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Neuro-pedagogy and the Development of the Educational System: A Scientific Approach Bridging Neurolinguistics and Educational Sciences

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Abstract:

This work seeks to highlight neuro-pedagogy as an interdisciplinary approach grounded in neurolinguistics, neuroscience, and educational sciences, with the aim of reconstructing educational practice on the basis of a scientific understanding of the learning brain. The theoretical section clarifies the nature of this emerging field and distinguishes it from quasi-scientific discourses, while emphasizing its role in bridging the gap between the laboratory and classroom practices. It also presents key brain mechanisms relevant to learning—such as neuroplasticity, memory systems, attentional dynamics, the function of emotion, the importance of multisensory processing, and individual differences—as foundational principles for redesigning learning situations. The applied section focuses on linguistic learning difficulties, particularly dyslexia, dysgraphia, and speech and language disorders, from a neuro-linguistic perspective that interprets them as differences in processing patterns rather than mere "low achievement." In this context, early identification and brain-based intervention are assigned a central place, through simple yet sensitive diagnostic protocols and targeted classroom support strategies. The work further underscores the centrality of teachers' training in educational neuroscience and a culture of error as a prerequisite for the effectiveness of any project aiming to integrate the neural dimension into educational policies. It concludes that reforming the educational system requires an epistemological shift from a pedagogy of content to a pedagogy of the learning brain, thereby ensuring deeper learning and a more inclusive, equitable, and effective school.

Keywords: Neuro-pedagogy -Neurolinguistics -Educational neuroscience -Learning difficulties -Brain-based learning.

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Introduction:

This chapter explores neuro-pedagogy as an emerging interdisciplinary field that brings together insights from neurolinguistics, neuroscience, and educational sciences in order to rethink teaching and learning in light of how the brain actually acquires, processes, and uses knowledge. It argues that any meaningful reform of the educational system must move beyond content-centred approaches towards brain-based pedagogies that take into account neuroplasticity, memory systems, attentional dynamics, emotion, and learner diversity. Within this framework, particular attention is given to language-related learning difficulties—such as dyslexia, dysgraphia, and speech and language disorders—and to the ways in which a neuro-linguistic perspective can inform early identification and targeted classroom intervention. By linking theoretical advances in brain and language research to concrete pedagogical practices, the chapter seeks to contribute to the development of a more inclusive, effective, and scientifically grounded educational system.

Here is the English translation of your text, maintaining the academic tone and technical terminology:

First: Theoretical Foundations of Neuropedagogy and its Relation to Neurolinguistics:

Neuropedagogy is a modern trend in educational thought that leverages accumulated data from neuroscience and educational sciences to build instructional practices consistent with the characteristics and functional mechanisms of the learning brain. This approach indicates that the pedagogical act is no longer merely an external organization of educational experiences; rather, it has primarily become a directed intervention toward complex neural systems that govern attention, memory, language, emotion, and decision-making within the learning situation. In this sense, neuropedagogy seeks to move beyond traditional conceptions of education—which focus on knowledge transmission—toward perspectives that respect "brain learnability" as described in contemporary neurological research, including the principle of **neuroplasticity**, sensory integration, and the role of emotional context and motivation in consolidating learning[1].

Neuropedagogy belongs to a broader field known as **Educational Neuroscience** (or Neuroeducation). This is an interdisciplinary field where cognitive neuroscience, cognitive psychology, and educational sciences intersect. It investigates the optimal neurological conditions for school learning and how to translate laboratory findings into practical classroom strategies. In this context, **brain-based learning** is defined as a mode of learning characterized by mindfulness, high levels of positive cognitive arousal, the absence of threat, active cooperation, and the integration of educational systems to ensure their compatibility with brain function. Consequently, neuropedagogy is not limited to "simplifying" neurological knowledge for teachers[2][2]; instead, it works to build epistemological and methodological bridges between the neuro-lab and the classroom.

From a conceptual perspective, neuropedagogy can be distinguished from other related concepts that may cause confusion, such as **Neuro-Linguistic Programming (NLP)**—which is considered a behavioral self-development approach rather than a rigorous experimental science—or various "neuromyths" prevalent in popular literature (such as the right-brain/left-brain dichotomy, rigid learning styles, etc.). In contrast, neuropedagogy is based on documented results in neuroscience and cognitive sciences, drawing on brain imaging techniques and experimental studies on memory, attention, and language. It constantly seeks to critique oversimplifications and ensures the appropriateness of the transfer from the laboratory to the classroom. This distinction is essential to ensure that the utilization of neurological knowledge in schools is rational, avoiding **biological reductionism**[3]or passing educational "fads."

