

**THE NEUROMYTH OF LEARNING STYLES: THE PERCEPTION OF
BIOLOGICAL SCIENCES PRE-SERVICE TEACHERS AT THE UNIVERSITY OF
BRASÍLIA, BRAZIL**

***O NEUROMITO DOS ESTILOS DE APRENDIZAGEM: PERCEÇÃO DOS
PROFESSORES EM FORMAÇÃO DE CIÊNCIAS BIOLÓGICAS NA UNIVERSIDADE
DE BRASÍLIA, BRASIL***

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PROFESORES EN FORMACIÓN DE CIENCIAS BIOLÓGICAS EN LA UNIVERSIDAD
DE BRASÍLIA, BRASIL***



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ABSTRACT: In recent years, neuroscience has gained prominence in the field of education. However, those who seek to learn about neuroscience on their own may encounter inaccurate information or misconceptions about neuroscientific findings, known as neuromyths. One of the most widespread myths among educators is the one about Learning Styles (LS), which suggests that students learn best when information is presented according to their preferred style. This study aimed to investigate the perception of Biological Sciences students at the University of Brasília (UnB) regarding this neuromyth. To achieve this, an online questionnaire was administered to the participants. The results indicated that students have a positive view of Learning Styles. Therefore, it is necessary to debunk this neuromyth in the academic environment by integrating the study of neuroscience and educational neuromyths into initial teacher education through courses, research projects, and extension activities.

KEYWORDS: Learning. Teacher Education. Neuroscience. Neuroeducation.

RESUMO: Nos últimos anos, a neurociência ganhou destaque no campo da educação. No entanto, aqueles que buscam aprender sobre neurociência por conta própria podem encontrar informações imprecisas ou concepções errôneas sobre os achados neurocientíficos, conhecidos como neuromitos. Um dos mitos mais difundidos entre os educadores é o dos Estilos de Aprendizagem, que sugere que os estudantes aprendem melhor quando a informação é apresentada de acordo com seu estilo preferido. Este estudo teve como objetivo investigar a percepção dos estudantes de Ciências Biológicas da Universidade de Brasília (UnB) em relação a esse neuromito. Para isso, um questionário on-line foi aplicado aos participantes. Os resultados indicaram que os estudantes têm uma visão positiva dos Estilos de Aprendizagem. Portanto, é necessário desmistificar esse neuromito no ambiente acadêmico, integrando o estudo da neurociência e dos neuromitos educacionais na formação inicial de professores por meio de cursos, projetos de pesquisa e atividades de extensão.

PALAVRAS-CHAVE: Aprendizagem. Formação de Professores. Neurociência. Neuroeducação.

RESUMEN: En los últimos años, la neurociencia ha ganado prominencia en el campo de la educación. Sin embargo, aquellos que buscan aprender sobre neurociencia por su cuenta pueden encontrarse con información inexacta o concepciones erróneas sobre los hallazgos neurocientíficos, conocidos como neuromitos. Uno de los mitos más extendidos entre los educadores es el de los Estilos de Aprendizaje (EA), que sugiere que los estudiantes aprenden mejor cuando la información se presenta de acuerdo con su estilo preferido. Este estudio tuvo como objetivo investigar la percepción de los estudiantes de Ciencias Biológicas de la Universidad de Brasília (UnB) con respecto a este neuromito. Para lograr esto, se administró un cuestionario en línea a los participantes. Los resultados indicaron que los estudiantes tienen una visión positiva de los Estilos de Aprendizaje. Por lo tanto, es necesario desacreditar este neuromito en el entorno académico mediante la integración del estudio de la neurociencia y los neuromitos educativos en la formación inicial de docentes a través de cursos, proyectos de investigación y actividades de extensión.

PALABRAS CLAVE: Aprendizaje. Formación de Docentes. Neurociencia. Neuroeducación.

Introduction

In the last few decades, neuroscience, the field that studies the functioning of the nervous system and its components, has gained prominence in the field of education. As a result, there has been an increased demand for pedagogical practices based on neuroscientific foundations. However, this has also led to the endorsement of neuromyths circulating in the classroom, both in primary and higher education settings (Newton, 2015; Silva, Pereira, 2018; Menezes, 2022).

