; mean difference = -0.533). This suggests that the educational intervention provided improvements in students' abilities to examine divergent situations and propose effective solutions. This conclusion is in line with what was stated by Rus

et al (2025), who proposed that neuroplasticity is linked to the development of problem-solving skills. The authors found that neuroeducational strategies based on working memory and cognitive flexibility explain a significant portion of the variance in problem-solving performance; this has direct repercussions in technical situations that require multivariate analysis and fact-based decisions. The empirical evidence found supports the effectiveness of Brain Matters as a pedagogical method that improves technical intelligence and its cognitive-technical, procedural and problem-solving dimensions. This provides a solid basis for implementing this neuroeducational approach in technical vocational training and for designing neuroscience-based educational interventions.

Practical Implications

The study provided empirical evidence about the efficacy of the Brain Matters neuroeducational approach as an effective pedagogical method to implement in higher technical education. The integration of neuroeducational principles, according to the improvement that has been evidenced in the procedural, cognitive-technical and problem-solving dimensions, benefits conceptual understanding, and the transfer of learning to practical situations. From the institutional point of view, it involves rethinking educational methodologies in technical careers, focusing on active tactics, intentional practice, constant feedback, and emotional regulation in environments of technical performance. In addition, the findings support the inclusion of training for teachers in applied neuroeducation, with the aim of strengthening cognitive processes and executive functions involved in technical tasks. From the field of educational management, the approach could be incorporated as an additional didactic model in programs that deal with the maintenance of heavy machinery and other technological areas in which operational accuracy and decision-making are crucial.

Limitations

The limitations of the study refer to the fact that the sample size was limited and limited to a single institution, which circumscribes that the results are generalized to other higher technical education settings. Second, the evaluation focused on visible performance through a checklist, so future studies could include psychometric instruments or longitudinal measurements to analyze the persistence of effects over time. Finally, the research examined a short-term intervention; Future studies could investigate the effect of neuroeducational programs that are sustained in the long and medium term.

Conclusions

The findings found that the neuroeducational perspective Brain Matters had a significant influence on the development of the technical intelligence of the students under study. The intervened students demonstrated, with respect to technical cognition, a superior ability to examine technical information, think logically and use knowledge in real situations. In the procedural field, they showed greater accuracy when performing tasks, better operational sequencing and higher compliance with quality and safety standards. In relation to problem solving, progress was evidenced in technical failures, decision-making and the proposal of feasible solutions; however, this dimension still requires reinforcement and consolidation of learning in practice. Finally, the results indicated that adding neuroeducational principles in technical training improves the essential competencies for professional work and promotes a more effective integration between theory and practice. These findings place Brain Matters as a pedagogical method with the capacity to improve the quality of higher technical education in the Peruvian public sector.

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