The Theoretical Background: Neurolinguistics and its Integration with Neuropedagogy:

Neuropedagogy draws much of its theoretical background from **Neurolinguistics**, a branch of applied linguistics that studies the neural mechanisms in the human brain that control language comprehension, production, and acquisition. Neurolinguistics views language as a higher neurological function distributed across overlapping brain networks. These networks include specialized areas for phonological, morphological, syntactic, and semantic processing—such as **Broca's and Wernicke's areas**—which operate in an interactive dynamic during linguistic activity[4] .The development of functional brain imaging techniques (such as **fMRI**) has provided a more precise understanding of how linguistic abilities are localized in the brain and how they are affected by neurological injuries or learning disabilities.

In various Arabic studies, **Neurolinguistics** is defined as the science that investigates the relationship between the nervous system and language, or as the branch of linguistics concerned with the encoding of

[1] . Brain-based Learning Principles in the Science Curricula Content of the Basic Education Stage in the Sultanate of Oman: An Analytical Study.
[2] . Neuroeducation: Applied Neuroscience in School Learning.
[3] . . Ahmed Bouanane, Educational Neuroscience: The Path of Establishment and the Challenge of Specialization - American International Journal of Humanities and Social Sciences.
4 . Amal Kaouache, The Physiology of Language and its Scientific Mechanisms from a Neurolinguistic Perspective, Journal of Arts and Islamic Civilization, Vol. 12, Issue 25, 2020.

linguistic competence in the brain. Its specificity lies in its adoption of the **experimental method** to study linguistic phenomena by linking linguistic data with neurological and psychological data. This aims to uncover linguistic processing patterns, the characteristics of a "healthy linguistic brain," and the manifestations of linguistic disorders in cases of aphasia, dyslexia, and dysgraphia. This experimental dimension makes it a field qualified to provide neuropedagogy with precise data on the mechanisms of learning language, reading, and writing, as well as individual differences in linguistic processing among learners.

In light of this, neurolinguistics represents a central intersection between neuroscience and educational sciences. On one hand, it explains how linguistic structures are represented in the brain and how they develop through growth stages. On the other hand, it allows for the construction of a scientific conception of linguistic learning difficulties and disorders within the school environment. For instance, studies in the **physiology of language** indicate that language production and comprehension rely on multi-level encoding and decoding processes (phonological, morphological, syntactic, and semantic) occurring within an integrated brain network. Any defect in one of these components may manifest as impaired linguistic performance. This explains the diverse forms of dyslexia, dysgraphia, and speech disorders among students, calling for the adoption of diagnostic and pedagogical approaches based on a neuro-linguistic understanding of these phenomena rather than relying solely on general educational explanations.

Educational Implications and Future Perspectives

At the educational level, this neuro-linguistic vision allows for the development of a pedagogy that respects individual differences in linguistic processing. This is achieved by identifying variations in processing speeds, working memory capacity, the quality of phonological representations, and other neuro-cognitive variables that influence learning to read and write. This perspective helps, for instance, in understanding that certain patterns of "slow learning" are not the result of negligence or laziness, but rather an expression of specific neurological characteristics in information processing. Such cases require a diversification of methods and tools, the provision of additional time, and the construction of individualized support tracks. Furthermore, it demonstrates that a learning environment rich in appropriate stimuli—one that stimulates attention without causing cognitive overload or distraction, and relies on multi-sensory interaction (visual, auditory, kinesthetic)—contributes to activating various neural circuits, thereby facilitating the **deep encoding** of information and its subsequent retrieval[5] .

On another note, brain-based learning literature emphasizes the pivotal role of emotion and motivation in activating learning networks within the brain. States of fear and chronic threat are linked to increased secretion of stress hormones that hinder working memory. In contrast, safe classroom environments built on mutual respect and positive reinforcement provide better neurological conditions for processing new information. Here, neuropedagogy aligns with educational sciences in emphasizing the importance of the emotional climate of learning; however, it adds a neuro-explanatory dimension that clarifies how this climate reflects on neuronal activity and the consolidation or inhibition of new **synaptic connections**[6]. This opens the door for educators to reconsider classroom management strategies, assessment methods, and the nature of feedback provided to learners in light of what neurological research reveals about the impact of emotion on learning.