Neuromyths, according to Pasquinelli (2012), are erroneous statements about the brain that can arise from distortions of neuroscientific findings, the dissemination of already debunked hypotheses, or the misinterpretation of experimental results. Belief in neuromyths can be detrimental as it hinders the application of scientifically grounded knowledge and practices, the understanding of mind and brain processes, and promotes the growth of pseudoscientific methods (Pasquinelli, 2012).

One of the most widely propagated neuromyths in the field of education is that of Learning Styles (LS), which claims that individuals learn in different ways according to their learning style or preference (Pashler *et al.*, 2008). The use and propagation of this myth have many negative consequences for learning, as it labels students with fixed learning styles and imposes financial and energetic burdens on teachers without scientific endorsement (Papadatou-Pastou *et al.*, 2021).

When correctly applied in the classroom context, neuroscience allows students to engage with the content and understand their cognitive processes (Cosenza; Guerra, 2011). Thus, the integration of neuroscience into initial teacher education is essential as it provides educators with a better understanding of learning and teaching in the classroom and enables the application of efficient methodologies based on scientific data and discoveries (Carvalho, 2010).

However, despite the emphasis on the importance of neuroscientific concepts in primary education and the National Common Curricular Base recognizing the importance of neuroscience for student learning, it is rarely discussed in initial teacher education, leading to fragmentation in teacher training (Carvalho, 2010; Carvalho; Boas, 2018). Carvalho and Gil Pérez (2011) also emphasize that science education is historically associated with so called "traditional" practices, where content is passively and technically transmitted from teacher to student, with the presence of concepts, theories, and laws, without the autonomy of the learner in constructing their own knowledge.

However, merely knowing the general principles and functioning of the brain, cognition, and their possible applications in the school context does not guarantee an effective contribution to learning. Therefore, educators must critically evaluate the discussed concepts before applying them in the school context (Cosenza; Guerra, 2011). Teachers need to apply neuroscience in the classroom, not only in a content-oriented manner but also in pedagogical approaches. Thus, it is necessary to understand the processes involved in learning, and academia plays a crucial role in the discussion of literature and research in the field (Cosenza; Guerra, 2011; Tardif; Doudin; Meylan, 2015).

According to Barcelos and Villani (2006), Lima (2008), and Mellini and Ovigli (2020), teacher education, whether initial or ongoing, should promote the development of disciplinary, curricular, didactic, and experiential knowledge that guides pedagogical practice in the classroom. However, Mellini and Ovigli (2020) emphasize that specific aspects of the course, focused on techniques, are prioritized in teacher education. This can create gaps in student training, as courses do not always fully adhere to what is outlined in the Course Pedagogical Project (CPP) regarding the development of subjects in their curriculum structure, contributing to a potential fragmentation in student education (Mellini; Ovigli, 2020; Catarino; Reis, 2021). Consequently, teachers undergo a simplified training, limited to content mastery and techniques to be used in the classroom (Baptista, 2003; Carvalho; Gil-Perez, 2011). Assuming that the use of theories lacking scientific evidence is detrimental to learning and displaces scientifically proven theories (Newton, 2015), and considering that initial teacher education provides an environment conducive to debunking false scientific knowledge as it is a field of interaction between students and academia, involving dialogue with scientific literature and current research (Tardif; Doudin; Meylan, 2015), this study seeks to answer the following research question: "Do undergraduate students in Biological Sciences at the University of Brasília understand that Learning Styles are a neuromyth?"

To address this question, the general objective of this study is to investigate the perception of undergraduate students in Biological Sciences at the University of Brasília regarding the neuromyth of Learning Styles, along with the specific objectives: i) Analyze students' knowledge of neuroscience and Learning Styles, as well as identify if and how they use these concepts in the classroom; ii) Explore how their knowledge on the subject was developed during their initial teacher education; and iii) Determine whether the students have a positive or negative view of the Learning Styles theory and whether they perceive it as a neuromyth.

Materials and Methods

The methodology used in this study was of a qualitative nature, specifically in the exploratory modality. The aim of the research was to obtain an overview of a particular situation, with the intention of becoming familiar with the subject matter (Gil, 2008).

The participant group of this research consisted of 71 undergraduate students majoring in Biological Sciences at the University of Brasília (UnB), representing approximately 13% of the total number of students enrolled in the program. All participants agreed to take part in the study by signing an Informed Consent Form (ICF).

