“Building blocks: Threshold concepts as interdisciplinary structures of learning”

Aminul Huq, Bijaya Aryal & **Marcia Nichols,** University of Minnesota Rochester, USA

Majority of disciplinary-based education research explore student understanding and misconceptions about various concepts. It is important to identify if some concepts or relationship amongst concepts are critical not only to have a holistic understanding within a discipline but also to apply those concepts and relationships to a new discipline. The notion of Threshold Concepts, as coined by Meyer and Land (Meyer & Land, 2003), holds the key to identifying and classifying such concepts and how they are connected together. It will be beneficial to identify threshold concepts that fall into three categories: ones that are independent, ones that are intradependent (i.e. they build upon each other), or they are interdependent on threshold concepts from other discipline. For example, there exists many threshold concepts in calculus (Artigue 1991; Orton 1983; Scheja & Petterson 2010; Williams 1991), e.g. like functions, limits, derivatives and integrals, that build on each other viz, they are intradependent. Other concepts from mathematics, statistics and physics, such as uncertainty, appear to be interdependent amongst these disciplines. For example, students’ understanding of this troublesome concept of uncertainty depends on their understanding of how to deal with data and how to use data for prediction (Wilsona 2010). Threshold concepts may also depend on level of student preparation, background and understanding of previous threshold concepts. Some threshold concepts may change over time-from threshold to non-threshold. On the other hand without frequent practice and application/integration of those concepts after the lapse of time may need another round of intervention to cross the threshold again (even though it has been argued that they are irreversible)- that means irreversibility may not be permanent (like ferromagnetic domains). Thus, impermanence can play a major role in irreversibility of threshold concepts and rebirth of similar threshold concepts in different disciplines. Through observation of students’ interaction with some learning activities and follow-up interviews with them, we hope to propose answers to some of the following questions:

- If and how do some threshold concepts in a discipline can help understand various key concepts in the discipline?
- What thresholds concepts in math are relevant to learn threshold and key concepts in physics?
- Are concepts like structure or uncertainty interdependent, not only among STEM disciplines but among STEM and humanities disciplines? I.e. are there conceptual connections between students in literature courses learning about “close-reading” techniques that focus on linguistic and grammatical structures and the learning of structural concepts in physics and mathematics?
- Does the attempt to make grammar knowledge explicit in humanities courses transfer into the problem of articulating mathematics problems verbally?
- What threshold concepts in physics are relevant to learn biology/engineering problems?
- How to measure if students have reached the threshold?
- What are better strategies to facilitate learning of threshold concepts?
- Do all Threshold concepts require critical thinking skill to achieve the concept image as outlined by Tall and Vinner (1981)?

References

Artigue, M., 1991, Analysis. In: D. Tall and S. Vinner (Eds.) Advanced mathematical thinking (Dordrecht: Kluwer Academic Publishers), p. 167-198.

Meyer, J. H. F., & Land, R. (2003). Threshold concepts and troublesome knowledge: Linkages to ways of thinking and practising within the disciplines. In C. Rust (Ed.), Improving student learning: Improving student learning theory and practice - Ten years on. Oxford: Oxford Centre for Staff and Learning Development.

Orton, A., 1983, Students' understanding of integration. Educational Studies in Mathematics, 14, 1-18.

Scheja, M., & Pettersson, K. (2010). Transformation and contextualisation: Exploring students' conceptual understandings of threshold concepts in calculus. Higher Education, 59(2), 221-241.

Tall, D., & Vinner, S. (1981). Concept images and concept definition in mathematics with particular reference to limits and continuity. Educational Studies in Mathematics, 12, 151-169.

Williams, S., 1991, Models of limits held by college calculus students. Journal for Research in Mathematics Education, 22(3), 219-236.

Wilson, A., Akerlind, G., Francis, P., Kirkup, L., McKenzie, J., Pearce, D., & Sharma, M. D. (2010). Measurement uncertainty as a threshold concept in physics. In Proceedings of The Australian Conference on Science and Mathematics Education (formerly UniServe Science Conference) (Vol. 16).