Research Brief

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The independent evaluation of the pilot of the linked pair of GCSEs in mathematics

First Interim Report

Alpha*Plus* Consultancy Ltd

Introduction

Alpha*Plus* Consultancy Ltd was commissioned – originally, in March 2010, by the Qualifications and Curriculum Development Agency (QCDA), and then, from March 2011, by the Department for Education (DfE) – to evaluate the pilot of the linked pair of GCSEs in mathematics. The pilot programme and the evaluation run until December 2013. This research brief reports interim findings from the second round of fieldwork conducted in spring 2011.

Key findings

Teaching for the linked pair of GCSEs in mathematics started in September 2010. These key findings are based on the early implementation of the pilot programme.

- Pilot centres were enthusiastic about the opportunities the pilot offered, with some recognising benefits over and above those of the new single GCSE in mathematics. Many centres will, however, have to make considerable further changes to teaching and learning if these opportunities are to be fulfilled.
- For the most part, centres were entering either whole-year cohorts or high attainers/gifted and talented students in the pilot.
- Students interviewed believed that mathematics was important for their future employability and/or progression to further study. Many stated that mathematics was generally more useful, and sometimes therefore more enjoyable, when it was based on real-life scenarios and did not just involve learning techniques to apply in an examination room.
- It is unclear at present whether the large number of Year 9 students taking part in the pilot are likely to complete GCSE mathematics early and not continue to study the subject in Year 11.
- Most centres participating in the online survey reported that the assessments in the January 2011 examination series were as challenging as expected, with one in four saying they were more challenging than expected.

Background and evaluation focus

The linked pair of GCSEs in mathematics qualifications are 'methods in mathematics' and 'applications of mathematics'. The two qualifications together cover the entire Key Stage (KS) 4 programme of study (PoS) for mathematics and contain some additional content. Neither qualification by itself covers the full KS4 PoS. A new single GCSE in mathematics was also developed for first teaching in September 2010 – the single qualification is 'nested' in the pair. Candidates are expected to be entered for either the single GCSE in mathematics, or for both qualifications of the linked pair of GCSEs.

The single GCSE and the pilot qualifications were developed with the three aims of increasing engagement and participation in mathematics at GCSE and beyond, enabling understanding of the relevance of mathematics, and offering opportunities to stretch and challenge all students. But there were also specific additional aims for the linked pair of GCSEs. These were to:

- increase student commitment to mathematics, with increased engagement with the subject
- develop greater breadth and depth of subject skills and knowledge by undertaking two GCSEs, including additional content, to prepare students for progression to further study
- develop students' recognition of, and capacity to use, the different methods of enquiry encouraged by having two distinctive GCSEs.

At the time of reporting there were 244[1] pilot centres in England and Wales across the four awarding organisations taking part in the pilot.[2]

The evaluation is based around four key themes:

- attitudes to mathematics
- comparability of demand of the pilot qualifications with each other and with other GCSEs in mathematics (including the new single GCSE)
- the views of pilot and non-pilot centres on the pilot
- the support offered to pilot centres by the awarding organisations.

This round of fieldwork focused on centre and student participation and engagement in the pilot, reported changes to teaching and learning as a result of the pilot qualifications and their assessment, and the extent to which these changes parallel those resulting from the introduction of the new single GCSE in mathematics. Reporting at this early stage of the pilot can give only an indication of the potential impact of the pilot, based on stakeholders' perceptions and an initial round of classroom observations.

[1] One centre appears to be registered with two awarding organisations.

[2] Participating awarding organisations: AQA (89 centres), Edexcel (92 centres), OCR (50 centres) and WJEC (13 centres).

Methodology

This report is based on the analysis of three sources of data collection.

In-depth interviews and observations at case study centres involved 13 case study pilot centres and interviews with 3 case study non-pilot centres. Eleven of the case study pilot centres had previously been visited for the pre-pilot report. Data was collected during spring term 2011. The observation of pilot qualification lessons in case study centres was central to the focus for this report.[3] Centres were asked to identify changes that had been made to teaching and learning as a result of piloting the linked pair of GCSEs; centres that were teaching the new single GCSE as well as the linked pair were also asked to identify the extent to which the same changes were being made for the single GCSE.

