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Effects of a Neuroscience-Based Instructional Guide on College Student Learning

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Abstract. The article aims to demonstrate the impact of neuroscience as an instructional strategy on student learning. This was an experimental research with a pre-experimental design that used a sample of 60 students on the Mathematics 1.0 course of the first cycle of the Continental University in the Academic period II - 2021. Significant contrasts were found between the results obtained before and after the application of the designed instructional guide, since the T value obtained is related with a significance level lower than 0.01, confirming the research hypothesis. When evaluating the effect of the application of the instructional guide with neuroscience as a strategy, it is shown to favorably affect the learning of students of the Mathematics 1.0 course of the first cycle of the Continental University, strengthening the entire learning process so that these can become meaningful. Therefore, it is recommended to continue implementing the instructional guide in all higher education courses without being limited to a single course as in the present study, as well as continue researching on the subject with larger samples.

Keywords: learning; instructional strategy; brain gymnastic; Neuroscience; Neuro-Linguistic Programming

1. Introduction

Experience indicates that there is no teaching scheme, so each teacher transforms their methods, techniques, and adequate resources to initiate the instructional process in order to self-evaluate and self-observe their own educational experience (Romero, 2020). Therefore, the techniques and methods applied in the training of students must be based on the analysis of institutional reality and the search for reflection. This is focused on the numerous theories of learning with the purpose of linking knowledge with experience (Carvajal, 2020; Falconi et al., 2018). The above admits that visualization involves all students in an educational institution and produces the construction of university prototypes as transformative axes of educational practice.

In this sense, the teachers must create strategies that benefit the effective approach of the students towards the essence of learning, thus contributing to the establishment of a spiritual and emotional environment to allow for efficient learning (Batac et al., 2021; Fuchs, 2021; Owusu & Cobbold, 2020). However, many times teachers discuss constructivism, and these become specialist exhibitors in the content, succumbing to the traditional and ineffective factors of knowledge. In addition, according to Jara et al. (2021) a training program should be designed with actions that facilitate the production of timely discernment for teachers with the possibility of renewing their daily practice by creating innovations and educational proposals to promote meaningful learning in their students, with the use of neuroscience as a basis.

Given this approach, it remains to be established that the performance of the educator in the training of future professionals must expand on NLP and brain gymnastics in any academic event as basic strategies, since this process is founded on communication and provides the opportunity to understand the foundation of feelings and thoughts. In addition, this will create the possibility of taking advantage of particular and external skills in order to create positive transformations that contribute to the advancement of more effective and timely learning to current socio-educational contexts (Tacca et al., 2019).

Likewise, Romero et al. (2021) express that NLP and brain gymnastics seek to understand that the individual experiences their realization through taking into account their autonomy. This benefits an individual as it allows them to understand the way each individual organizes their experience, both intrinsically and in relation to others in the environment where they develop. This is to favor in a particular way the achievement of triumph in the activities is developed. This is also to optimize the profile of oneself through self-acceptance, by producing transformations to increase particular skills for the achievement of learning (Jackman, 2018; Yusof et al., 2021).

In addition, NLP determines the extent to which a person has the power to achieve better results through the progress of the triune brain (Cruz et al., 2021; Vanga & Fernandez, 2016). At the same time, it trains internal and external communication to understand the discrepancy between excellence and pettiness. Thus, this contributes to the provision of new behaviors and the change of ineffective behaviors. At the same time, brain gymnastic exercises incite information and the energy current in the brain by promoting the student's ability to learn.

On the other hand, brain gymnastics, according to Gardner (2020), reinforce the achievement of communication between the body and the brain, which represents an exclusion of the stresses in the body by displacing the blocked energy to allow this energy to circulate easily. For this reason, training with corporal and mental actions is necessary in the educational field for the development of skills that lead to the neuroplasticity of the brain (Cordero & Rivera, 2020; Segarra et al., 2015).

On the other hand, according to Orozco et al. (2015), the conflicts that arise in the training of students are due to the fact that, in schools, as in homes, the development of both cerebral hemispheres is not prioritized, which creates uncreative individuals who do not achieve their goals.

