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IMPLEMENTING WILLIAMS AND SHELLENBERGER'S PYRAMID OF LEARNING IN THE EDUCATIONAL SYSTEM: A NEUROPEDAGOGICAL APPROACH

The purpose of this article is the analysis of theoretical and methodological aspects and perspectives of integrating Williams and Shellenberger's Pyramid of Learning into the neuropedagogical approach as a model for supporting sensory-cognitive development. It also aims to investigate strategies for preparing educators to apply neuropedagogical methods effectively. By considering European efforts, particularly through initiatives like the Erasmus+ program, this study explores ways to advance the training and resources available to educators. The research methodology is based on the principles of the neuropedagogical approach and analysis of Williams and Shellenberger's Pyramid of Learning theory to understand the implications of sensory-cognitive development to understand the implications of sensory-cognitive development within the educational system. Additionally, the study evaluates current training practices for educators in European, Ukrainian and Saudi Arabian contexts and examines best experience for embedding multisensory strategies in curricula. The scientific novelty of the study lies in its comprehensive analysis of Williams and Shellenberger's Pyramid of Learning as a sensory-cognitive framework within the field of neuropedagogy. By exploring this model's application in curricula, the article offers new insights into how structured sensory-based learning environments can enhance student engagement and academic outcomes. This research seeks to bridge theoretical insights with practical applications within diverse educational settings. Furthermore, it emphasizes the role of European initiatives in advancing neuropedagogical practices and the importance of aligning Ukrainian and Saudi Arabian training programs with these standards. Conclusions. The study supposes that implementation of Williams and Shellenberger's Pyramid of Learning within educational systems can address significant deficiencies in current teaching methods by fostering a neuropedagogical approach that supports various (neurotypical and neurodivergent) learners and their needs. However, the effective use of these methods remains limited due to insufficient teacher training, especially in non-European contexts. The findings suggest that future research should focus on validating sensory-based approaches and adapting Williams and Shellenberger's Pyramid of Learning to suit diverse educational settings, ensuring compatibility with both European, Ukrainian and Saudi Arabian standards. Equipping educators with neuropedagogical competencies through structured training programs will be essential to achieving neurodevelopmentally informed educational environments.

Key words: *neuropedagogy, sensory integration, Williams and Shellenberger's Pyramid of Learning, neuropsychology, teachers training.*

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ВПРОВАДЖЕННЯ ПІРАМІДИ НАВЧАННЯ ВІЛЬЯМСА ТА ШЕЛЛЕНБЕРГЕРА В ОСВІТНЮ СИСТЕМУ: НЕЙРОПЕДАГОГІЧНИЙ ПІДХІД

Метою цієї статті є аналіз теоретичних і методологічних аспектів та перспектив інтеграції Піраміди навчання Вільямса і Шелленбергера в нейропедагогічний підхід як моделі підтримки сенсорно-когнітивного розвитку. Також ця робота спрямована на дослідження стратегій підготовки педагогів до ефективного застосування нейропедагогічних методів. З урахуванням європейського досвіду, зокрема через такі ініціативи, як програма Erasmus+, у статті розглядаються шляхи покращення підготовки та ресурсного забезпечення педагогів. Методологія дослідження базується на принципах нейропедагогічного підходу й аналізі теорії Піраміди навчання Вільямса та Шелленбергера для розуміння впливу сенсорно-когнітивного розвитку в рамках освітньої системи. Крім того, у дослідженні оцінюються сучасні практики підготовки педагогів у європейському, українському та саудівському контекстах і аналізуються можливості впровадження мультисенсорних стратегій у навчальні програми. Наукова новизна цього дослідження полягає у всебічному аналізі Піраміди навчання Ві-