Observers were asked to record the variety and frequency of activity in the classroom, and instances and examples where the pedagogy observed corresponded to the wider aims of the linked pair of GCSEs. A framework was developed for the observations based on ideas from work by Greg Brooks [4] and Malcolm Swan.[5]

An online survey of pilot centres focused on centres' participation and management of the pilot qualifications, and on the planning and implementation of any changes to teaching and learning. Where pilot centres were also offering the new single GCSE, they were asked about the extent to which their responses to the questions would be the same or different for the single qualification. Of the 244 pilot centres, 112 responded to the survey (46%), with three-quarters of the respondents being heads of mathematics, and the remainder the teacher/manager responsible for the linked pair of GCSEs in that centre. Pilot centre participation, broken down according to awarding organisation, was AQA – 45%, Edexcel – 51%, OCR – 22%, WJEC – 62%.

Scrutiny of assessments was applied to assessments from the November 2010 and/or January 2011 examination series for the new single GCSE and the linked pair of GCSEs for each of the four awarding organisations. A total of 26 examination papers from four awarding organisations across three specifications and two tiers were scrutinised. The materials were not sampled but included all the live papers available at the time of undertaking the analysis (typically single units only), along with accompanying mark schemes and assessment grids.

The purpose of this analysis was to describe the differences and similarities across the applications of mathematics, methods in mathematics and the single specification GCSE examinations in mathematics. The aim of this work was to provide a baseline for future analysis and scrutiny, following further assessment in summer 2011.

[3] Total number of pilot centre visits that included observations: 10. Total number of observations: 18.

[4] Ideas developed from work by the University of Sheffield: Brooks, G. *et al* (2007) *Effective Teaching and Learning: Reading*. London: NRDC.

[5] Swan, M. (nd) Mathematics Matters Final Report.
https://www.ncetm.org.uk/public/files/309231/Mathematics+Matters+Final+Report.pdf

Summary of findings

Attitudes to mathematics

Centres responding to the online survey gave a range of reasons for participating in the pilot. Overall, they were enthusiastic about the opportunities the pilot offered, with some recognising benefits over and above those of the new single GCSE in mathematics. The main reasons centres gave for participating were:

- the opportunity to stretch higher-attaining students and/or for students to gain two GCSEs
- the content and approach to mathematics embodied in the pair of qualifications
- the flexibility to tailor the curriculum to the needs of all students
- the additional possibility the pilot qualifications offered of gaining an A*–C grade in mathematics.

In the case study pilot centres, students who participated in the focus groups saw mathematics as a difficult and highly important subject. They all believed that mathematics was important for their future employability and/or progression to further study and, on these grounds, often compared it to English. A substantial number of students said that the benefit of the linked pair of GCSEs was simply in getting more GCSEs, which looks good on students' CVs and makes them more employable.

Mathematics was generally seen as being more useful, and sometimes therefore more enjoyable, when it was based on real-life scenarios and did not just involve learning techniques to apply in an examination room. There were mixed views on some topics such as algebra, which students from three of the higher-tier groups considered to be enjoyable but of no use to them in life unless they were preparing for higher-level study. The majority of students said that they enjoyed mathematics more when the lessons were interactive and lively.

Many of the higher-tier students said that they were contemplating continuing their study of mathematics to A-level, generally because they recognised that they were very good at the subject and/or, specifically, that they needed further qualifications in mathematics to be employable in a chosen field. Those students not planning to continue studying mathematics gave a range of reasons for not doing so, including: not feeling confident in the subject; feeling that their strengths lay elsewhere; acknowledging that mathematics was useful in general, but that it was more important for them to specialise in other subjects that had direct relevance to their chosen area of employment; not needing it for their chosen area of employment.

The students interviewed had mixed views about the jump from KS3 mathematics to the linked pair of GCSEs, some feeling the change was substantial and others that mathematics had become easier or was about the same. Students from higher-tier and foundation-tier groups said that any detectable difference was just a natural step-up or progression. They also disagreed on whether methods in mathematics or applications of mathematics represented the greatest change.

