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## The independent evaluation of the pilot of the linked pair of GCSEs in mathematics (MLP): Second Interim Report

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AlphaPlus Consultancy Ltd

### Introduction

AlphaPlus 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 (MLP). The pilot programme and the evaluation run until December 2013. This research brief reports interim findings from the third round of fieldwork conducted in autumn 2011 and statistical analysis of summer 2011 examination data.

### Background and evaluation focus

The MLP qualifications are ‘methods in mathematics’ and ‘applications of mathematics’. The two qualifications together cover the entire Key Stage 4 (KS4) 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 MLP.

The single GCSE and the pilot qualifications were developed with three aims: increasing engagement with and participation in mathematics at GCSE and beyond, enabling understanding of the relevance of mathematics, and offering opportunities to stretch and challenge all students. There were also specific additional aims for the MLP. 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, with 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 267<sup>1</sup> pilot centres in England and Wales across the four awarding organisations taking part in the pilot.<sup>2</sup>

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)
- centres' views of the pilot
- the support offered to pilot centres by the awarding organisations.

Data collection and analysis reported here focused on the appropriateness of the MLP for different student groups and whether or not it provided value over and above the new-specification single GCSE in mathematics. Reporting at this early stage of the pilot can, however, give only an indication of the potential impact of the pilot and cannot test the appropriateness of the qualifications for all educational contexts and cohorts. Findings should therefore be treated with caution.

## Key findings

Teaching for the MLP started in September 2010. These key findings are based on the data collected after just over one year of implementation of the pilot programme.

- Examination entries so far suggest that high-achieving centres and students may be over-represented in the pilot. This may, however, be because some centres have entered higher-attaining students first.
- Centres often reported that the high-stakes nature of mathematics in school performance targets ('floor targets'), results in pressure to complete (with certification) GCSE mathematics by the end of Year 10. This was thought to restrict the time allowed for teaching and learning GCSE mathematics in many schools. However, nine of the ten case-study centres visited in autumn 2011 reported that they were delivering the MLP as at least a two-year programme.
- Most stakeholders recognise the value in the wider aims of the MLP, and there was broad support for the view that the MLP is encouraging a greater breadth of understanding of mathematics. However, there is currently no widespread understanding of how the structure and additional content of the two GCSEs are intended to work together to meet these aims and promote depth as well as breadth of mathematical understanding and application.
- Problem solving and functionality are central to mathematics at KS4. Currently problem solving in the MLP predominantly focuses on the application of known mathematical techniques to a realistic context or scenario rather than exploratory or developmental mathematical problem solving leading to conceptualisation and theorising.
- Pilot centres consider it important to introduce changes to improve teaching and learning, especially in problem solving, but are constrained by the heavy focus on assessment, the perceived lack of time to 'teach' content and uncertainty about how to teach problem solving effectively.

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<sup>1</sup> One centre appears to be registered with two awarding organisations.

<sup>2</sup> Participating awarding organisations: AQA (97 centres), Edexcel (94 centres), OCR (64 centres) and WJEC (13 centres).

- Centres offering both the MLP and the new single GCSE (joint-offer centres) found MLP students to be more engaged with and committed to mathematics than those doing the single GCSE. Overall, students reported that their enjoyment of, and to some extent engagement with, mathematics related directly to their levels of confidence and sense of achievement in the subject.
- Although it is not possible at this stage of the pilot to understand the appropriateness of the pilot to the full range of contexts, emerging evidence suggests that the MLP may not be suitable for some lower-attaining students. Learning takes much longer for these students and their language/literacy skills may mean, for example, that they struggle to make connections between ideas, to transfer knowledge between contexts, or to read more 'wordy' tasks with comprehension.

## Methodology

This report is based on the analysis of six sources of data collection:

**In-depth interviews and observations at 10 case-study pilot centres** in autumn 2011 – a total of 17 lesson observations were undertaken across the 10 centres. A framework for the observations was developed, based on the work of Malcolm Swan.<sup>3</sup>

**The online survey of pilot centres** (September 2011) – 105 (39%) of the 267 pilot centres completed the questionnaire; 75 (71%) of responding centres had also responded to the March 2011 survey, so 30 (29%) were new respondents. New centres were evenly split between those teaching only the MLP and those teaching both the MLP and the new single GCSE. Response rates across the awarding organisation varied: 48% of both AQA and Edexcel pilot centres responded, 8% of OCR centres responded,<sup>4</sup> and 62% of those with WJEC.