Based on these foundations, neuropedagogy can be viewed as a project to reformulate the relationship between theory and practice in education. It is based, on one hand, on robust knowledge in neurolinguistics and cognitive neuroscience regarding the nature of the learning brain. On the other hand, it benefits from the expertise of educational sciences in analyzing instructional situations and constructing objectives, content, and methods. Through this intersection, it becomes possible to formulate a **"neuro-educational**

5 . Ali Dallal, The Importance of the Brain and Senses in Accelerating the Learning Process, Journal of Arts and Human Sciences, Issue 18, Vol. 1, p. 153.

- [6] . Buthaina A. Al-Zaidi, Brain-based Learning Principles in the Science Curricula Content of the Basic Education Stage in the Sultanate of Oman: An Analytical Study.

profile" of the learner to guide the pedagogical design process[7] , allowing for a transition from a "one-size-fits-all" pedagogy to one that respects the neuro-cognitive diversity within the classroom.

In this conception, integrating neuropedagogy into the educational system is not a cognitive luxury but a scientific response to an urgent need for reform based on a deep understanding of the learner as a neuro-cognitive-linguistic being. Without this understanding, many reform programs remain confined to modifying curricula and textbooks at the content level, without touching the core of the educational process: how the "school brain" engages with this content. From here, the importance of this section emerges in paving the way for subsequent sections of the chapter, which will detail the principles of the learning brain's function, leverage neurolinguistic findings in managing learning difficulties, and propose practical ways to integrate the neurological dimension into the development of the educational system.

Second: Principles of the Learning Brain's Function and Their Implications for Classroom Practice:

This section focuses on highlighting the principles of the learning brain's operation as revealed by neurological and educational research, outlining their direct implications for learning design and classroom organization. These principles aim to transition from a pedagogy limited to knowledge transmission to one that respects the neuro-cognitive and emotional characteristics of the learner. Thus, activities, media, and educational environments are designed in harmony with how the brain **actually** learns, rather than how it is theoretically assumed to learn. Studies on **"Brain-Based Learning"** have shown that considering these principles in curriculum development and lesson delivery positively affects learner motivation, quality of comprehension, depth of learning, and the reduction of educational waste.

1. Neuroplasticity and the Potential for Educational Change:

Neuroplasticity is one of the central concepts in explaining learnability. It refers to the nervous system's ability to modify its structure and functions in response to experience by creating new neural connections, strengthening existing ones, and even reorganizing functional networks during intensive learning or following injury. Modern research confirms that the brain is not a static, closed structure, but a dynamic system that remains capable of reshaping throughout life, albeit at varying rates depending on age groups and contexts.

In an educational context, this means that a learner's performance is not a fixed destiny. Designing rich, scaffolded, and supported learning experiences can lead to actual neurological changes, translated into improved skills in reading, writing, problem-solving, and self-regulation.

Pedagogical Implications of Neuroplasticity:

