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Using mastery-based approaches to improve the progress of FS Level 1 achievers towards GCSE grade 4: identifying skills gaps and mapping across skillsets through bar modelling, variation, and collaboration

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About CfEM

Centres for Excellence in Maths (CfEM) is a five-year national improvement programme aimed at delivering sustained improvements in maths outcomes for 16–19-year-olds, up to Level 2, in post-16 settings.

Funded by the Department for Education and delivered by the Education and Training Foundation, the programme is exploring what works for teachers and students, embedding related CPD and good practice, and building networks of maths professionals in colleges.

Summary

As 6 teachers from 4 large London colleges, we were finding teaching 16-19-year-old GCSE resit classes with a variety of entry qualifications ranging from a GCSE grade 3 or below, or equivalent such as Functional Skills Maths Level 1, more challenging particularly after the return to classrooms after the COVID-19 lockdowns. Prior to the pandemic, anecdotal evidence had told us that those who joined a GCSE Maths resit class after completing a Functional Skills Level 1 Maths qualification then struggled compared to those who had achieved GCSE. As an Action Research Group (ARG), and in our local context, we wanted to research whether this held true, and we also wanted to create and develop resources and strategies to support progress of 16-19-year-old learners in a GCSE maths resit classroom from different qualification backgrounds, particularly those who had achieved Functional Skills Level 1. We particularly wanted to focus on how aspects of a mastery pedagogy could be used to map existing learning from that qualification to GCSE specification skills required, which Functional Skills Learners may have not acquired on their maths journey yet.

Through a literature review, Continuous Professional Development (CPD), ARG discussions and over three action research cycles, we aimed to review existing knowledge on bridging skills gaps from Functional Skills Maths Level 1 to GCSE grade 4, analyse our individual and collective learner skills gaps, research and improve our own teacher skills with aspects of a mastery pedagogy to identify and address misconceptions and skills gaps. The ultimate aim was to support learner progress, including the progress of those who had achieved Functional Skills Maths Level 1, towards achieving a GCSE grade 4 in the 16-19-year-old GCSE resit classroom in an FE setting.

Research activities included analysis of our learner skills gaps from baseline assessments, further diagnostic interventions, and interventions involving bar modelling, variation and collaborative activities with learners. We monitored progress, identified misconceptions and tracked teacher and learner reflections through learner and teacher questionnaires, learner work, learner interviews, pre-and post- intervention assessments, recorded discussions, teacher reflection logs, paired observations and observation schedules. Interventions lasted 3-4 weeks, however data was collected and analysed from September 2021 to May 2022.

Our key findings are:

- bar modelling, variation and collaboration activities can support the mapping of skills learned from Functional Skills Level 1 to GCSE grade 3 (number skills to algebraic skills)
- bar modelling supports learner understanding, particularly when learners engage with the activities more and can be most effective with adequate time allowed
- assessment and identification of misconceptions need to be ongoing throughout the year as learning gaps can quickly change
- care needs to be taken when designing diagnostic assessments to identify skills gaps
- finally, CPD, reflection time and peer support were crucial to teacher confidence with using bar modelling.

Contents

Background

Introduction and rationale for the research

At Newham College and in a significant number of our network partners, and FE colleges across the country, a system has existed over the past few years where those who have not achieved the equivalent of GCSE grade 3 would be placed onto the Functional Skills pathway, to work on their key skills before re-attempting their GCSE Maths course. Some colleges, such as Southwark college, have joined the general trend of "a gradual drift away from Functional Skills mathematics" to GCSE (Noyes, Dalby and Smith, 2020, p. 3) post the introduction of the Condition of Funding[1]. Even where colleges have retained Functional Skills Entry Level and Functional Skills Level 1 for some of their learners, many are now offering solely GCSE rather than Functional Skills Level 2 which is perhaps due "the comparative judgement [which] found that Functional Skills Mathematics Level 2 was harder than the Foundation Tier GCSE maths qualification" (Davies *et al.*, 2020, p. 5).

Thus, teachers in our colleges still find ourselves managing GCSE classes with a range of background entry qualifications treated as equivalent to a GCSE grade 3. As teacher-researchers, we wanted to focus on one group of these learners – those who have achieved Functional Skills Level 1 and are continuing on their journey to achieve a GCSE grade 4.

The aim of the research project is to use mastery-based approaches to identify and address gaps in knowledge and skills for these learners, and potentially lay out an approach which others could use to develop progress of learners from different qualification backgrounds.

For our research project, we were interested in trialling a 'scaling up' approach to mastery for learners who have successfully joined a GCSE course having passed L1 Functional Skills, by taking skills identified as successful to context-based learning (applied) and creating relationships to other non-FS areas found in GCSE. This includes the use of multiplicative and proportional reasoning skills typically required at FS L1 and expand to using the same skills in manipulating algebraic equations.

The wider setting and context of the background of our learners

The learners we are focussing on for this Action Research Project are 16-19-year-olds, on a study programme in a Further Education (FE) College, who are now sitting a 1-year GCSE Mathematics course having passed Functional Skills Level 1 Maths. These learners form a significant minority of our learners in GCSE classrooms – in our initial learner questionnaire we found that around two-fifths of the 71 respondents had previously achieved a Functional Skills Level 1 in Mathematics. As action research teachers, in September 2021, we felt that the gap from Functional Skills Level 1 to GCSE grade 4 was an area necessary to focus on in order to support this significant minority in their journey towards achieving.

Indeed, in our initial learner questionnaire, almost half of the Level 1 achievers said that they had achieved FS Level 1 in in 2020 or prior, and yet they are still studying on a GCSE resit course (in 2022). This could be in line with the argument expressed by Allan in his 2017 journal article, that the current education system is leading to "over-skilling and educational limbo for many young people" (2017, p. 1) – where learners are achieving their vocational aims, but they are not succeeding in their English and maths achievement. As action

[1] The Condition of Funding requires students in England, who are aged 16-18 and 19-25 with an education, health and care plan (EHCP) who have not achieved a GCSE grade 9 to 4 or equivalent qualification, to study maths and/or English as part of their study programme, for the study programme to be funded. For further details see https://www.gov.uk/guidance/16-to-19-funding-maths-and-english-condition-of-funding

research teachers, we are aiming to focus in on the Level 1 achievers, to improve their progress and avoid the educational limbo Allan speaks of.

Additionally, whilst there has been much focus on the progress of those who have achieved GCSE 3 and then resitting to achieve GCSE grade 4 in mathematics, we as an action research group at the time of writing have not found any specific studies into the progression route of Functional Skills Level 1 to GCSE grade 4. Thus, our action research project is exploring a gap in research and existing literature. We can, however, use studies and reading based on the general GCSE mathematics resit cohort to establish the wider setting and context of the background of our learners.

Noyes & Dalby explored FE mathematics resit students' perceptions of mathematics and their experiences of learning the subject in FE colleges. Their findings suggest the following:

- for the vast majority of students, motivation relies on the value of the qualification for progression to further study or career development, but they cannot see the relevance of the mathematics learned to their lives, careers or vocational studies;
- nearly all experience low confidence and anxiety, feelings that emerge from prior experiences in school and are sometimes reinforced by continuing failure in classroom or in examination performance;
- most students appreciate individual attention focused on their needs from understanding and approachable teachers but couldn't understand college's organisational systems;
- many students would prefer a different policy for improving their mathematical skills and knowledge, that doesn't involve resitting GCSE Mathematics but is more connected to specific vocational areas (Noyes and Dalby, 2020, pp. 55–63).

Whilst we are not able to change the requirement for our learners to achieve a GCSE grade 4 in this academic year, we can, as action research teachers look at how we teach the GCSE content for those who have progressed from Functional Skills Level 1 maths. The fact that these learners have achieved their Functional Skills Level 1 maths shows that they do have some motivation and that they are able to use areas of mathematical learning sufficiently to answer questions related to context-based learning, with certain levels of reasoning involved.

Thus, our action research aims to draw on the elements of their Functional Skills learning – the context-based application skills – and use this prior knowledge of the learners to enhance their knowledge in other areas of GCSE mathematics. The literature review that follows explores existing research on assessing the skills gaps in the knowledge of our learners and address them using mastery-based interventions. The hope of our research team was that trialling these approaches could ensure that students would get the individual attention focused on their needs from understanding, connect their learning to specific vocational areas, and continue to improve the confidence of the learners who have experienced some success in their maths learning through passing Functional Skills Maths Level 1.

Literature Review

In this literature review, we will discuss literature relating to identifying and addressing skills and knowledge gaps; the use of diagnostics within mathematics learning; mastery-based interventions; and mastery in general.

Identifying and addressing skills and knowledge gaps through assessments and diagnostic teaching

In order to bridge the gap for our Functional Skills Level 1 achievers to successfully gaining a GCSE grade 4 and progressing through their FE maths journey, we need to first identify the skills and knowledge gaps that they are experiencing. This is an important stage for our learners in the jump from Functional Skills Level 1 to GCSE grade 4, because as maths topics get more advanced, skills gaps can widen for learners, leading to further lack of engagement (Khan, 2015).

Identifying and addressing skills and knowledge gaps also goes hand in hand with mastery-based approaches to learning. It has been well established that most mastery learning models use targeted pre-assessment to check prerequisite knowledge and skills which are essential for the learning sequence (Guskey, 2010, p. 2). Guskey further goes on to argue that by using pre-assessment, “teachers ensure the conditions for success before instruction begins” (2010, p. 2). Thus, to address the skills gaps of our Functional Skills Level 1 learners, our first cycle of action research will focus on using pre-assessments. More specifically, in-depth diagnostic assessments on specific topics to identify not just the key mathematical skills that are missing, but why our learners struggle with these specific topics. When carrying out diagnostics to identify skills gaps, we need to consider Rowlandson’s suggestion that you might be revising certain topics that students did not understand before, and therefore, mastery-based strategies can help to close those gaps in knowledge (see Barton, 2017). This is particularly applicable for our 16–19-year-old Functional Skills Level 1 learners as most have been through at least 16 years of education, whether in the UK or abroad.

Again, considering the background of our learners, it is also useful to consider Khan’s argument on addressing skills gaps, that it is very important to find the strategies and resources that will fill in the skills gaps so that students can master those concepts and fix their mindset thinking that they are actually capable of learning maths (Khan, 2015).

Even though some believe that is can be difficult to address skills gaps as each student is on a different track (Khan, 2015), Barton believes that the use of diagnostic questions (during teaching) enables the “full participation of each and every student” (2018). In addition to baseline or initial assessments, formative assessment involving open questions and multiple-choice diagnostic questions can also be very effective in revealing the different mistakes or misconceptions that learners have made, which will also determine the type of intervention needed (Barton, 2018, p. 36).

Mastery in general

As rationale for using a mastery-based intervention, we turned to Guskey’s concise overview of the research into mastery learning up until 2010. Of Bloom’s Mastery Learning from 1971, Guskey states that “few strategies have been implemented as broadly or evaluated as thoroughly during the last 40 years” (2010, p. 1). What makes mastery so applicable to this action research is that fact that emphasis is placed on all learners being able to reach a high level of achievement, indeed Bloom believed that “nearly all students, when provided with

the more favourable learning conditions of mastery, could truly master academic content" (Guskey, 2010, p. 2).

Mastery-based learning, therefore, provides us with a basis from which our Functional Skills Level 1 achievers could thrive in a GCSE course which requires additional content knowledge and different ways of approaching answers on a more abstract level. When considering the MiFEC report findings discussed earlier on in this literature review (the wider setting), a mastery-based approach fits the needs of our learners; every description of mastery learning includes teaching adapted to the context, reflecting on student's interests and experiences and is differentiated according to students' individual needs (Astleitner, 2005; Conroy et al., 2008) (Guskey, 2010, p. 3).

Whilst this action research will not focus explicitly on learner confidence, a large body of research (Guskey and Pigott, 1988; Kulik, Kulik and Bangert-Drowns, 1990; Anderson, 1994) agrees with Guskey's (2010) finding that "students in well-implemented mastery learning classes consistently reach higher levels of achievement and develop greater confidence in their ability to learn and in themselves as learners", compared to learners taught in a traditional way. Thus, by using mastery-based interventions, this research should, as a by-product, support the continuing confidence of our learners. As an action research group, to support confidence for learning, we have also considered focussing on "enabling learners to stay in/return to the growth zone, where the most effective learning happens" (Mackrell and Johnston-Wilder, 2020, p. 2), in addition to perhaps "moderating or re-phrasing messages to students over the importance of high-stakes examinations" (Putwain and Symes, 2011, p. 470).

Mastery-based interventions

Taking into consideration the justification for using a mastery-based intervention for this set of learners, but also the need to use the results of diagnostic assessments to determine the type of intervention needed, we will use the results from our diagnostic interventions in research cycle 1 to determine the types of interventions we will use in cycles 2 and 3. This will help us decide which interventions will be most effective in addressing the skills and knowledge gaps of our learners.

At this stage, we can discuss mastery-based interventions which have been effective in prior literature at addressing skills and knowledge gaps and which we may choose to use in cycles 2 and 3. In particular, mastery-based interventions involving collaborative learning activities, cognitive conflict and discussion, and bar modelling have been reviewed by our action research group ahead of the action research cycles.

When looking at collaborative learning practices, Le, Janssen and Wubbels (2018, p. 103) define collaborative learning to be the use of teaching and learning strategies encouraging students to work collaboratively in small groups to maximise their progress and achievement. Guskey argues that collaborative learning activities can form part of "corrective instruction approaches that accommodate differences in students' learning styles, learning modalities, or types of intelligence (Sternberg, 1994)" (2010, p. 4). Whilst research has shown that collaborative learning activities can promote academic and social outcomes (Slavin, 1996; Johnson, Johnson and Smith, 2007), if we are to use this aspect of a mastery teachers' toolbox, we need to be mindful of the challenges and obstacles to collaborative learning that render it ineffective if not addressed, as discussed by Le, Janssen and Wubbels (ibid). The challenges and obstacles include unequal participation, lack of communication or collaboration and poor pairings/groups of learners, in addition to lack of formal instruction for students in collaborative skills needed to successfully complete a group

task (Le, Janssen and Wubbels, 2018). Thus, if we are to use collaborative learning activities with our learners to address their skills and knowledge gaps in order to "provide high quality corrective instruction designed to remedy whatever learning problems the assessments identified" (Guskey, 2010, p. 4), it will be important to factor in planning for training on how to work collaboratively, as well as planning strategies to encourage equal participation, communication and ensure that the pairings and groups are considered ahead of time.

As an action research group, we also reviewed the concept of cognitive conflict and discussion when researching interventions to address skills and knowledge gaps. A lesson design from Bell, Swan and others in the 1980s goes through the stages of pre-teaching assessment, making existing concepts and methods explicit in the classroom, provoking and sharing 'cognitive conflicts', resolving those concepts through discussion to formulate new concepts and methods, and finally consolidating learning by using the new concepts and methods on further problems (Swan, Wake and Joubert, 2006). The review by Swan, Wake and Joubert uses theoretical frameworks from Piaget and Vygotsky and highlights the role of group discussion in the learning process as key in the lesson design – it is there to avoid the creation of misconceptions and give opportunities for interaction and sharing of ideas and opinions which can result in a better understanding of a [mathematical] problem and eventually its solution. This then allows the development of conceptual understanding, a key part of mastery. Aside from the role that cognitive conflict and discussion plays in addressing misconceptions, Barton argues that it is also very important that students are given time to reflect on teachers' marking, to look back at their answers and correct any mistakes and misconceptions that have occurred (Barton, 2017). Thus, when planning our mastery interventions, we need to be realistic that whilst in class interventions can have an impact, they can also be supplemented by student activity outside of the class.

Bar modelling has also been discussed in the context of an intervention to develop deep conceptual understanding, and as a teaching and learning method aimed at resolving misconceptions to address skills and knowledge gaps. In a discussion around bar modelling and questioning Barton and Rowlandson provide us with a useful definition of bar modelling – it is a way of representing numbers/calculations using simple diagrams which enable students to see what happens to the numbers they work with (2017). For our set of learners, we are aiming to take the context-based skills and knowledge they have and aim to enable them to apply it in an abstract setting such as algebra. This could be possible using bar models as an intervention as Rowlandson states that illustrating the [mathematical] concepts is very useful as the students can see how different aspects of mathematics are linked together (Barton, 2017).

In a recent action research project, carried out by Duckett, in a primary school, "the findings show bar models to be an effective tool in promoting reasoning and understanding of multiplicative comparison" (2019, p. 3), and three of the four children in the study were able to move away from drawing the bar models to solve problems presented to them successfully. Whilst this study was based in a primary school, and was used in context-based questions, the learning from the study can provide our action research project with some key advice if using bar models to progress understanding. Duckett concludes that securing key knowledge of multiplication and division facts before using bar models is important, and that modelling language of bar modelling to the children ahead of the interventions was of high importance (2019). This ties in with Rowlandson's belief that students' confidence and competence with numbers must be there before they can use approaches like bar modelling (Barton, 2017). Therefore, for some action research projects and addressing skills gaps, bar modelling may not be the first mastery-based intervention which springs to mind. However, when considering the learners involved in this project, they

have already achieved Functional Skills Level 1 and have demonstrated key basic understanding in certain areas of maths.

Regardless of which mastery intervention is chosen, Guskey argues that students who do achieve success quickly must be given high quality tasks to enrich and deepen their learning and extend their understanding (2010). Therefore, we should not limit our FS Level 1 achievers, but we should also provide opportunities for extension and depth to ensure continued engagement and further progression.

Conclusion and implications for our research

In conclusion, we as an action research group have needed to consider a variety of aspects from academic literature to support our overarching aim to improve progress of 16-19-year-old maths learners who have achieved Functional Skills Level 1 and are now working towards GCSE grade 4 using mastery-based approaches to identifying and addressing gaps in knowledge and skills.

In order to identify the most applicable mastery-based approaches which will enhance the progress of this group of learners, we need to ensure that we include an important element of mastery-based learning – formative assessment that indicates clearly what skills students have mastered and identifies any gaps in their knowledge that have to be filled (Guskey, 2010). This will form the basis for our Cycle 1.

After reviewing the skills and knowledge gaps that exist for our group of learners, we need to plan and carry out mastery-based interventions based on the findings not just from the formative assessments, but that take into consideration the background and wider context of our learners. These interventions should also ensure that key misconceptions can be addressed so that learners progress with a deeper conceptual understanding, as well as responding to a student's learning in the moment and adapting our teaching according to the individual needs of the student (Barton, 2018).

Throughout our action research project, we should also be mindful of the confidence levels of our learners and ensure that students are comfortable within the intervention – if students don't feel comfortable with making mistakes, we can neither identify the gaps in their knowledge nor can we learn from their misunderstandings (Barton, 2018, p. 34).

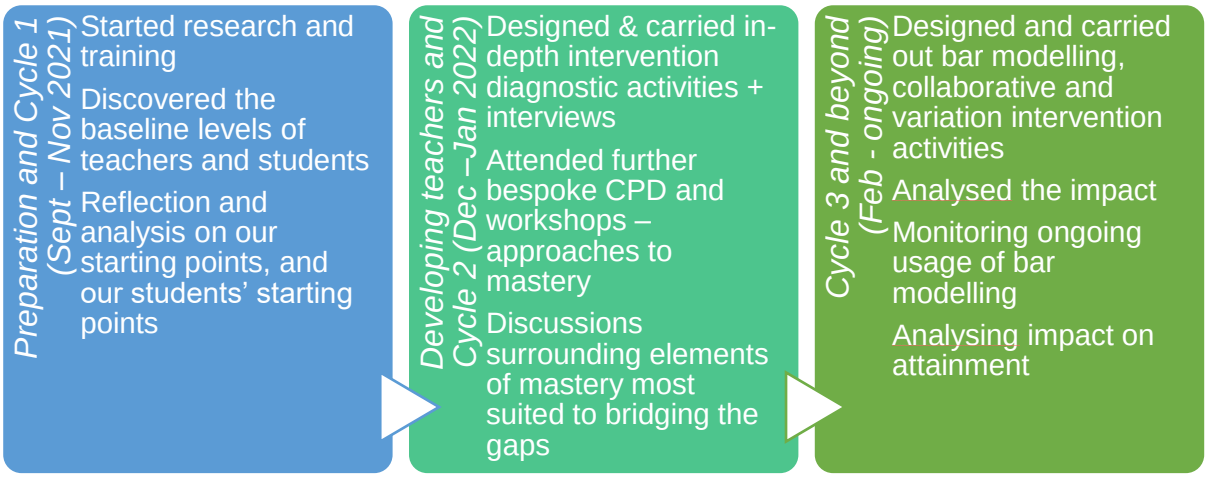
Our action research will hopefully shed light on the progress of a specific but significant minority group of learners in FE colleges, which so far has not been the focus of much academic literature. Perhaps, through this research, we will be able to join the likes of Allan, Davies et al. and Noyes and Dalby, in addressing the lack of progression shown by 16-19-year-olds in further education in England.