**Statistical attainment data** was received from each awarding organisation (AQA, Edexcel and OCR).<sup>5</sup> Data was received for the applications of mathematics GCSE (Applications), the methods in mathematics GCSE (Methods) and the mainstream GCSE. The data was combined into a single dataset, which included data from the National Pupil Database (NPD) on prior attainment, and census information.

**Wider stakeholder interviews** – representatives from 10 wider stakeholder organisations were invited to take part in a semi-structured interview during October 2011. The sample included subject associations,<sup>6</sup> professional bodies, and workforce development organisations. Data from six wider stakeholder organisation interviews has been used for this report.

**Awarding organisation focus group** – a focus group was held in autumn 2011 with representatives from the four awarding organisations involved in the pilot.

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<sup>3</sup> The pedagogical framework has eight descriptors: high-order questioning, stretching and challenging, creating connections, encouraging reasoning, supporting development of strategies for investigation and problem solving, the value of mathematics, making learning explicit, and developing 'mathematical' language. The descriptors are useful, as they can be used to identify the aims of the MLP in classroom practice.

<sup>4</sup> OCR's pilot project manager was on leave when awarding organisations were requested to send reminders to their centres, which may explain why there is a lower response rate from OCR centres for this survey.

<sup>5</sup> WJEC data was not included in the analysis, as first awards will not be made until 2012.

<sup>6</sup> This includes professional subject associations and other expert and advisory organisations.

**Joint-offer and single-GCSE-only centre telephone interviews** – the heads of mathematics from 33 centres were interviewed in autumn 2011. Of these centres, 11 offered both the new single GCSE in mathematics and the MLP, 21 offered the new single GCSE only and one centre only the iGCSE.

## Summary of findings

### Participation in the MLP

Understanding the potential impact of the MLP for a range of different student groups and in schools with fewer, or no, qualified mathematics teachers is made more problematic by the fact that the pilot cohort for this programme, as is often the case with pilots, may not be representative: high-achieving centres and students are over-represented in the attainment data for examination entries seen to date, and there is a higher-than-average proportion of qualified mathematics teachers involved in the pilot programme. It should be noted, however, that many centres report their intention to enter whole-year cohorts of students for the MLP. It may be that some of the centres that have already entered students for examinations have entered their higher-attaining students first.

The 'value' of the MLP is interpreted differently across the pilot centres. Many pilot centres gave their main reasons for taking part in the pilot as the opportunity for students to gain two GCSEs in mathematics, together with the opportunity to stretch and challenge their students, but the opportunity for some students to have two chances to gain a grade C at GCSE was also influential in centres' decision to participate. Most stakeholders recognised the value in the wider aims of the MLP, but there is currently no widespread understanding of how the structure and additional content of the two GCSEs are intended to work together to meet these aims. In the case-study centres this appears to be due, in part, to centres not fully recognising the 'difference' promoted by the MLP.

### Teaching and learning

The findings here have to be considered in the wider context of the high-stakes nature of mathematics in school performance targets (floor targets), which often results in schools narrowly focusing on preparing students for the examinations.<sup>7</sup> There is evidence across the range of primary and secondary data analysed for this study that schools focus strongly on C/D borderline students, monitoring them closely and providing additional intervention. The data shows that as a gate-keeper qualification, grade C at GCSE is important to students and centres. However, the emphasis on teaching to the test reported in the secondary data suggests the quality of teaching and learning for GCSE mathematics is often skewed by the focus on threshold attainment data. The importance of the C (and the A/A\*) grade in mathematics at GCSE is evident in pilot centres' perceptions of 'value' of the MLP as well as in the extent to which centres have (or have not) changed their approaches to teaching and learning.