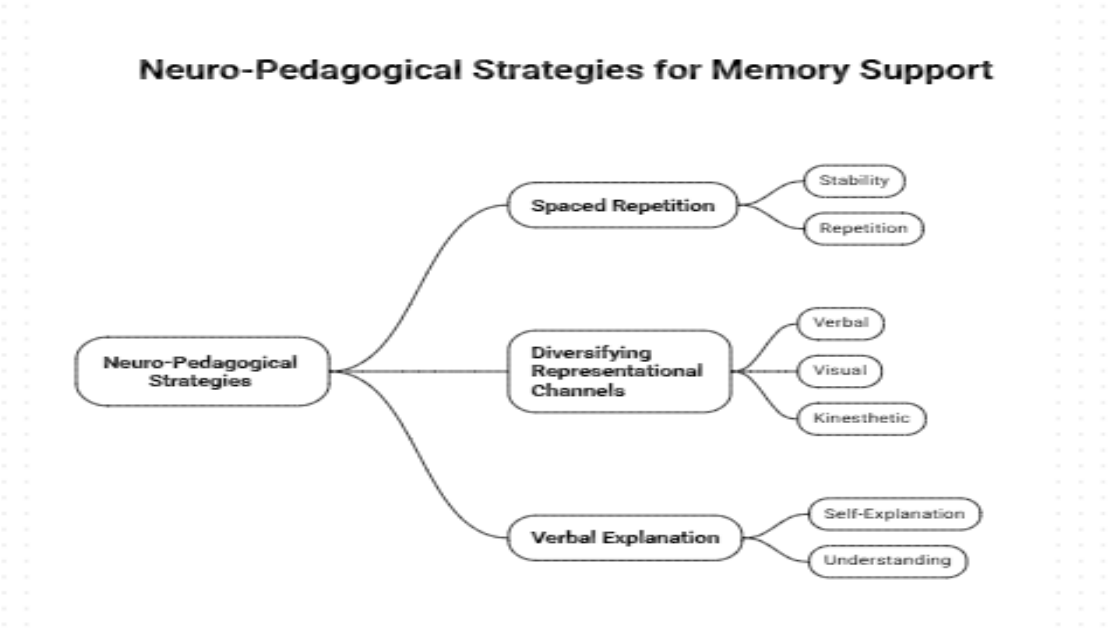
Several pedagogical outcomes stem from the principle of neuroplasticity, most notably that **error** should be understood as a "learning moment" and an opportunity to reorganize neural networks, rather than evidence of fixed disability or inherent deficiency. Literature on the **"Culture of Error"** [8]in neuropedagogy indicates that providing constructive feedback and encouraging repeated attempts within a safe environment helps consolidate more effective strategies and gradually strengthens the synaptic connections associated with correct solutions. Furthermore, it highlights the importance of:

- **Scaffolding difficulty:** Gradually increasing the complexity of tasks.

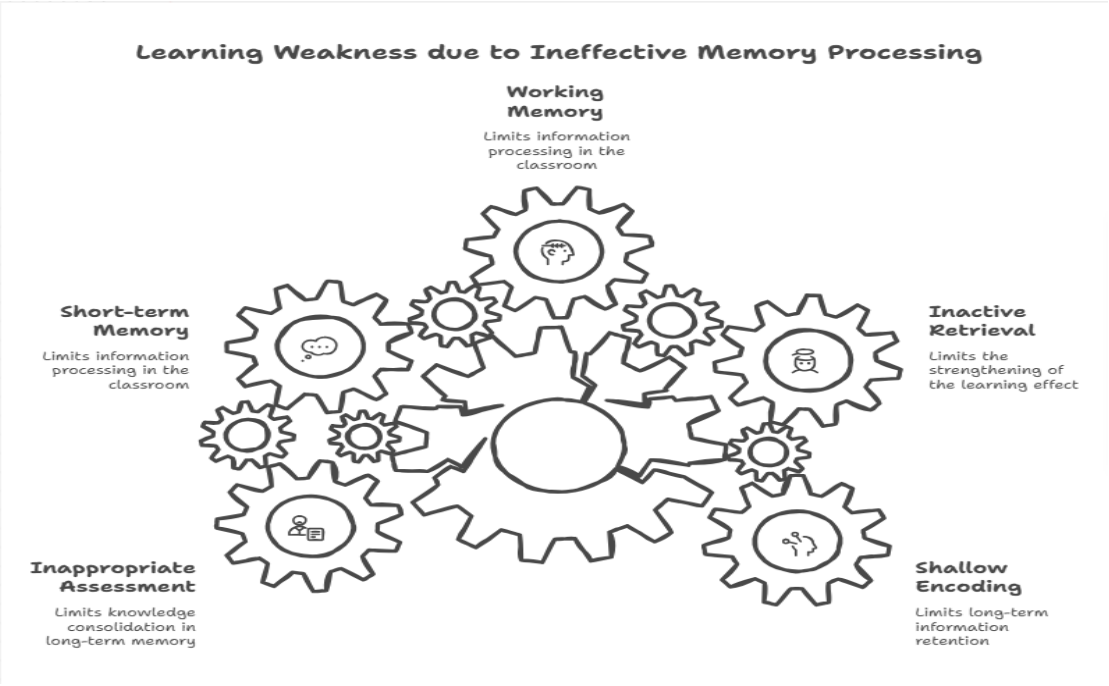
[7] . Ahmed Bouanane, Educational Neuroscience: The Path of Establishment and the Challenge of Specialization - American International Journal of Humanities and Social Sciences.

