The waxing and waning of Functional Skills mathematics

Diane Dalby* and Andrew Noyes.

University of Nottingham, Nottingham, England.

Diane Dalby (corresponding author)
School of Education
University of Nottingham
Jubilee Campus
Wollaton Road
Nottingham
NG8 1BB
0115 7484392
diane.dalby@nottingham.ac.uk

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There have been repeated attempts to establish mathematics qualifications for lower attaining students aged 16 years and over on vocational pathways in England. In 2004, the Tomlinson Report proposed Functional Mathematics and this paper examines the trajectory of this qualification (later Functional Skills mathematics) through analysis of policy literatures over the last twenty years and empirical data from two studies in Further Education colleges. For a time, Functional Skills mathematics flourished and was becoming valued by many stakeholders but the privileging of GCSE Mathematics in recent policy has affected its status and uptake. It is important to understand this waxing and waning trajectory if future skills policy is to have better chances of long-term success. Key challenges include the unsuccessful integration of Functional Skills with the established mathematics curriculum, the difficulty of achieving qualification recognition across the vocational-academic divide and the negative unintended consequences of linked policy decisions. Raising the adult skills base is currently a policy priority in England and understanding these challenges to a skills-based qualification that is more aligned to the needs of vocational education than to schools is important.

Keywords: policy; mathematics; functional skills; qualifications.

Introduction

England's secondary education system has a distinct academic-vocational division at age 16. Students with a strong grade profile in the General Certificate of Secondary Education (GCSE) examinations, taken at age 16 years, generally remain in schools or Sixth Form colleges and follow academic qualification pathways. Those with lower GCSE grades (around a third of the cohort), typically enter vocational education and training in large Further Education (FE) colleges. Irrespective of the pathway taken, the concerns of stakeholders and evidence of skills deficits in international comparisons (OECD 2016) have fuelled political interest in improving mathematics learning for these post-16 students. This can be seen clearly in the Industrial Strategy (BEIS 2017), Sainsbury Report (2016) and

Smith Review of Post-16 Mathematics (2017). The introduction of new level 3[1] Core Maths qualifications and the embedding of ‘general mathematical competences’ within new Technical Level qualifications aim to increase mathematics learning opportunities for more able students (The Royal Society 2019). Elsewhere, the challenge of establishing relevant and valued post-16 mathematics qualifications for what has been termed ‘the forgotten third’ of lower-attaining students continues.

Over the last 40 years, there have been repeated attempts to establish vocationally relevant mathematics qualifications, either as alternatives to repeating the GCSE mathematics examination or as additional qualifications. This succession of mathematics curricula and assessment frameworks have sought to apply mathematics in more relevant and realistic contexts as ‘core skills’ (1979-2000), ‘key skills’ (1996-2012) and, most recently, ‘functional skills’ (from 2004).

From September 2014, as part of the government’s Condition of Funding, 16-18 year olds in England who had not achieved a ‘good pass’ in GCSE Mathematics, i.e. Grade C (or 4) or higher, were required to continue their study of mathematics. This represents around one third of each national cohort. From September 2015, students with a prior attainment of Grade D (or 3) were required to retake GCSE mathematics rather than take alternative qualifications such as Functional Skills. The majority of these students make little further progress by age 18 with, for example, only 18.7% of 16-18 year olds re-sitting GCSE mathematics in 2018 achieving the required grade 4 (DfE 2019). Meanwhile, uptake of Functional Skills mathematics as an alternative qualification has waned, despite some stakeholder support for the qualification as a useful preparation for work (ETF 2015).

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[1] Level 3 qualifications are the level above a ‘good’ pass at GCSE.

Mathematics education in England's Further Education colleges is entangled in the academic-vocational divide, where qualifications for vocational education have often been subject to a "perverse synergy" (Hodgson and Spours 2008, 7), shaped more by academic values than by vocational purposes. This 'academic drift' within vocational education (Hodgson and Spours 2008), of which the privileging of GCSE retake is a pertinent example, is compounded by changing perspectives on skills and their assessment. There is not space herein to fully explore national and international perspectives on skills but, suffice to say, the low status of knowledge in the English interpretation of skills, and the strong association with practical tasks in work contexts (Brockmann, Clarke, and Winch 2008) makes the design and sustainability of appropriate mathematics qualifications for vocational contexts challenging. The young people for whom such qualifications are designed have arguably not been served well by regular qualification reforms.

