An alternative destination for post-16 mathematics: views from the perspective of vocational students

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The English government has recently raised the school leaving age to 18 and introduced a requirement for 16-year olds who have not achieved a grade C in the national certificate (GCSE) for mathematics to repeat this examination. These are significant changes affecting the place of mathematics in post-16 education. The current lack of an alternative qualification to GCSE implies an acceptance that a single mathematics curriculum is a suitable preparation for students of all abilities, despite their widely differing destinations. In this paper, case studies of vocational student groups in Further Education will be used to explore students' views of the relative merits of a GCSE mathematics course compared to one leading towards a functional mathematics qualification, in the context of their experiences in school and college. The evidence suggests that these students respond more positively to a curriculum that is related to their expected use of mathematics in the future rather than to the repetition of a subject they associate with school. The reasons for these views may provide a useful contribution to the discussion about an alternative curriculum.

Keywords: functional mathematics, GCSE mathematics, vocational.

The historical place of mathematics in vocational education

The traditional division in post-16 education between academic and vocational routes provides students with a choice between two broad pathways associated with different destinations and sets of values. These are based on their respective historical ideologies and socio-cultural practices (Rogers, 1998) but are subject to influences from politically-driven policies. Whilst the main focus of the academic path has been to prepare students for higher levels of study, vocational training has been centred on equipping students with the skills for employment in a range of trades, businesses and services.

Within these two pathways mathematics has occupied very different places (Rogers, 1998). In the academic arena, mathematics has taken a central position as a core discipline within the national curriculum. Forming a fundamental element of the knowledge-base expected for a continuation to higher level study, it is also a key part of other subjects, such as science, technology and business. The academic GCSE mathematics qualification is a critical subject in the qualification portfolio of any student.

The relationship between mathematics and vocational education has been rather more uncertain. Although the acquisition of a minimum level of mathematical skills has been viewed as necessary (Wolf, 2011), there has been a lack of clarity about the curriculum most appropriate to the vocational context (Bolton & Hyland, 2010). A succession of qualifications, each with variations in their conceptual foundations have been developed and discarded. From the original concept of an

essential set of generic skills, qualifications such as Key Skills shifted the focus of teaching towards vocationally-related applications and embedded practices became popular. More recently, functional mathematics qualifications have placed a greater emphasis on being able to apply mathematics across a range of contexts, including 'real life' scenarios (QCA, 2007). As a result, incorporating the use of unfamiliar contexts into teaching approaches has become preferable to the narrow vocational focus of embedding. With such differences between successive qualifications and the practical implications for teaching, the position of mathematics in vocational education has been difficult to establish with any certainty.

GCSE mathematics has retained a place in vocational education since it represents an accepted standard that has gained recognition and credibility with employers (Wolf, 2011). Alternative qualifications, although widely used with students on vocational courses, have failed to gain the status of GCSE mathematics. The recent dismissal of these alternatives, as conceptually flawed and of little value, (Wolf, 2011) has led to policy changes which mean GCSE mathematics now takes a more prominent position in post-16 vocational education.

Current policy now requires post-16 students who have not attained at least a grade C in GCSE mathematics to follow a course of study aimed at repeating the qualification until they succeed. This represents a major change for Further Education colleges where many of these students continue their education and there has been a reliance on offering alternative qualifications rather than resitting GCSE mathematics. Coupled with an extension of compulsory education this leaves many young people facing further years of chasing the elusive GCSE grade C.

Positioning mathematics in the vocational context

The need to improve the mathematical skills of young people and adults is well-evidenced. Concerns have appeared frequently in national reports about a deficit in the skills considered essential for life and work (Moser, 1999; Wolf, 2011). Selecting GCSE mathematics (at grade C or above) as the preferred minimum attainment for students acknowledges the general acceptance of the qualification as a recognised standard but prioritising this qualification over any alternatives implies that it is a suitable preparation for both academic and vocational student destinations.

One of the difficulties in placing GCSE mathematics centrally in both vocational and academic education is that mathematics is not value-free but neither are the educational institutions in which it is placed. The reconciliation of personal and subject values by practitioners, within these different value systems, has resulted in a polarity between academic and vocational views of mathematics (FitzSimons, 1999) that is transmitted to students implicitly or explicitly.

