NEUROSCIENCE RESEARCH NOTES

OPEN ACCESS | VIEWS ISSN: 2576-828X

Making neuroscience a priority in Initial Teacher Education curricula: a call for bridging the gap between research and future practices in the classroom

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Received: 17 June 2023; **Accepted:** 30 July 2023; **Published:** 1 October 2023
Edited by: King Hwa Ling (Universiti Putra Malaysia, Malaysia)
Reviewed by: Hera Antonopoulou (University of Patras, Greece);
Halkiopoulos Constantinos (University of Patras, Greece)
https://doi.org/10.31117/neuroscirn.v6i4.266

ABSTRACT: Constant global advancements and expanding evidence in the neuroscience of learning have provided compelling support for the inclusion of neuroscience as a crucial content priority in initial teacher education. Existing research confirms the efficacy of neurocognitive interventions for atypical and typical school-aged learners in a variety of key subject areas. Despite advances in the neuroscience of learning, the adoption of contemporary approaches and strategies that support and enhance neurocognitive development by education practitioners is yet to be the norm. Incorporating neuroscience education content, research, and practical application into initial teacher education curricula will enhance teacher preparation, leading to evidence-based education.

Keywords: Educational neuroscience, Translation, Interdisciplinary, Neuromyths

1.0 INTRODUCTION

Significant progress has been made in ensuring basic education rights since 2000 under the Education for All and the Millennium Development Goals frameworks. The United Nations (UN) 2030 agenda of Sustainable Development Goals (SDG) builds upon previous frameworks, recognising the critical need for inclusive and equitable quality education for all. To support schools to ensure inclusive and equitable education by 2030, initial teacher education (ITE) needs to ensure that future teacher preparation is not only evidence-based and practical but also takes advantage of advances across various fields, such as health sciences, kinesiology, neuroscience and connecting and refining current successful approaches in education. To this end, teachers need to be able to deploy the most effective pedagogical classroom practices in response to student's needs to ensure learning outcomes. They need to understand why those practices are effective, especially for the learner's brain. The deliberate inclusion of neuroscience within core content in ITE curricula for future use to enhance neurocognitive development in students may be a sound strategy on the long road to achieving the education targets of the UN 2030 SDG education goals.

This scholarly commentary presents articles and studies highlighting the urgent need to incorporate neuroscience into initial teacher education curricula and improve the educational process by applying neuroscientific data. Specifically, researchers screened for articles discussing the current use of neuroscience by teachers in education delivery in schools, how neuroscience influences the improvement of the education process and the potential for neuroscience to serve as a crucial instrument for implementing education innovations. The research methodology is depicted in the figure below (**Figure 1**).