This paper analyses the waxing and waning of the most recent version of mathematics for vocational learners - Functional Skills mathematics. Stephen Ball's (1993) ideas on policy development and enactment are fundamental to the approach taken. Although Ball's various studies are mainly of policy enactment in schools, Further Education colleges enact policy through similar processes of interpretation and modification as different actors interact with, and mediate, policy (Spours, Coffield, and Gregson, 2007; Dalby and Noyes, 2018). These actors are not only influenced by the official 'drivers' of policy, such as government documents and statements of priorities, but also by a range of 'levers' including performance targets, standards and inspection. These influence how FE colleges develop strategies or "gaming activities" (Pring et al., 2009) to position themselves favourably in a competitive market in an FE sector which has been chronically under-funded (Steer et al., 2007). Our study therefore brings together analysis of national policy discourses and implementation processes with research on institutional implementation in order to understand the qualification lifecycle in the critically important area of mathematics.

Further Education is a policy space that is inherently unstable and reliant on a devolved social partnership to inform policymaking. In this environment, contenders with different objectives play out their struggles over meaning (Taylor, 1997) in complex, messy interactions with policy discourse. Policy texts, such as commissioned or independent reports, can capture these stakeholder struggles whilst narratives from government documents provide insights into the assumptions of policy makers (Pring et al., 2009). In our analysis of policy development, both types of document make important contributions to our understanding of the trajectory of Functional Skills mathematics. Given this background, the paper seeks to answer two key questions:

(1) What are the reasons for the waxing and waning trajectory of Functional Skills mathematics?

(2) What is generalizable from this case and how can it inform future qualifications policy?

To answer these questions, we combine a fifteen year analysis of policies related to mathematics in Further Education colleges with data from two research studies that were conducted 5 years apart (2012/13 and 2017/18). This enables us to present the dominant views of college staff and students about Functional Skills mathematics at these two points on its trajectory, followed by a policy analysis that seeks to explain how the differences evidenced align to a changing trajectory. Whilst recognising that policy development involves complex relationships of power in a contested process (Taylor, 1997; Bell and Stevenson 2006), the analysis herein is a ‘helicopter view’ of the policy trajectory of a qualification, rather than a detailed analysis of the complex interrelationships within the policy system.

Methodology

We organise the description of methods, and the reporting of the analysis, into two parts: firstly, relevant findings from the two studies at different time points of mathematics in FE colleges are presented. These are followed by an analysis of policy literatures from the mid-2000s to the present.

Part 1: empirical studies in FE colleges

Findings from two empirical studies of mathematics in FE colleges are reported. In *Study 1*, detailed case studies were developed of students' experiences of Functional Skills mathematics in three Further Education colleges during 2012/13 (Dalby 2014). *Study 2* is based on case studies of six large FE providers in 2017/18. This forms part of a much larger ongoing study of mathematics in FE colleges[2] involving a balanced sample of large FE providers across England's regions, taking into account college type, location, the Department for Education's published 'maths progress measure' and Ofsted inspection grade. Further details of the methodologies for each study can be found in Dalby (2014) and Noyes and Dalby (2020).

Both studies involved semi-structured interviews with mathematics teachers and managers as well as student focus groups. Interviews and discussions were audio-recorded, transcribed, coded and analysed to identify dominant themes. In *Study 1*, case studies of 17 student groups were developed from interviews with managers and mathematics teachers (20) and vocational tutors (14), together with observations of over 30 Functional Skills mathematics lessons and termly meetings with a student focus group from each class (17

[2] The Mathematics in Further Education Colleges (MiFEC) project 2017-2020.

groups; 51 meetings). Each student focus group consisted of 4-6 representatives from the same Functional Skills mathematics class in one of three vocational areas (Hair and Beauty, Construction or Public Services). These focus groups used card-sorting activities to indicate their views of Functional Skills mathematics and discussed their learning experiences. Managers and teachers were asked about their views of Functional Skills mathematics, their teaching approaches (if teaching), student engagement and outcomes. A wider group of Functional Skills mathematics teachers (39) and vocational staff completed questionnaires about their backgrounds, teaching and student engagement.

In *Study 2,* case studies of six large FE providers were developed from interviews with mathematics teachers (32), managers (27) and vocational teachers (14), plus student focus groups (23). Student focus groups in *Study 2* consisted of mixed groups of students from several vocational areas taking mathematics at different levels, including GCSE and Functional Skills mathematics. The majority of students were from Health and Social Care, Construction and Business Studies. They were asked about their experiences of learning mathematics in college (GCSE and Functional Skills mathematics) and their views of policies concerning mathematics. Managers and teachers were questioned about the mathematics offered in the college, internal policies, teaching approaches used and challenges for students. These providers also provided documentary evidence about their mathematics policies, staffing and organisation, plus summaries of their student participation and success rates with mathematics qualifications over the previous 5 years.