[8] . In neuropedagogy, **"Culture of Error"** refers to a new representation of mistakes as essential neuro-cognitive events for the reorganization of neural networks, rather than signs of failure to be suppressed or punished. Rooted in neuroplasticity, every incorrect attempt is viewed as an opportunity to adjust representations and build more precise synaptic links through constructive feedback in a safe classroom climate free from threat or ridicule. In this sense, error becomes a diagnostic resource helping the teacher understand the learning brain's mechanisms, and correction becomes a metacognitive moment where the learner consciously participates (e.g., *Why did I make a mistake? How do I correct it?*). This supports intrinsic motivation, cognitive flexibility, and transforms the classroom into a space for experimentation without the fear of failure.

- **Task fragmentation:** Breaking down complex tasks into manageable parts.
- **Repetitive practice in diverse contexts:** Allowing learning to stabilize at deeper levels of processing.



From a neuropedagogical perspective, supporting memory necessitates the adoption of diverse strategies, such as **spaced repetition**, linking new knowledge to prior knowledge, utilizing contextual examples, diversifying representation channels (verbal, visual, kinesthetic), and encouraging the learner to "vocalize" their own explanations of what they are learning. Furthermore, research findings on incorporating brain-based learning principles into curricula indicate that activities requiring **active retrieval** of information—such as open-ended questions, problem-solving, and paraphrasing—contribute to strengthening the learning effect more effectively than mere presentation and reception. Consequently, neuropedagogy advocates for a re-evaluation of assessment patterns so they are not confined to measuring immediate rote memorization, but instead provide repeated opportunities to retrieve knowledge in different contexts, thereby supporting its consolidation in **long-term memory**.



3. Attention and Optimizing Cognitive Load:

Attention is the fundamental gateway to any learning; information cannot be processed or stored unless it receives a share of the learner's limited attentional resources. Brain-based learning research indicates that the ability of learners to maintain **sustained attention** is time-limited, and that attention levels are influenced by internal factors (motivation, fatigue, emotional state) and external factors (attractiveness of stimuli, clarity of instructions, lesson pacing). Research also shows that dividing attention between multiple tasks often leads to a decline in performance, particularly among younger learners, making it essential to minimize sources of distraction during learning activities.

In light of this, managing attention requires adopting classroom practices based on neuropedagogical principles. These include: starting lessons with "energizer" activities that pique curiosity, employing active learning that engages the learner both physically and mentally, and dividing sessions into short segments interspersed with changes in pace or activity type. Additionally, the literature recommends providing clear, specific instructions, using visual and auditory cues to direct attention to core elements, and incorporating short breaks or simple movements to help reactivate the neural networks responsible for self-regulation and focus[9] . Within this framework, "inattentiveness" is not viewed as a fixed trait, but as a phenomenon that can be modified if the classroom environment is reorganized to align with the brain's attentional dynamics.

4. Emotion and Learning: Psychological Safety as a Prerequisite for Cognitive Efficiency:

Neurological research has established a strong correlation between a learner's emotional state and the efficiency of cognitive processes responsible for comprehension, memory, and problem-solving. Chronic stress and fear of failure activate neural structures associated with the "threat response," which undermines the functions of the **prefrontal cortex**. This area is responsible for **executive functions** such as flexible attention, impulse control, and planning, thereby limiting the learner's ability to engage efficiently in learning tasks[10] . Conversely, feelings of safety, acceptance, and support help cultivate a neurological ground suitable for learning by enhancing neuroplasticity and improving communication between emotional and cognitive networks.

Arabic studies on the importance of the brain and senses in accelerating learning emphasize that a learner's sense of psychological comfort within a positive classroom environment accelerates learning processes. In contrast, a climate based on threat and ridicule generates negative emotions that inhibit motivation and obstruct assimilation. Consequently, neuropedagogy calls for rehabilitating the emotional dimension in classroom practice by adopting communication styles based on respect and encouragement, utilizing constructive assessment that rewards effort, and integrating **socio-emotional learning** activities that develop learners' awareness of their emotions and their ability to regulate them. Furthermore, it highlights the importance of designing tasks with an "optimal challenge"—tasks that are neither too easy (causing boredom) nor too difficult (generating anxiety)—as this "sweet spot" triggers the brain's reward networks and sustains perseverance.

