

Student Transition to Advanced Mathematical Thinking: A focus on 'Proof' as a Threshold Concept

Kamilah Jooganah, Education, University of Manchester, UK.

This paper explores how proof can be considered as a threshold concept. It investigates the conflicts students experience with proof when old ways of thinking and their identity as a mathematics student are no longer compatible in the different figured world students are expected to engage with at university (Holland et al 1998).

An ethnographic approach was employed: data methods consisted of semi-structured interviews with ten lecturers and seven students, focus groups, observations of various formal and informal teaching-learning environments and artefacts. Prominent themes were identified using a narrative and thematic analysis.

Proof was found to exhibit threshold like qualities. Student difficulties, or the troublesome knowledge encountered with proof were identified as conflicts between different figured worlds: that of an "A-level Mathematics student" and that of a "University Mathematics student" and the practices associated with these worlds. For example, practices students engaged with at A-level encouraged procedural approaches to learning whereas at university students were expected to critically engage with proof, and in general with Advanced Mathematical Thinking (AMT). These different practices resulted in conflicts between old and new ways of knowing and being. Reconciling such differences, or crossing the threshold, was seen as key in facilitating student transition to new ways of being in relation to mathematics. This change involved students entering a liminal space.

The liminal space from the perspective of figured worlds was framed as student self-authoring. Holland et al (1998) drawing on Bakhtin, Bourdieu and Vygotsky argue that this can be considered a socio-cultural space involving a political process. The research found that the different identities students carried signified different amounts of cultural capital. This influenced how they positioned themselves in the figured world of a University Mathematics student, and also the significance of proof in relation to their mathematical identities.

In general, the encounters students had with proof were noted to affect their approaches to learning, motivation, identities, and future trajectories in their mathematics degrees. These factors were instrumental in shaping student levels of engagement and identification with the figured world of a University Mathematics student as shaped by dominant discourses in the Mathematics department. Levels of acceptance/rejection to the positions afforded to students in this figured world were found to be key in student engagement with proof and in general their transition to AMT.

The paper raises issues concerning identity and agency and addresses how threshold concepts position students in relation to the figured world of a subject practitioner. Furthermore, the research makes recommendations of how school based practices and activity systems can be aligned with those at university. It is envisaged that this will help facilitate students' transition to AMT at university.

References:

- Holland, D., Lachicotte, W., Skinner, D., and Cain, C. (1998) *Identity and Agency in Cultural Worlds*. Cambridge, MA: Harvard University Press.
- Meyer, J.H.F., and Land, R. (2006) Threshold concepts and troublesome knowledge: an introduction. In J. H. F., Meyer and R. Land, ed. *Overcoming barriers to student learning: threshold concepts and troublesome knowledge*. Routledge: London.