Part II: the policy timeline

The policy trajectory analysis of Functional Skills mathematics examines how stakeholder reports, wider reforms and political ideologies interact and affect policy development. The analysis is based on a theory of change approach (Funnel and Rogers 2011) in order to understand historical developments in post-16 mathematics in FE as both product and process. This approach seeks explain how the various historical ‘interventions’ have worked, using a causal chain with a series of *inputs, outputs, outcomes* and *impact* (Funnell and Rogers 2011). In our case, we are considering complex historical policy implementation processes within a reflexive system in an unstable field (Lucas and Crowther 2016). This is a case of organised complexity (Rogers 2008) in which multiple parts and actions interact in unpredictable and non-random patterned ways. Whilst mindful of the limitations of oversimplifying the complexity and variability of policy and curriculum change, this approach to analysis enables the exploration of emergent patterns from consideration of key inputs and outputs under changing conditions over time.

A policy timeline was developed and a database of over 100 relevant documents, including summaries of their key messages, using a process of literature review and validation by individuals with different areas of relevant expertise (e.g. mathematics education, vocational education, government policy). These individuals reviewed drafts of the database and timeline at intervals during development and validated the final selection, basing document selection decisions on the relevance to either mathematics in FE, or wider reforms that had a secondary effect on mathematics. The final selection reflected the different educational, social, economic or institutional values of various stakeholders, including reports from 2004-2018 by stakeholder bodies or government in the form of 1) legislation and government consultation, 2) published reports led or commissioned by government, 3) published reports from other national organisations and stakeholder groups, and 4) published documents on curriculum development.

Analysis

The Functional Mathematics policy trajectory is presented in four sequential phases that were identified from the analysis:

- Conception (2004-2007) – the developmental process from first introduction of the concept of functional mathematics to a pilot qualification
- Inception (2007-2010) – the start of curriculum activity in the form of a limited pilot and evaluation of a Functional Mathematics qualification
- Implementation (2010-2015) – the wide scale national adoption of Functional Skills mathematics as the main mathematics qualification for 16-18-year-olds in FE
- Decline (2015-2018) – the decline in participation as government policy becomes less supportive of Functional Skills mathematics.

The transitions between these phases are associated with key processes and critical events: the first introduction of the concept; the pilot phase of the qualification; the national roll out and the emergence of new policy priorities.

Figure 1 below offers a visual representation of how the four phases of Part II and the two empirical studies of Part I fit together. We now proceed to present the two parts of the analysis.

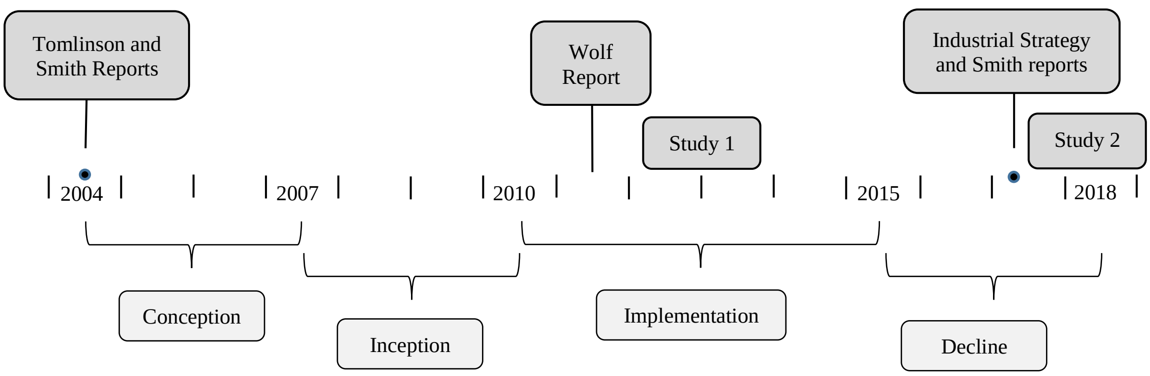

Fig 1. A timeline of the four phases, two studies and key reports

Part I: empirical studies in FE colleges

Study 1: College case studies (2012/13)

At the time of this study, policy required all 16-18 year old students to study at least one functional skill (Mathematics, English or IT) but the choice of which skill was generally made by the college for a student group. *Study 1* has been reported in detail elsewhere (Dalby and Noyes 2016, Dalby 2014) and so only the relevant points for the purposes of this paper are presented here. The study was undertaken in the middle of the *implementation* phase for Functional Skills mathematics and provided evidence of confidence in, and enthusiasm for, the qualification. The key findings relevant to this paper are summarised below.

Teacher participants reported that the curriculum was a significant improvement on Key Skills and more appropriate for vocational students than GCSE mathematics. Interview data showed how teachers' reasons for their confidence in, and support for, Functional Skills mathematics focussed mainly on the 'use-value' (Williams 2012) of the skills and content in relation to the future work and lives of students. Survey responses indicated that the majority of teachers believed Functional Skills mathematics involved the development of useful skills in mathematics needed for the workplace (92% agreed or strongly agreed), for real life (100% agreed or strongly agreed) and for students' personal lives in the future (90% agreed or strongly agreed). The majority of students in the focus groups stated that the skills were useful (85% agreed or strongly agreed) and their discussions centred on a similar theme of Functional Skills mathematics being relevant.