льямса та Шелленбергера як сенсорно-когнітивної моделі в рамках нейропедагогіки. Вивчаючи застосування цієї моделі в навчальних програмах, стаття пропонує нові перспективи щодо того, як структуровані сенсорно-орієнтовані навчальні середовища можуть сприяти залученню учнів і покращенню їхніх академічних результатів. Це дослідження спрямоване на поєднання теоретичних знань із практичним застосуванням ц різних освітніх контекстах. Крім того, наголошується на ролі європейських ініціатив у розвитку нейропедагогічних практик і важливості узгодження українських і саудівських програм підготовки педагогів із цими стандартами. Висновки. У дослідженні робиться висновок, що впровадження Піраміди навчання Вільямса та Шелленбергера в освітні системи може допомогти подолати значні недоліки сучасних методів навчання шляхом розвитку нейропедагогічного підходу, який є сприятливим для різних учнів (нейротипових і нейродивергентних) і враховує їхні потреби. Проте ефективне використання цих методів залишається обмеженим через недостатню підготовку педагогів, особливо в позаєвропейських контекстах. Результати дослідження свідчать про необхідність зосередження майбутніх досліджень на обґрунтуванні сенсорно-орієнтованих підходів та адаптації Піраміди навчання Вільямса та Шелленбергера до різноманітних освітніх середовищ, забезпечуючи їхню сумісність із європейськими, українськими та саудівськими стандартами. Оснащення педагогів нейропедагогічними компетенціями через структуровані програми підготовки стане ключовим для створення нейророзвиткових освітніх середовищ.

Ключові слова: *нейропедагогіка, сенсорна інтеграція, Піраміда навчання Вільямса та Шелленбергера, нейропсихологія, підготовка вчителів.*

Introduction. In recent years, there have been notable advancements in the comprehension of the interplay between sensory and cognitive development, the brain, and the learning process. Scholars across the globe in the fields of pedagogy, neuropsychology, psychology, and sensory integration have underscored the deficiencies in traditional teaching methodologies that frequently neglect the critical significance of sensory development in achieving academic success. The influence of globalisation has led to a shift in children's education. Consequently, there is a decrease in the stimulation of children's sensory system, motor skills, which is affecting their cognitive development [1]. In contemporary times, Europe has initiated progressive educational programs, such as the Erasmus+ initiative titled "Neuro-Pedagogy in Action: Innovative Strategies for Inclusive Education and Engaging Minds", which is focused on the advancement of neuropedagogical methodologies [2]. The program was officially announced on October 18, 2024, marking a significant milestone in the broader effort to integrate neuroscientific principles into modern educational practices across Europe. Ukraine actively participates in this initiative, seeking to enhance its educational landscape by adopting innovative approaches and fostering collaboration among educators across the continent [3]. Meanwhile, as Saudi Arabia prepares for EXPO 2030 with an emphasis on inclusive education, there is an increasing need to implement neuropedagogical methodologies to effectively support a diverse range of learners. Experiencing the shortage of specialised educators, this approach could serve as a bridge, fostering neurodevelopmentally-oriented learning environments that uphold the principles of inclusivity.

Despite advancements in understanding the role of sensory development in cognitive and academic success, traditional educational frameworks frequently lack structured approaches to incorporate these insights effectively. The research advocates for neuropedagogigal approach to accommodate learners and seeks to incorporate Williams and Shellenberger's Pyramid of Learning as a foundational framework for sensory-cognitive development within educational curricula.

This remains an unexplored area regarding the importance of conducting new research aimed at developing innovative teaching techniques that recognize sensory development as a vital component of the educational process and a foundation for academic achievement. Furthermore, the study outlines potential directions for future research focused on validating sensory-based methodologies and adapting them to educational contexts and emphasizes the importance of structured teacher training programs, building upon insights from European educational initiatives that prioritize equipping educators with neuropedagogical competencies.

Analysis of sources and recent research. Neuroeducation, or Mind, Brain, and Education (MBE) science, has emerged as a transformative cross-disciplinary domain. By blending insights from neuroscience, psychology, and education, this field aims to elevate teaching and learning methodologies. Tracey Tokuhama-Espinosa has played a crucial role in shaping and promoting this approach. In her doctoral dissertation from 2008, she examined the establishment of standards in neuroeducation, stressing the importance of teaching methods grounded in scientific evidence [4]. Neuropedagogy is an interdisciplinary area that combines knowledge from neuroscience, psychology, and education to develop teaching methods grounded in a scientific comprehension of brain operations and cognitive mechanisms.