Therefore, to promote talents, skills, and to reduce harmful habits – including repercussions such as decreasing stress, strengthening the immune system, mastering feelings, increasing creativity, and obtaining positive thoughts – it is significant to use both cerebral hemispheres to enjoy their full utility (Valerio et al., 2016). Likewise, neuroscience-based strategies are applied today in Western countries in the preparation of athletes. They are also applied in language teaching and are finally becoming popular in the educational context.

In this same order of ideas, Díaz-Barriga, F. and Hernández (2015) affirm that learning is a dynamic procedure; that is, in the course of the assimilation and accommodation of information, they imply that failures, direct practice, and the exploration of alternative solutions to the problems presented determine the way in which information is externalized and are relevant in doing so. For this reason, the primary intention is to create critical, reflective and creative individuals, and thus we must appeal to the tasks entrusted to the teacher: the individual responsible for future societies. It is through education that there is the possibility of favoring innovations that cause meritorious transformations in people.

In this way, Jartín and Chao-Fernández (2018) propose that the secrets of creative learning in higher education become formidable when the importance of the procedure, oriented from knowledge to communication, is perceived by some educators who intend to promote the creative potential of each student. Currently, there is a progressive solidity of evidence that shows how creativity is not limited to a few beneficiaries; even less is it externalized in the arts (Velázquez, 2020). Regarding the implications, all students have creative capacity. In each student there is a support for creativity which must be redeemed by the result of meaningful learning.

However, Semprún et al. (2020) states that most educators make little use of the andragogic praxis as a method to promote the learning potential of learners. This is subject to the use of a questionnaire that provokes reproductive and descriptive responses; there is no dependent distinction between body expression and appreciation, let alone a stimulation of creativity. For this reason, the development of NLP and brain gymnastics is necessary in order to provide ingenious and effective procedures in higher education courses.

In addition, this study highlights the importance of initiating the student in an environment in which space, time, and society merge, with distinct discernment of the sociocultural environment (Ordóñez-Pizarro et al. 2017). Indeed, Mazzoglio-y-Nabar et al. (2020) indicate that in most institutions the learning perspectives of learners are not developed, since novel instructional strategies that greatly promote the faculties of each student are not used.

At the same time, it should be noted that national universities are no exception to these scenarios. Thus, it is necessary to approach the instruction of students in different and innovative ways. Specifically, in subjects such as Mathematics, this problem is concretized by instructional programs and the content of their strategies, which are implemented by the majority of teachers with their students. This promotes a mechanized rote learning by leaving aside the expansion of the faculties of learners in higher education (Romero et al., 2021).

Finally, there is a need to transform the training of learners. Such firmness is specifically reflected in the will to modernize and contribute through a proposal that arises from a compatible purpose in professional experience. It is also seen through continuous preparation that requires a reflection on the strategies of the instructional program of the Mathematics 1.0 course of the first cycle of the Continental University. This is improved in the learning of the students of the referred subject through use of strategies that unlock negative energies, improve cognitive functions, and exercise the flexibility of the brain to mobilize the neurocytes and thus achieve effective learning (Menéndez & Gámez, 2019).

That is why the present study is carried out with the purpose of verifying the effects of neuroscience as an instructional strategy for student learning on the Mathematics 1.0 course of the Continental University in the Academic period II – 2021. The research hypothesis is as follows: Neuroscience as an instructional strategy has a positive effect on the learning of referred students.

2. Literature review

2.1. Neuroscience as the basis of didactic strategies

Neuroscience is a set of sciences, the fundamental pillar of which is the nervous system with a specific attraction in how brain action corresponds to behavior and learning. Therefore, it should not be considered only as a discipline (Ruiz, 2017).

Therefore, neuroscience was transmuted into an area of interest for all aspects of cognition and behavior, managing to conceptualize itself as a favorable platform to understand doctrines including, but not limited to, anthropology, economics, education, psychology and sociology. Likewise, neuroscience, according to Vitor and Salva-Pérez (2021), supports platforms in the empirical knowledge acquired from biological inquiries of the nervous system, its functions, and its structures.