Teachers stated that the focus on using and applying mathematics encouraged and supported the use meaningful and realistic connections to students' vocational or personal interests in their teaching. This helped mathematics become more relevant and engaging for students, which in turn contributed to positive changes in students' attitudes.

The narrower curriculum content compared to GCSE was also viewed positively by teachers since this allowed time for low-attaining students to build basic conceptual understanding and procedural fluency before learning how to apply those ideas, rather than trying to build understanding of a wide range of content upon insecure foundations. Some teachers also found Functional Skills mathematics valuable for higher-attaining students (Grade C or above) since skills in using and applying mathematics were often lacking, even when theoretical knowledge was secure.

Students generally agreed that Functional Mathematics was important, giving the main reasons as the need to use maths in a job one day (92% agreed or strongly agreed) and that maths is a subject you need to get on in life (93% agreed or strongly agreed). These capture general reasons why mathematics is important whilst the emphasis on useful skills is more specific to Functional Skills mathematics. There was however some conflict between students' perceptions of the use-value of Functional Skills and what they considered to be the higher 'exchange value' of GCSE.

Students also made frequent references to contrasts between GCSE mathematics in school and Functional Skills mathematics in college, in both the content and the teaching approaches used. Most students stated a preference for Functional Skills mathematics compared to their experiences of GCSE mathematics in school and said they found it easier to engage with the lessons.

Study 2: College case studies (2017/18)

At the time of this second study, the Condition of Funding required all 16-18 year-old students in FE colleges without a grade 4 or higher in GCSE Mathematics to continue working towards this goal. Only grade 3 students needed to be placed directly on to a GCSE retake course, leaving the Functional Skills mathematics as an optional 'stepping-stone' qualification for those with a lower grade (i.e. 1/2). Both GCSE and Functional Skills mathematics had undergone some review and changes to specifications and assessment had been made.

Evidence from interviews with managers showed that a growing number of FE providers were choosing to place low-attaining students (i.e. below GCSE grade 3) on GCSE courses rather than Functional Skills mathematics and that few were offering Functional Skills mathematics at level 2. Documentary evidence supported these indications that the number of students studying Functional Skills mathematics had declined whilst GCSE mathematics examinations entries had increased.

A common view amongst college staff was, however, that GCSE was not the best qualification for some students and that they needed an alternative that was more relevant to their vocational pathways.

> I do think that for a number of our students, frankly they would do better if they were able to do functional skills and to have a course that was more directly applicable to their vocational training. (Principal MC2)

Despite reservations about Level 2 Functional Skills mathematics, those teaching Level 1 or Entry level, or teaching adults, often remained enthusiastic about the suitability and relevance of Functional Skills mathematics. A mathematics qualification aligned to vocational study, rather than academic progression, was viewed as a desirable alternative by many managers and teachers. Students again acknowledged that mathematics was important to their lives and careers but this did not generate any particular enthusiasm for learning. Those who intended to progress to Higher Education often appeared to be better motivated than those who expected to move into employment after college because the qualification had a clear personal ‘exchange value’ (Williams 2012). Students frequently expressed their dislike of repeating GCSE mathematics and their reluctance to engage with lessons, even if they believed the subject to be important because they failed to see the relevance of the actual mathematics they were studying.

Perceptions of the relative merits of Functional Skills mathematics and GCSE were variable across the case study colleges. Those who expressed a lack of confidence in Functional Skills mathematics were mainly concerned about the relative value afforded to different qualifications.

> I think the problem has always been that Functional Skills is still perceived a bit as the poor relation despite the changes that are being proposed and the new standards and everything. (Maths teacher, MC3)

Arguments for the prioritisation of GCSE Mathematics were frequently founded on the premise that the qualification is an important gatekeeper for progression to further study (HE or vocational learning at a higher level) and is recognised by employers. Managers justified placing low-attaining students on GCSE rather than Functional Skills mathematics as an opportunity for them to improve their GCSE grade, even if their prior attainment was well below grade C (or 4). However, the prominence of a new maths progress measure in discussions with managers suggested that this had become a driving factor for entering more students for GCSE who might have studied Functional Skills mathematics under previous college policies.

There was less evidence amongst students of tensions between GCSE and Functional Skills mathematics and wider acceptance that GCSE was the ‘best’ qualification to take. However, most of these students had been directed to take GCSE mathematics by their college and had no experience of Functional Skills mathematics with which to compare. Perceptions that GCSE was the qualification most employers would want were evident, though whether this is merely an inculcated view from the policy discourses is moot.