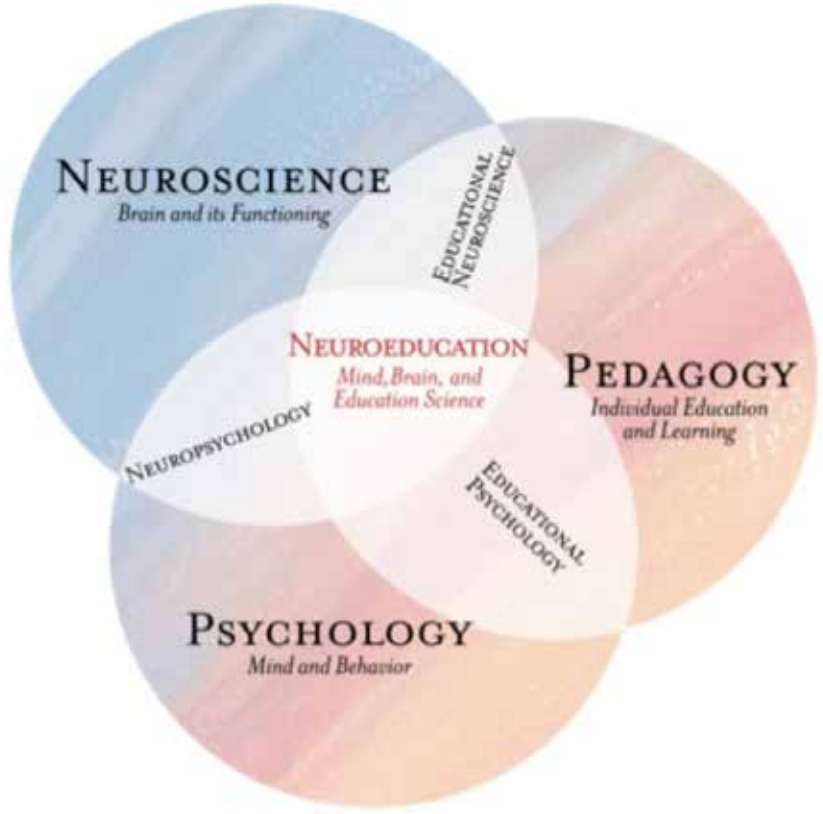

Fig. 1. Pyramid of Learning [5]

Researchers require comprehensive networks from diverse fields of knowledge that encompass social, cognitive, biological, and behavioral dimensions, which can directly or indirectly enhance and advance educational practices [1]. This domain aims to unify contemporary findings on brain growth, neuroplasticity, memory, emotional involvement, and sensory processing to better assist a variety of learners. Recent research highlights the potential of neuropedagogy to enhance and modernise educational systems, with scholars demonstrating its benefits in higher education. In 2018 researchers Tünde Szécsi, László Varga, and Veronika Mak highlighted the prevalence of misconceptions regarding the brain and its educational applications [6]. They emphasized the necessity for further research to clarify and refine these understandings. As this body of knowledge expands, educators will be better prepared to implement curricula that are developmentally aligned and scientifically informed. A 2021 study by Nurmakhanova, Rakhmetova, Kassymbekova, Meiirova, and Rakhimzhanova concluded that implementing neuropedagogical methods offers valuable opportunities to improve the educational process [7].

An essential component within neuropedagogy is Williams and Shellenberger's Pyramid of Learning, a framework that elucidates the stages of sensory and motor development as foundational to academic success. Developed by occupational therapists Mary Sue Williams and Sherry Shellenberger, the Pyramid of Learning emphasises that cognitive development relies on the integration of sensory and motor experiences [8]. Based on Goddard Blythe's research, children with advanced neuromotor functions are more capable of absorbing new information, participating in learning activities, and effectively expanding their knowledge [9].

