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Transfer of mathematics learning to problems of electrical and electronic engineering during the first year of university

Pauline Davis, Diane Harris, Kamilah Jooganah
University of Manchester, Manchester, United Kingdom

Background

This paper presents data gathered from interviews with electrical and electronic engineering students during their first year at university who may therefore be described as being in transition from pre-university student to student engineer in university. These interviews were conducted as part of a larger research project funded by the ESRC into the place of mathematics during this same transition. By choosing to study engineering, students are selecting courses which are mathematically demanding and subsequently this selection may influence their overall success or failure on the course. The student engineers who were interviewed as part of the project tell stories about the transition they were experiencing and the `obstacles' they encounter in their journey to become engineers. These interviews reveal their experiences of and their engagement with mathematics and how these shape their disposition towards mathematics in particular and their respective engineering courses in general.

In particularly, the paper examines the transfer of mathematics learning from pre-university mathematics courses to its use in electrical engineering degrees. It considers how apparently small changes in context, problem and the expression of mathematics can lead to disconnection from mathematics amongst students. Commonalities and differences in mathematics assessment pre and during university give rise to mathematical boundary objects (Star, 1989) that carry with the student as they move from their pre-university to their university learning context. The paper considers how mathematics is used by students in the context of problem solving during their electrical engineering degree, by identifying and examining the use of such mathematical boundary objects. In order to do this we examine how electrical engineering students mathematise in the context of solving problems of electrical engineering during the first year of the university degree course.

Research Questions

One objective of the paper is to provide concrete examples of students practice drawn across three case studies of electrical engineering students in three higher education institutions situated in the North of England, so as to make explicit students' mathematisation and their use of models and metaphors. We ask, how can such mathematical boundary objects be understood and how can they be used to facilitate better understanding of problems of engineering during the electrical and electronics engineering degree?

Students are also asked about their identification with mathematics and how this has changed over time; we ask, what are electrical and electronic engineering students‘ subjectivities towards mathematics and how does this change as they transition into university student?

Methods

The paper draws on the "Transmaths project", "Mathematics learning, identity and educational practice: the transition into higher education, ESRC grant (RES-000-22-2890)". An aspect of this project focused on electrical engineering students in the first year of a degree course studying in three universities in the North of England .

The initial data for our investigation were gathered via a survey of 800 students at three data points: (i) either just before or just after they started higher education; (ii) shortly after the Christmas break; and (iii) at the beginning of their second year. From these we identified twenty-six engineering

students who were willing to be interviewed at these same time intervals i.e. three times during twelve months.

Interviews were transcribed and analysed for identification with mathematics, Sfard and Prusak (2005). Particular attention was paid to statements of self-identity because these show most clearly subjectivities towards mathematics (Williams, Davis and Black, 2007).

In addition, Ethnographic methods are used to reveal students' use of mathematics to solve engineering problems. Methods include observation of students‘ problems solving in situ, and reflective discussions about their problem solving. This analysis examined mathematics genres apparent within problem solving and focused on tensions between competing genres evident in the students talk and mathemisation (Williams and Wake, 2006).

Frame

Conceptually, this analysis draws on theories of mathematical genre, after Bakhtin (1986) and Wake and Williams (2006), use of models and metaphor, after the work of Freudenthal and the Freudenthal Institute, which has shown how models and modelling problems drawn from the culture can be significant in the service of abstracting mathematics and building new mathematics, through ‘horizontal' and ‘vertical' mathematisation and Activity Theory (Engestrom 2001).

Research findings

The paper concludes that the transfer of " school" genre mathematics to use in other contexts is often problematic for students. A number of key mathematical boundary objects crossing into degree level electrical engineering courses are identified and . The case studies suggest that approaches to engineering curriculum design, which start with an engineering context, extract the mathematics and offer generalisation in other contexts may impact positively on subjectivities towards mathematics, for those students who are less well prepared in mathematics and who may be at risk of marginalisation or drop out from their degree because of the demand of mathematics.

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