Changes in GCSE and Functional Skills qualifications had also affected perceptions of the two qualifications. Functional Skills, especially the level 2 qualification, was now considered so demanding that most colleges were no longer offering this to 16-18 year olds. Teachers also explained how the new GCSE was more challenging and better suited to students on academic progression pathways due to the wide range of content and the need to spend time building or repairing the conceptual foundations of low-attaining students.

> The problem is that the GCSE syllabus has evolved more and more, in our opinion, towards something which is preparing students primarily for going on to higher study in maths. (Principal, MC3)

Teachers and managers also questioned the value of 16-18 years olds having to re-sit a qualification that they had 'failed' at school and the negative effects of repeated failure with the same examination.

Summary

A comparison of the findings from *Studies 1* and *2* shows a change in views of Functional Skills mathematics amongst teachers, managers and students. In *Study 1*, there was enthusiasm for Functional Skills as a suitable qualification for 16-18 year olds students in vocational education due to the relevance of the skills. Teachers in *Study 2* were still keen to have an alternative qualification for some vocational students but identified deficits in Functional Skills mathematics. Although supportive of the need for a more vocationally relevant qualification, the higher relative (exchange) value of a GCSE mathematics qualification was problematic. Furthermore, qualification reforms had increased the academic content of both qualifications but had positioned Functional Skills mathematics closer to GCSE, thereby undermining its distinctive focus on skills. The shift in teachers' and students' views highlights the sensitivity of perceptions about qualifications resulting from minor curriculum changes and external influences. The reasons for these changes in perceptions of Functional Skills mathematics are discussed in more detail in the following section.

Analysis – Part II: the qualification cycle

Stage 1: Conception (2004-2007)

Before the first appearance of the term functional mathematics in the Tomlinson Report (2004), the ground had already been prepared in FE for the introduction of a new qualification appropriate for vocational pathways. Concerns about adult skills expressed in earlier reports (e.g. Moser 1999) and the ongoing, high-profile Skills for Life Initiative (2001-2010) continued to promote participation and attainment with numeracy. Demanding government targets for student participation and achievement in courses designated, for this purpose, as Skills for Life (which included Key Skills) ensured that maths for 16-18 year-olds remained a priority for FE providers during this period, despite earlier doubts about the credibility of the concept of general transferable skills in post-16 education (Hyland and Johnson 1998) and questions about the effectiveness of attempts to define such skills (Green 1998).

The mathematics needs of industry and business were prominent during this time, including demands for better basic skills levels (Hoyles et al. 2002) amongst employees as well as a need for those with higher level mathematics (Roberts 2002). These identified deficits reinforced perceptions that the country needed to prepare young people more adequately for the mathematics demands of their future lives and work. The apparent failure of previous policies concerning generic skills was attributed primarily to weak policy development, although interaction with other reforms and socio-economic trends were identified as significant influences (Hayward and Fernandez 2004).

Meanwhile, work on more general reforms of 14-19 education was taking place, presenting opportunities for a second look at mathematics vocational pathways from a different perspective, where academic and vocational needs were both under consideration. The Tomlinson Report (2004) attempted to resolve some of the divisions between vocational and academic pathways and, almost simultaneously, Smith (2004) reported a need to develop flexible mathematics learning pathways for all 14-19 students. This attempt to reconcile vocational and academic perspectives was a significant step beyond the traditional skills-knowledge divide and led to a major national curriculum and assessment reform project, the Mathematics Pathways Project, from 2005-10. One of the innovations proposed was the inclusion of Functional Mathematics into the programme of study for 14-16 year-olds, thereby bridging the school to FE division and offering the possibility of a qualification recognised in both vocational and academic education

Despite uncertainty about proposed changes in post-16 education, with many of Tomlinson’s (2004) recommendations discarded, the concept of functional skills survived. A new 14-19 white paper (DfES 2005) and Further Education white paper (DfES 2006) began to map out the future terrain for the introduction of Functional Skills mathematics qualifications. In addition, the announcement in the 2007 Queen’s speech about raising the school leaving age reinforced the need for relevant post-16 mathematics qualifications for students at all levels on both vocational and academic pathways. Considering that low-attaining students were typically those who were leaving school at age 16, increased demand could be expected for non-academic mathematics qualifications suitable for those below the minimum standard (Grade C) in the GCSE examination. Functional mathematics was well placed to address a recognised, need with support from vocational and academic perspectives.

Stage 2: Inception (2007-2010)

By 2007, new Functional Mathematics qualifications were ready for piloting and plans were underway for the withdrawal of Key Skills. Functional Mathematics retained a place in the qualifications landscape and was well positioned to become the preferred alternative mathematics qualification in post-16 education, especially for students on vocational study programmes, thereby displacing Key Skills. Its future was however becoming more closely linked to vocational education alone, due to a critical point in the development of 14-19 mathematics pathways.