Research has consistently shown that movement plays a crucial role in children's cognitive development, enhancing their ability to focus, retain information, and engage in learning tasks. Physical activities have been linked to improvements in memory, attention, and executive functioning, which are foundational for academic success.

The purpose of the article is to analyse how adopting structured frameworks, such as the Pyramid of Learning in neuropedagogical training and practice, can help foster a more engaging learning environment, proving that sensory and motor availability are recognized as essential elements in learning.

Presenting main material. Theoretical and methodological research by observation and interviews. Conflicts, natural disasters, and health emergencies, as highlighted by UNICEF, have deeply disrupted education systems around the world, leading to extended school closures and limiting children's access to essential learning resources. During the peak of the COVID-19 pandemic, over 1.6 billion students worldwide faced school closures, causing an unparalleled disruption to education systems across the globe [15]. As reported by Education Cannot Wait, an estimated 224 million children affected by crises are in urgent need of access to quality education, highlighting the critical necessity for targeted interventions in these vulnerable communities [16]. The war in Ukraine has had a devastating impact on the country's education system, leaving millions of children without stable access to learning opportunities. UNICEF reports that over 5 million children have experienced interruptions to their education due to the ongoing conflict, with more than 2,600 schools damaged and over 400 completely destroyed since February 2022 [15]. According to Alsamiri [18], the educational system in Saudi Arabia struggles to provide teachers with the necessary training and resources to support twice-exceptional learners effectively. These disruptions to education systems have created serious challenges for children, including falling behind in their studies, struggling with basic skills like reading and math, and a troubling rise in the number of students dropping out of school. For children living through conflicts, natural disasters, and health emergencies, the loss of consistent access to education deepens inequalities and threatens their ability to achieve their full potential both academically and personally.

This empirical study involved conducting structured interviews with educators through Zoom and analyzing existing curricula in depth. The primary objective was to identify the specific challenges educators face and to highlight gaps within the educational system and learning environments that may hinder effective teaching and learning. This study examines the impact of systemic gaps on children's educational outcomes in Ukraine and Saudi Arabia, focusing on preschool-age children and primary-age children. During the conducted research, at the initial stage, children development was analysed according to factors: neuromotor development, social-psychological readiness, motivation aspect, emotional and volitional development, neuropsychological. The findings indicate a significant correlation between neuromotor development, physical engagement and cognitive performance [10]. It suggests that pre-schools and schools should prioritise active learning strategies to foster holistic development. By exploring these specific contexts, the research highlights the importance of integrating Williams and Shellenberger's Pyramid of Learning into educational systems and underscores the need for targeted teacher training to address these challenges effectively.

Without well-developed sensory systems and motor skills, children may find it challenging to engage in activities that require coordination, balance, and fine motor control, which can hinder their ability to participate in classroom tasks. Consequently, they might feel frustrated and overwhelmed, potentially leading to various reactions such as withdrawal, disengagement, or even the avoidance of specific activities. Additionally, these children may display signs of apathy, often report physical complaints like headaches or stomach aches, or struggle with completing assignments that necessitate attention, coordination, or fine motor dexterity.

Moreover, when there is a delay or deprivation in sensory and motor development, children may struggle with self-regulation and maintaining focus, which can further impede their capacity to succeed in a structured educational setting [11]. These difficulties underscore the necessity of addressing sensory and motor readiness as a crucial component of early education to ensure that every child builds a strong foundation for cognitive and emotional development within the classroom.

Being aware of neuropedagogy and having a clear understanding of the Pyramid of Learning, teachers possess a powerful tool to unlock children's full potential. The Pyramid of Learning, developed by Mary Sue Williams and Sherry Shellenberger, outlines four essential stages (the connection between the sensory system, the sensory motor development, the perceptual motor and the cognitive development) that contribute to a child's success for academic learning.