Methods

Overview of research design

Our action research project can be broken down into three cycles:

1. Cycle 1 included carrying out the literature review and discovering the baseline skills and thoughts of our students and teachers – this was to establish our own current thinking and practice, as well as to compare and contrast the thoughts and opinions of the two subsets of students within our GCSE classes.
2. In cycle 2, we collaboratively designed in depth diagnostic interventions and carried out interviews focussing on the FS Level 1 achiever subset of our classes. We developed our teacher skills for cycle 3 and established our mid-project concept of the elements of mastery most suited to bridging skills gaps identified in cycle 1 and cycle 2 analysis – choosing bar modelling, variation and collaborative activities.
3. Moving through to cycle 3, we collaboratively designed and carried out bar modelling interventions to address and impact student progress with skills gaps identified and then analysed the impact on attainment. Finally, we monitored the usage of bar modelling after the interventions had ended.



Throughout the cycles, we gathered and analysed a mixture of qualitative and quantitative data – ensuring to follow BERA and GDPR guidelines with regards to holding confidential information and to seek consent for use of anonymised data from teachers and students alike. We needed to balance the research ethically with the context of returning post-COVID affected years – our teachers and learners felt the increased strain of preparing for exams after two years of interrupted learning. This also meant that attendance was affected, as well as the number of interventions and data collection opportunities we felt we could complete and carry out. Additionally, illness (including COVID) affected teacher participation, particularly in Cycle 1. In the tables on the next page, please see for each data collection method the participant numbers.

	Cycle 1			Cycle 2			
Data collection methods	Initial Teacher Questionnaire	Initial Learner Questionnaire	Baseline analysis	Diagnostic Intervention assessments	Interviews for diagnostic interventions	Understanding of mastery discussion	Evidence of learner work
Number of AR teachers responding	3		4 – (95 learners)			6	Examples given by 2 AR teachers
Number of additional teachers responding	8						
Number of learners responding		71		57 from 3 intervention sets	24 from 3 intervention sets		

	Cycle 3							
Data collection methods	Initial Teacher form Cycle 3	Pre-intervention assessment context & algebra	Teacher reflection log	Observation schedule	Learner work	Post-intervention assessment context & algebra	Post-intervention learner questionnaire	Post-AR teacher questionnaire
Number of AR teachers responding	5		6	6	Work from 3 AR teachers			6
Number of learners responding		Context: 71 Algebra: 74				Context: 68 Algebra: 65	57	

Overarching aim: To improve progress of 16-19-year-old maths learners who have achieved Functional Skills Level 1 and are now working towards GCSE grade 4 using mastery-based approaches to identifying and addressing gaps in knowledge and skills.

Our target group was learners aged 16-19 in GCSE maths resit classes, who have previously passed Functional Skills Level 1, at Newham College, CONEL, Westminster Kingsway College (WKC) and Lambeth College. We involved 6 teachers from the 4 colleges, 1 at Newham, 1 at CONEL, 2 at WKC and 2 at Lambeth.

Research objectives:

1. To share existing knowledge and current practice surrounding bridging the gap from Functional Skills Level 1 to GCSE Maths grade 4 and explore further literature to support the rationale and findings for the research
2. To compare and contrast the knowledge base and skillset of those who have achieved Functional Skills Maths Level 1 vs GCSE Maths grade 3
3. To identify mastery-based interventions that could support the addressing skills gaps and the application of the skillset learnt from context-based learning in Functional Skills Maths Level 1 to other non-FS areas found in GCSE maths grade 4
4. To research and plan interventions, using a mastery pedagogy, to address skills gaps and support the application of the skillset learnt from context-based learning in Functional Skills Maths Level 1 to other non-FS areas found in GCSE maths grade 4 for learners who have passed FS Level 1
5. To investigate how different groups of learners respond to different teaching interventions and strategies, and collect teacher reflections on the impact of these interventions
6. To share best practice and findings internally and externally

Results and Discussion

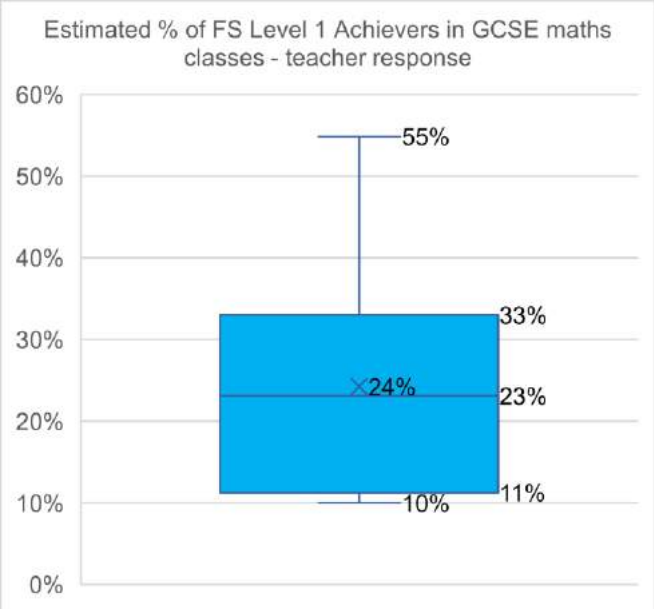
Cycle 1: Identifying the baseline, finding skills gaps and collecting learner and teacher views

During cycle 1, we focused on our research objectives 1 and 2*: to share existing knowledge and current practice surrounding bridging the gap from Functional Skills Level 1 to GCSE Maths grade 4 and explore further literature to support the rationale and findings for the research; to compare and contrast the knowledge base and skillset of those who have achieved Functional Skills Maths Level 1 vs GCSE Maths grade 3*. Whilst objective 1 was met during the literature review and through ARG discussions, we felt we needed to delve deeper into our own practice, as well as gathering the data surrounding learner perceptions and learner skills profiles.

Firstly, we asked our teachers and learners involved to complete initial questionnaires (Appendices 1 and 2). The teacher questionnaire asked for responses around how many learners teachers had, the qualification options at their college, perceived differences between those who had achieved GCSE grade 3 and Functional Skills Level 1, why this might be and what strategies teachers would employ to support these learners. 11 teachers answered the initial teacher questionnaire in October 2021, 3 of whom were involved in the action research project, and all of whom taught at colleges which provide Functional Skills Maths. The learner questionnaire had 71 responses, 6 from Newham College, 14 from Lambeth College, 28 from Westminster Kingsway College and 23 from CONEL. Of these learners, 29 respondents had achieved Functional Skills Maths Level 1 previously, with 16 of these respondents achieving Functional Skills Maths Level 1 in 2020-2021. The learner questionnaire asked all learners about their levels of English, their vocational course, how maths relates to their vocational course and what, if any, topics of maths they feel less confident in. Specifically, for those who had achieved FS Level 1, learners were asked what qualifications they did prior to FS Level 1, where they were studying, why they were placed on FS Level 1 and their opinion of being placed on and having completed FS Level 1 before re-sitting GCSE maths.

Key results and discussion of the initial questionnaires

On average, teachers estimated that 24% of the students they taught in 21-22 had achieved Functional Skills Maths Level 1 the year prior – the total number of learners taught by respondents to this survey is around 450. This estimation from the teachers contrasts with the findings from our learner questionnaire where Functional Skills Maths Level 1 achievers made up around two-fifths (40%) of respondents. Perhaps this discrepancy is linked to the context of teaching in FE, that learner qualifications are sometimes not updated on systems quickly enough for teachers to have accurate knowledge of their learners' qualification backgrounds early enough to then create the best conditions for supporting learner progress.



Our learner questionnaire then went on to ask FS Level 1 achievers which college they were at when they achieved FS Maths Level 1, as well as what other qualifications they had previously achieved:

3. Which college or school were you at when you achieved Functional Skills Maths Level 1?

City & Islington	4	14%
City of Westminster	1	3%
CONEL	9	31%
Lambeth	6	21%
Newham	1	3%
WMK	8	28%
TOTAL	**29**	

4. What qualification(s) did you achieve before you did your Functional Skills Maths Level 1?

A Non-UK based qualification	5	17%
FS Entry level 3	9	31%
GCSE Grade 3	1	3%
GCSE Grade 1 or 2	10	34%
None	4	14%
TOTAL	**29**	

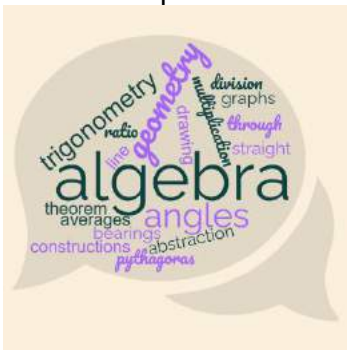
The above results show that there is quite a wide range of entry pathways before completing a Functional Skills Level 1 qualification, though the majority of learners remained at the same college at which they had completed Functional Skills Level 1 to then study GCSE. As an ARG, this meant we needed to be mindful of the diverse learner pathways shown by just a small group of learners.

When teachers were asked “What differences do you perceive there to be between a 16-19-year-old learner who has achieved GCSE Maths grade 3 vs a learner who has achieved Functional Skills Maths Level 1?” a variety of responses were received. The majority gave responses that Functional Skills Maths Level 1 achievers were weaker – reasoning that these learners have less prior knowledge, are weaker with abstract topics and struggle with exam skills, though 2 responses did note them as being stronger problem solvers. Others discussed why GCSE grade 3 learners are stronger (5 positive responses vs 1 negative response) – with these learners having more prior knowledge. This response from teachers, that FS Level 1 achievers having less prior knowledge does seem to be common across FE, though from our learner questionnaire, just under 2/5 of those who had achieved FS Level 1 had already achieved a GCSE at either grade 1, 2 or 3. Thus, these learners will have been exposed to GCSE level knowledge prior to their resit course. 2 respondents commented on a different factor: that learners who had studied outside of the UK have a stronger academic knowledge base. This could be the case for some of the FS Maths Level 1 achievers – roughly one sixth of the learners responding to the questionnaire had achieved a non-UK based qualification. From the learner questionnaire, perhaps it is their attitude about their learning journey which affects their learner profile – almost a third of the FS Level 1 achievers felt that the qualification was a progression to GCSE Maths, and another 5 learners said they preferred GCSE Maths to FS Maths.

Respondents were then asked, “Which learners do you think are more successful at achieving GCSE Maths grade 4 on the resit programme?”. The response to this was split, with 4 respondents indicating GCSE grade 3 achievers, 4 respondents indicating other (3 for students who have studied abroad and 1 for learners with good engagement for the course), and 3 respondents indicating neither or not sure. Across the board, perceived prior knowledge was a popular reason for indicating success (7 respondents), but 4 respondents also indicated that attitudes, and not prior achievement, are a major factor when considering which of their learners would be successful. For those who indicated GCSE grade 3 achievers, prior knowledge and only needing to revise were reasons for their potential

success. When this question was posed at the CfEM Live presentation (see appendix 3 for a poll taken at CfEM Live), of 46 respondents, 31 chose those who have achieved GCSE grade 3, suggesting that our smaller scale questionnaire was skewed towards other factors. This could be affected by teachers from our questionnaires teaching in London colleges, thus having more exposure to learners who have studied abroad previously, compared to the main teaching populace.

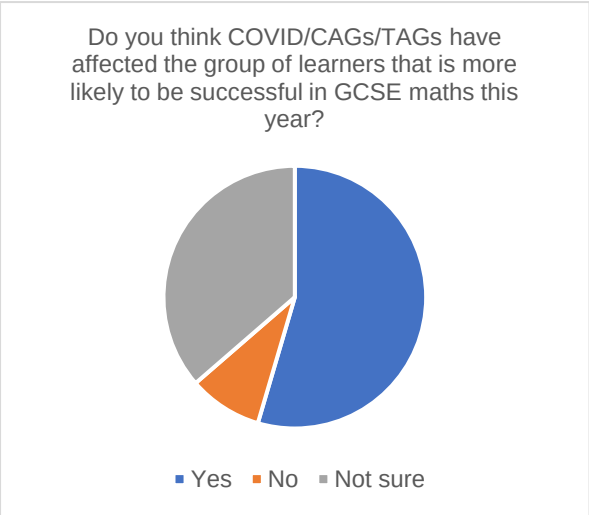
When looking at the topics that teachers thought FS Level 1 achievers might struggle with compared to a GCSE learner, and that learners from different qualification backgrounds were less confident with, the below word clouds give a weighted indication. We can see that teacher perceptions differ from those of FS Level 1 achievers, and again from the topics contributed by other learners.

Teacher responses	FS Level 1 Achievers	Other learners
		

A surprising contradiction to note is the prominence of algebra in the teacher responses, and how few FS Level 1 achievers responded as less confident with this topic (2). A higher proportion of learners who have gone straight to GCSE without completing FS Level 1 reported feeling less confident not just in algebra, but also in geometry. Additionally, these learners were also able to identify a wider variety of topics they struggled with, with a small number saying they were less confident in everything. Perhaps this is due to higher awareness of GCSE topics from those who have not sat FS Level 1, around a fifth of FS Level 1 achievers did not know what they are less confident in. What remained consistent is the proportion of learners who said no to being asked if there were any areas they feel less confident in – around a quarter.

What is also crucial to note is that for teacher responses, ratio was only mentioned on a small number of occasions, and fractions/percentages do not appear at all – these are key topics that around a fifth of the FS Level 1 achievers felt less confident with, and around one tenth of other learners reported less confidence in the topics.

The most popular strategy to employ to support those who have achieved Functional Skills Maths Level 1 in a GCSE Maths class was key topic work, with focus on key vocabulary also being mentioned by a couple of respondents. The other strategies suggested by teachers all had a focus on the individual learner – whether that be contextualisation, scaffolding, building in work with additional resources or methods or extra time.



Finally, teachers were asked whether they thought COVID/CAGs/TAGs had affected the group of learners that was more likely to be successful in GCSE maths this year. There was a split response: 6 – yes; 4 – not sure; and 1 – no. For those who did say they thought these circumstances made a difference, the main two reasons attributed were issues with CAGs/TAGs grading for GCSE learners, resulting in a grade 3 now reflecting a wider range of abilities, and that FS Level 1 achievers have had recent exam experience which could make them more equipped for success.

Baseline diagnostic analysis

As our learners had already completed baseline diagnostics (BKSB and Pearson Baseline at Newham, college-designed mixed past paper diagnostics at Lambeth and CONEL), we felt it could impact lesson time and motivation if learners were required to complete another diagnostic test. Thus, as an Action Research Group, we used the ASK 84 topic skills identifiers (see Appendix 3) for key GCSE topics as a topic framework through which each teacher could analyse their groups baseline test, paper based diagnostic or online diagnostic results. We compared and contrasted the topics which FS Level 1 achievers and GCSE grade 3 achievers were struggling or had strengths in, completed individual analysis and discussed as an ARG.

From the analysis, we concluded the following:

- Functional Skills Level 1 achievers were not performing at a grade 4 standard; however, they were performing better than those who had previously achieved a Grade 3
- All students were struggling in the key GCSE topics of ratio and proportion
- Common topics across the colleges that Functional Skills Level 1 achievers were comparatively weaker in were:
    - Algebra (solving equations and rearranging equations)
    - Highest Common Factor and Lowest Common Multiple
    - Volume.

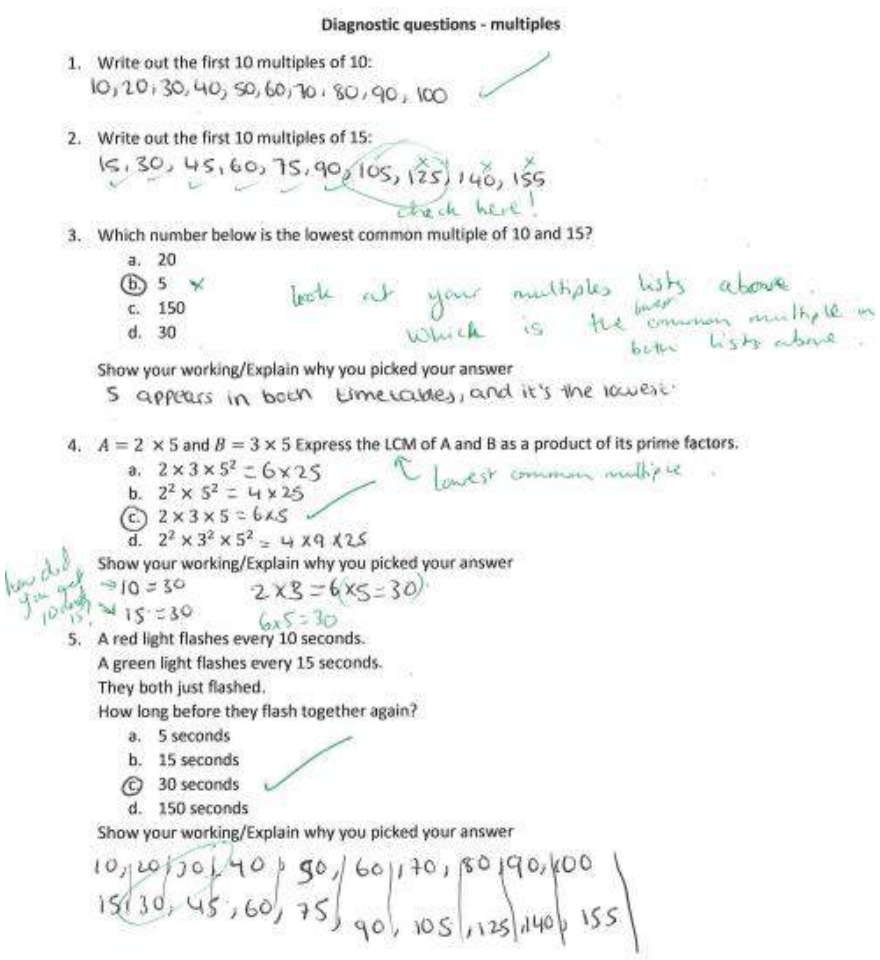
We found in cycle 1 that whilst we had started to identify some key skills gaps for our learners, some of the results were surprising and contradictory. For example, the Functional Skills Level 1 achievers were performing at a higher level than those who had achieved grade 3 – yet teachers' perceptions did not reflect this. In discussions, we also found it surprising that Functional Skills Level 1 achievers were still struggling and less confident with ratio and proportion – a key topic in the Functional Skills Level 1 specification. We also found it difficult to identify why learners were struggling with these topics from the baseline and diagnostic results. This sentiment was reflected in the post-AR teacher questionnaire (see appendix 15), in that only half the teachers agreed that analysing the baseline questionnaires in October had a positive impact on their ability to address skills gaps and support learners with the application of skillsets learnt from context-based to other areas of the GCSE specification with mastery interventions.

Cycle 2 – Getting deeper into the why behind our learner skills profile and identifying strategies to address their needs

For cycle 2, we decided to focus on the 3 topics above, designing a set of diagnostic assessment interventions (appendix 4) and set of interview questions (appendix 5) which could delve deeper into misconceptions and why learners were struggling.