Thus, neuroscience comprises numerous areas of research that approve the explanation of cognitive phenomena, beginning with information derived from various lines of biological research and focusing on the different levels of complexity that the nervous system has. These levels are represented at a micro level and are related to genetics, cells, and molecular biology. They are also represented at the macro level, linked to the development of the central nervous system, behavior, and systemic biology (Tacca et al., 2019). On the other hand, Velázquez (2020) expresses that the human brain is formed through a network of links that communicate through nerve cells and have an invariable chemical and electrical action.

2.2. Learning styles

According to Gamboa et al. (2015), it is the accumulation of psychological typologies that are usually externalized simultaneously when an individual must face a learning circumstance; in other words, the different ways in which a person can learn. Likewise, learning modes or styles are cognitive, and physiological and affective attributes serve as comparatively constant indications of how a student distinguishes correlations and offers answers in their learning context (Segarra et al., 2015).

In other words, it corresponds to the way in which students organize content, create and use conceptions, solve difficulties, decipher information, and choose the means of representation, whether auditory, kinesthetic, or visual. Therefore, each individual assimilates differently from the others. Whilst it is true that the modes of learning are comparatively constant, there is a possibility of variance; in other words, there is a probability of different results depending on the context and the extent to which a mode can be optimized.

2.3. Types of learning

Human beings learn and perceive life differently and through various means, which involves alternate methods of representing or absorbing information through various sensory pathways. At the same time, just as there are different channels of communication, there are also various types of students (Zapata-Ros, 2015). At present, and in accordance with the available information, there is no universal learning environment or technique that is suitable for all.

On the other hand, Segarra et al. (2015) established the correlation between the typologies of learning, the hemispheres of the brain, and the capacity of each hemisphere to transform the knowledge achieved and the adaptation made. Likewise, the typologies of learning must be understood in a comprehensive and correct way. This is why research has been carried out on the different types of learning, among which is that of Zapata-Ros (2015), which proposes six types of learning for development: associative, observational, rote, receptive, discovery, and significance (the latter one of the most relevant.)

- Associative learning. Associative learning is a process through which one aspect of content is taught through a separate, corresponding aspect (Zapata-Ros, 2015). On the other hand, operant conditioning is the use of effects in order to transform ingenuity and the way of proceeding. At the same time, it differs from Pavlovian conditioning as operant conditioning employs rewards or sanctions to change behavior.

- Observational. This learning occurs when the individual observes the behavior of a pattern. However, a behavior can be learned without the need to execute it. According to Nicolás and Ramos (2020), observational learning originates through the expectation of another individual's behavior and the effects that such behavior has on him. This is recognized by different names: social learning, and imitation learning, among others. This method is known as observational because it is based on observation and is recognized as social as it requires the intervention of at least two individuals: the observer and the model.

- Rote. This type of learning is considered as the simplest and most elementary learning action that has been used over time, disguised under traditionalist teaching. It lies in the simple collection of information that has the possibility of providing effects that, in some cases, symbolize a lower group given that it is based on information and data that must be learned without a significant result. For Orozco et al. (2015), rote learning has been presented as the textual assimilation of data or facts, since there is no need to understand them.

- Receptive learning. García et al. (2016) notes that in receptive learning, the individual only needs to understand the content in order to disseminate it, but it reveals absolutely nothing. In other words, the reason for the learning or content is shown to the student in its latest form. He is only invited to internalize or collect the material. Likewise, receptive learning, according to Orozco et al. (2015), represents the collection of completed information, where the student only has to internalize said information. That is, the student collects the contents that must be internalized, especially through the illustration of the educator, audiovisual information, and printed material, among others.

- Learning by discovery. According to Nicolás and Ramos (2020), current learning was based on the dynamic intervention of students and the adaptation of science methods. It provides a passive option as it is a methodology that follows routine and memorization. For this reason, according to this perspective, dynamism in the classroom should be based on the analysis, focus, and resolution of separate procedures, in which the individual learning has the possibility to build scientific principles.

- Meaningful learning. According to Carranza (2017), this learning occurs when the tasks have significant links and the individual makes the conscious decision to learn like this. Therefore, according to this type of learning, the student is the mentor of his knowledge linked to the conceptions of learning. On the other hand, few people learn efficiently, and many others believe that learning is acquired only by reading or listening. In relation to the implications, learning is a dogmatism based on well-defined procedures and principles; therefore, regardless of the individual skill level of a student, these principles can be used to teach oneself new information.