The Mathematics Pathways Project initially proposed that Functional Mathematics would be structurally linked to the GCSE, acting as a hurdle to achieving a pass grade, but it soon became clear that this was unworkable so GCSE and Functional Mathematics were decoupled. Although the GCSE did retain ‘functional elements’, this separation of functional and GCSE mathematics helped to maintain an academic-vocational division in approaches to mathematics rather than a reconciliation.

The Mathematics Pathways Project (2010) continued to encourage the development of skills in using and applying mathematics in GCSE despite this de-coupling. Recommendations of an alternative GCSE in Use of Maths, with a heavy emphasis on application of mathematics, foundered over regulatory issues and a proposed linked-pair of GCSE mathematics qualifications incorporating the two different aspects of mathematics was piloted but not fully implemented. Consequently, the focus on using and applying mathematics was limited in GCSE a remained primarily the domain of alternative post-16 qualifications for students on non-academic pathways.

In this period there was however continuing support for mathematical skills development from other sources. The influential Skills for Life Initiative maintained a focus on basic skills development in FE through to 2010. The Leitch review (2006) made a strong connection between the importance of such skills to the economy and the future prosperity of the nation. Although the ambitions stated within the government response (Department of Innovation 2007) were most concerned with improving numeracy to a minimum level (Entry 3), the commitment to continual improvement to 2020 was farsighted.

This ongoing need for better numeracy skills and a renewed call for improvement from the government supported the need for alternative qualifications to GCSE mathematics. The absence of other voices at this time in policy discourse is noticeable but this allowed Functional Mathematics to follow a smooth journey through its pilot phase, leading to a positive evaluation (Noyes et al. 2010).

Stage 3: Implementation (2010-2015)

During the early years of the Conservative-led coalition government, the scene changed significantly with a sharp rise in the number of official reports and position papers on all aspects of mathematics education. Disappointing evidence from the Skills for Life survey (BIS 2011) showed that adult numeracy skills were not improving. If adult numeracy and Key Skills policy had not delivered the hoped-for improvement then Functional Skills mathematics seemed well positioned as a new approach to improving mathematical competence in FE.

International survey results (BIS 2013) raised new concerns about skills in mathematics and there was justification for improving mathematics achievement on economic grounds from the OECD (2010). The ongoing need to improve mathematics skills was reinforced by the Vorderman (2011) and the Mathematical Needs reports (ACME 2011), Industry voices continued to highlight the need for mathematics skills through a series of reports (RAE 2011, British Academy 2015, CBI 2015) and research into the nature of mathematics required for the workplace (Hodgen and Marks 2013) reinforced earlier work by

Hoyles et al. (2002) on the importance of being able to apply basic mathematics in complex settings. These reports all supported the need for qualifications appropriate for developing the mathematics skills of the workforce and resonated with the intentions of Functional Skills mathematics.

In the midst of this support for a qualification such as Functional Mathematics, one report signalled a critical point in the Functional Skills trajectory. The influential Wolf review (2011) was highly critical about both Key Skills and Functional Skills, thereby triggering doubts about the value of these qualifications. GCSE was promoted by Wolf as the ‘gold standard’ qualification that lower attaining students should aspire to achieve. This move undermined growing optimism in the FE sector that Functional Skills mathematics was a credible alternative for vocational students.

The influence of the Wolf report remained strong and revisions of Functional Skills qualifications were announced (Ofqual 2012) to address these concerns. A period of uncertainty followed in which confidence in the qualification might have been undermined but there was still support from the FE sector, including indications that it was becoming more widely recognised and valued by employers (The Research Base 2014, ETF 2015)..

As calls for mathematics-for-all-to-18 featured more strongly in policy discourse it became important to identify mathematics qualifications to meet the needs of all 16-18 year-old students. Curriculum development turned towards an alternative to A level mathematics (Core Maths) and diverted attention away from the need for a qualification at GCSE level and below that could prepare lower-attaining post-16 students for the mathematical demands of the workplace. The development of Core Maths was disconnected from the Functional Skills suite of qualifications, which were quickly becoming positioned as low-level qualifications of questionable value outside vocational education.

Decline (2015-2018)

In this phase, the position of Functional Skills was further undermined, despite reports highlighting the need for better skills. International comparisons (Kuczera, Field, and Windisch 2016), reported low levels of literacy and numeracy skills for over a quarter of adults in England (aged 16-65 years), thereby reinforcing the need for 16-18 year-old students to improve their mathematics. The pathway to improvement was however not identified as one where Functional Skills mathematics was the focus.