As the 3 topics were not relevant to all our classes' skills gaps, we decided that teachers could choose the most relevant topics to pick for their classes. Additionally, attendance impacted the number of learners exposed to these in-depth diagnostic interventions, and so whilst some teachers wanted to carry out the algebra diagnostic interventions, they were not able to. For algebra, due to a data processing error, we were unable to collect scores of GCSE grade 3 achievers. Thus, these results should be viewed as indicative and in the context of a very small sample size, so analysis cannot be conclusive. In total, a mixed group of 35 GCSE grade 3 achievers and FS L1 achievers took part in the diagnostic interventions and the interviews, from Newham, CONEL and Lambeth. Due to staffing changes, Westminster Kingsway was unable to carry out the interventions in cycle 2.

Number of learners	Multiples	Volume	Algebra
Diagnostic intervention results GCSE grade 3 achievers	21	13	0
Diagnostic intervention results FS Level 1 achievers	10	6	7
Interviews	11	7	7



Diagnostic questions - multiples

1. Write out the first 10 multiples of 10:
   10, 20, 30, 40, 50, 60, 70, 80, 90, 100
2. Write out the first 10 multiples of 15:
   15, 30, 45, 60, 75, 90, 105, 125, 140, 155
   check here!
3. Which number below is the lowest common multiple of 10 and 15?
   a. 20
   b. 5 ×
   c. 150
   d. 30
   look at your multiples lists above. Which is the lowest common multiple in both lists above.
   Show your working/Explain why you picked your answer
   5 appears in both timetables, and it's the lowest
4. $A = 2 \times 5$ and $B = 3 \times 5$ Express the LCM of A and B as a product of its prime factors.
   a. $2 \times 3 \times 5^2 = 6 \times 25$
   b. $2^2 \times 5^2 = 4 \times 25$
   c. $2 \times 3 \times 5 = 6 \times 5$ ← Lowest common multiple
   d. $2^2 \times 3^2 \times 5^2 = 4 \times 9 \times 25$
   Show your working/Explain why you picked your answer
   how did you get 10 and 15?
   10 = 30
   15 = 30
   2 x 3 = 6 x 5 = 30
   6 x 5 = 30
5. A red light flashes every 10 seconds.
   A green light flashes every 15 seconds.
   They both just flashed.
   How long before they flash together again?
   a. 5 seconds
   b. 15 seconds
   c. 30 seconds
   d. 150 seconds
   Show your working/Explain why you picked your answer
   10, 20, 30, 40, 50, 60, 70, 80, 90, 100
   15, 30, 45, 60, 75, 90, 105, 125, 140, 155

The diagnostic assessment intervention worksheets (see appendix 4) were designed to be scaffolded so that we could pick out at which stage in the topic learners were struggling.

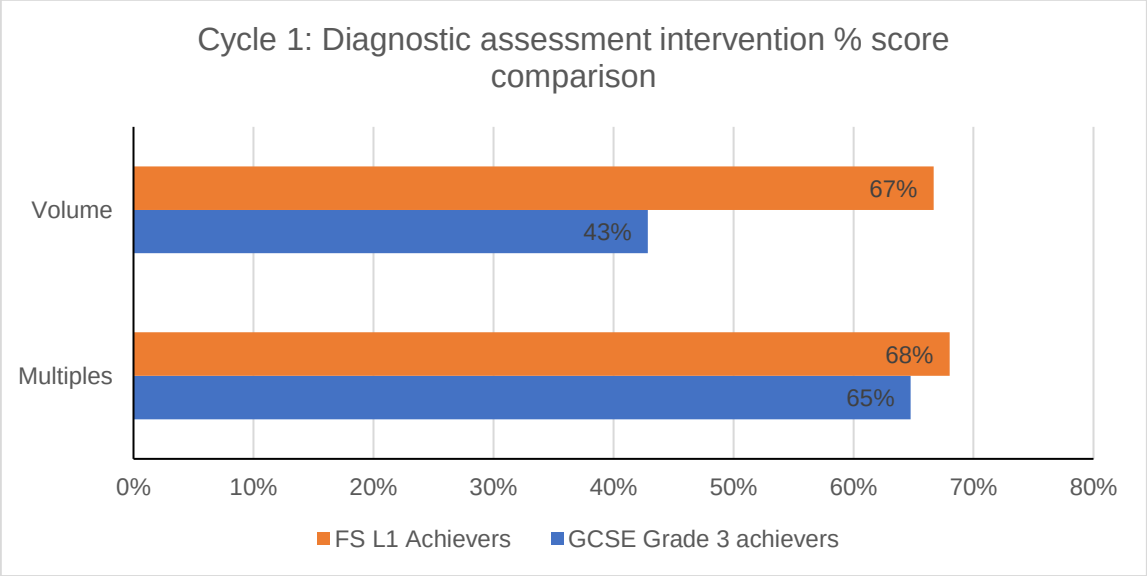
For example, within the learner work (a Newham FS Level 1 achiever), you can see that the main strategy employed was listing, rather than the use of factor trees. As a method, listing can be limiting for learner success, as it increases the time taken to answer questions, and does not support work with more complex numbers.

After the worksheets were completed, but before they were marked, FS Level 1 achievers were interviewed about the following: their confidence levels, if they struggled, when they struggled, why they struggled and strategies to help them improve. If they were confident, learners were asked what has helped them with this topic in the past.

As an ARG we then reflected on common misconceptions or alternative methods such as these that were appearing, and that learners identified in their interviews. Key areas that FS Level 1 achievers struggled with are below for the 3 topics:

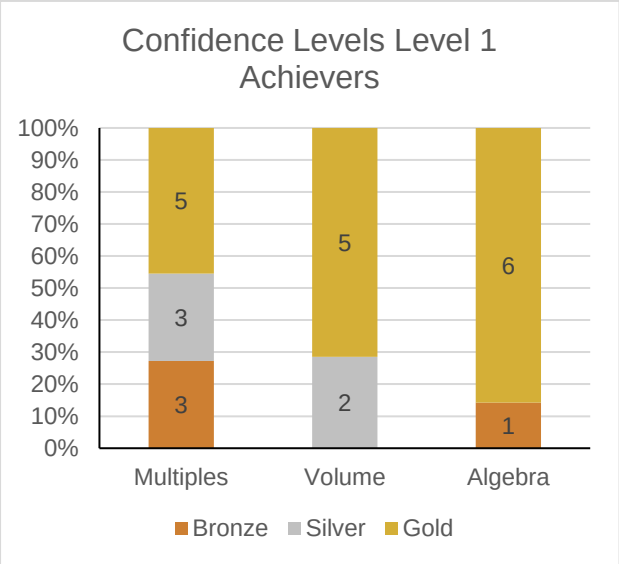
Multiples:	**Volume:**	**Algebra:**
Product of primes	Remembering the formula	Identifying mistakes
The method of factor trees	The unit cube representation	Understanding what to do
Worded questions	Comparing volumes	Variable on both sides

What was common across both FS Level 1 achievers and GCSE grade 3 achievers is that they were all struggling with the worded, problem-solving style questions, and from teacher feedback, all learners were struggling the most with the algebraic assessment.



The graph above shows the diagnostic assessment intervention average percentage scores for FS Level 1 achievers vs GCSE grade 3 achievers for volume and multiples. For both volume and multiples, surprisingly, the FS Level 1 achievers did better than their GCSE grade 3 achiever counterparts for this small sample size.

For algebra, due to a data processing error and small sample size, we are not able to compare this to scores for GCSE grade 3 achievers, but this was the area the FS Level 1 achievers were weaker in compared to volume and multiples, scoring on average 63%.



We also rated FS level 1 achiever confidence levels from the interviews carried out. The graph shows whether learners rated themselves as very confident (gold), somewhat confident (silver), and not very confident (bronze). These categorisations were agreed as an ARG to interpret the different language learners used in their interview responses.

What is interesting to note is that the confidence levels of learners showed the opposite trend of the diagnostic assessment intervention results. Using gold=3, silver=2 and bronze=1, learners were overall least confident with the topic of multiples (average confidence score of 2.2), in which their result was highest, and then a higher confidence score of 2.7 for volume and algebra, for which they scored lower on the assessment. During the interviews, learners did report that the scaffolding of the questions supported their success, and thus perhaps supported their confidence levels. This was particularly noted for the volume questions.

At the end of the Cycle 2 interventions, we decided that we needed to collect more data surrounding skills gaps within algebra, as well as answering worded, problem-solving style questions, as algebra was the topic that our FS Level 1 achievers were struggling most with (from the assessment results, and from verbal discussions with the ARG). All learners were showing low confidence levels with the worded, problem-solving style questions, including the FS Level 1 achievers, from their interview responses, and from teacher observations.

In the post-AR teacher questionnaire, after Cycle 3, most teachers agreed that the diagnostics assessment interventions from Cycle 2 supported them with unpicking reasons behind why learners were struggling in key areas.

After the interventions with the learners in Cycle 2, we worked together as an ARG to develop our understanding of mastery and discuss how we could use a mastery pedagogy or method to address skills gaps identified already, as well as gathering further data surrounding skills gaps and misconceptions. This would support us in completing our third research objective*: to identify mastery-based interventions that could support the addressing skills gaps and the application of the skillset learnt from context-based learning in Functional Skills Maths Level 1 to other non-FS areas found in GCSE maths grade 4*. After reviewing our literature review, we came together as a team for a PD session with Martin Newton, an expert maths consultant from MEI (a national maths education charity). The main purpose of the online PD session was to review where the action research (AR) teachers were with their views, values and belief of what 'Mastery' is and how that could be taken forward into the next cycle. When asked at the start of the PD session 'What is mastery?' the answers were as follows:

'A new way of thinking and teaching that involves all leaners.'

'To be able to demonstrate a confidence and ability at a task.'

'To me, it's a mastery pedagogy with the aim of deepening learners' understanding and ensuring they have the mathematical flexibility to approach problems in all areas of maths in different ways. Mastery approaches might involve variation, bar modelling, representation, and structure'

'It means closing the achievement gaps using mastery-based approaches.'

At this point it seemed that ARG teachers had interpreted the question in slightly different ways, however when they discussed their opening statements further, justification was given for the views and further reflection given. A new way of teaching referred to the use of bar modelling. There was then further discussion about making connections and multiple representations and how this was part of mastery.

After an activity to categorise belief statements surrounding mastery, teachers reflected well about their evolving views of mastery, and as a group, we gleaned 3 key points from the activity:

- The need to assess what learners already know about a topic.
- The importance of making connections
- The importance of practice, but not necessarily rote practice.

After discussing which aspects of the 5 Key Principles for Mastery in FE (Department for Education, 2020, p.1) the group thought would be most important to the research (representations, collaborative learning and variation), we started planning the next research cycle – to take contextualised questions and map them into algebraic, worded, problem-solving questions, to explore how bar modelling could be used to support learner progress with both types of questions. As an ARG, we then took part in bespoke CPD, further discussions and teacher reflection time on bar modelling, using WACOM tablets for visualisations/bar modelling interactively, and further CPD on questions to use – we felt these aspects were crucial to the impact made in Cycle 3. In the post-AR questionnaire, all teachers agreed that the CPD sessions with Martin Newton on bar modelling, mastery interventions and using WACOM tablets positively impacted:

- Their own personal understanding of mastery
- Their confidence with bar modelling
- Their ability to support learners with addressing their skills gaps and applying their existing knowledge to other areas of maths

Cycle 3 – Addressing skills gaps and application of knowledge

For Cycle 3, we wanted to collect further data surrounding skills gaps for FS Level 1 achievers and GCSE grade 3 achievers, build on supporting learners with ratio and proportion (identified as an area for all learners in Cycle 1), and support all learners to apply skills learned to worded, problem solving algebraic style questions, which could support learner understanding, through the use of bar modelling. Thus, we collaboratively designed a series of bar-modelling intervention activities (see appendices 6 and 7) and pre- and post-intervention formative assessments (see appendix 8) with support from Martin Newton and Katharine Davies at MEI. This would round off our section of the project focussing on our fourth objective, *to research and plan interventions, using a mastery pedagogy, to address skills gaps and support the application of the skillset learnt from context-based learning in Functional Skills Maths Level 1 to other non-FS areas found in GCSE maths grade 4 for learners who have passed FS Level 1*.

For our fifth AR objective, *to investigate how different groups of learners respond to different teaching interventions and strategies and collect teacher reflections on the impact of these interventions*, we analysed the scores and misconceptions revealed from the pre- and post-intervention assessments using a standardised mark scheme and analysis grid (see appendix 8). We also gathered learner and teacher reflections before, throughout and after using a Cycle 3 initial teacher form (see appendix 9), a teacher reflection proforma (see appendix 10), paired observations with teacher visit observation schedules (see appendix

11), a post-intervention learner question (see appendix 12) and a post-AR teacher questionnaire (see appendix 13).

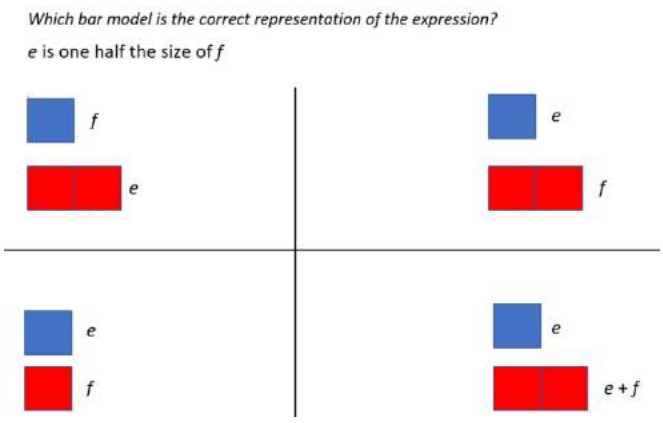
The pre- and post-intervention assessments (see appendix 8) were collaboratively adapted from the exemplar examination papers from *A new mathematics GCSE curriculum for post-16 resit students: Final Report* (Davies et al., 2020, pp. 82-133). We designed both the pre-intervention assessment and the post-intervention assessment to comprise of two parts – a contextualised number-based assessment, and an additional algebraic based version of the same assessment. This was to see how learners responded to a non-FS topic, algebraic manipulation and forming expressions, compared to a question with the same basis of mathematical skillset and method required. The assessment questions were similar in style to diagnostic questions, with multiple choice answers and misconceptions identified for each incorrect answer. We further adapted the questions to include learners showing their working, and added question 9, based on a previous Pearson GCSE exam question that learners in Lambeth had struggled with.

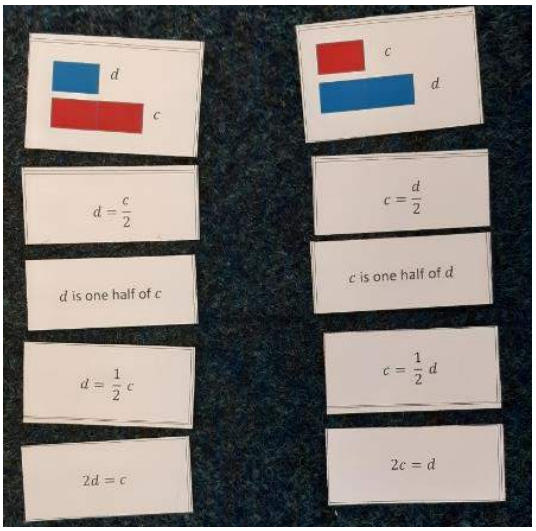
In the pre-assessment there was not a huge difference between the scores of GCSE grade 3 vs FS Level 1 (see later discussion), but both groups showed they were still struggling with the algebra content. This tied in with our teacher reflections from cycle 2, that algebra was still an area to bridge skills gaps. This also supported our continued action research journey and our rationale for carrying out the interventions we had designed.

The intervention activities carried out were designed to identify and address key misconceptions, with variation theory and learner collaboration built in. Each intervention activity was based on one of the pairs of questions from the pre-assessments. Teachers in the ARG were required to carry out at least 3 intervention activities, from a choice of 6 based on 6 of the questions from the pre-assessments.

At the beginning of each intervention activity, we carried out simple discussion and matching tasks for learners to get to grips with bar modelling.

The matching tasks and answers were thought out specifically to ensure that learners had a deeper understanding of multiple representations, and misconceptions were addressed by the teachers through questioning techniques.





Which is (was) easiest to do? If you successfully completed these questions, please prepare to present your successful method to the class

6. Sadia's car has enough petrol to travel 50 miles.
She spends £25 on petrol and now has enough to travel 165 miles.
How much does petrol cost per mile for Sadia's car?

A £4.60 B £2.17 C 22p D 15p

Show your working out:

6. Sadia's car has enough petrol to travel, 50, miles.
She spends £30 on petrol and now has enough to travel m miles.
How much does petrol cost per mile in pounds for Sadia's car, in terms of m?

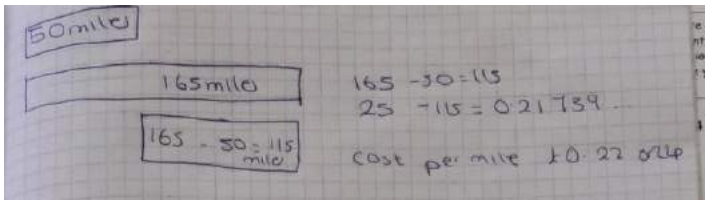
A $\frac{m-50}{30}$ B $\frac{50-m}{30}$ C $\frac{30}{m-50}$ D $\frac{30}{m}$

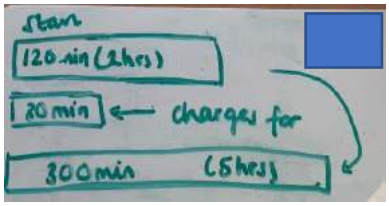
Show your working out:

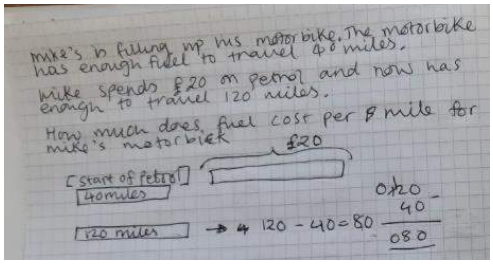
Then, we returned to the focus question for the activity from the pre-assessments. Learners were asked which question (context or algebra) they found easiest to check their confidence, and stronger learners were asked to prepare to present their successful methods to the class. For this question, from observations, almost all the learners said the context-based question was easier than the algebraic question.

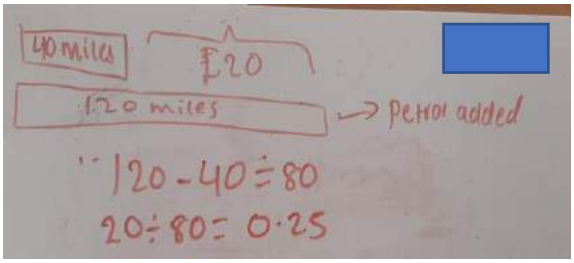
Next, we would ask learners to try the question they found easier again, firstly using bar modelling on mini-whiteboards or in their books. We as teachers would then model this question using animated bar models, or drawing on screen using WACOM tablets. Before each animation, teachers would use questioning to elicit the steps from learners, or ask them after each animation which part of the question related to which part of the bar model. Additionally, as learners also need to show their working in the exam, the modelled example would have the full working out at each stage of the bar model.

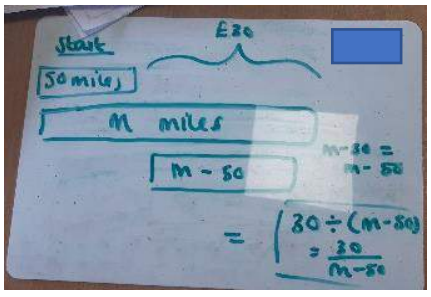
The next section of the intervention activity would take learners through a set of carefully sequenced questions, designed with inspiration from variation theory, and would gradually change the question context and then from number contexts to algebraic versions of those questions. For each question, learners would be encouraged to work through with bar modelling – see the examples of learner work here.