3. Methodology

The present study is experimental, because it carries out an "investigation in which one or more independent variables (supposed causes) are deliberately manipulated to analyze the consequences of that manipulation on one or more dependent variables (supposed effects) within a control situation for the researcher" (Hernández-Sampieri & Mendoza, 2018, p. 151). In this case, the manipulated variable is the neuroscience-based instructional program that examines the effects on the learning of students of the Mathematics 1.0 course in the first cycle at the Continental University.

The present research has a pre-experimental design. According to Hernández-Sampieri and Mendoza, (2018, p. 163) it "consists of administering a stimulus or treatment to a group and then applying a measure of one or more variables." In effect, pre-test and post-test administration is incorporated into the units of analysis that comprise the experiment. The pre-test is applied before developing the experimental process with the neuroscience-based instructional guidance. After treatment, the subsequent test is administered.

This case study is comprised of 540 students of the course of Mathematics 1.0 in the first Psychology career cycle of the Continental University. The selection of the sample was non-probabilistic. "In non-probabilistic samples, the choice of units does not depend on probability, but on reasons related to the characteristics and context of the research" (Hernández-Sampieri & Mendoza, 2018, p. 200). Sample selection is not random, although the assignment of students to the group is. Generally, there are 60 students on the Mathematics 1.0 course of the Psychology career cycle, established in section 13882 of the Continental University Filial Lima in the Academic Period II – 2021.

For this research, observation is used as a technique and as an instrument an estimation scale to evaluate learning, which is presented as Appendix 1. It consists of 27 items with three alternative responses (See Appendix 1). Additionally, it is defined as an evaluation instrument that used in order to record the level of realization at which an observable action or an attribute is outsourced. In this, the evaluation marks the level at which the evaluated information is related to a specific characteristic (the learning of the students). It is important to note that the reliability of the instrument is determined with an Alpha Cronbach coefficient of 0.78.

The data processing is experimental, carried out in a multivariate manner and with discriminant analysis, using the SPSS Statistical Program. The p-value is calculated: if the test produces a p-value less than 0.01, statistical significance is declared, and the research hypothesis is accepted.

Figure 1 summarizes the procedures of the experimental treatment developed with the instructional guide using neuroscience as a strategy for its respective validation, in which NLP and brain gymnastics strategies are developed to strengthen the didactic process that endorses the active progress of learning. Thus, it was necessary to diagnose the learning of the students before developing the treatment. This was then designed and applied to verify its influence on the students. Finally, the post-test is executed, contrasting the learning results of the students before and after implementation of the instructional guide.

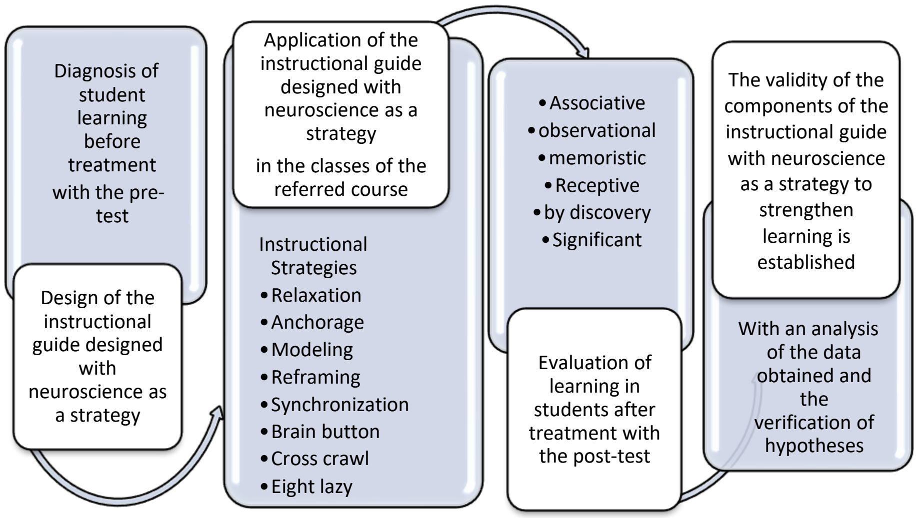

Figure 1. Study procedures.