For data collection, a semi structured questionnaire was employed, comprising three types of questions. The first type consisted of multiple-choice sociodemographic questions, aimed at gathering information about the participants' profiles, such as gender, age, and current semester in the program.

The second type of questions consisted of seven open ended questions related to neuroscience and Learning Styles (LS), aiming to identify the perceptions of the preservice teachers regarding these concepts and their applicability in the classroom. The open ended questions were as follows: i) What is your understanding of the term "Neuroscience"?, ii) How were you exposed to Neuroscience? If you were exposed to Neuroscience during your studies, in which course(s) did this occur?, iii) In your perception, what is the applicability of Neuroscience in the classroom?, iv) In your opinion, what are "Learning Styles"?, v) Which Learning Styles are you familiar with?, vi) How can Learning Styles influence the way students learn?, and vii) How would you identify the Learning Styles of your students?

The third type of question consisted of true and false statements about Learning Styles, where participants were required to indicate whether they agreed ("Yes"), disagreed ("No"), or didn't know ("I don't know"), with the option to not respond. These statements were adapted from Dekker *et al.* (2012) into the Portuguese language. The questionnaire was created using the online platform Google Forms and comprised a total of 21 questions. Data collection took place from December 13th to December 23rd, 2022.

The methodology used content analysis (Ferreira, 2000). Content analysis involves identifying and categorizing the main themes, patterns, and trends present in participants' responses. To conduct the analysis, the responses to open-ended questions were first transcribed and organized into categories. This categorization considered the specific educational objectives of the study, such as understanding different learning styles and the applicability of

neuroscience in the classroom. This process allowed for the grouping of responses into relevant themes, facilitating data interpretation.

Next, a quantitative analysis was performed on the responses to true or false statements about learning styles. This analysis involved data tabulation and pattern identification. The percentage of participants who agreed, disagreed, did not know, or did not respond to each statement was determined. These results were used to identify trends and patterns of thinking regarding learning styles.

Furthermore, a descriptive analysis was conducted on the participants' sociodemographic data, such as gender, age, and current semester in the course. This analysis enabled the profiling of participants and understanding potential relationships between individual characteristics and perceptions of learning styles. After analyzing the collected data, the findings were related to the established educational objectives.

Results

After the completion of the questionnaire distribution, 71 responses were obtained, corresponding to 13.4% of the students regularly enrolled in the Biological Sciences teaching program. The majority of participants ($n = 36$, 50.7%) identified themselves as female, while 33 (46.5%) identified as male. The questionnaire was answered by at least one person from each semester of the Biological Sciences teaching program (1st to 9th), with most participants ($n = 58$, 81.7%) having completed the 5th semester or beyond.

When asked about their previous exposure to neuroscience, 32.8% of students ($n = 44$) stated that they had been exposed through university courses, 20.1% ($n = 27$) through reading articles and scientific texts, 15.7% ($n = 21$) through social media, 11.2% ($n = 15$) during primary and secondary school classes, and 9% ($n = 12$) through attended lectures.

Furthermore, when asked about their understanding of the term "neuroscience," 45.1% of participants ($n = 32$) presented incomplete or simplistic concepts, focusing on a single aspect of the system, such as the brain and neuronal connections, or specific mechanisms, such as the learning process or behavior. Approximately 14.1% of students ($n = 10$) provided erroneous concepts, such as exclusively relating neuroscience to the study of the human mind, which is more commonly addressed by neuropsychology, or exceeding the scope of the question. Moreover, only 40.8% of participants ($n = 29$) had a correct understanding of neuroscience, and only one student associated it with education.

When asked about the applicability of neuroscience in the classroom, most students (n = 41, 57.7%) mentioned applicability's related to the teacher, such as the development of new teaching strategies, understanding of learning processes, and behaviors that aid classroom performance. These students perceive the integration between neuroscience and education positively, believing that neuroscientific knowledge can offer new perspectives for their pedagogical strategies.

Other participants (n = 10, 14.1%) mentioned direct applications for students, including improvements in learning mechanisms and the application of knowledge in daily life. However, a significant number of students (n = 20, 28.2%) declared not identifying any applicability for neuroscience in the classroom, indicating that the incorporation of neuroscientific concepts into teacher education has not been fully achieved.