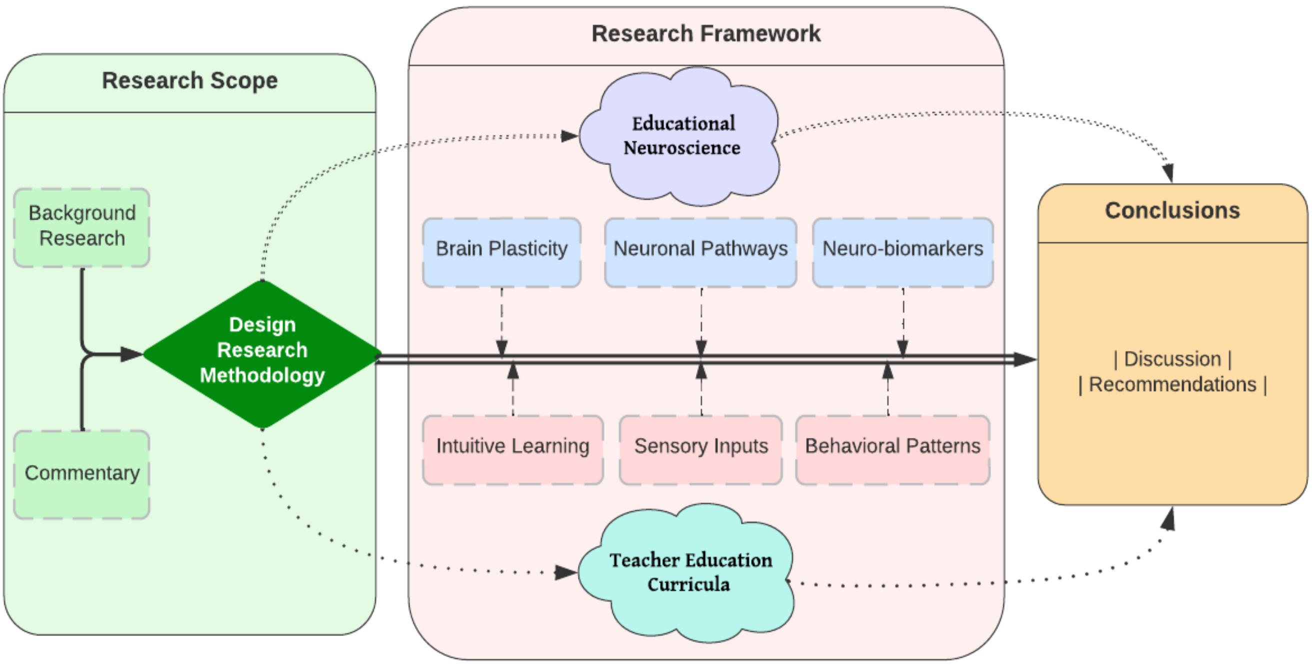

Figure 1: Methodology flowchart

2.0 THE CURRENT STATE OF NEUROSCIENCE IN LEARNING

Over the past two decades, the potential of neuroscience to advance pedagogical practices and nurture student well-being has grown (Chang et al., 2021). The growth and recognition of neuroscience to advance school and education practices have derived from educators' and researchers' curiosity to discern and identify approaches that can meet the diverse needs of students in schools and complex education settings (increasingly diverse and challenging) while also trying to find a neurobiological and physiological basis to support popular theories in education (Goldberg, 2022). Neuroscience is recognised as a valuable field of study for improving educational practices as it develops a greater awareness and understanding of brain mechanisms that underpin effective learning and student well-being interventions (Thomas et al., 2019b).

Teachers nurture students' brains to develop critical thinking, numeracy, literacy, and life skills (Goldberg, 2022). Because of this, schools and classrooms are ideal for neuroscience-based interventions to improve the learning potential of typical and atypical developing learners. In many countries, ITE curricula lack educational neuroscience content or the scope and depth required for accurate application in the classroom (Arnaiz-Sánchez et al., 2023; Ching et al., 2020; Coch, 2018; Rato et al., 2022). Limited knowledge and understanding of educational neuroscience have led to the high prevalence of neuromyths among teachers and the difficulty experienced by teachers in discriminating available information correctly (Arnaiz-Sánchez et al., 2023; Gleichgerrcht et al., 2015; Rato et al., 2022). For teachers to be able to deploy the most effective practice in response to a learner, they require a foundation of why those practices are effective in terms of a learner's brain. Otherwise, it is unlikely that they will understand how and why their students learn or be able to consciously define strategies that facilitate the creation of favourable environments for the development of educational processes.

3.0 WHY EDUCATIONAL NEUROSCIENCE SHOULD BE INTEGRATED INTO ITE CURRICULA

Neuroscience research has illuminated neurocognitive challenges, neural correlates of student mental health issues and pedagogical practices to help struggling students (Livingston & Happé, 2017). For example, research has shed light on the mechanisms and interventions for dyslexia (Munzer et al., 2020) and provided insights into how relationships, anxiety, attention, persistence, physical activity levels and sleep influence the achievement of educational outcomes (Whiting et al., 2021). Similarly, research has established the neurobiological foundations for physical education curriculum outcomes by modulating neuro-biomarkers to stimulate health and well-being, prevent and treat depression in children and adults (Jemni et al., 2023).

Through the student well-being lens, neuroscience has also provided insight into the neurobiological basis for learning, memory, and influencing factors such as life experiences (i.e., trauma) and lifestyle components such as stress, exercise, sleep, and nutrition (Zaman et al., 2019). Teachers understanding the interrelated relationship between these factors and learning and memory can help in recognising and helping students with behavioural, cognitive, emotional, and social challenges (Whiting et al., 2021). Schools can reverse trauma-related brain damage by providing safe, enriched learning environments that support alternative neuronal pathways (Thomas et al., 2019a).

Incorporating neuroscience into initial teacher education programs can be advantageous for many reasons. Neuroscience provides insight into how the brain learns and remembers information. Understanding when the brain is most receptive to new information and how to structure lessons to correspond with these periods can help teachers develop more effective instructional strategies and techniques (Gkintoni & Dimakos, 2022). Understanding cognitive processes such as memory formation, attention, and cognitive burden can enhance the efficacy of educators. In the Venn diagram depicting the application of substantiated neuroscience findings in the classroom, the most effective learner meticulously captures the knowledge and transforms it into a behavioural schema through sensory inputs, i.e., via direct engagement (**Figure 2**).