4. Analysis of Results

The study of the learning variable begins with the dimension of styles. The is swapped in the arrangement of the indicators of this dimension in the pre-test (before) and after the application of the designed instructional guide (post-test). Highly significant contrasts can be observed in Table 1, since the T values obtained are related with levels of significance lower than 0. 01.

With regard to the visual, there is a huge discrepancy between the means of the previous test $\bar{x}$ = 0. 7 and that of the subsequent test $\bar{x}$ = 2. 4; there is a difference of 1. 7. Confirming that which Gamboa et al. (2015) proposed, the visual learning style or mode establishes that, in the instructional process, students with this style do not show a high capacity with written documents, but learn better with images, diagrams, and graphs, etc.

Likewise, in the auditory there is a huge discrepancy between the means of the pre- test $\bar{x}$ = 1.1 and that of the following test $\bar{x}$ = 2.5, with a difference of 1.4. This corroborates the approach of Ordóñez-Pizarro (2017): of all the distinctive forms of learning, this is the one that best fits a daily environment of analysis in the classes.

On the other hand, the greatest impact is presented after applying the instructional guide with neuroscience as a strategy, en the kinesthetic indicator, being its means of the had a pre-test $\bar{x}$ = 0. 6 and the post-test $\bar{x}$ = 2. 7, displaying the biggest difference of 2. 1. With this, the benefits of the developed procedure are manifested.

Table 1: Test of related samples for the styles dimension of the learning variable

	Arithmetic means	Related differences		t	Sig. (bilateral)
		Middle	Deviation		
By 1 VISUAL- A VISUAL - B	0. 7 2. 4	1. 7	. 62	54.48	. 00
By 2 AUDITORY - A AUDITORY - B	1. 1 2. 5	1. 4	. 49	70.22	. 00
By 3 KINESTÉSICO - A KINESTÉSICO - B	0. 6 2. 7	2. 1	. 72	47.48	. 00

*A represents the results of the pre-test and the B represents the del post-test

Table 2 specifies the indicators of the types of dimensions of the learning variable, before and after the execution of the designed guide. This demonstrates again highly significant contrasts: in each case the T values obtained are related with levels of significance less than 0.01.

Likewise, there are huge discrepancies in the means reached before and after the procedure. The greatest contrast was achieved with the significant learning of 2.5. This was followed by learning by discovery, with 2.2 points, after which came rote learning with a minimum contrast of 0.5. This demonstrates the effect of the application of the instructional guide with neuroscience as a strategy in the improvement of learning.

Table 2: Test of related samples for the dimension types of the learning variable

	Arithmetic means	Related differences		t	Sig. (bilateral)
		Middle	Deviation		
By 1 ASOCIATIVO-A ASOCIATIVO-B	0. 8 2. 4	1. 6	. 93	70.13	. 00
By 2 OBSERVATIONAL - THE OBSERVATIONAL - B	0. 7 2. 8	2. 1	. 84	47.48	. 00
By 3 RED - B ROTE - A	1. 8 2. 3	0. 5	. 93	75.57	. 00
By 4 RECEPTIVE - A RECEPTIVE - B	0. 7 2. 4	1. 7	. 83	54.47	. 00
By 5 BY DESCUBRIM - A BY DESCUBRIM - B	0. 5 2. 7	2. 2	. 81	48.05	. 00
By 6 SIGNIFICANT - A SIGNIFICANT - B	0. 5 3. 0	2. 5	. 79	47.46	. 00

*A represents the results of the previous test and B represents those of the subsequent test.

5. Discussion

The above results allow us to infer that with the execution of the instructional guide based on neuroscience, the learning of the students of the Mathematics 1.0 course of the first cycle of the Continental University improved. The greatest contrast was achieved in the significant learning, symbolizing a perfect benefit after the improvement of the applied procedure with the aforementioned orientation. In this case the student is the mentor of their knowledge, demonstrating an opposition to mechanistic learning. With these results, the research hypothesis is ratified: neuroscience as an instructional strategy has a positive effect on the learning of students of the Mathematics 1.0 course of the first cycle of the Continental University in the academic period II – 2021.