In the second part of the questionnaire, aimed at identifying participants' perception of learning styles, the majority of responses (n = 58, 81.7%) demonstrated a misconceived understanding of the theory, erroneously relating it to the teaching and learning process or teaching and study strategies.

When asked about the learning style theories they were familiar with, 37 participants (52.1%) demonstrated knowledge of some existing classifications, with the VARK model (Visual, Auditory, Read/write, Kinesthetic) being the most recognized by students, mentioned in 25 responses. Other mentioned models included Felder Silvermann, Honey Alonso, David Kolb, and Gardner's Multiple Intelligences model. Furthermore, 34 participants (47.9%) indicated that they were not familiar with a specific learning style model or confused the term with teaching strategies, studies, or educational resources.

The last two questions addressed the influence and identification of learning styles in the classroom. For these questions, the responses were grouped according to the perspectives presented by the students. The majority (84.5% for the question about influence and 80.3% for the question about identification) expressed a positive view of learning styles in the classroom.

Finally, the last stage of the questionnaire consisted of presenting various statements, both false and true, about Learning Styles, in an adapted format from the studies by Dekker *et al.* (2012). Regarding this, the participants of this research generally agree with the statement that students learn better when they receive information according to their Learning Style, even though this view is considered a neuromyth (Table 1).

Table 1 – Results of the beliefs of the graduates regarding statements about Learning Styles

Statement	1	2	3	4
Students learn better when they receive information according to their Learning Style.	88.8%	7%	4.2%	0%
Each student has a preference for how they learn.	88.8%	5.6%	5.6%	0%
The preferences and life experiences of a student can impact how they learn.	98.6%	1.4%	0%	0%
Learning is a long and continuous process and does not occur in the same way for all living beings.	94.4%	4.2%	0%	1,4%
Teaching tailored to meet each student's Learning Style improves academic performance.	93%	4.2%	2.8%	0%

(1) Agree; (2) Disagree; (3) I don't know; (4) I prefer not to answer.

Source: Prepared by the authors.

The sentences two and three, which address true statements about the learning process, were also strongly believed by the participants (Table 1). Over 94% of the participants agreed with the statement that learning is a long and continuous process (Table 1).

Continuing with the questionnaire, the statement that teaching tailored to each student's Learning Style improves academic performance, a neuromyth, received a positive response from 93% of the participants (Table 1).

The remaining statements addressed Learning Styles based on popular models and sought to verify if the participants agreed with the assumptions proposed by these theories. The first statement, which states that students learn better when presented with their preferred Learning Style, such as visual, auditory, or kinesthetic (known as the VARK classification), obtained a relatively lower agreement rate compared to the previous statements but still significantly high (Table 2). Therefore, although the prospective teachers believe in this theory and may use it in their teaching practices, the lack of empirical evidence and consistent research raises doubts about its effectiveness.

Table 2 – Results of beliefs of education graduates in learning style theories

Statement	1	2	3	4
Students learn better when they are exposed to their preferred Learning Style, such as visual, auditory, or kinesthetic.	77.5%	14.1%	7%	1.4%
There are individuals whose preferred Learning Style includes a preference for group work and reflecting on the content while engaging in exercises.	90.2%	4.2%	5.6%	0%
Some individuals have a preference for working alone and calmly reflecting on the content before attempting the exercises as part of their Learning Style.	90.2%	2.8%	7%	0%

It is important to identify the student's Learning Style and multiple intelligences to ensure meaningful learning.	93%	2.8%	4.2%	0%
Individuals who possess good verbal communication skills, proficiency in spoken and written language, exhibit what is referred to as linguistic intelligence, whereas those with logical-mathematical intelligence demonstrate a well-developed logical reasoning.	56.3%	25.4%	15.5%	2.8%

(1) Agree; (2) Disagree; (3) I don't know; (4) I prefer not to answer.

Source: Prepared by the authors.

The statements two and three (Table 2) were based on the Felder Silverman Theory, which suggests that students "choose" how they prefer to receive and process information. Regarding these statements, both obtained the same percentage of agreement, with 64 participants agreeing with the theory's assumptions (90.1%). However, the major issue with this theory is that it relates learning styles to people's personalities, treating them as behavioral classifications.