According to the Pyramid of Learning, children's development is like a carefully constructed building, with the nervous system as its foundation. This foundation supports the essential building blocks. Neuropedagogy creates tools for educators to build well-developed children by nurturing each layer: sensory, motor, perceptual, and cognitive. To achieve academic success, neuropedagogy

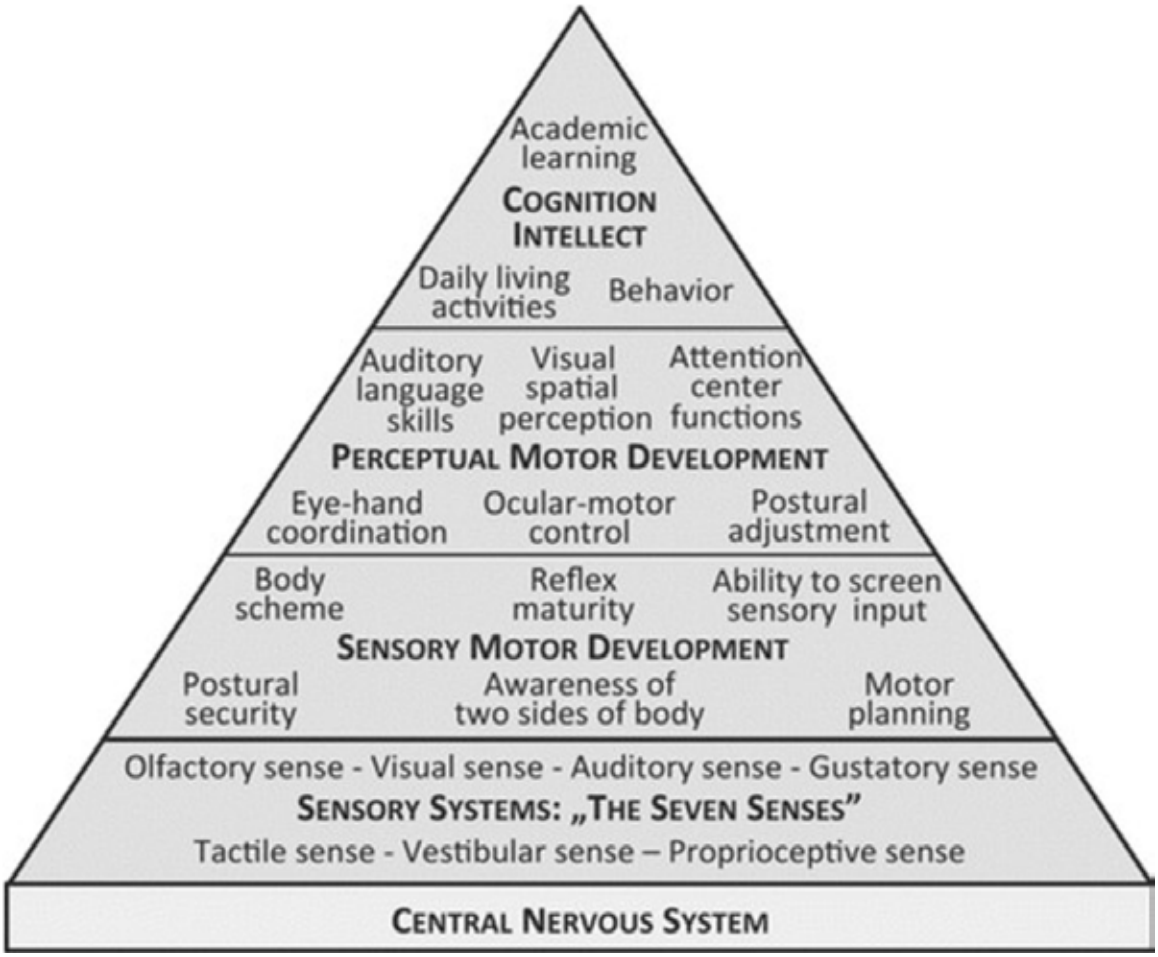

Fig. 2. The Pyramid of Learning by Williams and Shellenberger

emphasises the importance of nurturing each foundational layer within Williams and Shellenberger's Pyramid of Human Development. These layers include:

1) The sensory system lies at the base of the building blocks (the first layer), forming the core upon which all other skills are constructed. This important level includes essential sensory abilities such as olfactory (smell), visual (vision), auditory (hearing), gustatory (taste), tactile (touch), vestibular (balance), and proprioceptive (awareness of body positioning in space). These sensory experiences are crucial as they inform a child's perception and interaction with the world around them. Without this solid sensory base, a child may encounter difficulties in further stages of development, much like a building that cannot stand strong without a firm foundation.