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<sup>7</sup> Ofsted (2008) reported the use of 'booster' lessons, revision classes and extensive intervention, coupled with a heavy emphasis on 'teaching to the test'. While these strategies were successful in preparing students to gain the qualifications the narrow emphasis on 'disparate' skills did not necessarily support mathematical understanding. Ofsted (2008) *Mathematics: understanding the score*. London: Ofsted.

Most centres remained enthusiastic about the opportunities the MLP offered, but there was still a tension between the pressure to ‘teach to the test’ and the exploration of new ways of teaching – which may be more effective in developing students’ mathematical proficiency but are considered to be more time consuming. In some of the pilot centres, enthusiasm for the MLP was tempered in part by students’ performance in the examinations, which determined whether more or fewer students were entered from subsequent cohorts.

Nine of the ten case-study centres visited in autumn 2011, however, reported that they were delivering the MLP over two years at least. The statistical data for results from the first year of the pilot also suggests that most MLP candidates taking qualifications in the first year of the pilot will continue to take mathematics in their second year. A few centres felt that having two GCSEs had ‘created’ time because they were perceived to be, at least, a two-year programme.

Of those who have completed a mathematics qualification, MLP candidates were more likely to complete it earlier than their mainstream equivalents. This suggests that many MLP pilot centres are aiming to complete the MLP qualifications sequentially (mostly taking the methods in mathematics GCSE first, during the first year of teaching).

The KS3 mathematics level of attainment tends to be higher and the age slightly lower for candidates for MLP Methods, which perhaps offers an explanation for relatively poor grades achieved for the methods in mathematics GCSE: the strongest candidates are being entered for MLP Methods, but at a slightly younger age, and are therefore performing less well (in comparison with Applications and mainstream mathematics candidates). Awarding organisations expressed the opinion that centres may be experimenting with entry patterns for MLP with different cohorts, using opportunities for early entry and re-sits.

Despite the focus on assessment, there was broad support for the view that the MLP is encouraging a greater breadth and, to some extent, more in-depth understanding of mathematics than the new single GCSE in mathematics, by virtue of either the extra content or the structure of the linked pair. Most of the centres participating in the online survey that offered the MLP and the new single-specification GCSE felt that the MLP promoted the pedagogical approaches associated with effective mathematics teaching and learning and the wider aims of the MLP, more than the new single GCSE.

## **Problem solving in the MLP**

Problem solving and functionality are central to mathematics at KS4. The previous reports on the MLP have identified the lack of a shared understanding by centres of what problem solving and functionality mean in relation to mathematics teaching and learning generally, and in particular in relation to the revised assessment objectives for GCSE mathematics. The fact that there is no common definition for these terms across the range of instances and contexts – such as the two MLP qualifications – in which they are used is problematic. An absence of clear definitions might lead to a failure to recognise and understand the different types of problem solving which the structure of the MLP promotes. It has previously been reported that the effective teaching and assessment of problem solving and functionality are still in relatively early stages of their development. This is not an issue specific to the MLP: centres offering the MLP together with the single GCSE, awarding organisations and wider stakeholders all suggest that the issues regarding the teaching of problem solving are also evident for the single GCSE in mathematics.

The potential for the structure of the MLP qualifications to promote depth as well as breadth of mathematical understanding and application will not be realised if centres are not supported to recognise the full spectrum of problem-solving activity in their teaching. What is taught and how it is taught influence

the type of knowledge students develop. The main focus of the problem solving that was seen in the majority of the MLP observations, or described by teachers, was applying mathematics in everyday contexts or scenarios rather than problem solving within the domain of academic mathematics (e.g. conceptualisation and theorising). The problem solving described by the case-study centres can generally be defined<sup>8</sup> in terms of word problems with arithmetical steps or worded contexts, which require the learner to decide to use standard techniques. Relatively basic mathematics was generally required to reach a solution.

In a minority of case-study centres, problem solving involved worded contexts in which there was no standard relationship to apply, or algorithm to use, but a solution was expected – alternatively, problem solving entailed exploratory situations in which there was an ill-defined problem. With these exceptions, the problem solving observed or discussed related to a ‘realistic’ context rather than a mathematical context. The two latter types of problem solving offer opportunities for student-led peer or group working activities, but there was no evidence that this sort of interaction was regularly used in practice in the case-study centres.