5. The Role of Senses and Multi-modal Learning:

Literature related to "Accelerated Learning" and brain-based learning demonstrates that engaging different senses in the learning situation contributes to accelerating and deepening the process. This is because the brain processes information received via multiple sensory channels through parallel, integrated networks. This literature explains that employing consistent visual, auditory, and kinesthetic stimuli facilitates **multi-modal encoding**, allowing information to be stored through different representations, which increases the chances of later retrieval. Multi-modal learning also encourages the engagement of diverse learner groups and reduces the dominance of a single style of content delivery.

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[9] . Christopher Pappas, Neuroeducation Principles: A Brain-Based Approach To Learning Effectively, eLearning Industry.

[10] . Neuropedagogy Module 5: Emotions (Project Report/PDF).

Accordingly, neuropedagogy recommends designing learning activities that include: visual media (images, concept maps, charts), auditory elements (reading aloud, dialogues, recordings), and kinesthetic movement (role-playing, hands-on experiments, physical gestures), all within a balanced structure that does not overwhelm the learner with stimuli to the point of confusion. Recent works on applying brain-based learning principles in science and Arabic language curricula indicate that instructional units built according to this vision show higher levels of engagement and comprehension compared to units limited to verbal presentation. However, this does not mean adopting the rigid idea of "Learning Styles"; rather, it means using multi-modality flexibly based on an understanding of how the brain benefits from a diversity of sensory channels.

6. Individual Differences and Celebrating Neurodiversity:

Research in educational neuroscience highlights that learners differ across a range of neuro-cognitive indicators, such as **working memory capacity**, processing speed, executive control patterns, and sensitivity to emotional stimuli. These differences are reflected in learning styles and task responses. This suggests that treating a class as a homogeneous mass ignores a fundamental reality: **Neurodiversity**. This concept also encompasses learners who face specific learning difficulties, such as dyslexia, ADHD, and other conditions. Therefore, neuropedagogy calls for a shift from the logic of "the average student" to the logic of "reasonable individualization" in learning design.

The pedagogical response to these differences lies in adopting **Differentiation** in objectives, media, activities, and learning pace, allowing learners to reach the same competencies through different pathways that respect their characteristics. Studies on applying brain-based principles in curriculum design indicate that reasonable customization (through task variation, providing choices, and individual feedback) improves achievement and reduces academic anxiety. In this context, classroom observation tools, diagnostic tests, and continuous monitoring become essential for forming an accurate **"neuro-educational profile"** [11]for each learner, which in turn guides the teacher's decisions in planning and execution.

From Principles to Classroom Practice:

The aforementioned principles (**neuroplasticity, memory, attention, emotion, sensory role, and individual differences**) are not merely theoretical data; rather, they represent a reference framework for restructuring classroom practice in light of neuropedagogy. Literature addressing the integration of brain-based learning principles into science and Arabic language curricula clarifies that the effectiveness of these principles depends on the extent to which they are translated into concrete practical decisions at the level of lesson design[12] . This includes defining objectives focused on deep understanding, organizing the sequence of activities to align with **attention curves**, selecting consistent multimedia, and planning periods for practice and **active retrieval**. It also highlights the importance of teacher training in these principles to ensure they do not turn into general slogans that are impossible to implement.

Modern approaches in educational neuroscience show that learning environments based on active learning, continuous feedback, collaborative work, and emotional regulation are capable of providing better neurological conditions for learning. This is reflected in learner outcomes and indicators such as motivation, self-confidence, and **cognitive flexibility**. Thus, the section regarding the principles of the learning brain serves as an essential link between the theoretical framework of neuropedagogy on one hand, and its practical applications in developing classroom practices and the educational system on the other[13] . This paves the way for the next section of the chapter concerning the management of learning difficulties and the integration of this approach into educational reform policies.

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[11] . Leopoldo Alonso, Neuroeducation: Transforming Higher Education, Planeta Formación y Universidades

12. Brain-based Learning Principles in the Science Curricula Content of the Basic Education Stage in the Sultanate of Oman: An Analytical Study.

[13] .Christopher Pappas, Uniting Neuroscience And Education: The Foundational Principles Of Neuroeducation, eLearning Industry.