2) Sensory-Motor Development forms the next layer, and is a crucial stage where the nervous system is further supported through motor refinement and body awareness. This stage includes the development of body scheme, reflex maternity (establishing necessary safety reflexes), postural security (confidence in maintaining balance and posture), bilateral integration (awareness of both sides of the body), motor planning (planning and executing movements), and the ability to screen sensory input, enabling children to discern which sensory information requires focused attention.

3) The following building block, Perceptual-Motor Development, serves as a bridge to higher cognitive functions. Children develop more complex abilities, such as auditory language skills (effective hearing and speaking), visual-spatial perception (understanding visual information and spatial relationships), and eye-hand coordination (using visual input to guide hand movement), ocular motor control, postural adjustment, and attentional skills, which allow children to sustain focus – a vital component for successful learning.

4) At the top, Intellectual/Cognitive Development serves as the final building block, where children demonstrate readiness for academic tasks, daily living activities, and behaviour management.

Much like the pinnacle of a well-built structure, this level relies on the stability of the foundational sensory and motor skills below. If these foundational skills are not solidly established, higher-level learning and behaviour may be compensated but remain unstable.

In summary, the Pyramid of Learning highlights how each developmental building block supports the next, underscoring the importance of addressing each stage fully to unlock children's academic and personal potential. Teachers who possess neuropedagogical knowledge and understand this framework hold the key to supporting a child's journey from sensory development to cognitive readiness, fostering a well-rounded and resilient foundation for lifelong learning.

Regarding the neuropedagogical method, the development and academic success of well-balanced children are fundamentally supported by a well-functioning nervous system. This understanding is essential in neuropedagogical approach, which provides educators with the knowledge to comprehend crucial developmental building blocks beyond cognitive and academic aspects, pointing out (recognizing) the interrelated nature of sensory, motor, and cognitive growth.

Conclusions. In perspective, teachers will be able to understand the different learning styles of children and be able to apply neuroeducational techniques (adapted teaching material) that are appropriate for children's development and accelerate the development of slow learners. Neuropedagogical method incorporates educational strategies in accordance with developmental phases that need to be completed in the Pyramid of Learning (Williams and Shellenberger).

Neuroscience offers a substantial basis for the advancement of educational reforms and strategies, elucidating aspects of the learning process that can guide the creation of more efficacious pedagogical methodologies [9]. Targeted professional development programs, resource sharing, and collaborative networks can effectively facilitate the effective implementation of these strategies by empowering educators. Moreover, the establishment of partnerships with neurodiversity organisations can significantly enrich these initiatives by equipping educators with valuable insights and practical resources specifically designed to support all learners. In addition, the integration of technology within these initiatives has the potential to enhance personalised learning experiences, enabling educators to tailor their instructional methodologies to align more closely with the unique needs and preferences of individual students. By employing data analytics and adaptive learning platforms, educators are able to monitor student progress in real-time, thereby enabling them to make informed adjustments to their instructional strategies.

By implementing structured neuropedagogical models based on the Pyramid of Learning in the educational system, we ensure that sensory and motor readiness are addressed as integral components of the educational system. While promising, the integration of the Pyramid of Learning in educational settings may face challenges related to training resources for teachers and standardised implementation. Future studies should explore these limitations to strengthen practical applications in diverse contexts.

Effective implementation of the Pyramid of Learning by Williams and Shellenberger relies on comprehensive educator training, giving teachers the skills needed to apply neuropedagogical methods that enhance sensory-cognitive development and address diverse learning needs. Meanwhile, such training not only supports student engagement and academic success but also aligns with global educational standards, as reflected in European initiatives, underscoring the value of harmonizing practices across international contexts.

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