Differentiated instruction in the classroom is an inclusive method of instruction that provides a broad range of possibilities for learning based on students' profile, interests, readiness, unique brain structure and way of learning (Weber & Mofield, 2023). Understanding the fundamentals of neuroscience can assist educators in recognising these distinctions and adapting their teaching methods accordingly for all to reach the learning goals. For instance, a teacher may comprehend why some students require more repetition while others may benefit from additional visual learning aids. Neuroscience can assist teachers in comprehending the relationship between emotions, tension, and learning. Teachers can create more empathetic, supportive, and effective learning environments by understanding how emotional states influence students' ability to learn and retain information (Gkintoni et al., 2022). It can also serve as a guide for teaching students how to manage their emotions and stress levels to enhance their learning outcomes.

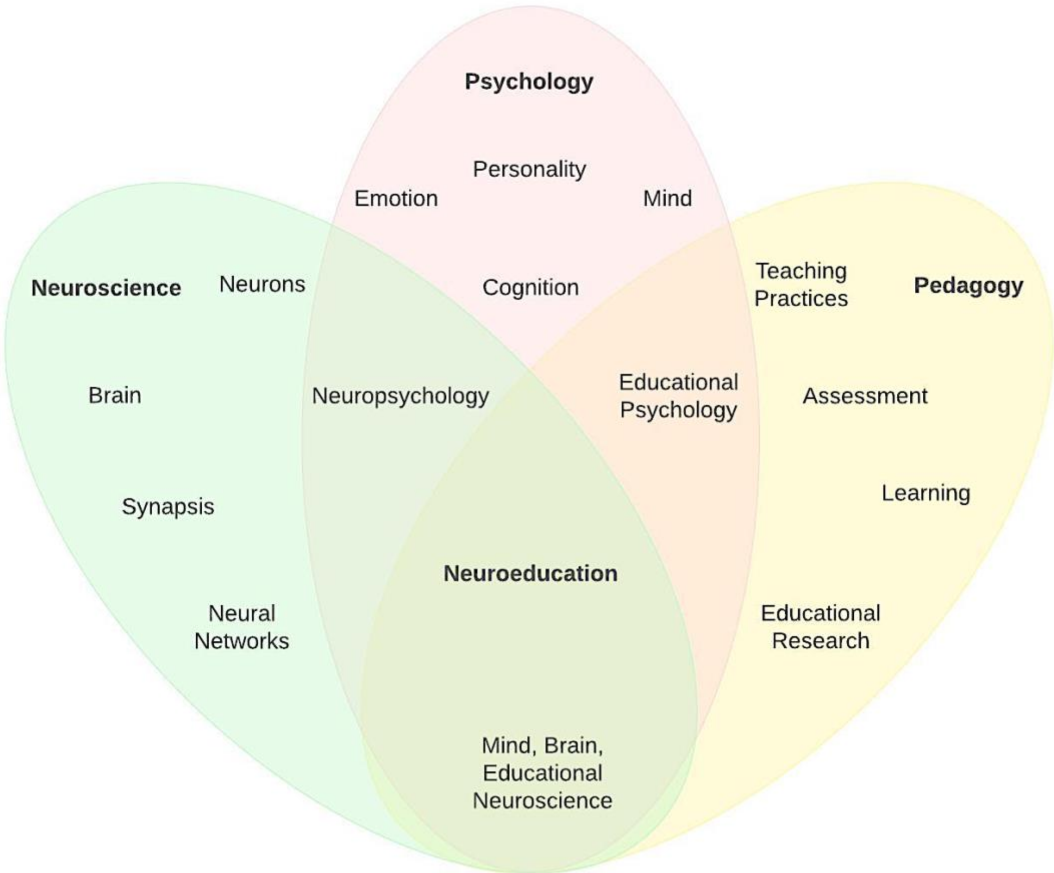

Figure 2: The interdisciplinary fields of neuroeducation

Neuroscience can shed light on effective planning and pedagogical practices for various cognitive disorders, including dyslexia, ADHD, and autism. Graduates of ITE equipped with this knowledge can better comprehend, empathise with, and meet the needs of these students. Moreover, they can collaborate more effectively with professionals in special education (Brown et al., 2019). Neuroscience incorporated into ITE can also reinforce a growth mindset's belief that intellect is not fixed and can be developed over time if people can access the right opportunities of context and stimuli (Ng, 2018). Teachers who understand a growth mindset are more likely to encourage students to embrace challenges, persevere in the face of adversity, view effort as the path to mastery, and learn from criticism if they comprehend the concept of neuroplasticity or the brain's ability to change and adapt due to experience (Ng, 2018).

Although neuroscience can provide valuable insights, it is essential to observe that it is not a silver bullet. Teachers must also have a solid foundation in educational theory, pedagogical methodologies, practical skills, and experience. In addition, neuroscience research must be correctly translated into educational practice, avoiding oversimplifications and misunderstandings that could result in ineffective or detrimental teaching techniques. Therefore, incorporating neuroscience into ITE should be conducted with care and rigour.