These derivations confirm that to improve the learning of the students of the Mathematics 1.0 course of the first Psychology career of the Continental University, it is of utmost relevance to consider the application of neuroscience through the strategies of brain gymnastics and NLP, because with them, the students have the possibility of contributing to the provision of new behaviors and the transformation of inefficient behaviors. Students can also remedy learning and communication difficulties, giving way to maximum efficiency in all subjects. The results, in general, differ with that expressed by Segarra (2015). Kinesthetic is the slowest learning style and confirms that which was proposed by Nicolás and Ramos (2020), which describes it as the most positive learning style. Specifically, that which is proposed by Orozco et al. (2015) is reaffirmed; rote learning is manifested when the task of learning constitutes strictly partial links or when the individual does it partially. Conjecture a memorization of facts, data or conceptions with insufficient or no correlation between them. As expressed by Zapata-Ros (2015), learning by discovery is based on the dynamic contribution of students and the adaptation of knowledge methods. Passive memorization methodologies are requested as an option and their independent action is promoted.

In addition, the conditions of meaningful learning, as raised by Carranza (2017) in his study, are strengthened. Meaningful learning occurs when tasks are properly related and when an individual makes the decision to learn in such a manner. Likewise, as indicated by Romero et al. (2021), this learning works to use existing sources but in new circumstances, in a different scenario, and to pertinently transfer that which has been learned.

6. Conclusion

When examining and debating the results obtained from the study, the following conclusions are deduced: first, the diagnosis was made regarding the learning of the students of the Mathematics 1.0 course of the first cycle of the Continental University, which showed that the students were not learning in a significant way, but, rather, in a rote way. Therefore, an instructional guide was designed and applied with neuroscience as a strategy to strengthen the learning of students in the subject Mathematics 1.0 to enable the evolution of skills and the possibility of producing the results that have been proposed, either personally or professionally.

In effect, students are trained for new transformations and use modeling techniques to quickly assimilate what others manage to learn with greater dedication and energy, and at the same time, make better use of their own resources. Consequently, the effect of the application of the instructional guide with neuroscience as a strategy was evaluated, demonstrating that it has favorable effects that strengthen the entire learning process of the students on the Mathematics 1.0 course of the first cycle of the Continental University. Therefore, the research hypothesis has been confirmed.

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Appendix 1

Information Collection Tool

	Estimation scale			
No	**The student:**	**1**	**2**	**3**
1	Develops the visual sense effectively when performing academic work.			
2	Reinforces visual memory in their academic activities.			
3	It facilitates the proper use of the image with the word when capturing knowledge.			
4	It raises the need to use music as a complement to develop activities in			
5	Reorder information through auditory representation systems.			
6	It establishes logical-semantic connections between the elements of a developed experiment.			
7	It guides the information given through kinesthetic representation			
8	Develop imagination in the elaboration of educational projects.			
9	Dramatizes educational activities in classes.			
10	Learn one element through association with another element.			
11	Use consequences to maintain or decrease a behavior.			
12	Modifies the forms of behavior through the association of stimuli.			
13	Learn by observation or imitation in the activities developed.			
14	It favors creative work in the social learning environment.			
15	Acquires cognitive representations of the teacher's behavior.			
16	Performs a memorization of data or facts with no interrelation between			
17	Memorize concepts with little interpretation of them.			
18	Learning consists of purely arbitrary associations.			
19	You receive the content that you have to passively internalize.			
20	Reproduces the information managed in class satisfactorily.			
21	It incorporates the material that is presented to you in such a way that at a later time you can retrieve it.			
22	Discover the material for yourself, before incorporating it into your cognitive structure.			

23	Forge your learning with a leading role.				
24	Incorporate the contents into your mental structure comprehensively.				
25	It is the very driver of its knowledge relating it to the concepts to be				
26	It makes an anchoring of the new contents with those already				
27	Manages to make transfers of the knowledge learned.				

Alternative answers:

1. Never (N)
2. Sometimes (AV)
3. Always (S)