From failure to functionality: a study of the experience of vocational students with functional mathematics in Further Education

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Many students who undertake vocational courses in Further Education colleges in England enter post-compulsory education as mathematical 'failures' at GCSE level but their experience in college has the potential to change not just their attainment, but also their future attitude and 'functionality' with mathematics in employment and society. This paper outlines the early stages of a mixed methods study to identify the main influences on the student experience and their effects on the aspirational trajectory from 'failure' to 'functionality'.

Keywords: functional, mathematics, Further Education, vocational.

The context for the study

Many students who have not achieved grades A*-C at *GCSE* (the standard English and Welsh mathematics qualification taken at age 16) choose to undertake vocational training post-16, often in a Further Education college, where they are often recommended to improve these skills and may be expected to take a functional mathematics qualification in addition to their vocational course. It is the experience of these vocational students with functional mathematics that is the focus of this research.

International comparisons of mathematical performance show England in a relatively weak position (Organisation for Economic Co-operation and Development (OECD) 2010) and adult numeracy levels have been a concern since this was highlighted by the Moser Report (1999). Despite the Skills for Life Strategy (Department for Education and Employment (DfEE) 2001), there has been little significant change in adult numeracy skills (Department for Business, Innovation & Skills (BIS) 2011) and recognition of the need to improve the mathematics skills of the nation is not lacking in recent reports although the means of effecting the change is still unclear. Evidence of the transmission of low numeracy across generations (Parsons and Bynner 2005) and suggestions that school leavers with low levels of mathematics may be disadvantaged economically as adults (Ananiadou, Jenkins, and Wolf 2004) provide further reasons to improve the mathematical skills of young adults, both for their own benefit and for the future of the next generation.

The mission for colleges is to transform these 'failures' into 'successes' within the constraints of policy, funding and curriculum. The first stages of this research indicate that this involves not just the challenge of getting students through an examination but also a battle in the affective domain to change their established attitudes to mathematics.

Research Aims

The research takes the form of a comparative study of the experience of vocational students with functional mathematics in colleges with different staffing structures.

The aim is to identify the major influences and their effects on the learning of functional mathematics.

Staffing structures for functional mathematics may be divided broadly into two types: those with a *centralised* functional mathematics team and those with functional mathematics teachers *dispersed* into the vocational departments. However, between these two structural extremes lie a range of *hybrid* management structures that combine some dispersed functions with a variable level of centralised control. The three colleges engaged in the research use either a dispersed arrangement or a more centralised hybrid arrangement but are such that comparisons between the effects of centralisation or dispersion can be made.

The main research question of 'What factors influence the experience of functional mathematics for vocational students in Further Education?' is followed by the additional questions summarised below, but, from a social constructivist view, it is the social interactions within these areas that are of particular interest.

- What effect do college structures and policies have on the student experience?
- In what ways is functional mathematics relevant to students?
- What approaches to teaching functional mathematics are being used and what effect do they have on student learning?
- What influence do the students' prior experience and background have?
- What influence do the attitudes, beliefs and values of vocational and mathematics staff have on the students' experience of functional mathematics?

Potential factors affecting the student experience

Structures, policies and systems

Organisational structures link people together, creating bonds or barriers and there are both benefits and disadvantages in the different structures. For example, a dispersed structure may facilitate a more integrated approach to functional mathematics, resulting in greater relevance for students, but can isolate functional mathematics specialists from their professional community leading to negative effects on teacher attitudes.

College policies operate within the constraints of government policy and funding but individual colleges do retain some freedom. Some may direct all students on a particular vocational course to take functional mathematics but others may exempt those with high grades in GCSE mathematics or even direct all students to a different functional skill. Early indications from the research suggest that these policies affect individual student attitudes depending on whether they perceive a need to improve their mathematical skills or not.

The functional mathematics curriculum

The functional mathematics curriculum (Qualification and Curriculum Authority (QCA) 2007) requires students to be able to make sense of situations, represent them, analyse them, use appropriate mathematics, interpret results and communicate. This is based on the assumption that learners need certain mathematical skills and abilities "to gain the most out of life, learning and work." (QCA 2007, 3). Early indications from the research suggest that this concept of mathematics for real life and work has been adopted by functional mathematics teachers. There is some ambiguity about what skills people actually need (Roper, Threlfall, and Monaghan 2006) and whether this is just knowledge with limited utility value (Ernest 2004) or a wider set of skills that goes beyond basic numeracy (Hoyles et al. 2002). However, the view that functionality involves problem-solving and communication and "requires more than fluency with 'the basics'" (Wake 2005, 6) is consistent with the views of functional mathematics teachers at this stage in the research.

For students, how they relate to the functional mathematics curriculum is a key issue. Disaffection or lack of interest in mathematics often stems from a failure to see relevance (Nardi and Steward 2003) . This may be because mathematics does not relate to their personal goals and interests (Ernest 2004) and is perceived to have no practical usefulness, transferable process skills or professional exchange value (Sealey and Noyes 2010). The emphasis in the curriculum on being able to apply mathematics in a range of contexts (QCA 2007) restricts the opportunity to use a relevant context and the problems of 'transferability' between the classroom and real life mathematics (Lerman 1999; Nunes, Schliemann, and Carraher 1993) also present difficulties for students.

Prior experience

The view that the nature of an individual is both socially constructed and emergent is a useful starting point for a consideration of students in Further Education since they bring with them a legacy from their previous lives but are still engaged in a learning process that shapes their future.