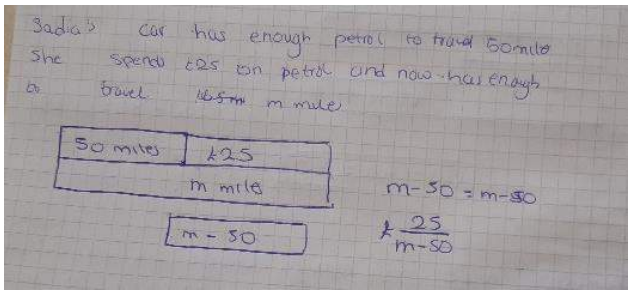




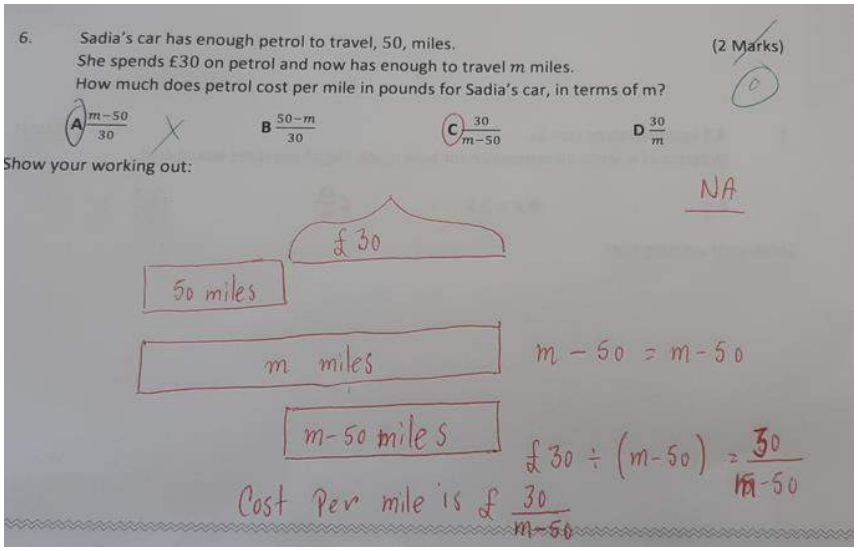


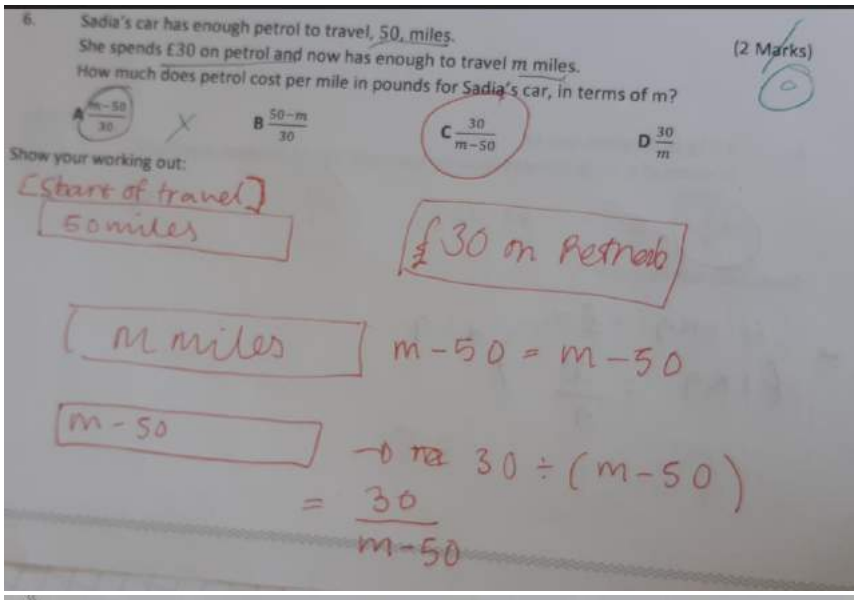


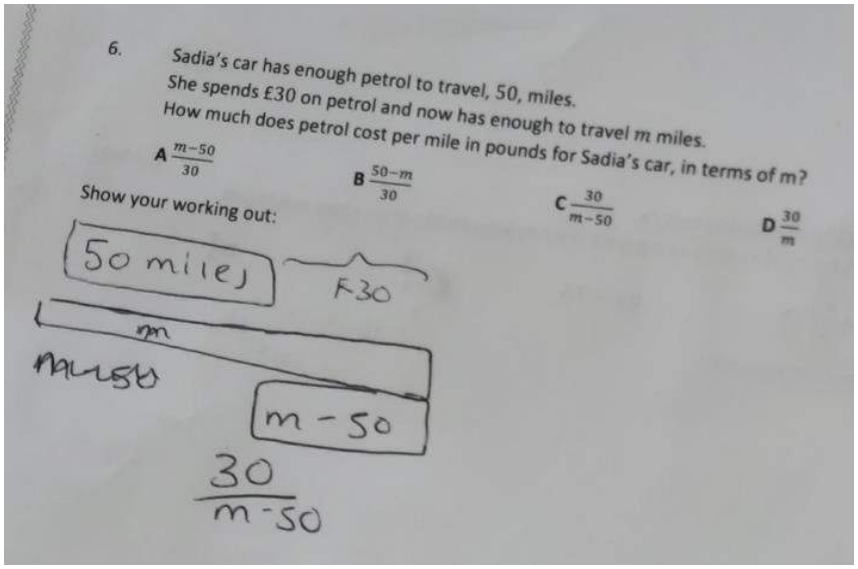




Finally, we asked learners to try the algebraic question from the pre-assessment again with bar modelling, and to share their own methods if different to the class.







At the end, learners were asked whether they found the context or algebraic questions easier – after the interventions, we noticed a significant increase in the number of learners saying they thought the algebra questions were easier – less steps to work out! Teachers also commented that bar modelling provided a more tangible way for students to approach and access the questions, supporting issues with low confidence.

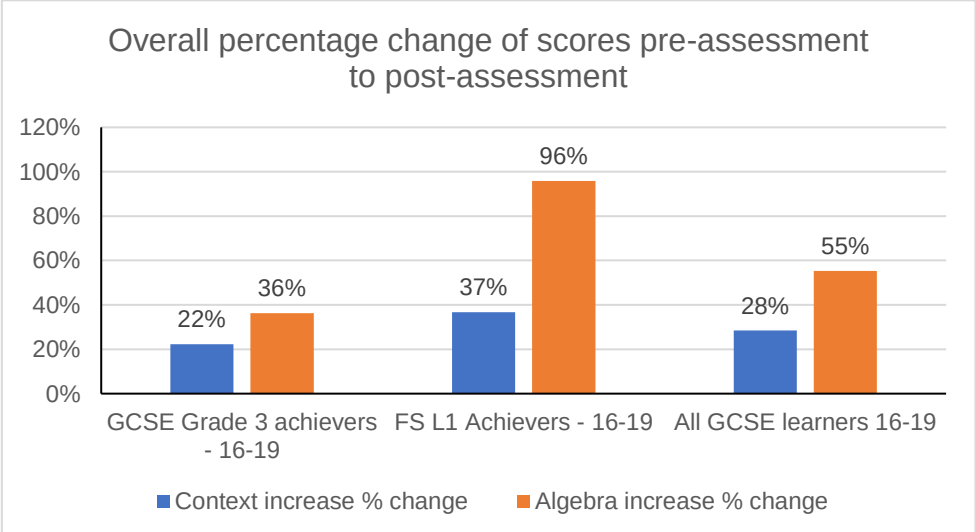
Analysis and discussion Cycle 3 – pre- and post-intervention assessments

When looking at the impact of the cycle 3 interventions, we looked firstly to the pre- and post-intervention assessment scores[2]. All the assessments were out of 16, and in the table below, you can see the average scores for the different groups of learners – this is the overview for all learners who took the assessments, as well as the average change in their marks. This data includes some adult learners, as one class was a mixed post-16 group, however the results for the 19+ learners are based on a very small cohort.

Average Scores overall	Context pre	Algebra pre	Context post	Algebra post	Context change	Algebra change
Average Score GCSE Grade 3 achievers - 16-18	6.8	5.0	8.3	6.8	1.5	1.8
Average Score FS L1 Achievers - 16-18	7.3	4.4	10.0	8.6	2.7	4.2
Average Score 19+ non L1	9.3	5.8	13.0	9.0	3.7	3.2
Average Score 19+ L1	10.5	4.0	12.0	9.0	1.5	5.0
Average score 16-18	7.0	4.9	9.0	7.5	2.0	2.7
Average score 19+	9.6	5.4	12.8	9.0	3.1	3.6

Generally, this shows an increase in learner scores across all assessments after the interventions, but particularly for the algebra assessment scores for those who have achieved Functional Skills Level 1 previously.

Focussing on the 16-19-year-old learners, the graph below shows the impact of the intervention activities on learner scores in the assessments:

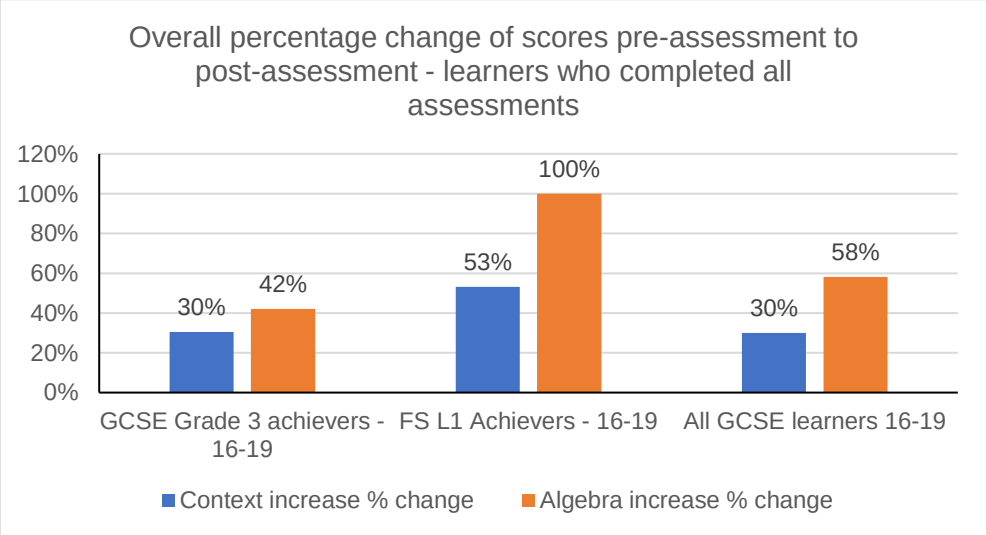


[2] These results differ slightly to the provisional reported during CfEM Live – further learner assessment scores were identified and added to analysis in July 2022

These results show that all GCSE learners made progress over the intervention period and made more progress with the algebraic based questions after the bar modelling interventions. The FS L1 Achievers made a significant increase to their algebra assessment score (96% increase), almost doubling their assessment score. When we focus on just the 16-19-year-old GCSE grade 3 achievers and FS L1 achievers who did all the assessments and therefore were the most consistent to attendance to interventions, we see the following results:

Average scores learners who did all assessments	Context pre	Algebra pre	Context post	Algebra post	Context change	Algebra change
Average Score GCSE Grade 3 achievers - 16-19	6.4	4.5	8.3	6.3	1.9	1.9
Average Score FS L1 Achievers - 16-19	7.0	4.6	10.7	9.2	3.7	4.6
Average score 16-18	6.7	4.6	9.3	7.5	2.6	2.9

Learners who did all assessments	Context increase % change	Algebra increase % change
GCSE Grade 3 achievers - 16-19	30%	42%
FS L1 Achievers - 16-19	53%	100%
All GCSE learners 16-19	30%	58%



For this group of learners, we can see that the % increase in scores was even higher still, and the FS L1 achievers who completed all 4 assessments doubled their score from the pre-intervention assessment for algebra to the post-intervention assessment. For the context assessment, the FS L1 achievers who completed both assessments had a significantly higher percentage increase than the GCSE grade 3 achievers. Reasons as to why the impact was such for the FS L1 achievers could be that they were affected by attended levels, or other factors, but we as an ARG agreed that we felt the grade 3 achievers throughout the interventions mostly preferred to stick to their own previously learnt method – thus, their misconceptions were harder to address, and they were more reluctant to use the

bar modelling method. Additionally, a higher proportion of the FS L1 achievers are ESOL/EAL learners or had previously been taught in a different country. These learners may have been studying FS Level 1 initially rather than GCSE grade 3 due to language barriers, and the progress with their mathematical skills could have been supported by an improvement in their language skills. Another possible linked reason is that bar modelling may have helped the FS Level 1 achievers understand the question by breaking down the language within the question.

As an ARG, we were also interested in exploring what misconceptions a Functional Skills Level 1 achiever had, and whether these could be addressed with the bar modelling intervention. Using the mark scheme, and an identification grid, we analysed the misconceptions in the pre- and post- context and algebra assessments for the FS Level 1 achievers. In the table below, you can see the questions in which there were the strongest clusters of misconceptions indicated by the assessment results for the pre-assessments.

Misconceptions	Context pre-intervention assessment	Algebra pre- intervention assessment
FS L1 Achievers - 16-19	Qu 5: • Dividing £600 into 2 equal parts rather than the ratio Qu 7: • Dividing by 3 friends instead of Lisa and 3 friends (4 people) • Did not include the 10% tip	Qu 4: • Multiplying by 1.15 Euros instead of dividing (assuming 1 Euro = £1.15) • Has worked as if pounds and Euros are in the reverse placement in the question

This was based on a small cohort of learners, and as such we cannot conclude that all FS L1 achievers would show these misconceptions – however, identifying the misconceptions for our individual classes was useful in selecting intervention topics. The intervention topics were based on what we felt would support our class as a whole, not just the FS Level 1 learners, so some of the questions above were not chosen as dedicated intervention topics as for individual classes, the misconceptions were not so evident.

In the context post-assessment, the misconception question 5 had been largely resolved – there were no evident misconceptions – this was a question on which one of the bar modelling interventions was based. However, for question 7, which was not covered in the bar modelling interventions due to time constraints, the misconception of dividing by 3 instead of 4 was still present for some learners, as was not including the percentage increase. Next steps could be to trial this type of question with bar modelling.

For the algebra post-assessment, the misconception of switching the currency in the formula was still present for the FS Level 1 achievers. However, from 9 questions, there were no overarching, shared misconceptions that could be identified from the assessment results – as an ARG group we felt based on this data that this indicated that you cannot classify misconceptions based on whether a learner has achieved FS Level 1 in the past, or GCSE grade 3. The reasons for misconceptions can be varied and based on a significant number of factors, so it is important to continue to identify and address misconceptions each year, throughout the year, with different learners.

Analysis and discussion Cycle 3 – teacher reflections before and during

At the beginning of Cycle 3, 5 of our 6 ARG teachers completed an initial teacher reflection form (see appendix 9). On the whole, the ARG teachers felt that bar modelling interventions would make a positive contribution to learners improving their algebra skills (1 predicting the interventions would be highly effective, and 4 predicting effective). Other key, common responses were:

- Bar modelling would lead to a deeper understanding, and that once grasped it would be a skill that students could apply broadly and confidently
- Concern for a need for greater planning for differentiation
- Ratio was mentioned consistently among the skills mentioned that bar modelling could be used to teach
- 4 teachers felt that learners would perform better at the context-based questions initially, with 1 teacher identifying algebra-based questions due to ESOL students in their class being more familiar with algebra but struggling with language.

During the interventions, teacher reflection proformas (see appendix 10) were completed by all 6 ARG members on a weekly basis, and 6 teacher visits with observation schedules (see appendix 11) were carried out. In the teacher reflection proformas, teachers commonly reported that learners were still more confident with the context-based questions, and that there was slow progress with the algebra-based questions – not due to the bar modelling being ineffective, but due to more time being needed for the algebraic bar modelling, and that the project/interventions should be held over a longer period. For most learners, teachers reflected that bar modelling did not come easily and intuitively, this was also evidenced in the observation schedules, teachers observed that learners need much guidance in developing use of bar modelling. However, one learner surprised a teacher by showing mathematical understanding through bar modelling not evidenced before.

Teachers also reflected that the visual nature of bar modelling promoted discussion in both the reflection logs and observation schedules, which also supported collaborative learning. Additionally, the engagement with bar modelling was linked to learner ability – teachers reflected that “students who were not so able at maths were more likely to engage with bar modelling”. This was reflected in the teacher observation schedules – again, a consensus that bar modelling is not intuitive to learners who are not confident with maths. The teacher observation schedules also proposed that teacher fluency with bar modelling would further support the interventions, and teachers could benefit further from seeing other examples of its application.

Although teachers did not feel that the interventions had made an overnight and dramatic change, there was a consensus that bar modelling was a vital tool that would lead to greater maths understanding amongst students – vitally, it should be introduced earlier in the curriculum. One quote from a teacher reflection reflects why bar modelling supports great understanding: “[Through bar modelling], students can understand what is happening with the numbers they are working with.”

Analysis and discussion Cycle 3 – post-intervention questionnaires

After the interventions, learners and teachers were invited to share their reflections through an MS Form (see appendices 12 and 13).

From the learner questionnaire (57 respondents), a mixed picture arose.

- Just under half agreed that:
    - Bar modelling helped understanding (22/27) and helped them in areas they weren't confident in (25/57)
    - The matching tasks helped them learn how to bar model (26/57)
- Just over a third agreed that bar modelling helped them apply knowledge from one area to another (21/57)

On a more positive note:

- Over half agreed that sharing their own methods was a helpful way to learn (32/57)
- Despite the opinions above, around 4/5 of the learner respondents would use or might use bar modelling even when they are confident with another method.

From the teacher questionnaire, a cautious, but positive set of reflections can be shown around their own progress, the impacts of the different parts of the intervention, and the overall progress of their learners:

- By the end of cycle 3, all teachers felt highly confident or confident in using bar modelling as a teaching tool – CPD prior to cycle 3, and the opportunity to visit other teachers and see bar modelling in action supported this confidence.
- In terms of learners developing independent usage of activities within the interventions, 5/6 teachers reported that their students have been sharing their own methods independently, and 2/6 teachers reported independent use of bar models by learners.
- All teachers either agreed or strongly agreed that:
    - Matching tasks supported their learners with mathematical understanding
    - A learner sharing their methods with others supported their own progress and mathematical understanding (5/6 said it also supported others' progress)
- 5/6 teachers either agreed or strongly agreed that:
    - Matching tasks supported learners with bar modelling
    - Bar modelling was effective in addressing skills gaps for FS Level 1 achievers and supported their learners in areas of maths they weren't confident with
- Teachers reflected that the bar modelling interventions were most useful for the topic of ratio – this was also reflected in the learner questionnaire

Teachers remained cautious around whether the bar modelling interventions helped learners to apply knowledge from the context-based questions to the algebraic-based questions and vice versa – half agreed with this statement. Overall, only half agreed that the bar modelling interventions had a positive impact on learner progress overall, with 2 teachers responding that they were unsure. The one teacher who disagreed clarified that this was due to time constraints of the project.

Analysis and discussion Cycle 3 – triangulation

Overall, for cycle 3, it can be said that teachers had a confident start and were positive in their outlook for the interventions. Teacher initial reflections were then supported by the learner assessment results and the final teacher reflections, with the bar modelling interventions contributing to progress in learner understanding, varied misconceptions needing varied support, ratio standing out as improving misconceptions and learners performing better with context-based questions.

Despite teachers reflecting that more time was needed for the algebra bar modelling, all categories of learners still made a higher percentage increase for these questions, and so there was still positive impact on bridging the learner gaps, and we can pose that bar modelling interventions do support the applications of FS Level 1 topics to non-FS Level 1 topics found in the GCSE syllabus (context to algebra), for those who have achieved FS Level 1. The learner assessment score gaps from the context assessment to the algebra assessment pre- to post-intervention were also smaller for all sets of learners, again supporting the claim that bar modelling is a mastery method which can support bridging skills gaps. Despite low numbers of positive learner reflections surrounding bar modelling, it is clear to see that teachers value the interventions as having supported their learners, and it is evident from the assessment results that learner progress was made.