Smith (2017) highlighted the need for alternative mathematics qualifications for some students on vocational or technical pathways, echoing his earlier report (Smith, 2004) which called for “a highly flexible set of interlinking pathways that provide motivation, challenge and worthwhile attainment across the whole spectrum of abilities and motivations, but avoid the danger of returning to the O-level/CSE ‘sheep and goats’ divide” (Section 0.32). Functional Skills mathematics was noticeably missing fron the report as a possible way forward. It would have been difficult, politically, for the 2017 report to support Functional Skills mathematics at this time, especially with the qualification under review, but the call for a new qualification presented a clear challenge to the government’s commitment to retaking GCSE mathematics.

Summary

The decline in Functional Skills examination entries and responses to the reforms evidenced in *Study 2* indicate that the qualification is struggling to find a place within current post-16 mathematics policy. The promise of a new skills strategy (DfE/BIS 2016) and the reform of technical education (Sainsbury 2016) both emphasised the importance of mathematics skills in the workplace but the revised Functional Skills qualifications have more ‘academic’ content and less alignment to workplace skills. Other development work has focussed on mathematics within the higher level vocational/academic qualifications in FE, which, like Core Maths, is unconnected to the Functional Skills suite of qualifications.T levels). Whether Functional Skills mathematics can recovery from its current decline phase in debatable. So far it has followed a wax and wane trajectory in a cycle not dissimilar to that of ‘core’ and ‘key’ skills qualifications.

Discussion

Our analysis of both policy and practice evidences an instance of the waxing and waning of ‘alternative’ mathematics qualifications for vocational students in post-16 education. This is not the first such cycle and, we suggest, it will not be the last. Given the high political priority currently given to the improvement of mathematics (and English) skills in post-16 education, with the obvious implications for personal, economic and societal flourishing in post-Brexit Britain, understanding this repeated cycle is important.

Functional Skills mathematics has been devalued by the favouring of GCSE in recent policy, yet there is broad agreement that an alternative is needed, both amongst college staff in our research studies and from other stakeholders (Smith, 2017). The failure to establish Functional Skills mathematics as that alternative points to deeper-rooted issues that go beyond the specifics of the particular qualification. The trajectory mapped out for Functional Skills mathematics above highlights fundamental problems in the development and sustainability of ‘alternative’ mathematics qualifications in vocational programmes. We discuss these below and consider any generalizable underlying reasons for such cycles.

Teachers have consistently reported that the classroom approaches engendered by the Functional Skills mathematics curriculum tend to make mathematics more relevant to low-attaining vocational students which can help improve student motivation, increase engagement and reduce negative attitudes. The motivation of low-attaining students to study mathematics has been identified as a major challenge for FE providers (Higton et al, 2017) and Smith (2017) identifies the need to improve attitudes to mathematics as an ongoing need but the potential of Functional Skills mathematics to address this need is being limited by the current policy focus on GCSE. Such 'affective' elements need to be considered alongside the exchange value or public perception of the qualification.

One of the reasons for the waning of Functional Skills mathematics in our research is the ineffectiveness of the qualification as a stepping-stone to GCSE. This was never the intended purpose of the qualification and demonstrates the difficulty in trying to reposition an existing qualification within a different structure. A particular problem arises here from the erroneous idea that there is only one 'mathematics' and that it is linear, only to be differentiated by quantity and level of content. With such a framework, qualifications are conceptualised as sequential steps along one pathway rather than the multiple pathways as envisaged by Smith (2004). Alternating between knowledge-based qualifications (e.g. GCSE) and those focussing on application (e.g. Functional Skills) can result in a disjointed progression route. Both the current 'stepping stone' problem and the historical failure to embed functional mathematics within GCSE mathematics (Noyes et al., 2010) suggests that the integration of mathematics qualifications from opposite sides of the academic-vocational divide is unlikely to succeed as a direction for future post-16 mathematics policy.

The need for an alternative but distinctive level 2 post-16 mathematics qualification that focusses on using and applying mathematics in vocationally relevant ways has been well evidenced (Noyes et al., 2010, ACME 2011) but designing an acceptable, high-status and sustainable alternative is difficult. Different stakeholders have varied ideas about the purpose of post-16 education and the type of mathematics to be learned. There remains a duality of purpose (at least) in the design of mathematics qualifications for vocational students and, without understanding the knowledge politics, this will continue to hamper future developments.

Given this duality, an alternative would be to establish greater understanding of the fitness for purpose, ‘use’ and ‘exchange’ value, of any alternative qualifications. This goal is made difficult by the longstanding hierarchical knowledge politics of academic and vocational education in England. Alternative qualifications have primarily been associated with the needs of students on post-16 vocational pathways rather than in schools. Functional Skills mathematics was viewed positively and at one point seemed to be achieving wider recognition (The Research Base 2014) but doubts about the integrity of key and functional skills (Wolf, 2011), exacerbated by recent government policy, undermined public confidence. Furthermore, at this critical point, revisions to Functional Skills mathematics, which were intended to strengthen and improve the qualification, have inadvertently had the opposite effect; rendering the level 2 qualification inaccessible for some students and furthering the decline in participation. This attempt to bring academic and vocationally relevant qualifications closer together has resulted in an ‘academic drift’ towards an untenable ‘middle ground’ for Functional Skills mathematics.