Centre and student representation and participation in the pilot

Some centre types are under-represented in the pilot and others over-represented. The extent of under- and over-representation of different school types is not enough to be of major concern at present; indeed, in the case of schools with sixth forms, over-representation may even help to clarify the impact on progression to level 3 learning later in the pilot. The issue of representation of different student cohorts will need to be considered in future statistical analysis: it has the potential to skew findings if, for example, there is a higher or lower proportion of higher-attaining students than in the mainstream GCSE cohort or a greater or smaller proportion of particular minority groups. The lack of further education (FE) institutions and adult community learning centres in the pilot will also need to be addressed further through case study non-pilot activity to

ensure there is sufficient understanding of the potential impact of the linked pair of GCSEs for students in these contexts.

For the most part, centres were entering either whole-year cohorts or high attainers/gifted and talented students in the pilot, although more middle attainers (C/D borderline) were entered in Year 11. There is strong evidence to suggest that Year 11 students are being entered for the linked pair of GCSEs assessments. These students will have started their KS4 programme of study before the first teaching of the linked pair of GCSEs in September 2010, and will therefore have been following the specifications for the legacy qualifications. It will be important to monitor the attainment of these students, as the type or amount of teaching and learning they experienced may differ. It will also be important to evaluate the extent to which the pilot qualifications are suitable for all students and, for that reason, to monitor any emerging trends of participation, with a focus on specific cohorts.

As the pre-pilot report identified, a large number of Year 9 students are taking part in the pilot. Case study centres cited this as one way to increase the amount of time available for the qualifications. What is unclear at present is the impact this will have on early entry, and whether students will continue to study mathematics in Year 11 if they have already finished their GCSE in mathematics. Case study pilot centres that had previously offered *additional* mathematics[6] or statistics in Year 11 suggested that the linked pair of GCSEs would be used as an alternative to these.

Only one in four of the centres reporting that the linked pair of GCSEs raised issues for lower-attaining students or students with weaker literacy believed that the new single GCSE raised the same issues. Why centres believe this to be the case requires further investigation.

One awarding organisation reported that a significant number of pilot centres had not registered for the June 2011 assessment window, perhaps because they have opted for a linear approach to assessment (i.e. entering students for all papers at the end of the programme of study). Other awarding organisations have reported numbers of entries but not centres entering. The number of centres still participating will need to be monitored carefully to ensure they are sufficient for piloting purposes.

Comparability of demand of the pilot qualifications with each other and with other GCSEs in mathematics

Centres participating in the online survey and offering both the linked pair of GCSEs and the new single GCSE reported that the linked pair was leading students to acquire skills and knowledge that they could transfer to other subjects, although almost two-thirds believed that the single GCSE was having the same effect. The majority of these centres also said that the linked pair of GCSEs was more demanding and challenging than the new single GCSE, and more than one-third said that the linked pair was more interesting.[7]

[6] In addition to the GCSE a*dditional* mathematics qualification offered by AQA and OCR as part of the Mathematics Pathways pilot, CCEA also offers a 'GCSE additional mathematics', which is taken by a small number of candidates in England and which is not funded under Section 96 (Section 96 lists all qualifications which are approved for use in maintained schools and colleges). Throughout the report, the use of the term 'GCSE *additional* mathematics' refers solely to the pilot qualification in the Mathematics Pathways project.

[7] None of the centres that offer the single GCSE in mathematics as well as the linked pair of GCSEs in mathematics reported that the linked pair of GCSEs in mathematics was less interesting, demanding, or challenging than the new single GCSE.

The initial scrutiny of the assessments was undertaken to give a benchmark for future analysis and suggests that:

- the weighting of marks for assessment objective 1 (AO1), AO2 and AO3 is appropriate[8]
- examination papers contain some questions that are unstructured and require longer chains of reasoning
- there was a relatively high level of analysing-procedural questions in the papers scrutinised.

It is too early at this stage to draw any conclusions from the analysis and scrutiny, given that full suites of live papers are not currently available. Awarding organisations have confirmed that the development of examination questions that assess problem-solving skills is on-going and changes are being made that will be reflected in the questions in future papers. But, as examination questions are being written already for 2013, there may not be sufficient time in the piloting phase for these to be evaluated fully. What will need to be monitored, given the pilot timescales, is the speed and direction of change and the extent to which the changes will allow and encourage candidates to use higher-level mathematical skills, such as generalising and constructing arguments.