Next steps

In terms of next steps for the ARG teachers, all teachers have said they will continue using bar modelling in their practices and will continue to encourage learners to share their own methods with the class. Five out of six of the teachers said that they will continue to use bar modelling specifically for context-based questions to algebraic based questions, and two thirds of the teachers said they will continue using careful sequencing of questions (variation theory. Additionally, all teachers felt that the CPD received in Cycle 2, and the continued opportunities for reflection and discussion throughout are important to be continued in their practice and their workplace, and as such will be disseminating these findings across their teams in their respective colleges and informally trialling the methods and resources used.

The ARG teachers would also like the opportunity to trial these interventions on a larger scale, particularly surrounding contrasting and comparing the learner progress of GCSE grade 3 achievers and FS Level 1 achievers to see if there are more widespread common misconceptions within those groups, and to see if other groups of FS Level 1 achievers make as much progress as those within our study. Another area for exploration could be to delve deeper into the why behind engagement with bar modelling – some reasons have been suggested as to why there was more engagement from FS Level 1 achievers, but this would be an area of interest to research further.

Conclusions and Recommendations

Conclusions

Our conclusions can be separated into three key areas. Overall conclusions around using diagnostics effectively and different intervention activities, conclusions specifically around bar modelling, and finally conclusions around the AR process, CPD for AR teachers and the overall benefits to learners.

Overall conclusions around diagnostics and different intervention activities

1. Most teachers agreed the diagnostic interventions in Cycle 2 were useful for identifying learner skills gaps and identifying the why behind learner struggles – combined with the interview questions, this gave teachers an insight into why their perceptions on why they were struggling were different from learners' opinions.
2. However, teachers did also agree that the scaffolded nature of those diagnostics, whilst useful for identifying at which point learners struggled in a sequenced topic, the scaffolding did support some learners in ways they might not be supported during an exam. For example, longer, complex questions are not normally preceded by questions using the individual skills required.
3. All teachers agreed that learner willingness to share their own methods improved over the course of the project.
4. All teachers agreed that learners sharing their own methods supported learner understanding and said they would continue to encourage learners to share their own methods in class.
5. Teachers feel that all the methods/activities that were trialled during the AR project have, in different ways, contributed to learners' overall mathematical understanding.

Conclusions around bar modelling

6. All teachers felt that bar modelling was a good method for developing learner understanding even though learners did not show an overall positive response to using bar modelling methods.
7. Learner understanding, particularly for FS Level 1 maths achievers, improved through the use of bar modelling – five out of six of the AR teachers believed that bar modelling was effective in addressing their skills gaps.
8. Despite a short intervention period, we are seeing some ongoing independent learners use of bar models.
9. All teachers said they would continue to use bar modelling in their classroom practice.

Conclusions around the AR process, CPD and overall benefits to learners

10. The wider impact on teachers from the AR project and process overall included the following: positive responses to increased reflection time for teachers, boosts in teacher confidence with their practice, a change in teacher mindsets and an increase in teacher skills.
11. The CPD provided during the course of the project particularly impacted teachers' ability to address skills gaps and support their learners to apply their knowledge in different mathematical areas.
12. All teachers felt that being part of the action research project benefitted their learners.
13. Five out of six action research teachers feel the Action Research CPD modules and the support they have received mean they are able to carry out their own smaller scale action research project in the future.

Recommendations

Likewise, for our recommendations, we can give overall recommendations about carrying out interventions and surveys, recommendations surrounding bar modelling, and recommendations surrounding the whole process of carrying out an action research project in an FE maths GCSE resit setting.

Overall recommendations around diagnostics and different intervention activities

1. We would recommend doing diagnostics of the type we did, but with the following changes.
2. We would plan for more time with the action research project interventions, particularly with analysis of diagnostics to further understand the changing nature of our learners' misconceptions – these changed throughout the year, so ensure to continue identifying and addressing misconceptions consistently
3. When planning a diagnostic intervention, be careful to ensure the diagnostic assessment is structured correctly, either to include scaffolding or to avoid scaffolding which would affect learner results.
4. Consistency is key with the methods and interventions discussed, whether that be bar modelling, questionnaires or surveys
5. We would recommend that these intervention activities be carried out with larger numbers, and across different college settings, in order to be able to make stronger conclusions comparing GCSE maths grade 3 and FS maths Level 1 achievers – our ARG was a very small, focussed group this year.

Overall recommendations surrounding bar modelling

6. As a group, we would recommend using bar modelling in a post-16 setting, as we found it to be effective and worthwhile.
7. In order to be most effective, and increase learner positivity towards bar modelling, we would start the bar modelling interventions earlier in the year.
8. To fully maximise the impact bar modelling can have on learner understanding, we would incorporate bar modelling with simpler topics, such as basic fractions or ratio before moving on to harder topics, such as algebraic modelling.
9. We would recommend consistency with the use of bar modelling and extend the use out to Functional Skills classes to introduce the method earlier in the mathematical journey for some of our learners.
10. Bar modelling should be considered as a valid method to improve learner understanding, particularly with learners who have achieved non-GCSE qualifications prior to taking GCSE maths in the 16-19-year-old age group

Recommendations for the AR process and around CPD

11. We would highly recommend a continued recognition that the process of action research, or independent research, is a highly valued form of continuous professional development for teachers
12. Where teachers are lacking in confidence with pedagogical methods or interventions, we would strongly recommend that teachers are provided with bespoke CPD and support from both experts and peers, ahead of carrying out a research intervention.
13. Finally, we would recommend that the maths FE sector as a whole gives support to teachers carrying out small or large research projects, as it not only impacts and empowers the teacher researcher, but gives them time to reflect on their learners' diverse needs in a short GCSE resit year

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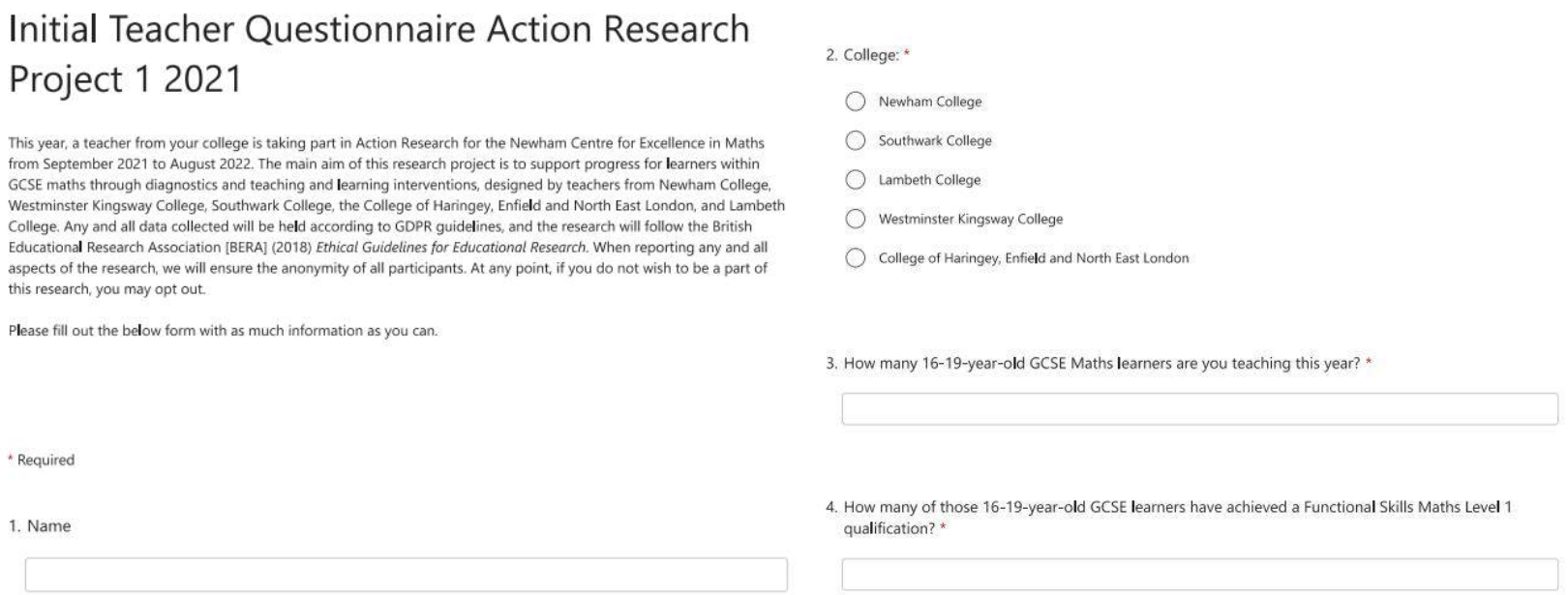
Appendices

All appendices, including PPTs of intervention activities can be found here: https://padlet.com/elizabeth_hopker/2122NewhamCfEMARProject1

Appendix 1: Cycle 1 – Initial Teacher Questionnaire



Initial Teacher Questionnaire Action Research Project 1 2021

This year, a teacher from your college is taking part in Action Research for the Newham Centre for Excellence in Maths from September 2021 to August 2022. The main aim of this research project is to support progress for learners within GCSE maths through diagnostics and teaching and learning interventions, designed by teachers from Newham College, Westminster Kingsway College, Southwark College, the College of Haringey, Enfield and North East London, and Lambeth College. Any and all data collected will be held according to GDPR guidelines, and the research will follow the British Educational Research Association [BERA] (2018) *Ethical Guidelines for Educational Research*. When reporting any and all aspects of the research, we will ensure the anonymity of all participants. At any point, if you do not wish to be a part of this research, you may opt out.

Please fill out the below form with as much information as you can.

* Required

1. Name

2. College: *

- Newham College
- Southwark College
- Lambeth College
- Westminster Kingsway College
- College of Haringey, Enfield and North East London

3. How many 16-19-year-old GCSE Maths learners are you teaching this year? *

4. How many of those 16-19-year-old GCSE learners have achieved a Functional Skills Maths Level 1 qualification? *

5. Does your college provide Functional Skills Maths for 16-19 year olds? *

- ◯ Yes
- ◯ No

6. What differences, if any, do you perceive there to be between a 16-19-year-old learner who has achieved GCSE Maths grade 3 vs a learner who has achieved Functional Skills Maths Level 1? *

7. Which learners do you think are more successful at achieving GCSE Maths grade 4 on the resit programme? *

- ☐ Those who have achieved GCSE Maths grade 3
- ☐ Those who have achieved Functional Skills Maths Level 1
- ☐ Other

8. Please say why you have chosen the group above from question 7: *

9. What topics do you think those who have achieved Functional Skills Maths Level 1 might struggle with compared to a GCSE Maths grade 3 achiever, if any? *

10. If you employ strategies to support those who have achieved Functional Skills Maths Level 1 in your GCSE Maths class, can you please describe those strategies below: *

11. Do you think COVID/CAGs/TAGs have affected which group of learners is more likely to be successful in GCSE maths this year? *

- ◯ Yes
- ◯ Not sure
- ◯ No

12. Please explain your answer to question 11: *

Appendix 2: Initial Learner Questionnaire

Initial Learner Questionnaire Action Research Project 1 2021

This year, your teacher is taking part in Action Research for the Newham Centre for Excellence in Maths from September 2021 to August 2022. The main aim of this research project is to support progress for learners within GCSE maths through diagnostics and teaching and learning interventions, designed by teachers from Newham College, Westminster Kingsway College, Southwark College, the College of Haringey, Enfield and North East London, and Lambeth College. Any and all data collected will be held according to GDPR guidelines, and the research will follow the British Educational Research Association [BERA] (2018) *Ethical Guidelines for Educational Research*. When reporting any and all aspects of the research, we will ensure the anonymity of all participants. At any point, if you do not wish to be a part of this research, you may opt out.

Please fill out the below form with as much information as you can.

* Required

1. Name

2. ID Number:

3. Which college do you go to? *

- ◯ Newham College
- ◯ Southwark College
- ◯ Lambeth College
- ◯ Westminster Kingsway College
- ◯ College of Haringey, Enfield and North East London

4. Have you achieved Functional Skills Maths Level 1? *

- ◯ Yes
- ◯ No

5. In which academic year did you achieve Functional Skills Maths Level 1? Please write in if other. *

- ◯ 2020-2021
- ◯ 2019-2020
- ◯ 2018-2019
- ◯ Other

6. Which college or school were you at when you achieved Functional Skills Maths Level 1? *

7. What qualification(s) did you achieve before you did your Functional Skills Maths Level 1?
Please select all that apply. If other, please write in your answer *

- [ ] Functional Skills Maths Entry 3
- [ ] GCSE Maths Grade 1 or 2
- [ ] A non-UK based qualification
- [ ] None
- [ ] I don't know
- [ ] Other

8. In the year before you were placed onto your Functional Skills Maths Level 1 course, where were you studying? *

- ◯ England
- ◯ Another part of the UK
- ◯ An English speaking country
- ◯ A non-English speaking country
- ◯ Other

9. Why were you placed on a Functional Skills Maths Level 1 course previously?
Please select all that apply. *

- [ ] I had not achieved a GCSE grade 3
- [ ] I wanted to be placed on Functional Skills Maths Level 1
- [ ] I achieved Functional Skills Maths Entry Level 3
- [ ] Other

10. What is your opinion of being placed on Functional Skills Maths Level 1 instead of GCSE? *

11. How do you feel about having completed Functional Skills Maths Level 1 before re-sitting GCSE Maths, or taking GCSE Maths for the first time? *

12. Are there any areas of the GCSE Maths course that you feel less confident in?
Please list these topic areas below. *

13. What is the highest English qualification you have achieved? *

- ◯ ESOL Entry Level
- ◯ Functional Skills English Entry Level qualification
- ◯ Functional Skills English Level 1 qualification
- ◯ GCSE English grade 1, 2, or 3
- ◯ GCSE English grade 4 or above
- ◯ Other

14. Do you consider English to be your first language? *

- ◯ Yes
- ◯ No
- ◯ Prefer not to say

15. Since what age have you been speaking English? *

16. What vocational course are you studying? *

17. How does maths relate to your vocational course? *

18. If you are willing to be contacted for more information about your responses, please put your e-mail address in the box below:

Appendix 3: ASK Skills Identification Framework

The below list of 84 maths skills come from a resource trialled from the Stoke-on-Trent Opportunity Area Project with MEI – further information on the project can be found here: https://mei.org.uk/case-studies/stoke-mep/

1	Recognise types of number - Prime, odd, even, square etc.
2	Identify factors and multiples.
3	Use index notation.
4	Find percentages, fractions and decimals of positive integers.
5	Find 'highest common factors' and 'lowest common multiples'.
6	What indices laws are.
7	Solve problems using HCF, LCM and primes.
8	Simplify and manipulate algebraic expressions (including surds).
9	Collecting like terms.
10	Use place value, including ordering.
11	Apply 4 operations (+, -, ×, ÷), including written methods for integers, decimals and simple fractions (positive and negative).
12	Use brackets, powers and hierarchy of operations correctly.
13	Use one calculation to find the answer to another.
14	Be able to effectively use a calculator for all calculations.
15	Use laws of indices.
16	Use and interpret algebraic manipulation.
17	Substitute numerical values into formulae and expressions.
18	Record, describe and analyse the frequency of outcomes of probability experiments using tables and frequency trees.
19	Calculate outcomes of multiple future events by applying ideas of randomness, fairness and equality.
20	Relate relative expected frequencies to theoretical probability using the 0-1 probability scale.
21	Effectively record exhaustive sets of outcomes equalling 1.
22	Enumerate sets systematically, using tables, grids and Venn diagrams.
23	Use ratio notation, including reduction to simplest form.
24	Divide a given quantity into two parts in a given part:part or part:whole ratio.
25	Express the division of a quantity into two parts as a ratio.
26	Apply ratio to real life contexts and problems.
27	Express a multiplicative relationship between two quantities as a ratio or fraction.
28	Relate ratios to fractions and to linear functions.
29	Compare lengths, areas and volumes using ratio and scale factors.
30	Use standard units of mass, length, time, money and other measures; and related concepts
31	Use standard compound measures
32	Convert between standard units of measure in the same system.
33	Estimate answers; check calculations using approximation and estimation.
34	Round numbers and measures to an appropriate degree (dp and sf).
35	Identify nets and elevations of different shapes
36	Know and apply formulae to calculate: area of triangles, parallelograms, trapezia.
37	Know and apply formulae to calculate: volume of cuboids and other right prisms (including cylinders).
38	Know and apply formulae: circumference of a circle
39	Know and apply formulae: area of a circle.

40	Calculate perimeters of 2D shapes, including circles, areas of circles and composite shapes.
41	Use scale factors, scale diagrams and maps.
42	Use proportion as equality of ratios
43	Solve problems involving direct proportion.
44	Multiplying a single term over a bracket.
45	Taking out common factors.
46	Simplifying expressions involving sums, products and powers, including the laws of indices.
47	Use standard mathematical formulae; rearrange formulae to change the subject.
48	Generate terms of a sequence using term-to term or position-to-term rules.
49	Deduce expressions to calculate the nth term of linear sequences.
50	Define percentage as 'number of parts per hundred'; compare two quantities using percentages.
51	Express one quantity as a percentage of another.
52	Interpret percentages and percentage changes as a fraction or a decimal.
53	Work with percentages greater than 100%.
54	Solve problems involving percentage change: increase/decrease and original value problems.
55	Interpret fractions and percentages as operators.
56	Simple and compound interest.
57	Use conventional terms and notation.
58	Apply the properties of angles at a point, angles at a point on a straight line, vertically opposite angles.
59	Understand and use alternate and corresponding angels on parallel lines.
60	Derive and use the sum of angles in a triangle.
61	Interpret and construct tables, charts and diagrams (frequency tables, bar charts, pie charts, pictograms)
62	Use and interpret scatter graphs.
63	Recognise correlation.
64	Work with coordinates in all four quadrants.
65	Plot graphs of equations that correspond to straight-line graphs in the coordinate plane.
66	Identify and interpret gradients and intercepts of linear functions both graphically and algebraically.
67	Recognise, sketch and interpret graphs of linear and quadratic functions.
68	Plot and interpret graphs in real contexts.
69	Solve linear equations in one unknown algebraically; find approximate solutions using a graph.
70	Interpret, analyse and compare the distributions of data sets.
71	Appropriate graphical representation involving discrete, continuous and grouped data.
72	Appropriately use median, mean, mode, modal class and range (spread)
73	Identify, describe and construct congruent and similar shapes.
74	Use and apply rotation, reflection, translation and enlargement.
75	Solve geometrical problems on coordinate axes.
76	Describe translations as 2D vectors.
77	Apply operations (+, -), including written methods for decimals (positive and negative).
78	Apply operations (+, -), including written methods for decimals (positive and negative).