Students who opt for vocational education are exposed to a value system which is orientated towards developing practical skills for use in an adult working environment. The academic value of knowledge is replaced by a more utilitarian view of acquiring skills for a specific purpose. Students' intended destinations become influential in their value structures and they are more likely to view mathematics in relation to their primary goal of a vocational occupation. Mathematics becomes a part of the preparation for employment rather than a subject with intrinsic worth. The place of mathematics in vocational education, therefore, depends on the mathematical demands of the workplace.

Mathematics in workplace situations is often hidden within work practices (Williams & Wake, 2002) and some ambiguity exists about the skills needed (Roper,

Threlfall & Monaghan, 2006). The uses of mathematics in the workplace are diverse, subject to unforeseen changes and increasing complexity (FitzSimons, 2013) but research suggests that competencies in applying mathematics and understanding the workplace context (Hoyles, Wolf, Molyneux, Hodgson & Kent, 2002) are important. In most occupations the actual mathematics may be relatively simple but the settings are complex (Hodgen and Marks, 2013). Preparation for the workplace depends not only on a grasp of basic mathematical concepts but on the ability to apply appropriate mathematics in situations that may not be straightforward.

A mathematics curriculum that addresses the needs of the workplace, as outlined above, may place the subject in a more harmonious relationship to the values and goals of vocational students. An understanding of these values, from a student perspective, is a key factor in the process since student views do not necessarily reflect the same values as those who shape the curriculum, either at national or classroom level.

Research methods and results

In this research, students' own comparisons of GCSE mathematics to functional mathematics provide data about their perceptions of these two curricula. The research forms part of a larger study of students' experiences of functional mathematics, involving seventeen case study groups, in three Further Education colleges, within the vocational areas of Hair and Beauty, Construction, and Public Services. By focussing on the students' experience of the curriculum in practice this paper presents one aspect of the response to the research question: In what ways is functional mathematics relevant to students?

Qualitative data was gathered from student focus groups, interviews with teachers, lesson observations of functional mathematics and observations of vocational sessions. Card-sorting activities were also used with individual students prior to the focus groups, to ascertain their views. Interviews and focus group discussions were audio-recorded, transcribed, coded and compared with other data, both within and across cases, to identify the main themes.

The responses from the initial individual student activity indicated more positive attitudes to functional mathematics in college than towards mathematics in school. This finding was supported by students' comments in the focus groups. The reasons for these attitude changes will be explored here by referring to two short case studies of student groups in the same college. These cases constitute only a small section of the data but the points extracted represent some of the dominant themes that emerged from the full data set.

Case study A: Public Services

The student group was predominantly male and aged 16-18 years. Most of the group were intending to enter the armed forces, the police or the fire service. Their teacher, Lindsay, was part of a central team that provided functional skills lessons for other college departments as requested.

Lindsay used a range of *scenarios that related to students' personal lives* but rarely used the students' vocational context. The scenarios were used to *stimulate discussions* about 'real life' situations and demonstrate *how mathematics could be applied.* This strategy was effective in generating interest and engaging students in the lessons. The tasks were often practical, multi-step problems and students were encouraged to use a variety of methods. Although some of the applications were not

naturally occurring problems, the *descriptive details of the scenarios were accurate* and came from genuine sources. Students viewed these as authentic and understood the connections to their lives.

The students referred to the skills they were developing in college as the mathematics they needed for everyday life. Tasks that *connected directly to their vocational area*, such as calculating BMI (Body Mass Index) or problems that *related to their current concerns*, like the cost of smoking or alcohol awareness, were regarded as interesting. Through tasks such as these, that linked the classroom to their current values, the relevance of mathematics became more apparent to students.

These students felt the content of functional mathematics was limited compared to GCSE mathematics but were better motivated by a curriculum that excluded topics they viewed as irrelevant such as algebra. For some students these were also the topics they had found difficult in GCSE so the functional curriculum appeared *more achievable.*

The problem of the relative value of a functional mathematics qualification compared to GCSE grade C was apparent in student discussions. They felt the skills they were developing in functional mathematics were more useful but that the GCSE qualification was "better CV wise".