Problem solving was not described by case-study teachers in terms of abstract, mathematical problems that require methods of enquiry and thinking specific to mathematics. Nevertheless, many of the case-study teachers interviewed welcomed and valued the additional emphasis on proof in the MLP.

In a few centres depth was recognised in terms of creating connections across mathematics topics and developing conceptual knowledge and understanding. The absence in classrooms of the kind of problem-solving activity that provides opportunities for creating connections by building on conceptual understanding and theorising may explain why many case-study centres felt that breadth rather than depth was promoted by the MLP. Most of the problem solving observed or discussed at case-study centres involved applying known mathematics rather than using problem solving as a means of introducing new learning.

## **CPD support**

The teachers’ needs for support that the previous MLP report identified are still valid.<sup>9</sup> However, CPD should also support teachers to:

- reflect on and make explicit the different methods of enquiry they use
- recognise the full spectrum of problem-solving activity in their teaching and have strategies for teaching it
- recognise the different types of knowledge within the MLP and the significance of different pedagogical approaches.

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<sup>8</sup> For the analysis, Watson’s (2009) typology of problem solving has been used. See: Watson, A (2009) ‘Key Understandings in Mathematics Learning – Paper 7: Modelling, problem-solving and integrating concepts’, London: Nuffield Foundation.

<sup>9</sup> A minority of centres require a minimal level of input; most centres, however, although they recognise the need for change, will require support to implement planned changes to their teaching in terms of developing more skills-based, interactive approaches, and fully effecting the move from topic-based to process-skills assessment in their practice. A significant minority, however, require support to enable them to recognise that changes to their teaching and learning are needed.

There is some evidence to suggest that mathematics teachers' knowledge of mathematical methods has often become tacit, which leads to them assuming such understanding in their own teaching rather than making the different methods explicit to their students.

## **Student engagement**

The consensus was that what promoted engagement and commitment for many students was not a love of mathematics but the extrinsic value of gaining the required grade at GCSE or the perceived relevance and usefulness of mathematics for further study or life. A majority of the heads of mathematics from the case-study centres felt that their higher-attaining students were highly motivated and committed to mathematics. Some centres attributed this to the MLP, but others felt that by Year 11 the higher-tier students were usually very focused on their mathematics and, in particular, on achieving their target grade (A\*/A).

Centres offering both the MLP and the new single GCSE found MLP students to be more engaged with and committed to mathematics than those doing the single GCSE. Overall, students reported that the extent to which they enjoyed and engaged with mathematics related directly to their levels of confidence and their sense of achievement in the subject. There was often a stark contrast within the same case-study centre between how higher-tier and foundation-tier students felt about mathematics – this contrast seemed to relate to prior as well as current experiences of success in mathematics and to how individual teachers relate to and engage students. Some stakeholders saw the MLP as providing a better foundation for studying mathematics at A level than the new single GCSE.

## **Appropriateness of the MLP for different student groups and learning contexts**

The MLP may not be appropriate for all student groups and contexts. Emerging findings suggest that the MLP may not be suitable for some lower-attaining students: learning takes much longer for these students and their language/literacy skills may mean, for example, that they struggle to make connections between ideas or transfer knowledge between contexts, or to read more 'wordy' tasks with comprehension. There was no consensus across the range of centres interviewed as to which of the MLP qualifications was likely to be more challenging for lower-attaining students. Although it is not possible to understand at this stage of the pilot the implications for the full range of contexts, there is some evidence to suggest a linked pair of GCSEs in mathematics may be less suitable in centres where students are already disengaged and/or may have greater restrictions on the amount of time available for teaching (for example, pupil referral units, further education institutions or adult education).

Centres with higher-attaining students have historically offered more than one qualification in mathematics at KS4. The majority of case-study centres that have previously offered additional mathematics qualifications felt that the MLP offered a sufficiently challenging or better alternative. Some high-achieving schools currently offering the single GCSE only, however, were concerned that the MLP would not be sufficiently challenging; these schools were considering offering an additional mathematics qualification or the iGCSE.

### **Additional Information**

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

The views expressed in this report are the authors' and do not necessarily reflect those of the Department for Education.