79	Apply operations (×, ÷), including written methods for decimals (positive and negative).
80	Apply operations (+, -), including written methods for simple fractions (positive and negative).
81	Apply operations (×), including written methods for simple fractions (positive and negative).
82	Apply operations (÷), including written methods for simple fractions (positive and negative).
83	Use bearings
84	Estimating measurements

Appendix 4: Cycle 2 Diagnostic Intervention Activity Plan and Assessment

Action Research Newham CfEM Project 1 – **To improve progress of 16-19-year-old maths learners who have achieved Functional Skills Level 1 and are now working towards GCSE grade 4 using mastery-based approaches to identifying and addressing gaps in knowledge and skills.**

Include timings for each activity

ARG Intervention Activity – Cycle 2		
Teacher: College:		
Notes about the class: Age group: Attendance: Profile of the class:		
Relevant ARG objectives	2. To compare and contrast the knowledge base and skillset of those who have achieved Functional Skills Maths Level 1 vs GCSE Maths grade 3 5. To investigate how different groups of learners respond to different teaching interventions and strategies, and collect teacher reflections on the impact of these interventions 6. To share best practice and findings internally and externally	
Big picture	Using specific diagnostic interventions to delve deeper on specific topics with 16-19 FS Level 1 and GCSE grade 3 achievers in a GCSE maths class. To find out why FS Level 1 learners struggle with specific topics, in order to then discuss and identify mastery-based strategies to carry out in cycle 2 to address skills or knowledge-based gaps in FS Level 1 achievers.	
Outline of intervention	1. Learners attempt the question set on a specific topic 2. FS Level 1 achievers are then interviewed about the question set – teachers record the interview where possible and take notes of their responses	
Specific topic questions	See document	
Intervention Plan	Learners attempt the question set above. Learners are encouraged to show as much working as possible, and to explain their answer. At the end, the teacher should take in the question sets for marking/photo evidence	10 mins

Post assessment interview	Questions to be asked to FS Level 1 achievers – see proforma 1. How confident do you feel that you have got the questions right? 2. Did you struggle with any parts of these questions? 3. If you struggled: a. Can you identify which bit(s) you struggled with? b. Why do you think you struggled with those parts of the questions? c. Before trying these types of questions again, what do you think would help you complete the question successfully?	5-10 minutes
Reflection form (Teacher to answer/reflect on the questions to the right after the interventions)	• Were the diagnostic techniques useful for finding out why FS level 1 learners struggled? • Did the interviews give us enough information?	After the lesson/activity

Name: Class:

College: Date:

Cycle 2: Diagnostic questions - multiples

1. Write out the first 10 multiples of 10:

2. Write out the first 10 multiples of 15:

3. Which number below is the lowest common multiple of 10 and 15?
   a. 20
   b. 5
   c. 150
   d. 30

   Show your working/Explain why you picked your answer

4. $A = 2 \times 5$ and $B = 3 \times 5$ Express the LCM of A and B as a product of its prime factors.
   a. $2 \times 3 \times 5^2$
   b. $2^2 \times 5^2$
   c. $2 \times 3 \times 5$
   d. $2^2 \times 3^2 \times 5^2$

   Show your working/Explain why you picked your answer

5. A red light flashes every 10 seconds.
   A green light flashes every 15 seconds.
   They both just flashed.
   How long before they flash together again?
   a. 5 seconds
   b. 15 seconds
   c. 30 seconds
   d. 150 seconds

   Show your working/Explain why you picked your answer

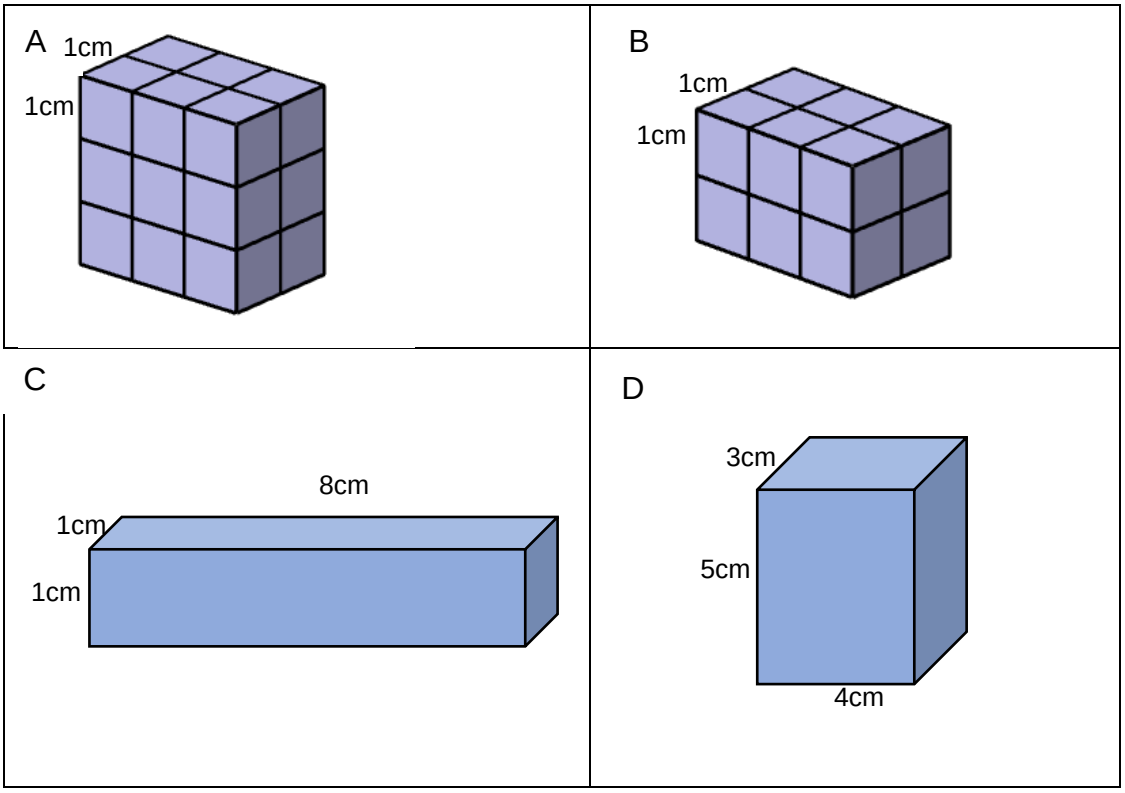
Name: Class:

College: Date:

Cycle 2: Diagnostic questions - volume

1. Write down the formula to find the volume of a cuboid:

2. Which of these shapes has the biggest volume? Show your working out and explain why.



3. Alice has a cuboid with length 4cm, width 6cm and height 10cm

   Ben has a cuboid with length 6cm, width 10cm and height 4cm

   Chad has a cuboid with length 10cm, width 4cm and height 7cm

   Davhood has a cuboid with length 8cm, width 3cm and height 9cm

   Which volumes are the same? Why?

   Which volume is the biggest? Why?

Name: Class:

College: Date:

Cycle 2: Diagnostic questions – solving equations

1. Solve the equations below. Show your working.

   a. $x + 6 = 11$

   b. $x - 5 = 24$

   c. $3x = 12$

   d. $\frac{x}{2} = 8$

   e. $3x + 2 = 20$

   f. $4(x - 5) = 36$

   g. $6x - 1 = 2x + 7$

2. **Equation A** **Equation B**

   $5(x + 3) = 20$ $5x + 15 = 20$

   Are these equations the same? How do you know?

3. Find the mistakes in the following equations. Explain each mistake and correct the answers

(i)
$$3x - 2 = x + 7$$
$$4x - 2 = 7$$
$$4x = 7 - 2$$
$$4x = 5$$
$$x = 1$$

(ii)
$$3(x + 4) = 15$$
$$3x + 4 = 15$$
$$3x = 19$$
$$x = 6.33333$$

Appendix 5: Cycle 2 Learner Interview Proforma

Interviewer		Learner ID		Learner name	
1. How confident do you feel that you got the questions right?					
2. Did you struggle with any parts of these questions? (If they didn't, ask why?)					
3. If you struggled: a) Can you identify which bit(s) you struggled with					
b) Why do you think you struggled with those parts of the questions?					
c) Before trying these types of questions again, what do you think would help you complete the question successfully?					
Other comments from the learner/relevant information					

Appendix 6: Cycle 3 Intervention Plans

See below one of the intervention plans, for all the intervention plans please head to https://padlet.com/elizabeth_hopker/2122NewhamCfEMARProject1

Action Research Newham CfEM Project 1 – To improve progress of 16-19-year-old maths learners who have achieved Functional Skills Level 1 and are now working towards GCSE grade 4 using mastery-based approaches to identifying and addressing gaps in knowledge and skills.

Include timings for each activity

ARG intervention Activity – Cycle 3 – Question Set 3	
Teacher: College:	
Notes about the class: Age group: Attendance: Profile of the class:	
Relevant ARG objectives	3. To identify mastery-based interventions that could support the addressing skills gaps and the application of the skillset learnt from context-based learning in Functional Skills Maths Level 1 to other non-FS areas found in GCSE maths grade 4 4. To research and plan interventions, using a mastery pedagogy, to address skills gaps and support the application of the skillset learnt from context-based learning in Functional Skills Maths Level 1 to other non-FS areas found in GCSE maths grade 4 for learners who have passed FS Level 1 5. To investigate how different groups of learners respond to different teaching interventions and strategies, and collect teacher reflections on the impact of these interventions 6. To share best practice and findings internally and externally

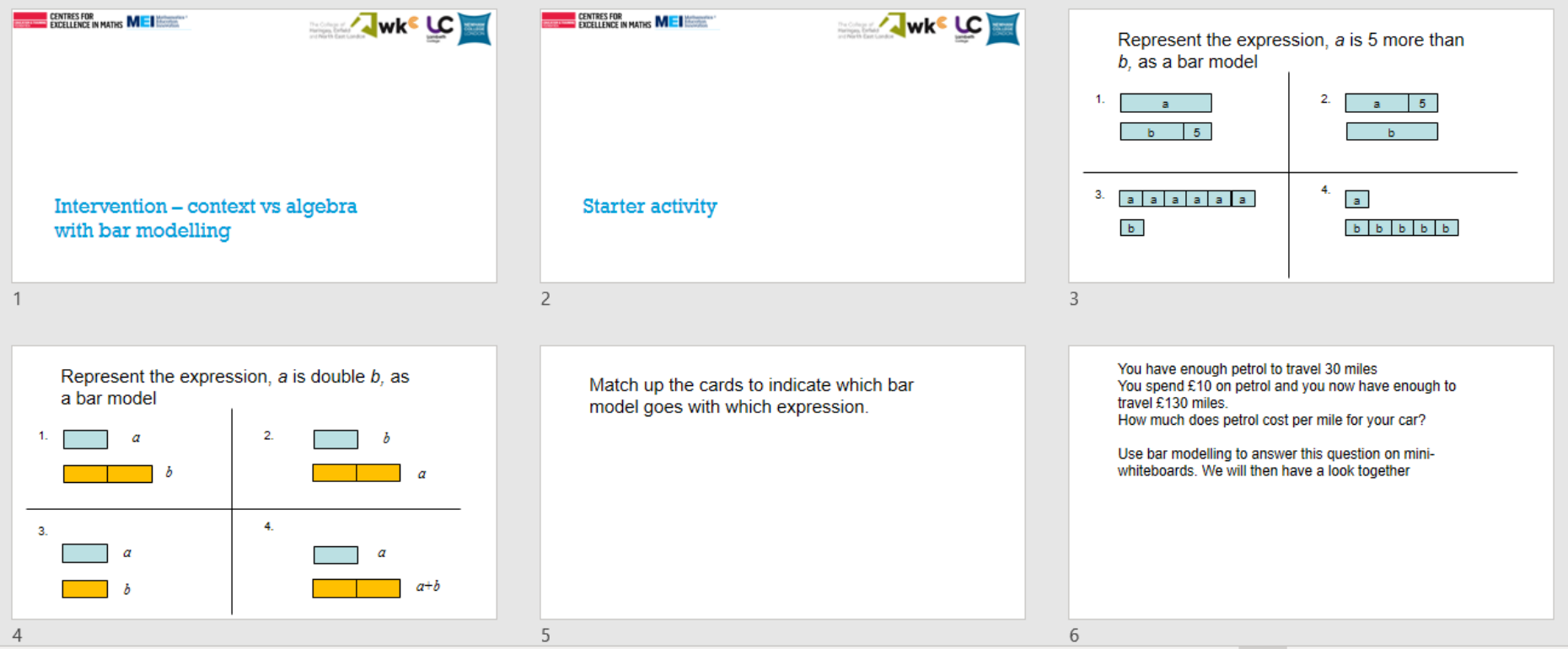
Big picture	Using mastery-based interventions address skills gaps on specific topics with 16-19 FS Level 1 and GCSE grade 3 achievers in a GCSE maths class. To support FS Level 1 achievers to apply the skillset learnt from the context-based learning in FS Maths Level 1 to other non-FS areas.	
Outline of intervention	1. Prior to interventions, we give out assessments and also do mini bar modelling for the suggested questions to acclimatise learners to bar modelling 2. Each intervention would focus on 1 or 2 of the question pairs 3. Starter activity with simple bar modelling 4. Matching task with simple bar modelling to encourage collaborative learning 5. Depending on which question the learners were strongest at – i.e. algebra or context, use this as a starting point 6. Bar model this question 7. If starting with context, go through a series of sequenced questions to slightly change the question into an algebraic format 8. Then link it to the paired question (different numbers and the algebra) – ask them to bar model 9. Extension/strong learners: for strong learners, prepare to present to the class their method and then present 10. Reserved for the last intervention - look at the exam style questions and learners choose which method they would use (bar model, algebra, other)	
Intervention Plan	<u>Starter activity (slides 2-6):</u> Two multiple-choice questions to ask which bar model represents the expression. If learners are still struggling, complete the matching task with bar models and simple expressions. Learners then attempt to bar model a similar question to the context-based question from the assessment. Learners use mini-whiteboards and share their ideas with the rest of the class. <u>Main intervention (slides 7-17):</u> Ask the class which question was easiest to do – take a tally/poll. As a teacher, we would also have the knowledge from the pre-intervention assessment.	5 mins 10-15 mins

	At this point, ask successful learners to review their work and prepare to present their method clearly to the rest of the class. Slides 8-15 are a series of slides with small changes from one to the next. It starts with the context-based question, but the slide order could be reversed to start with the algebra-based question, if that is what the learners are more confident with. Learners should be given the chance to bar model each question, and example slides should be used if learners are struggling. The teacher can also model using the graphics tablet if this is a preferred method of showing a bar model. Learners can use mini whiteboards to bar model and share their bar models with the rest of the group. For each slide, if a learner has used a different method of bar modelling, the graphics tablets could be used for learners to show the rest of the class on the main board. Collaborative discussion should be encouraged throughout. <u>Recap/round up (slides 16-18):</u> Check in with the learners again as to which is now easiest to do, learners should have another try at the question they found trickiest initially. Ask learners to take pictures of their work and send to you. Slide 17 can be used as a final show of how to bar model the question. For the final section of the intervention, those who were initially successful on the assessment should share their method. If time, guided discussion/questioning can then be used to show how methods may look different, but they have similar features (such as multiply and divide). Encourage learners to use the method they are most confident with, and that they make the least errors with.	5-10 mins

Post-intervention assessment	Learners have another attempt at the question they found the most trick – algebraic or context based. Take photos of learner work for evidence base/for comparison to their original methods.	
Evaluation of activity (student)	At the end of all the interventions, learners will fill out the MS forms	After the intervention cycle
Reflection form (Teacher)	Teacher to fill out the reflection log (separate document) as a minimum at the end of each week. The teacher may prefer to complete this more often. Questions are as below: Which question set(s) did you use in the interventions this week? Were your learners stronger with the algebraic questions or context-based questions for this/these question set(s)? Thinking about the structure (small changes from one step to another, multiple choice bar models) of the intervention: • What went well and why? • What could be improved? • How will you improve the intervention next week? How do you feel the bar modelling intervention affected learner progress with this/these question set(s)? How do you feel the bar modelling intervention affected learner confidence with this/these question set(s)? Did any other factors affect the intervention this week? Did anything surprise you when carrying out the intervention this week? What was the impact of stronger learners sharing their methods? Any other comments:	Minimum at the end of each week

Appendix 7: Cycle 3 Intervention PPTs & Bar Model Matching Task

For all PPTs please go to https://padlet.com/elizabeth_hopker/2122NewhamCfEMARProject1. Please see below for one PPT intervention and one set of matching cards.



Which is (was) easiest to do? If you successfully completed these questions, please prepare to present your successful method to the class

6. Sadia's car has enough petrol to travel 50 miles.
She spends £25 on petrol and now has enough to travel 165 miles.
How much does petrol cost per mile for Sadia's car?

A £4.00 B £2.17 C 22p D 15p

Show your working out:

6. Sadia's car has enough petrol to travel, 50, miles.
She spends £30 on petrol and now has enough to travel m miles.
How much does petrol cost per mile in pounds for Sadia's car, in terms of m?

A $\frac{m-50}{30}$ B $\frac{50-m}{30}$ C $\frac{30}{m-50}$ D $\frac{30}{m}$

Show your working out:

7

Sadia's car has enough petrol to travel 50 miles.

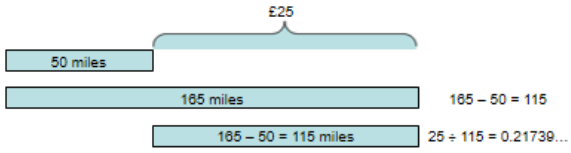
She spends £25 on petrol and now has enough to travel 165 miles.

How much does petrol cost per mile for Sadia's car?

Use bar modelling to answer this question

8

Sadia's car has enough petrol to travel 50 miles.
She spends £25 on petrol and now has enough to travel 165 miles.
How much does petrol cost per mile for Sadia's car?
Use bar modelling to answer this question



Cost per mile is £0.22 or 22p

9

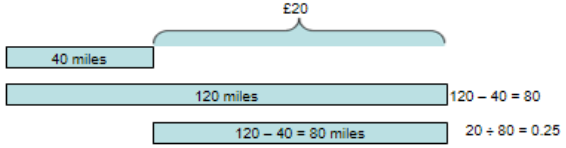
Mike is fuelling up his motorbike. The motorbike has enough fuel to travel 40 miles.
Mike spends £20 on petrol and now has enough to travel 120 miles.

How much does fuel cost per mile for Mike's motorbike?

Use bar modelling to answer this question

10

Mike is fuelling up his motorbike. The motorbike has enough fuel to travel 40 miles.
Mike spends £20 on petrol and now has enough to travel 120 miles.
How much does fuel cost per mile for Mike's motorbike?
Use bar modelling to answer this question



Cost per mile is £0.25 or 25p

11

Aliyah's drone has enough charge to fly for 2 hours.

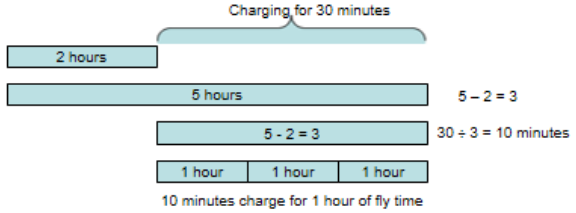
Aliyah puts the drone's battery on charge for 30 minutes and now has enough charge to fly for 5 hours.

How long do you need to charge the drone to get 1 hour of fly time?

Use bar modelling to answer this question

12

Aliyah's drone has enough charge to fly for 2 hours.
Aliyah puts the drone's battery on charge for 30 minutes and now has enough charge to fly for 5 hours.
How long do you need to charge the drone to get 1 hour of fly time?
Use bar modelling to answer this question



13 ★

Aliyah's drone has enough charge to fly for 2 hours.

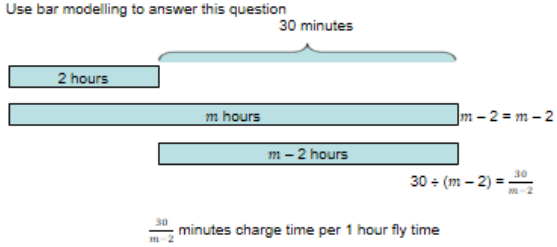
Aliyah puts the drone's battery on charge for 30 minutes and now has enough charge to fly for m hours.

How long do you need to charge the drone to get 1 hour of fly time?

Use bar modelling to answer this question

14

Aliyah's drone has enough charge to fly for 2 hours.
Aliyah puts the drone's battery on charge for 30 minutes and now has enough charge to fly for m hours.
How long do you need to charge the drone to get 1 hour of fly time?
Use bar modelling to answer this question



15 ★

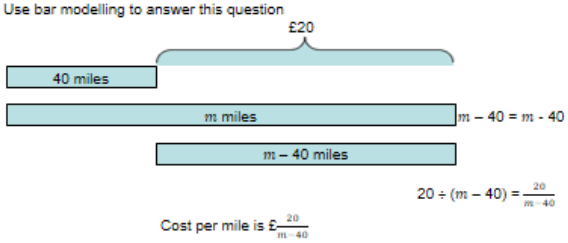
Mike is fuelling up his motorbike. The motorbike has enough fuel to travel 40 miles.
Mike spends £20 on petrol and now has enough to travel *m* miles.