Students in this group had difficulty identifying the mathematics they used within their vocational course but were observed in a vocational session planning an expedition that required use of speed, distance and time, map scales, bearings, accurate measurements and a simple formula (Naismith's rule). They could, however, readily provide examples of uses of mathematics in their personal lives. This seemed consistent with the emphasis in lessons which focussed on applications to life rather than to the vocational area.

Case study B: Hairdressing

This student group was entirely female with a mixed age range. Most of the students were aiming for a career as a stylist in a salon but some intended to eventually run their own business. Their teacher, Richard, was based in the Hair and Beauty department as a specialist functional mathematics teacher for vocational groups.

In the lessons the hairdressing context was used frequently and students commented on how Richard *related everything back to salon practices*. The tasks used were often *authentic problems* that would actually occur in the hairdressing salon, such as planning appointment schedules, and students were sometimes expected to use vocational knowledge as well as mathematics to solve these problems. Tasks were often loosely structured with choices of methods and multiple alternative solutions.

The students felt the functional mathematics lessons were more interesting and fun because of the scenarios used by Richard. They noticed an *increased use of problems* compared to school, including questions that needed "thinking" rather than straightforward answers.

These students were able to identify several *uses of mathematics in occupational practices* such as planning time schedules, handling cash, cutting angles, weighing materials and working with ratios when mixing hair dyes. They rarely mentioned personal uses of mathematics outside the vocational context but understood the *relevance of mathematics to their intended occupation* and the importance of competence with these applications in the salon.

Summary of main points

For these students there were several key factors that contributed to a more positive experience of mathematics in college, resulting in changed attitudes, better motivation and increased engagement.

- The content of the functional mathematics curriculum was perceived as the *mathematics that was useful and relevant* to students' personal lives or future employment. For some students the curriculum seemed *more achievable* compared to GCSE mathematics because of the absence of topics they had previously found difficult but others noted an *increase in problem-solving* activities and the additional cognitive demands of these tasks.
- Perceptions of relevance were supported by teaching that involved the use of scenarios that *connected mathematics to students' current lives and values.* These connections were made most readily when the *descriptive details of the scenarios were authentic* and they were associated with values relevant to their transition to adult life or employment.
- The *use of discussion* around these scenarios was an important factor in stimulating interest and facilitating students' understanding of how mathematics was relevant to life and work.

Discussion and conclusions

Many of these students were disaffected by their experience of mathematics in school and overcoming negative attitudes was an important part of preparation for using mathematics confidently in the workplace. Failing to see the relevance of mathematics is a common reason for disaffection (Nardi & Steward, 2003). These students discovered the relevance of mathematics in college and attitudes became more positive as a result. The combination of a functional curriculum, with the teaching approaches used in these case studies, was effective in communicating the usefulness of mathematics in relation to their lives and values.

These students saw the relevance of the functional mathematics they learned in college when the links to their current values were explicit. Using scenarios that related to personal issues or vocational interests was effective because these related to key values and goals in their progression towards adult life and employment. Personal values are closely associated with affective responses (DeBellis & Goldin, 2006) and mathematics-related goals make an important contribution to attitudes towards mathematics (Hannula, 2003, p. 26). Students who saw a link to their goals and values found a purpose for mathematics in their lives that influenced their affective responses. More positive attitudes then led to increased motivation and engagement.

Despite the value and relevance that these students attributed to the skills they learned in functional mathematics, they recognised that GCSE mathematics was more widely accepted. There was a tension between acquiring skills that would be useful or gaining a widely-recognised qualification as evidence of reaching an accepted standard. For these student groups, the gatekeeping role of GCSE mathematics was not particularly important and the research suggests that the alternative curriculum had more to offer as a preparation for the workplace. For vocational students on other courses, with less certainty about their pathway or destination, the need for a GCSE qualification may be greater and outweigh the benefits of the functional approach.

This research suggests that the functional curriculum had benefits for vocational students. The prominence of GCSE mathematics seems unlikely to be

challenged in the near future by alternative qualifications but maximising the potential of the functional elements within GCSE may be a step towards a more positive experience for vocational students.

The functional skills specification itself, however, was insufficient to change attitudes without the construction of appropriate links by teachers to students' goals and genuine interests. Faced with an increasing number of vocational students retaking GCSE mathematics, the integration of these attitude-changing teaching approaches may well yield some benefits. This study has highlighted the changes in attitude but the impact on student attainment would be a useful direction for further research.

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