Lastly, the last two sentences address the dissemination of Gardner's Theory of Multiple Intelligences as a Learning Style (Table 2). The first statement emphasizes the importance of identifying the student's learning style and multiple intelligences to ensure meaningful learning. The majority of participants agreed with this statement (93%). The second statement describes one of the classifications proposed by Gardner's theory, linking skills such as good public speaking and proficiency in written language to linguistic intelligence, and logical mathematical skills to logical-mathematical intelligence. In this statement, the agreement percentage decreased to 56.3%. It can be observed that some participants agreed with the theory even without having an in-depth understanding of its assumptions, as students appear to agree with Gardner's theory but not with one of its postulates, described in statement 4.

After analyzing the questionnaire, the results of this research revealed a majority belief in the myth of learning styles. Most students demonstrated belief in and reaffirmation of this theory, with percentages above 50% and reaching over 90% in some statements. However, the content analysis of the open-ended responses showed that many prospective teachers have a limited understanding of the scope of neuroscience and are not truly familiar with learning style theories, despite claiming knowledge.

It was found that most students are unfamiliar with the concept of learning styles and confuse it with teaching resources and methodologies. Even after taking neuroscience related courses, many have incomplete knowledge, and few associated neurosciences with education and its role in the classroom. Many participants who claimed to be familiar with neuroscience and learning styles confused the concept with general pedagogical practices, indicating a

misconstrued perception of the theory. Furthermore, in general, students were unable to distinguish between learning styles and student preferences, agreeing with true and false statements in a similar manner. This shows that they have difficulty understanding the difference between these concepts.

Moreover, students believe that learning styles can be beneficial and assist in the teaching learning process, expressing interest in using the theory in their future teaching practices without recognizing the issues involved in the learning style myth. This is concerning as it leads to the classification of students based on individual characteristics, wasting energy and resources on scientifically unproven theories, and limiting the exploration of new forms of learning. Finally, we consider that the results obtained in this research have achieved the established objectives and have answered the research question that underpinned the study.

Discussion

The lack of understanding among students can be attributed to seeking information from unreliable sources or misinterpreting data in other languages (Dekker *et al.*, 2012; Gleichgerricht *et al.*, 2015; Tardif; Doudin; Meylan, 2015). Furthermore, there has been a misconception of the theory, incorrectly relating it to the teaching and learning process, as well as teaching or study strategies and methods. The study conducted by Papadatou-Pastou *et al.* (2021) revealed this conceptual confusion, in which teachers confused Learning Styles with theories or approaches to learning. It is important to note that a preference for a Learning Style does not determine learning, as learning is a multisensory process and is not limited to a single sensory channel (Westby, 2019).

A positive view of Learning Styles was also observed in the research conducted by Howard-Jones and colleagues (Howard-Jones; Jay; Galeano, 2020) in the United Kingdom, which may lead teachers to administer tests based on these theories to support their lessons, although this does not guarantee a significant improvement in student performance. It is important to remember that the learning process is influenced by various individual factors, and considering only the presentation format of the content can result in an inadequate allocation of instructional resources. Identifying students' Learning Styles may limit them in their teaching and learning process and restrict their learning possibilities (Pashler *et al.*, 2008).

Darling-Hammond (2015) and Westby (2019) emphasize that teachers should focus on the best mode of content presentation, meaning the most effective way to deliver the material.

Therefore, teachers should consider the mode that serves the objectives of their lesson, seeking the best way to convey the content, rather than adapting to students' Learning Styles (Westby, 2019). Furthermore, Learning Styles do not assist the student, but only accommodate them to a single way of learning, which can lead to misconceptions that their difficulties in other areas are due to an inappropriate style, as discussed by Pasquinelli (2012) and Newton (2015).

It is important to highlight that the topic of neuroscience in teacher education is scarce and, when addressed, is often more focused on biological analyses rather than its application in education, which contributes to a content-oriented approach to the subject (Almeida; Farias, 2011; Carvalho; Gil-Perez, 2011).

Amorim and Rato (2021) emphasize the importance of discussing neuroscientific updates in initial teacher education, integrating neuroscience with teaching practice, with the aim of demystifying neuromyths and promoting evidence-based practices. Although students may have learning preferences, there is no evidence that this guarantees better academic performance. However, due to Learning Styles accommodating their individual preferences, some students may believe that their Learning Style is responsible for their performance, even though not everyone learns in the same way (Pasquinelli, 2012; Newton, 2015).