How much does fuel cost per mile for Mike's motorbike?

Use bar modelling to answer this question

16

Mike is fuelling up his motorbike. The motorbike has enough fuel to travel 40 miles.
Mike spends £20 on petrol and now has enough to travel *m* miles.
How much does fuel cost per mile for Mike's motorbike?
Use bar modelling to answer this question



17 ★

Which is easiest to do? Have another try

6. Sadia's car has enough petrol to travel 50 miles.
She spends £25 on petrol and now has enough to travel 165 miles.
How much does petrol cost per mile for Sadia's car?

A £4.60 B £2.17 C 22p D 15p

Show your working out:

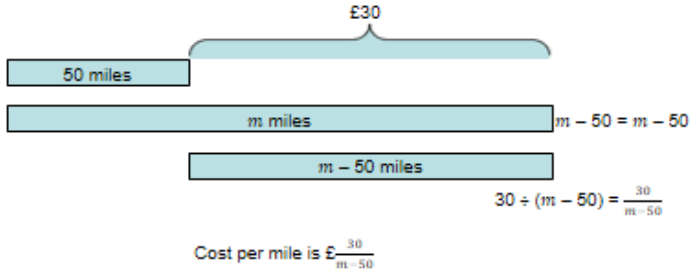
6. Sadia's car has enough petrol to travel, 50, miles.
She spends £30 on petrol and now has enough to travel m miles.
How much does petrol cost per mile in pounds for Sadia's car, in terms of m?

A (m−50)/30 B (50−m)/30 C 30/(m−50) D 30/m

Show your working out:

18

Sadia's car has enough petrol to travel 50 miles.
She spends £30 on petrol and now has enough to travel m miles.
How much does petrol cost per mile in pounds for Sadia's car in terms of m?



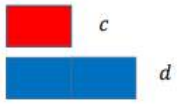
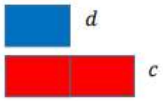
19

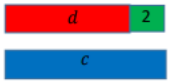
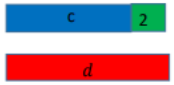
Which is easiest to do?
Those of you who were confident, now you'll share your method

Traditional method/your method

Bar model

20

Bar model thinker 1	
c is one half of d	d is one half of c
$c = \frac{d}{2}$	$d = \frac{c}{2}$
	
Bar model thinker 1:extension	
$2c = d$	$2d = c$
$c = \frac{1}{2}d$	$d = \frac{1}{2}c$

Bar model thinker 2	
d is 2 less than c	c is 2 less than d
$d = c - 2$	$c = d - 2$
	
$c = d + 2$	$d = c + 2$

Context-based pre-intervention assessment **Name:**
20 minutes

Appendix 8: Cycle 3 Pre- and Post-intervention Assessments, Mark Schemes and Assessment Analysis Blank Grid

(see https://padlet.com/elizabeth_hopker/2122NewhamCfEMARProject1 **for Excel assessment grid)**

1. How many grams in a kilogram?
(1 Mark)

A 10 **B** 100 **C** 1000 **D** 10 000

Show your working out:

2. One morning the temperature was −5 °C.
At lunchtime, the temperature is 3 °C.
How many degrees has the temperature gone up by?
(1 Mark)

A 8 °C **B** 2 °C **C** −2 °C **D** −8 °C

Show your working out:

3. 2.5 kg of potatoes cost £2.
How much does 1 kg of potatoes cost?
(1 Mark)

A 40p **B** 50p **C** 80p **D** £1

Show your working out:

Context-based pre-intervention assessment **Name:**
20 minutes

4. £1 is worth 1.25 Euros.
What is 6 Euros in pounds?
(1 Mark)

A £7.50 **B** £5.75 **C** £4.80 **D** £4.08

Show your working out:

5. Lee and Victor share £600 in the ratio 2 : 3.
How much does Lee get?
(2 Marks)

A £300 **B** £360 **C** £240
D £120

Show your working out:

6. Sadia's car has enough petrol to travel 50 miles.
She spends £25 on petrol and now has enough to travel 165 miles.
How much does petrol cost per mile for Sadia's car?
(2 Marks)

A £4.60 **B** £2.17 **C** 22p **D** 15p

Show your working out:

Context-based pre-intervention assessment **Name:**
20 minutes

7. Lisa and 3 friends have a meal in a restaurant.
The total bill is £72.
They want to share the bill equally.
They want to pay roughly 10% extra to leave a tip.
How much should each person pay?
(3 Marks)

A £16 **B** £18 **C** £20 **D** £25

Show your working out:

8. The time that a good cyclist takes to travel any distance is about 75% of the time an average cyclist would take.
A good cyclist does a particular journey in 45 minutes.
(2 Marks)
Which is the best estimate of the time an average cyclist takes to do the same journey?

A 34 minutes **B** 56 minutes **C** 1 hour **D** 70 minutes

Show your working out:

9. A college has

A total of 105 teachers
19 more female teachers than male teachers

What proportion of the teachers are female?
(3 marks)

Algebra-based pre-intervention assessment **Name:**
20 minutes

1. Write an expression to convert x kilograms into grams
(1 Mark)

A $10x$ **B** $100x$ **C** $1000x$ **D** $10\,000x$

Show your working out:

2. One morning the temperature was −5 °C.
(1 Mark)

At lunchtime, the temperature is x °C.
In terms of x, how many degrees has the temperature gone up by?

A $x - -5$ °C **B** $5 - x$ °C **C** $x - 5$ °C **D** $-(x + 5)$ °C

Show your working out:

3. 4.5 kg of potatoes cost £x.
(1 Mark)

In terms of x, write an expression for how much 1kg of potatoes would cost.

A $\frac{x}{9}$ **B** $x - 3.5$ **C** $\frac{2x}{9}$ **D** $\frac{x}{4}$

Show your working out:

Algebra-based pre-intervention assessment **Name:**
20 minutes

4. £1 is worth 1.15 Euros.
(1 Mark)

Create a formula to work out the number of pounds, p, when you have e Euros.

A $p = 1.15e$ **B** $p = 1.15 + e$ **C** $p = \frac{e}{1.15}$ **D** $e = \frac{p}{1.15}$

Show your working out:

5. Lee and Victor share £a in the ratio 3 : 4.
(2 Marks)

How much money, in terms of a, would Lee get?

A $\frac{a}{2}$ **B** $\frac{4a}{7}$ **C** $\frac{3a}{7}$ **D** $\frac{a}{7}$

Show your working out:

6. Sadia's car has enough petrol to travel, 50, miles.
(2 Marks)

She spends £30 on petrol and now has enough to travel m miles.
How much does petrol cost per mile in pounds for Sadia's car, in terms of m?

A $\frac{m-50}{30}$ **B** $\frac{50-m}{30}$ **C** $\frac{30}{m-50}$ **D** $\frac{30}{m}$

Show your working out:

Algebra-based pre-intervention assessment **Name:**
20 minutes

7. Ahmed and 4 friends have a meal in a restaurant.
(3 Marks)

The total bill is £x.
They want to share the bill equally.
They want to pay roughly 15% extra to leave a tip.
How much should each person pay, in terms of x?

A $\frac{0.85x}{5}$ **B** $\frac{x}{5}$ **C** $\frac{1.15x}{5}$ **D** $\frac{1.15x}{4}$

Show your working out:

8. The time that a good cyclist takes to travel any distance is about 60% of the time an average cyclist would take.
A good cyclist does a particular journey in, m, minutes.
(2 Marks)
Which is the best estimate of the time an average cyclist takes to do the same journey?

A $0.6m$ **B** $1.4m$ **C** $\frac{m}{0.6}$ **D** $m + 40$

Show your working out:

9. A college has

a total of 150 teachers
f more female teachers than male teachers

In terms of f, what proportion of the teachers are female?
(3 marks)

Mark Scheme Pre-Intervention Assessment Cycle 3

Contextualised assessment

Question number	Working stage/correct answer	Mark awarded	Misconceptions associated with incorrect answers
1. (taken from Qu 1 on MEI)	Circles C 1000	1 mark	1A Thinks there are 10 g in a kg 1B Thinks there are 100 g in a kg 1C Correct answer 1D Thinks there are 10 000 g in a kg
2. (taken from Qu 2 on MEI)	Circles A 8 °C	1 mark	2A Correct answer 2B Realises the temperature has gone up but has found the difference between 3 and 5 2C Has done 3 − 5 2D Has found the difference but may have thought that one number negative and the other positive will result in a negative answer
3. (taken from Qu 7 on MEI)	Circles C 80p	1 mark	A Has found cost of 0.5 kg B Has subtracted 1.5 from each of cost and amount C Correct answer D Has halved given price to find cost of 1.25 kg
4. (taken from Qu 9 on MEI)	Circles C £4.80	1 mark	A Has calculated 1.25 × 6 instead of 6 ÷ 1.25 B The number of Euros has gone up by 4.75. The number of pounds has been increased by the same amount C Correct answer D Has interpreted 4.8 as £4.08 instead of £4.80
5. (taken from Qu 10 on MEI)	Finds one part (£120) i.e. 600 ÷ (2+3) Circles C £240	1 mark 1 mark	A Has just found half the total amount B Has found the amount that Victor gets instead of the amount Lee gets C Correct answer D Has found one part instead of two parts
6. (taken from Qu 21 on MEI)	165 – 50 Circles C 22p	1 mark 1 mark	A Has divided the number of miles by the number of pounds instead of the other way round B Has misinterpreted 0.217… C Correct answer D Has assumed it is £25 for 165 miles instead of 115 miles
7. (taken from Qu 29 on MEI)	Finds price including tip i.e. 1.1 × 72 Finds price for each person 79.2÷4 Circles C £20	1 mark 1 mark 1 mark	A May have taken 10% off the bill. This will not be enough B Has not added on 10% C Correct answer D Too much; the tip is £28 which is more like 40%. May have misread as 3 friends and not included Lisa

8. (taken from Qu 32 on MEI)	Completes reverse percentage calculation i.e. 45 ÷ 0.75 Circles C 1 hour	1 mark 1 mark	A Has found 75% of 45 minutes and rounded B Has increased 45 minutes by 25% and rounded C Correct answer D Has added 25 (100 – 75) to 45
9. (taken from AQA past exam paper)	Works with 19 more i.e. 105 – 19 (=86) Finds number of female teachers i.e. 86 ÷ 2 + 19 $\frac{62}{105}$ oe	1 mark 1 mark 1 mark	Common misconceptions: Interpreted the question as 19 female teachers, so would get answer of 19/105

<u>Algebra assessment</u>

Question number	Working stage/correct answer	Mark awarded	Misconceptions associated with incorrect answers
1. (taken from Qu 1 on MEI)	Circles C 1000x	1 mark	1A Thinks there are 10 g in a kg 1B Thinks there are 100 g in a kg 1C Correct answer 1D Thinks there are 10 000 g in a kg
2. (taken from Qu 2 on MEI)	Circles A $x - -5$ °C	1 mark	2A Correct answer 2B Realises the temperature has gone up but has found the difference between x and 5 2C Has done x − 5 2D Has found the difference but may have thought that one number negative and the other positive will result in a negative answer
3. (taken from Qu 7 on MEI)	Circles C $\frac{2x}{9}$	1 mark	A Has found an expression for the cost of 0.5 kg B Has subtracted 3.5 from each of cost and amount to get £1, 1kg C Correct answer D Has quartered given price to find the rough cost of 1kg
4. (taken from Qu 9 on MEI)	Circles C $p = \frac{e}{1.15}$	1 mark	A Has calculated 1.25 × e instead of e ÷ 1.25 B The number of Euros has gone up by e Euros. The number of pounds has been increased by the same amount C Correct answer D Has worked as if the pounds and euros are reversed in placement of question

5. (taken from Qu 10 on MEI)	Finds one part i.e. a ÷ (3+4) Circles C $\frac{3a}{7}$	1 mark 1 mark	A Has just found half the total amount B Has found the amount that Victor gets instead of the amount Lee gets C Correct answer D Has found one part instead of three parts
6. (taken from Qu 21 on MEI)	Expression for difference between no. of miles i.e. m – 50 Circles C $\frac{30}{m-50}$	1 mark 1 mark	A Has divided the number of miles by the number of pounds instead of the other way round B Has divided number of miles by pounds, and also incorrectly calculated the number of miles increased C Correct answer D Has assumed it is £30 for m miles instead of m – 50 miles
7. (taken from Qu 29 on MEI)	Finds price including tip i.e. $1.15x$ Finds price for each person , divides by 5 Circles C $\frac{1.15x}{5}$	1 mark 1 mark 1 mark	A May have taken 15% off the bill. This will not be enough B Has not added on 15% C Correct answer D May have misread as 4 friends and not included Ahmed
8. (taken from Qu 32 on MEI)	Identifies multiplier for 60% i.e. 0.6 Circles C $\frac{m}{0.6}$	1 mark 1 mark	A Has found 60% of m minutes B Has increased m minutes by 40% C Correct answer D Has added 40 (100 –60) to m
9. (taken from AQA past exam paper)	Works with f more i.e. 150 – f Finds number of female teachers i.e. 0.5(150 – f) + f OR 75 + 0.5f $\frac{75+0.5f}{150}$ oe	1 mark 1 mark 1 mark	Common misconceptions: Interpreted the question as f female teachers, so would get answer of f/150

Context-based post-intervention assessment **Name:**
20 minutes

1. How many cm in a metre?
(1 Mark)

A 10 000 **B** 1000 **C** 100 **D** 10

Show your working out:

2. In Warsaw the temperature was −8 °C.
(1 Mark)

In Krakow, the temperature is 2 °C.
What is the difference in temperature between Krakow and Warsaw?

A 6°C **B** 10 °C **C** -6 °C **D** −10°C

Show your working out:

3. 6.5 litres of petrol cost £9.75.
How much does 1 litre of petrol cost?
(1 Mark)

A 75p **B £**2.13 **C** £4.25 **D** £1.50

Show your working out:

Context-based post-intervention assessment **Name:**
20 minutes

4. £1 is worth 1.36 American dollars
What is 10 American dollars in pounds?
(1 Mark)

A £7.35 **B** £13.06 **C** £10.11 **D** £13.60

Show your working out:

5. Aadi and Asha share £1800 in the ratio 7: 2.
How much does Asha get?
(2 Marks)

A £200 **B** £1400 **C** £900 **D** £400

Show your working out:

6. James has to drive 170 miles to his parent's house.
(2 Marks)
He drives for 80 miles and reckons it will take 2 hours to reach his parents from there.
What speed, in miles per hour, does James think he will be driving at?

A 0.02mph **B** 22mph **C** 45mph **D** 85mph
Show your working out:

Context-based post-intervention assessment **Name:**
20 minutes

7. Jana and her 3 sisters buy their mother some earrings for her birthday (3 Marks)

The cost of the earrings is £260 plus VAT at 20%
They want to share the cost equally.
How much should each person pay?

A £104 **B** £78 **C** £58.50 **D** £65

Show your working out:

8. Due to a virus the number of fish in a pond has decreased by 20% in a year
This year there are 160 fish in the pond. (2 Marks)
How many fish were in the pond last year?

A 180 **B** 200 **C** 128 **D** 172

Show your working out:

9. A creche has

A total of 68 babies
24 more boys than girls

What proportion of the babies are boys?
(3 marks)

Algebra-based post-intervention assessment **Name:**
20 minutes

1. Write an expression to convert x metres into centimetres
(1 Mark)

A $10\,000x$ **B** $1000x$ **C** $100x$ **D** $10x$

Show your working out:

2. In Warsaw the temperature was −6 °C.
(1 Mark)

In Krakow, the temperature is x °C.
In terms of x, what is the difference in temperature between Krakow and Warsaw?

A $-(x+6)$ °C **B** $x-6$ °C **C** $6-x$ °C **D** $x+6$ °C

Show your working out:

3. 7.5 litres of petrol cost £x.
In terms of x How much does 1 litre of petrol cost?
(1 Mark)

A $\frac{15x}{2}$ **B** $x-7.5$ **C** $\frac{2x}{15}$ **D** $\frac{x}{7}$

Show your working out:

Algebra-based post-intervention assessment **Name:**
20 minutes

4. £1 is worth 1.39 American Dollars.
(1 Mark)

Create a formula to work out the number of pounds, p, when you have d American Dollars.

A $d = \frac{p}{1.39}$ **B** $p = 1.39 - d$ **C** $p = 1.39 + d$ **D** $p = \frac{d}{1.39}$

Show your working out:

5. Aadi and Asha share £k in the ratio 5 : 3.
(2 Marks)

How much money, in terms of k, would Asha get?

A $\frac{5k}{8}$ **B** $\frac{3k}{8}$ **C** $\frac{k}{8}$ **D** $\frac{k}{3}$

Show your working out:

6. James has to drive 210 miles to his parent's house.
(2 Marks)

He drives for m miles and reckons it will take 3 hours to reach his parents from there. What speed, in miles per hour, does James think he will be driving at? Write your answer in terms of m

A $\frac{m-210}{3}$ **B** $\frac{3-m}{210}$ **C** $\frac{210-m}{3}$ **D** $\frac{210}{m}$

Show your working out:

Algebra-based post-intervention assessment **Name:**
20 minutes

7. Jana and her 4 sisters buy their mother some earrings for her birthday (3 Marks)

The cost of the earrings is £x plus VAT at 20%
They want to share the cost equally.
How much should each person pay, in terms of x?