Further reasons for the undervaluing of Functional Skills mathematics are rooted in the ‘gold standard’ status of GCSE and its role as a ‘gate-keeper’ for progression to many educational pathways and careers. The case studies evidence the tensions - for students, teachers and managers - between the general privileging of GCSE and the unsuitability of the qualification content for some post-16 students. Such tensions reflect a more general conflict in English post-16 education between knowledge and skills and the tendency to maintain the established academic position when contestation occurs.

Evidence of historical numeracy skills deficits in the adult population (Moser, 1999; Leitch 2006), which have not been ameliorated by over thirty years of GCSE mathematics, strengthen the argument for alternative qualifications. Yet the task of designing such an alternative that might address the nation's quantitative skills needs seems fraught with difficulties. In the case of Functional Skills mathematics and its precedents, the qualifications have tended to become associated with lower-grade students rather than achieving broader recognition as a level 2 qualification comparable to GCSE. The criticism is about level rather than fitness for purpose and points to the enduring problem of conceptualising the necessary generic underpinning skills (Hyland and Johnson 1998; Green 1999) and their position in post-16 education. Moreover, the weaknesses in policy design identified by Hayward and Fernandez (2004) appear to have not been addressed.

The research also shows how policy levers have also hastened the waning of Functional Skills mathematics by influencing college management decisions. In some cases, financial concerns and college performance measures have become more important drivers than students' needs. Despite calls for greater policy stability in the FE sector (City and Guilds 2016, The Policy Consortium 2018), regular variations in these levers and increasingly stringent accountability measures encourage managers to adapt college strategies in order to maximise funding and performance.

Conclusions

Many of issues discussed concerning the trajectory of Functional Skills mathematics are grounded in more general problems that have affected other post-16 mathematics qualifications. For example, the Functional Skills mathematics trajectory has been highly influenced by key reports on the curriculum (e.g. Wolf, 2011) and evidence of the need for better mathematics skills (Moser, 1999; Leitch 2006) but is also affected by the wide acceptance and longevity of GCSE Mathematics with its roots in the more stable academic learning pathways.

Our analysis identifies some specific contributory factors to the waning of Functional Skills mathematics but it also highlights underlying issues that remain unresolved and are difficult to address within a divided academic-vocational system. Without further attention it seems highly likely that the next attempt to develop appropriate mathematics qualifications for post-16 learners on vocational pathways will end up producing yet another relatively short qualification cycle, with vocationally-relevant alternatives being either discarded or suffering from an 'academic drift' that changes their nature or purpose.

The challenge of achieving consensus about a curriculum when there are multiple views of the type of mathematics that is most appropriate for post-16 students to develop is a chronic one. Alternative qualifications may initially find favourable conditions for growth, such as the decline in popularity of a predecessor or a strategic linkage to other initiatives, but cannot be sustained as they will continue to fare unfavourably alongside the 'gold standard' GCSE. The tension between the 'exchange value' of GCSE and the sector-perceived 'use value' of functional skills is critical here. It should not be forgotten that the original aim of functional mathematics was to address a concern amongst employers that GCSE was not good preparation, or a useful indicator of workers' preparedness for employment. It is unlikely that, given the increasing demands of the new GCSE, this has changed at all. There is therefore an outstanding need for an alternative pathway to GCSE and, in that sense, the original call from Smith (2004) for new qualification pathways is no nearer to being addressed now than it was then.

Despite a short and uncertain history in an unstable Further Education environment, there is evidence to suggest that Functional Skills mathematics has been of positive benefit to students on vocational pathways and has value in preparing them for the quantitative demands of the workplace. Functional Skills mathematics has helped to engage many students by making mathematics more relevant (Dalby and Noyes, 2016; Higton et al., 2017).

It is disappointing, therefore, that its potential for tackling disengagement (and thereby under attainment) has been largely unrealised and that it is now established in a decline phase that seems likely to continue.

The need for an ‘alternative’ mathematics qualification still features in policy discourse though currently political appetite for curriculum reform seems low. However, at such a time as the political desire emerges for new qualifications to address England’s skills deficit, and the mathematical needs of vocational learners, this present analysis is salutary. The trajectory of Functional Skills mathematics suggests that any new mathematics learning pathway and qualifications for lower attaining students and/or those on vocational programmes is likely to follow a similar trajectory without 1) consistent messaging from all stakeholders about the value of such qualifications, 2) sufficient focus on using and applying mathematics in contexts relevant to these learners, 3) the careful design of supporting levers and implementation policies, and 4) stability over time and evolutionary improvement.

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