8. Toward an Inclusive Pedagogy Based on Brain Research:

These findings lead to a comprehensive conception of neuropedagogy as a pillar for building an **inclusive school** that recognizes the neuro-cognitive and linguistic diversity among learners and seeks to prepare flexible learning environments that respond to their different needs. Instead of neuro-linguistic diagnosis being an entry point for exclusion or stigmatization, it becomes a tool for designing adapted learning pathways, support programs, and partnerships between the school, family, and specialists, ensuring every learner's right to quality education. As modern educational neuroscience literature shows, understanding the neural dynamics governing learning does not only serve those with difficulties but contributes to improving education for all, as brain-based practices are often inherently "good practices."

In this light, this section represents a strategic link in the chapter, moving the discussion from the level of general neuropedagogical principles to the level of the most vulnerable groups in the educational system: learners with **linguistic learning difficulties**. By linking neurolinguistics with educational sciences, it provides a practical framework for developing early detection policies, intervention programs, and training pathways, enhancing both educational equity and quality. This foundation prepares the ground for the subsequent section, which addresses the integration of neuropedagogy into the development policies of the educational system as a whole[14], at the levels of curricula, assessment, training, and decision-making.

Conclusion and Findings:

1. **Neuropedagogy** emerges as a scientific approach linking neuroscience, neurolinguistics, and educational sciences to redesign instructional practices according to the characteristics of the learning brain.
2. The principles of brain function (**neuroplasticity, memory, attention, emotion, multi-sensory engagement, and individual differences**) confirm that learning is a dynamic and modifiable process, necessitating a pedagogy based on scaffolding, spaced repetition, active learning, and a safe classroom environment.
3. **Neurolinguistics** demonstrates that linguistic learning difficulties (**dyslexia, dysgraphia, and speech/language disorders**) have specific neuro-cognitive roots. Understanding these mechanisms allows for more accurate diagnoses and targeted pedagogical interventions.
4. Early detection, brain-based intervention, adaptation of methods and media, and **differentiated learning** are essential practical entries to empower learners with difficulties through equitable and effective educational pathways.
5. The successful integration of the neurological dimension into the educational system depends on training teachers in educational neuroscience and the **"culture of error,"** and on developing curricula and assessments that leverage these principles to build an inclusive school that improves learning quality for all.

References

1. Brain-based Learning Principles in the Science Curricula Content of the Basic Education Stage in the Sultanate of Oman: An Analytical Study.
2. Neuroeducation: Applied Neuroscience in School Learning.
3. Ahmed Bouanane, Educational Neuroscience: The Path of Establishment and the Challenge of Specialization - American International Journal of Humanities and Social Sciences.
4. Amal Kaouache, The Physiology of Language and its Scientific Mechanisms from a Neurolinguistic Perspective, Journal of Arts and Islamic Civilization, Vol. 12, Issue 25, 2020.

[14] . Sylviane Valdois, The Cognitive and Neuronal Bases of Developmental Dyslexia: A Review with Emphasis on the Arabic Language, Al-Lisaniyyat.

5. Ali Dallal, The Importance of the Brain and Senses in Accelerating the Learning Process, Journal of Arts and Human Sciences, Issue 18, Vol. 1, p. 153.
6. Buthaina A. Al-Zaidi, Brain-based Learning Principles in the Science Curricula Content of the Basic Education Stage in the Sultanate of Oman: An Analytical Study.
7. Ahmed Bouanane, Educational Neuroscience: The Path of Establishment and the Challenge of Specialization - American International Journal of Humanities and Social Sciences.
8. Christopher Pappas, Neuroeducation Principles: A Brain-Based Approach To Learning Effectively, eLearning Industry.
9. Neuropedagogy Module 5: Emotions (Project Report/PDF).
10. Leopoldo Alonso, Neuroeducation: Transforming Higher Education, Planeta Formación y Universidades
11. Brain-based Learning Principles in the Science Curricula Content of the Basic Education Stage in the Sultanate of Oman: An Analytical Study.
12. .Christopher Pappas, Uniting Neuroscience And Education: The Foundational Principles Of Neuroeducation, eLearning Industry.
13. Sylviane Valdois, The Cognitive and Neuronal Bases of Developmental Dyslexia: A Review with Emphasis on the Arabic Language, Al-Lisaniyyat.