Asian Journal of Health Research
Journal Homepage: https://a-jhr.com
Published by Ikatan Dokter Indonesia Wilayah Jawa Timur

Editorial

D4P4: A Neuro-Pedagogic Model for Developing High-Risk/ High-Precision Procedural Skills in Residency Training

Hermanto TJ*

Magister Program in Medical Education, Faculty of Medicine, Universitas Airlangga

***CORRESPONDING AUTHOR**
Hermanto TJ
hermanto.tri@fk.unair.ac.id
Magister Program in Medical Education, Faculty of Medicine, Universitas Airlangga

This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License. (https://creativecommons.org/licenses/by/4.0/)

Cite this as: Hermanto TJ (2025) D4P4: A Neuro-Pedagogic Model for Developing High-Risk/ High-Precision Procedural Skills in Residency Training. *Asian J Heal Res*. 4 (2): 1–2. doi: 10.55561/ajhr.v4i2.274

Medical education stands at a pivotal juncture. The long-standing "see one, do one, teach one" model, once the cornerstone of clinical training, is increasingly inadequate for preparing today's physicians [1,2]. Rising resident-to-patient ratios, overwhelmed faculty, and the distinct learning preferences of Generation Z demand a more sophisticated and responsive approach [3]. In response to these challenges, the D4P4 model emerges as a transformative framework—rooted in decades of neuroscience and educational theory—designed to cultivate high-risk, high-precision procedural skills in residency programs.

At its core, D4P4 is a neuro-pedagogic model that aligns the acquisition of procedural skills with the brain's natural learning mechanisms. Rather than relying on passive observation or trial-and-error, D4P4 emphasizes deliberate, cognitively attuned practice [4,5]. Drawing from foundational neuroscience—such as Santiago Ramón y Cajal's neuron doctrine and Donald Hebb's principle that "cells that fire together wire together"—the model integrates insights from brain-based learning and accelerated education to offer a structured, evidence-informed pathway to mastery [6,7].

The model unfolds through eight interrelated principles. First, deconstruction and chunking break complex procedures into manageable steps, reducing cognitive load on the prefrontal cortex and allowing for focused repetition. Over time, these chunks consolidate into long-term procedural memory, freeing mental bandwidth for higher-order decision-making [8]. Complementing this is the use of checklists, which serve as external cognitive aids. By offloading sequential information from working memory, checklists enable the brain to concentrate on motor execution and error detection [9].

Mental rehearsal plays a critical role in D4P4, with memorization and visualization activating the same neural circuits as physical practice. This technique, long employed by elite athletes, strengthens motor pathways and builds confidence before a resident even handles an instrument [10]. The model also incorporates whole-part-whole learning, where residents first observe an entire procedure to form a global mental schema, then practice individual components for precision, and finally reintegrate the parts into a cohesive whole. This cyclical approach mirrors the brain's process of consolidating complex motor skills [11,12].

Simulation-based training across diverse environments—such as computer-assisted modules, dry labs and wet labs—is another cornerstone of D4P4. These safe, high-frequency practice settings accelerate the transition from conscious, effortful control to automatic, efficient execution, engaging subcortical and cerebellar circuits. Equally vital is the role of supportive feedback and reflection [13]. Constructive feedback fosters psychological safety, enhancing synaptic plasticity and memory consolidation. Reflective observation activates neural networks for self-awareness and adaptive learning, nurturing not only technical skill but also resilience and a growth mindset [14]. The model

also leverages the protégé effect, where residents deepen their understanding by teaching peers. This process transforms passive recall into elaborative encoding, resulting in richer and more durable synaptic connections [15]. Additionally, pre-rotational preparation activities ensure that learners enter clinical settings with a foundational readiness, optimizing their engagement and performance from the outset [16].

In conclusion, D4P4 marks a decisive shift from traditional apprenticeship toward a model of deliberate, evidence-based mastery. By synthesizing neuroscience and pedagogy into a practical framework, it equips physicians to perform high-stakes procedures with precision, confidence, and cognitive resilience. Ultimately, D4P4 is designed to more fundamentally address patient safety through a step-by-step approach and a participant-centred process, serving as an advanced foundation prior to assessment-driven models and replacing the traditional 'see one, do one' paradigm.

REFERENCES

1. So HY. Postgraduate medical education: see one, do one, teach one…and what else? Hong Kong Med J, 2023; 29: 104.e1-9
2. Asan O, D Smith P, Montague E. More screen time, less face time - implications for EHR design. J Eval Clin Pract, 2014 Dec;20(6): 896-901. doi: 10.1111/jep.12182.
3. Schenarts, PJ. Now Arriving: Surgical Trainees From Generation Z, Journal of Surgical Education, 2020; Vol 77, Iss 2, Pp 246-253, ISSN 1931-7204,
4. Hermanto TJ. Developing Psychomotor Skills: 4Ds4Ps. Presented at Dynameid online seminar 2023
5. Hermanto TJ. Introduction to Brain-based learning in Medical Education. 2024. Malang: UB
6. Rozo JA, Martínez-Gallego I, Rodríguez-Moreno A. Cajal, the neuronal theory and the idea of brain plasticity. Front Neuroanat. 2024 Feb 19; 18: 1331666.
7. Lazari A, Salvan P, Cottaar M, et al. Hebbian activity-dependent plasticity in white matter. Cell Rep. 2022 Jun 14;39(11):110951. doi: 10.1016/j.celrep.2022.110951.
8. Giacomino K, Caliesch R, Sattelmayer KM. The effectiveness of the Peyton's 4-step teaching approach on skill acquisition of procedures in health professions education: A systematic review and meta-analysis with integrated meta-regression. Peer J. 2020 Oct 9; 8: e10129. doi: 10.7717/peerj.10129. PMID: 33083149; PMCID: PMC7549471.
9. Etherington NB, Baston C. Checklists and Clinical Competency. Getting to the Heart of the Matter. ATS Sch. 2020 Sep 4;1(3):201-204. doi: 10.34197/ats-scholar.2020-0118ED.
10. Dreyfus, S. E., & Dreyfus, H. L. A Five-Stage Model of the Mental Activities Involved in Directed Skill Acquisition. Bulletin of Science, Technology & Society, 1980; 24(3), 177-181
11. Sullivan R. Competency based approach to training. 1995. Baltimore: JHPIEGO
12. Margarick RH, Skeels A, Lewison D. (eds). Igniting Change in the Landscape of Healthcare for Women and Families. 2016. Baltimore: JHPIEGO
13. Branditz, L. D., Kendle, A. P., Leung, C. G., et al. Bridging the procedures skill gap from medical school to residency: a simulation-based mastery learning curriculum. Medical Education Online, 2024; 29(1).
14. Natesan S, Jordan J, Sheng A, et al. Feedback in Medical Education: An Evidence-based Guide to Best Practices from the Council of Residency Directors in Emergency Medicine. West J Emerg Med, 2023 May 5; 24(3): 479-494. doi: 10.5811/westjem.56544.
15. Omar, Zaheer, Achmad. Effectiveness of peer teaching in medical education: medical student's perspective. Advances in Medical Education and Practice, 2019 March; 199-201 DOI:10.2147/AMEP.S161507
16. Burke, J. F., Bann, S., & Stubblefield, J. L. Pre-rotation Educational Activities and Their Impact on Resident Learning and Confidence. Advances in Health Sciences Education, 2017; 22(2), 359-372