Affective factors such as attitudes, beliefs and emotions, have been shown to have an influence on the learning of mathematics (Hannula 2002; Zan et al. 2006) and the concept of attitude as a set of emotions associated with the situation, combined with a belief about the expected consequences and the relationship to the individual's personal values (Hannula 2002) is useful for this study. Affective and cognitive structures are closely intertwined (Goldin et al. 2011) and there is some evidence of this in early discussions with students. Both stable and rapidly changing affective traits have been recognised (Goldin 2003) suggesting that although deep emotions and beliefs may be resistant, there is some scope for change.

Social and cultural factors produce dispositions towards certain behaviours that are often resistant and may adversely affect student attainment (Noyes 2009) or performance in the classroom (Lubienski 2000). Not all these factors can be examined in this research but initial discussions indicate that attitudes from the past are evident in students and remain a significant influence on initial attitudes.

Vocational staff

The transition from school to college brings students into a new social environment and learning community in which they adjust, establish their identity and adopt behaviours that relate to the group norms.

In an organisation, the complex set of rules or traditions often referred to as 'organisational culture' (Deal and Kennedy 2000) reproduces patterns of thinking, feeling and behaviour in a community. In a large and complex organisation there may be several localised, departmental communities with different values and attitudes but the vocational department is the main learning community for vocational students. Attitudes and values are often transmitted implicitly and as students adjust to the values and behaviours of the department, vocational teachers can become significant influences. Their frequent social interactions with students may have more effect than those of the functional mathematics teacher and differences between the vocational and functional mathematics teams may only serve to reinforce beliefs that functional mathematics is unrelated to their vocational world.

Functional mathematics teachers

Teachers of functional mathematics may be part of a mathematics team, a functional skills team or a vocational team in the college structure. The combination of subjects that they teach and the team or department they are affiliated to will affect their sense of identity within their learning community and their approaches to teaching functional mathematics. Early interviews indicate that functional mathematics teachers have clear ideas about the concept of functional mathematics and how to teach it but the external assessment and college performance measures do have an impact.

Initial lesson observations indicate that teaching approaches are varied but it is teachers' beliefs about the value of functional mathematics and their ability to build positive relationships with students that are emerging as significant. In the interviews teachers frequently referred to their main challenges as: changing negative student attitudes, persuading students that functional mathematics is relevant to them and boosting the confidence of students who have already experienced failure.

Research methods

The range of and type of information to be gathered is wide and a mixed methods approach is appropriate since both qualitative and quantitative data will be collected and integrated at the analysis stage.

The main methods are: interviews with managers to gain an overview of structures and policies; questionnaires for functional mathematics teachers on their background, beliefs, teaching approaches and attitudes; interviews with functional mathematics teachers to further explore these areas; lesson observations of certain student groups; student focus groups to gain a student perspective on the lessons, their beliefs about functional mathematics and their prior experience; questionnaires and interviews with vocational staff to gain understanding of their beliefs and attitudes towards functional mathematics. The central part of the research concerns the student experience in the classroom and the triangulation of student perceptions, functional mathematics teachers' views and lesson observations by the researcher.

Some early indications are described in the following section, based on ten individual interviews with functional mathematics teachers, 30 questionnaires, two student focus group discussions and ten lesson observations, plus preliminary work with five student groups, three teachers and one functional mathematics team.

Early emerging themes

The first indications reinforce the suggestion that less than a grade C in GCSE mathematics is regarded as failure. Low attainment is strongly linked to negative emotional responses and expectations of continuing failure. Comments such as "We're thick, therefore we're doing functional maths", "I'm never going to get it, I feel so stupid" and "Always dreaded it, since school" illustrate the negativity, assumptions and lack of confidence present in many students.

Students frequently stated a belief that functional mathematics had value and the comment "You can't get anywhere without maths" is typical. Their explanations revealed that some see functional mathematics skills as useful tools for real life and others acknowledge the exchange value of the qualification to access further training or a career. However, their beliefs about the value of mathematics, coupled with their own lack of success, seem to reinforce feelings of failure for some students yet provide motivation for others.

Staff interviews show that teacher backgrounds vary widely and that few would be seen as mathematics specialists in a school situation. All the staff interviewed had had other careers before entering teaching and many had used mathematics in that career.

The teachers interviewed all shared an enthusiasm for functional mathematics and strongly believed that students needed these skills for life, even if they would not actually use mathematics in a job. They made a clear distinction between 'functionality' and 'traditional' mathematics, referring to functional mathematics as the application of mathematical skills in real life situations and the development of transferable, problem-solving skills. They believed that functional mathematics has value but this is more about the value of the skills students develop than the actual qualification they achieve, which they feel has variable levels of acceptance amongst employers and HE institutions. There was strong opinion that functional mathematics is useful and that even students with high grades in GCSE mathematics benefit from a functional mathematics course since it develops skills that are often lacking.

There are some indications from staff interviews that student attitudes to mathematics and their attainment can change. In preliminary work, students at the end of their course agreed that the teacher-student relationship in college was different to school and they felt more positive about mathematics as a result. In the main study student comments such as "If I'd had Pete as a teacher at school I'd have passed my GCSE" and "I really enjoyed that lesson, considering I hate maths" suggest that new relationships and environments can change attitudes but it may take time. As one teacher commented when referring to the relevance of functional mathematics to real life, "They don't see it at first but in the end they do."

Concluding comments

The transition from school to Further Education provides an opportunity for change in students who may have previously experienced failure with mathematics. The early indications of this research are that students bring a legacy from school but it is possible to provide an environment in which student beliefs and attitudes can be re-shaped, useful mathematical skills for the future can be developed and students can gain the confidence to use them.

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