

THRESHOLD CONCEPTS: CHALLENGING THE WAY WE THINK, TEACH AND LEARN IN BIOLOGY AND SCIENCE

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ABSTRACT

Meyer and Land (2003, 2005) proposed the notion of 'threshold concepts', which are central to the mastery of a specific discipline due to their transformative, irreversible and integrative nature. Using the methodology of Davies and Mangan (2007) we interviewed novice students (58) and expert academic staff (11) from three Australian universities and conducted an international survey of academics (55) to identify differences in novice and expert conceptions. We matched these data with understandings from the 'misconceptions' literature to create the 'biology thresholds matrix'. The matrix demonstrates that threshold concepts in biology are not necessarily the troublesome content, but rather the tacit understandings of the discipline (Taylor, 2006, 2008; Ross & Tronson, 2007, Ross, Taylor, Hughes, Kofod, Whitaker, Lutze-Mann & Tzioumis, 2010). These are often not explicitly taught (Perkins, 2006) yet underpin difficult content areas including: energy and energy transformation, variation, probability and randomness, proportionality and surface area to volume ratio, dynamic equilibrium, linking the subcellular (submicroscopic) with the macroscopic, temporal and spatial scales (Ross et al., 2010), and the formulation and testing of hypotheses (Taylor & Meyer, 2010). These threshold concepts are not hierarchical in nature, but form a web of epistemes which has commonalities with tacit understandings in other science disciplines.

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REFERENCES

- Davies, P. & Mangan, J (2007). Threshold concepts and the integration of understanding in economics. *Studies in Higher Education*, 32(6), 711–726.
- Meyer, J.H.F. & Land, R. (2003). 'Threshold concepts and troublesome knowledge (1): linkages to ways of thinking and practising within the disciplines.' In C. Rust (Ed.), *Improving Student Learning – Theory and Practice ten years on* (pp. 412–424). Oxford: OCSLD.
- Meyer, J.H.F. & Land, R. (2005). Threshold concepts and troublesome knowledge (2): Epistemological considerations and a conceptual framework for teaching and learning. *Higher Education* 49, 373–388.
- Perkins, D. (2006). Constructivism and troublesome knowledge. In J.H.F. Meyer & R. Land (Eds), *Overcoming Barriers to Student Understanding: Threshold concepts and troublesome knowledge*. (pp. 33–48). Abingdon: Routledge.
- Ross, P. M. & Tronson, D. (2007). Intervening to create conceptual change. *UniServe Science Teaching and Learning Research Proceedings* (pp. 89–94). Sydney: UniServe Science.
- Ross, P.M, Taylor, C.E., Hughes, C., Kofod, M., Whitaker, N., Lutze-Mann, L. & Tzioumis, V. (2010). Threshold concepts: challenging the culture of teaching and learning biology. In J.H.F Meyer, R. Land & C. Baillie (Eds.), *Threshold Concepts: from theory to practice* (pp. 165–178). Rotterdam: Sense Publishers.
- Taylor, C.E. (2006). Threshold Concepts in Biology: do they fit the definition? In J.H.F Meyer & R. Land (Eds.), *Overcoming Barriers to Student Understanding: Threshold Concepts and Troublesome Knowledge* (pp. 87–99). London: Routledge.
- Taylor, C.E. (2008). Threshold concepts, troublesome knowledge and ways of thinking and practicing - can we tell the difference in Biology? In R. Land, J.H.F. Meyer & J. Smith (Eds.), *Threshold Concepts in the disciplines* (pp. 185–197). Rotterdam: Sense
- Taylor, C.E. & Meyer, J.H.F. (2010). The testable hypothesis as a threshold concept for Biology students. In J.H.F Meyer, R. Land & C. Baillie (Eds.), *Threshold Concepts: from theory to practice* (pp. 179–192). Rotterdam: Sense.