In this context, Carvalho (2010) emphasizes that understanding neuroscience can assist teachers in developing more effective teaching methodologies, allowing for better connection with students and a deeper understanding of the cognitive processes involved in learning. The author further suggests that understanding cognitive processes and neuroscience is essential for teachers to organize their teaching practice, taking into consideration students' emotions, memory, and perception. Additionally, the National Common Curricular Base (NCCB) highlights the importance of developing the ability to think, reflect, and draw conclusions based on knowledge about natural sciences, underscoring the relevance of neuroscience in the classroom (Brasil, 2018).

Regarding the claim that teaching tailored to meet each student's learning style improves academic performance, this can be explained by the fact that students feel more comfortable with the idea of personalized and adapted instruction that meets their individual needs, leading to increased engagement and motivation to learn (Pashler *et al.*, 2008). However, Newton (2015) explains that classifying students based on their preferences is not the ideal solution. It is more effective to develop teaching strategies based on each student's knowledge and difficulties, rather than focusing solely on a specific sensory style. In line with this statement, Carvalho (2010) and Westby (2019) add that regardless of how the stimulus is presented, the

process of synaptic formation and brain plasticity are essential aspects of learning, along with the meaning attributed to the message by the student.

Previous studies, such as those conducted by Newton (2015), Dekker *et al.* (2012), and Amorim and Rato (2021), have shown similar results in which educators believe in and teach this classification to students. This finding suggests that teacher candidates can also adopt this theory in their teaching practices. However, the lack of solid empirical evidence and consistent research raises doubts about the effectiveness of learning styles as a valid approach (Pashler *et al.*, 2008).

One of the main issues with this theory lies in its association with people's personalities, treating learning styles as behavioral classifications. This makes the theory resemble more of a behavioral classification, such as the MBTI (Myers-Briggs Type Indicator), rather than a theory of learning based on scientific evidence (Pashler *et al.*, 2008).

The lack of solid empirical grounding and the tendency to relate learning styles to personality traits are elements that raise questions about the validity and usefulness of this approach. It is crucial for teaching practices to be based on consistent scientific evidence in order to promote an effective learning environment and meet the diverse needs of students.

Therefore, although teacher candidates may believe in the theory of learning styles and even use it in their teaching practices, it is necessary to consider the limitations and gaps in the evidence base. The pursuit of pedagogical approaches based on consistent and up to date research is essential to promote quality education and prevent the spread of neuromyths that could hinder the teaching and learning process.

Conclusions

In conclusion, this study investigated the perception of undergraduate students in Biological Sciences at the University of Brasília regarding the neuromyth of Learning Styles. The results emphasized the importance of initial teacher education as a strategic moment to address and eradicate misconceptions related to this concept.

Through the analysis of the students' perceptions, it was evident that access to neuroscientific knowledge during teacher training can play a fundamental role in deconstructing unfounded beliefs and adopting evidence based pedagogical practices. Additionally, the availability of neuroeducation courses, scientific outreach projects, and lectures related to the

topic can contribute to the dissemination of this neuroscientific knowledge among future educators.

However, it is important to note that the existence of educational neuromyths represents a challenge to be confronted. The lack of solid scientific foundation and the inappropriate association between learning styles and personality traits raise questions about the validity and usefulness of this approach in the educational context. Therefore, conducting further research in the field of neuroeducation, with a specific focus on investigating the neuromyth of Learning Styles, is necessary to provide a solid evidence base that assists in dispelling these misguided beliefs.

In light of these results, it is recommended that higher education institutions, such as the University of Brasília, adopt a pedagogical approach based on neuroscience, promoting the integration of theory and practice and equipping future teachers with an understanding of the cognitive processes involved in learning. Through neuroeducation courses, extension projects, and research in the field of neuroeducation, universities can play a fundamental role in the training of professionals capable of providing quality education grounded in updated scientific knowledge and free from neuromyths.

In summary, this study highlights the importance of initial teacher education and the dissemination of neuroscientific knowledge in combating neuromyths, particularly regarding Learning Styles. The construction of a solid evidence base and the integration of this knowledge into pedagogical practices are essential to promote quality education that meets the diverse needs of students and contributes to their cognitive and academic development.

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