Most centres participating in the online survey that had entered students for the January 2011 examination series reported that the assessments were as challenging as expected, with one in four saying they were more challenging than expected. There was no significant difference between the perceptions of levels of difficulty between methods in mathematics and applications of mathematics.

The views of centres (both pilot and non-pilot) on the pilot

Where centres reported that the linked pair of GCSEs had necessitated design changes in the curriculum, or changes to their teaching, many reported that the new single GCSE had had the same effect.

Centres were enthusiastic about the opportunities the linked pair of GCSEs offered, but many of them will have to make considerable changes to teaching and learning if these opportunities are to be realised. How far centres are able to do this depends primarily on the extent to which they embrace a more student-led, challenging and open approach in their teaching. Although there is obviously a need for some teacher input and modelling at this early stage, in the majority of the lessons observed, reasoning and conceptualisation were predominately teacher-led and structured.

[8] Assessment objective 1: recall and use knowledge of prescribed content; assessment objective 2: select and apply mathematical methods in a range of contexts; assessment objective 3: interpret and analyse problems and generate strategies to solve them (applications of mathematics) and interpret and analyse problems and use mathematical reasoning to solve them (methods in mathematics).

	Assessment objective 1	Assessment objective 2	Assessment objective 3
Methods in mathematics	50–60%	15–25%	20–30%
Applications of mathematics	40–50%	30–40%	15–25%

Only in a minority of centres was there a high level of effective questioning, creating opportunities for the development of reasoning, problem-solving skills and making connections with other aspects of mathematics. These centres, however, reported that this had been their approach to teaching before the changes in September 2010.

Centres expressed concern that more student-led group and peer problem-solving activities would reduce the time available to cover the content, especially in foundation-tier classes. There was a stark difference in the level of higher-order questioning and reasoning observed between foundation-tier and higher-tier lessons, with little evidence of this at all in the foundation-tier classes. The majority of teachers nevertheless recognised the need to change their teaching approaches and were looking for resources to do this.

Centres were working hard to incorporate more functional elements into their teaching and learning and to apply mathematics to everyday scenarios. In general, they understood the need to teach students how to approach less-structured problem-solving activities, but there was still little evidence at this stage of students experiencing the entire problem-solving cycle.

Many of the case study pilot centres were continuing to relate topics to GCSE grades and seemed unaware of the implications of the change to assessment objectives and grade descriptions that require different mathematical behaviour from candidates.

The support offered to pilot centres by the awarding organisations

The pilot centres said they had received good support from awarding organisations, but they appear to be over-reliant on resources generated by these organisations. The early findings for this report suggest that three levels of support may be required if all centres are to realise the full potential of the linked pair of GCSEs:

(i) A minority of centres require a minimal level of input, clarifying the difference within and between the two qualifications that make up the linked pair. This should in particular focus on what problem solving looks like in methods in mathematics.

(ii) For the majority of centres, in addition to the support outlined in (i) above, the evidence suggests that what is needed is help in implementing planned changes to their teaching in terms of developing more approaches that are skills-based and interactive and fully recognising the move from topic-based to process-skills assessment in their practice.

(iii) A significant minority, as well as needing (i) and (ii) above, also need support to enable them to recognise what changes need to be made to their teaching and learning, which teaching approaches and strategies are likely to be most effective, and how these can be managed and planned for.

Some teachers will also need to undertake continuing professional development (CPD) which specifically addresses the new content. The extent of the support they will require is likely to depend on where the centre in which they teach sits in the three levels of support identified above. The rate of change needed in teaching styles and approaches for the linked pair of GCSEs and the new single GCSE may affect lower-attaining students more, as they tend to find investigative approaches challenging.

Additional Information

The full report can be accessed at http://www.education.gov.uk/publications/

Further information about this research can be obtained from
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This research report was commissioned before the new UK Government took office on 11 May 2010. As a result the content may not reflect current Government policy and may make reference to the Department for Children, Schools and Families (DCSF) which has now been replaced by the Department for Education (DFE).