4.0 OUTCOMES OF INFUSING NEUROSCIENCE INTO ITE

Recent studies have shown that neuroscience knowledge is useful for teachers, justifying its use in education (Chang et al., 2021; Cherrier et al., 2020). Teachers who understand the importance of neuroscience for education are more likely to use this knowledge to guide planned and intuitive pedagogical decisions and assess student capabilities (Chang et al., 2021; Cherrier et al., 2020; Tan & Amiel, 2022). Despite the rigorous nature of educational neuroscience research, the evidence is often ineffectively translated into pedagogical practice, hampered by a lack of teacher training in neuroscience education and a negative tension between the recent evidence and what happens inside the classroom. Lack of neuroscience in teacher training and oversimplification of findings dilute approaches, resulting in poor translation (Rato et al., 2022). Neuromyths like hemisphere dominance and preferred learning styles have spread due to teachers' lack of educational neuroscience knowledge (van Dijk & Lane, 2018; Vig et al., 2023). Higher education institutions delivering ITE curricula should develop students' deep understanding of educational neuroscience to instil the value and appreciation of why specific neuroscience learning instructional practices work. Moreover, it will help increase the acceptance and implementation of these practices in the classroom. Curricula must also teach future teachers to critically evaluate neuroscience education literature and confidently implement effective practices (**Table 1**).

Table 1: Suggested neuroscience outcomes for ITE students

Description of Outcomes
Knowledge of: • Neuroscience concepts and ideas relevant to education that underlie the nervous system's molecular, cellular, and physiological underpinnings. • Evidence-based educational neuroscience to guide pedagogical decision-making and strategies to meet student's diverse learning and well-being needs.
Understanding of: • Scientific methods to evaluate effective learning interventions based on empirically educational psychological and neuroscientific literature.
Skills / Capabilities: • Self-directed learning in developmental, cognitive, and affective disorders through the lens of neuroscience that enables the teacher to evaluate whole school and classroom educational approaches that purport to enhance learning.

The interdisciplinary union of neuroscience, psychology, and education can revolutionise ITE in the short term, leading to change over time in the broader teaching profession. As our comprehension of the brain evolves, new technologies that facilitate learning may also be developed. A potential consequence is the increased use of data-driven instruction derived from neuroimaging and other neuroscience technologies, providing more accurate data on how students learn and allowing teachers to tailor instruction to meet the specific individualised requirements of each student for enhanced learning outcomes. Infusing neuroscience into ITE contains great promise, but it is important to remember that it is a young and rapidly developing field. Its practical implementation within the classroom must be approached with scientific scepticism and rigour. In addition, it is crucial to consider the ethical implications of these developments, particularly in terms of neuroimaging and data privacy.

5.0 CONCLUSIONS

Although this commentary paper may not have covered all aspects of this current issue in-depth, it has integrated and synthesised diverse ideas and opinions from researchers in related fields to facilitate a comprehensive perspective and to call for bridging the gap between research and future practices in the classroom. Although a strong consensus is emerging among researchers in education and neuroscience concerning the need for making neuroeducation a priority in ITE, little has changed in ITE curricula.

Indeed, neuroscience in education has matured enough to promote neuroscience-based educational interventions. Neuroscience can support or disprove educational theories. Understanding brain behaviour in complex learning environments is the key to developing effective educational interventions. For teachers, understanding the neurobiology underlying behaviour complements educational theories and practices to strengthen a more profound understanding, resulting in more efficient implementation of interventions. Understanding neuroscience and its relation to specific education outcomes (e.g., literacy and numeracy) is essential to motivating schools and teachers to use neuroscience-education methods.

Every child deserves a good education to succeed. Quality teaching, the most important in-school influence on student learning, is essential to achieving this UN 2030 Agenda of SDG vision of inclusive and equitable quality education for all. Therefore, making neuroscience a priority in ITE curricula is needed to support the development of teacher expertise to deliver quality teaching for all. In this respect, we recommend that the nature of the school/university partnership is pertinent to ITE innovation for the positioning of the field of neuroeducation as a central focus that develops theoretical/conceptual understanding and integrates practical experience with the modelling of effective application of neuroeducation as an inherent part of ITE.

Acknowledgements: This research received no specific grant or funding from any funding agency in the public, commercial, or not-for-profit sectors.

Author Contributions: All authors contributed conceptually and provided ideas. All authors collaboratively developed the article, had input into the revisions and redrafting, and reviewed the article before each submission.

Conflicts of Interest: The authors declare no conflict of interest.

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