A $\frac{0.8x}{5}$ **B** $\frac{x}{5}$ **C** $\frac{1.2x}{5}$ **D** $\frac{1.2x}{4}$

Show your working out:

8. Due to a virus the number of fish in a pond has decreased by 30% in a year
This year there are f fish in the pond. (2 Marks)
How many fish were in the pond last year? Write your answer in terms of f

A $0.7f$ **B** $1.3f$ **C** $\frac{f}{0.7}$ **D** $f + 30$

Show your working out:

9. A creche has

a total of 68 babies
b more boys than girls

In terms of b, what proportion of the babies are boys? (3 marks)

Mark Scheme Post-Intervention Assessment Cycle 3

Contextualised assessment

Question number	Working stage/correct answer	Mark awarded	Misconceptions associated with incorrect answers
10. (taken from Qu 1 on MEI)	Circles C 100	1 mark	1A Thinks there are 10 000 cm in a m 1B Thinks there are 1000 cm in a m 1C Correct answer 1D Thinks there are 10 cm in a m
11. (taken from Qu 2 on MEI)	Circles B 10 °C	1 mark	2A Realises the temperature has gone up but has found the difference between 2 and 8 2B Correct answer 2C Has found the difference but may have thought that one number negative and the other positive will result in a negative answer 2D Has done 2 − 8
12. (taken from Qu 7 on MEI)	Circles D £1.50	1 mark	A Has found cost of 0.5l B Has divided by 6 and added 0.5 C Has subtracted 5.5 from each of cost and amount D Correct answer
13. (taken from Qu 9 on MEI)	Circles A £7.35	1 mark	A Correct answer B Has interpreted 13.6 as £13.06 instead of £13.60 C The number of Euros has gone up by 8.75. The number of pounds has been increased by the same amount D Has calculated 1.36 × 10 instead of 10 ÷ 1.36
14. (taken from Qu 10 on MEI)	Finds one part (£200) i.e.1800 ÷ (2+7) Circles D £400	1 mark 1 mark	A Has found one part instead of two parts B Has found the amount that Aadi gets instead of the amount Asha gets C Has just found half the total amount D Correct answer
15. (taken from Qu 21 on MEI)	170– 80 Circles C 45	1 mark 1 mark	A Has divided the time by the number of miles instead of the other way round B Has misinterpreted 0.022 C Correct answer D Has assumed it is 170 miles instead of 90 miles
16. (taken from Qu 29 on MEI)	Finds price including VAT i.e. 1.2 × 260 Finds price for each person 312÷4 Circles B £78	1 mark 1 mark 1 mark	A May have misread as 3 sisters and not included Jana B Correct answer C May have taken 10% off the cost. This will not be enough D Has not added on 20%

17. (taken from Qu 32 on MEI)	Completes reverse percentage calculation i.e. 160 ÷ 0.8 Circles B 200	1 mark 1 mark	A Has added 20 (100 – 80) to 160 B Correct answer C Has found 80% of 160 minutes D Has increased 160 minutes by 20%
18. (taken from AQA past exam paper)	Works with 24 more i.e. 68–24 (=44) Finds number of boys i.e. 44 ÷ 2 + 24 $\frac{46}{68}$ oe	1 mark 1 mark 1 mark	Common misconceptions: Interpreted the question as 24 boys, so would get answer of 24/68

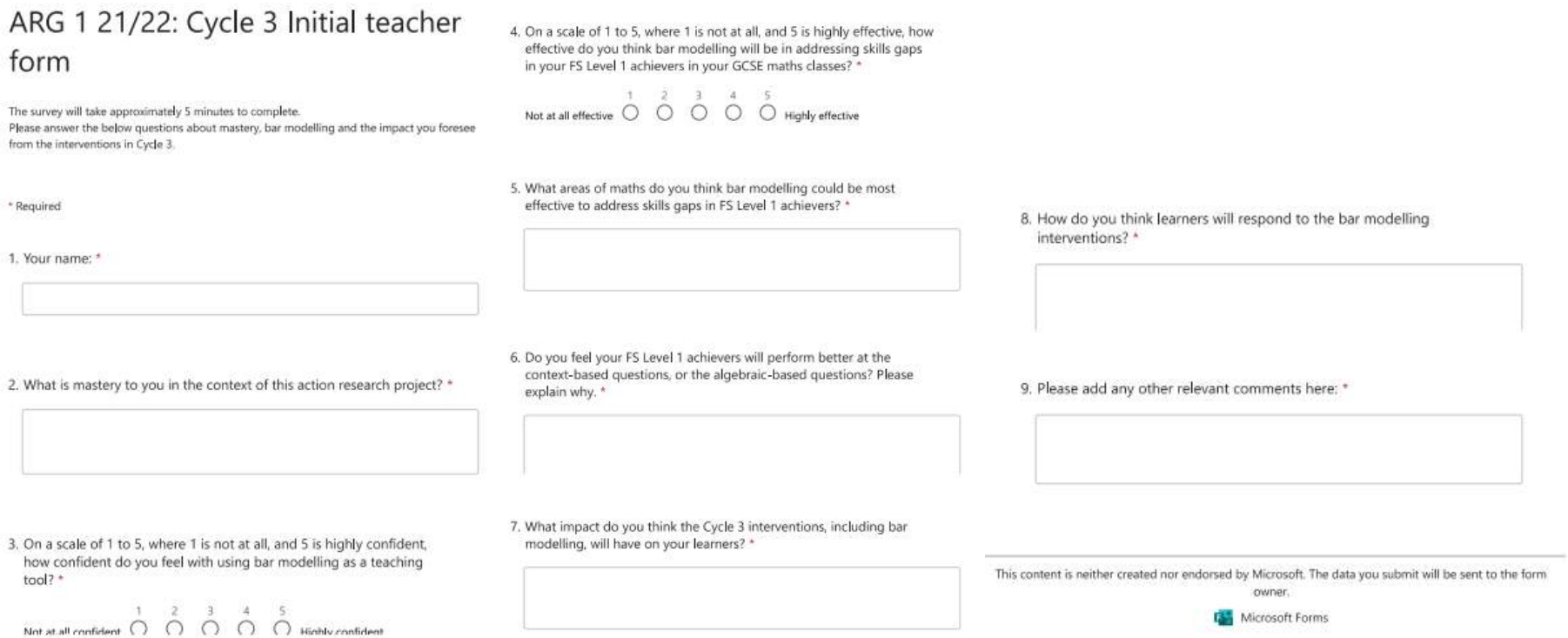
Algebra assessment

Question number	Working stage/correct answer	Mark awarded	Misconceptions associated with incorrect answers
10. (taken from Qu 1 on MEI)	Circles C 100x	1 mark	1A Thinks there are 10 cm in a m 1B Thinks there are 100 cm in a m 1C Correct answer 1D Thinks there are 10 000 cm in a m
11. (taken from Qu 2 on MEI)	Circles D $x - -6$ °C	1 mark	2A Has found the difference but may have thought that one number negative and the other positive will result in a negative answer 2B Realises the temperature has gone up but has found the difference between x and 6 2C Has done 6− x 2D Correct answer
12. (taken from Qu 7 on MEI)	Circles C $\frac{2x}{15}$	1 mark	A Has found an expression for the cost of 0.5 lt flipped the fraction incorrectly B Has subtracted 7.5 from each of cost and amount C Correct answer D Has divided by 7
13. (taken from Qu 9 on MEI)	Circles D $p = \frac{d}{1.39}$	1 mark	A Has worked as if the pounds and euros are reversed in placement of question B The number of Euros has gone up by d dollars. The number of pounds has been decreased by the same amount C The number of Euros has gone up by d dollars. The number of pounds has been increased by the same amount D Correct answer

14. (taken from Qu 10 on MEI)	Finds one part i.e. a ÷ (5+3) Circles B $\frac{3k}{8}$	1 mark 1 mark	A Has found the amount that Aadi gets instead of the amount Asha gets B Correct answer C Has just found half the total amount D Has found one part instead of two parts
15. (taken from Qu 21 on MEI)	Expression for difference between no. of miles i.e. 210–m Circles C $\frac{210-m}{3}$	1 mark 1 mark	A Has divided the number of miles by the time instead of the other way round B Has taken the m off the time instead of distance C Correct answer D Has assumed it is 210 miles for 3 hours instead of 210 – m miles
16. (taken from Qu 29 on MEI)	Finds price including VAT i.e. $1.2x$ Finds price for each person , divides by 5 Circles C $\frac{1.2x}{5}$	1 mark 1 mark 1 mark	A Has taken 20% off the bill first B Has not added on 20% C Correct answer D Has divided by 4 so may have forgotten to add Jana
17. (taken from Qu 32 on MEI)	Identifies multiplier for 70% i.e. 0.7 Circles C $\frac{f}{0.7}$	1 mark 1 mark	A Has found 70% of fish B Has increased f by 30% C Correct answer D Has added 30 (100 –70) to m
18. (taken from AQA past exam paper)	Works with b more i.e. 68 – b Finds number of boys i.e. 0.5(68 – b) + b Or 34 + 0.5b $\frac{34+0.5b}{68}$ oe	1 mark 1 mark 1 mark	Common misconceptions: Interpreted the question as b boys, so would get answer of b/68

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	**Context-based pre-intervention assessment**	Grams to kg		Temperature difference		Proportion and cost		Converting euros to pounds		Dividing into a ratio		Price per mile		Percentages and price per person		Reverse percentages		Ratio to proportion - how many more		Total
2	**Question number**	Q1 (mark)	Q1 (mis-concepti on)	Q2 (mark)	Q2 (mis-concepti on)	Q3 (mark)	Q3 (mis-concepti on)	Q4 (mark)	Q4 (mis-concepti on)	Q5 (mark)	Q5 (mis-concepti on)	Q6 (mark)	Q6 (mis-concepti on)	Q7 (mark)	Q7 (mis-concepti on)	Q8 (mark)	Q8 (mis-concepti on)	Q9 (mark)	Q9 (mis-concepti on)	
3	**Student number/anonymous identifier (highlights in yellow have achieved FS Level 1 in lieu of grade 3)**	**Mark out of 1**	**Letter or n/a**	**Mark out of 1**	**Letter or n/a**	**Mark out of 1**	**Letter or n/a**	**Mark out of 1**	**Letter or n/a**	**Mark out of 2**	**Letter or n/a**	**Mark out of 2**	**Letter or n/a**	**Mark out of 3**	**Letter or n/a**	**Mark out of 2**	**Letter or n/a**	**Mark out of 3**	**Letter or n/a**	**Total out of 16**
4	1																			0
5	2																			0
6	3																			0
7	4																			0
8	5																			0
9	6																			0
10	7																			0
11	8																			0

Appendix 9: Cycle 3 Initial Teacher Form



ARG 1 21/22: Cycle 3 Initial teacher form

The survey will take approximately 5 minutes to complete.
Please answer the below questions about mastery, bar modelling and the impact you foresee from the interventions in Cycle 3.

* Required

1. Your name: *

2. What is mastery to you in the context of this action research project? *

3. On a scale of 1 to 5, where 1 is not at all, and 5 is highly confident, how confident do you feel with using bar modelling as a teaching tool? *

Not at all confident 1 2 3 4 5 Highly confident

4. On a scale of 1 to 5, where 1 is not at all, and 5 is highly effective, how effective do you think bar modelling will be in addressing skills gaps in your FS Level 1 achievers in your GCSE maths classes? *

Not at all effective 1 2 3 4 5 Highly effective

5. What areas of maths do you think bar modelling could be most effective to address skills gaps in FS Level 1 achievers? *

6. Do you feel your FS Level 1 achievers will perform better at the context-based questions, or the algebraic-based questions? Please explain why. *

7. What impact do you think the Cycle 3 interventions, including bar modelling, will have on your learners? *

8. How do you think learners will respond to the bar modelling interventions? *

9. Please add any other relevant comments here: *

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Microsoft Forms

Appendix 10: Cycle 3 Teacher Reflection Proforma

Action Research Project 1 Newham CfEM Teacher reflection proforma, Cycle 3 – Intervention week 1
Teacher name:
Key info about the class(es) (attendance, delivery mode, age range etc):
Which question set(s) did you use in the interventions this week?
Were your learners stronger with the algebraic questions or context-based questions for this/these question set(s)?
Thinking about the structure (small changes from one step to another, multiple choice bar models) of the intervention: • What went well and why? • What could be improved? • How will you improve the intervention next week?
How do you feel the bar modelling intervention affected learner progress with this/these question set(s)?
How do you feel the bar modelling intervention affected learner confidence with this/these question set(s)?
Did any other factors affect the intervention this week?
Did anything surprise you when carrying out the intervention this week?

What was the impact of stronger learners sharing their methods?
Any other comments:
Action Research Project 1 Newham CfEM Teacher reflection proforma, Cycle 3 – Intervention week 2
Key info about the class(es) (attendance, delivery mode, age range etc):
Which question set(s) did you use in the interventions this week?
Were your learners stronger with the algebraic questions or context-based questions for this/these question set(s)?
Thinking about the structure (small changes from one step to another, multiple choice bar models) of the intervention: • What went well and why? • What could be improved? • How will you improve the intervention next week?
How do you feel the bar modelling intervention affected learner progress with this/these question set(s)?
How do you feel the bar modelling intervention affected learner confidence with this/these question set(s)?

Did any other factors affect the intervention this week?
Did anything surprise you when carrying out the intervention this week?
What was the impact of stronger learners sharing their methods?
Any other comments:
Action Research Project 1 Newham CfEM Teacher reflection proforma, Cycle 3 – Intervention week 3
Key info about the class(es) (attendance, delivery mode, age range etc):
Which question set(s) did you use in the interventions this week?
Were your learners stronger with the algebraic questions or context-based questions for this/these question set(s)?
Thinking about the structure (small changes from one step to another, multiple choice bar models) of the intervention: • What went well and why? • What could be improved? • How will you improve the intervention next week?
How do you feel the bar modelling intervention affected learner progress with this/these question set(s)?

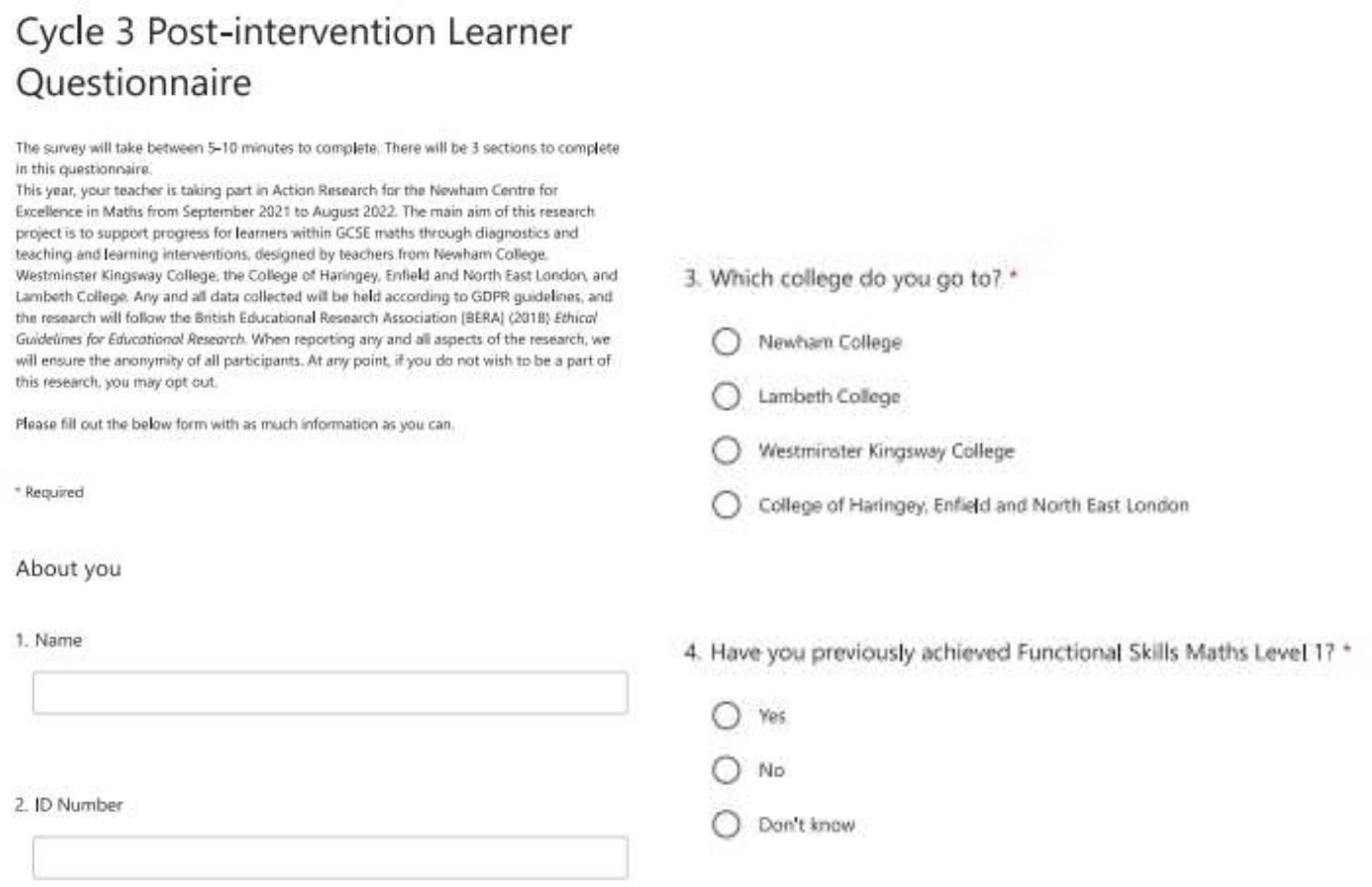
How do you feel the bar modelling intervention affected learner confidence with this/these question set(s)?
Did any other factors affect the intervention this week?
Did anything surprise you when carrying out the intervention this week?
What was the impact of stronger learners sharing their methods?
Any other comments:

Appendix 11: Cycle 3 Teacher Visit Observation Schedule

Observing Teacher Teacher being observed:

Date and time of intervention:	Which intervention question set:	Key details about the class, and which students are being focussed on:	
How well do the focus students cope with the contextualised questions?		How well do the focus students cope with the algebraic questions?	
How many times does each focus student uses a bar model method unprompted? Indicate at what point in the intervention lesson this happens.	Student 1: Student 2: (Student 3:)	When prompted by the teacher to use a bar model, does each focus student use a bar model method or not?	
How many times does each focus student use a bar model method when prompted? Indicate at what point in the intervention lesson this happens.	Student 1: Student 2: (Student 3:)	Tally the total number of times that the teacher prompts students to use a bar model	
What are the students' responses to using bar modelling? Facial expressions, body language, indicators of motivation and engagement etc.		Overall, how successful were the students with bar modelling during the intervention? Did the students improve?	
Any other reflections:			

Appendix 12: Cycle 3 Post-intervention Learner Questionnaire



Cycle 3 Post-intervention Learner Questionnaire

The survey will take between 5-10 minutes to complete. There will be 3 sections to complete in this questionnaire.
This year, your teacher is taking part in Action Research for the Newham Centre for Excellence in Maths from September 2021 to August 2022. The main aim of this research project is to support progress for learners within GCSE maths through diagnostics and teaching and learning interventions, designed by teachers from Newham College, Westminster Kingsway College, the College of Haringey, Enfield and North East London, and Lambeth College. Any and all data collected will be held according to GDPR guidelines, and the research will follow the British Educational Research Association (BERA) (2018) *Ethical Guidelines for Educational Research*. When reporting any and all aspects of the research, we will ensure the anonymity of all participants. At any point, if you do not wish to be a part of this research, you may opt out.

Please fill out the below form with as much information as you can.

* Required

About you

1. Name

2. ID Number

3. Which college do you go to? *

- Newham College
- Lambeth College
- Westminster Kingsway College
- College of Haringey, Enfield and North East London

4. Have you previously achieved Functional Skills Maths Level 1? *

- Yes
- No
- Don't know

Your views, experience of maths and bar modelling

5. At the moment, how do you feel about doing GCSE Maths classes this year? *

6. Which areas or topics in the GCSE Maths course, if any, are you less confident on?
Please list these topic areas below. *

7. Please describe what you think bar modelling is: *

8. What do you remember about using bar modelling in your GCSE maths classes since January? *

9. Thinking about the lessons involving bar modelling, if you could improve them, what would you suggest? *

10. What parts of the lessons involving bar modelling did you feel provided you with the most support? *

11. What parts of the lessons involving bar modelling did you enjoy the most? *

Rate the following statements then answer the final questions

Please rate the following statements on a scale of 1 to 5, where 1 is strongly disagree and 5 is strongly agree, about your recent experience in the bar modelling interventions/lessons. If you

12. Matching tasks have helped me learn how to do bar modelling

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly Agree

13. Sharing my own methods/ways of solving a maths problem was a helpful way to learn

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly Agree

14. Bar modelling helped me in areas of maths that I wasn't confident on

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly Agree

15. Bar modelling has been more helpful than other methods that I've been taught

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly Agree

16. Bar modelling has helped me apply knowledge from one area of maths to another (i.e. number to algebra)

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly Agree

17. Overall, bar modelling has helped me understand maths better

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly Agree

18. In which areas or topics in the GCSE maths course do you find bar modelling to be a useful strategy, if any? *

19. If you were already confident with a different method for maths problems, would you now use bar modelling instead? *

- ○ Yes
- ○ No
- ○ Maybe

20. Please write below any other feedback you have which you think could be applicable

Appendix 13: Post-AR Teacher Questionnaire

ARG 1 21/22: Cycle 3 Post-intervention teacher form and Post Project questionnaire

The survey will take approximately 11 minutes to complete. You will answer questions on both Cycle 3 and the project as a whole. As per our other data collection, your responses will be used for the purposes of the action research project, but all responses will be anonymised.

* Required

1. Your name: *

2. Now that we are moving towards the end of this action research project, what is mastery to you in the context of this action research project? *

3. On a scale of 1 to 5, where 1 is not at all, and 5 is highly confident, how confident do you feel now with using bar modelling as a teaching tool? *

Not at all confident 1 2 3 4 5 Highly confident

4. On a scale of 1 to 5, where 1 is not at all, and 5 is highly effective, how effective did you feel bar modelling was for addressing skills gaps in your FS Level 1 achievers in your GCSE maths classes? *

Not at all effective 1 2 3 4 5 Highly effective

5. What areas of maths was bar modelling most effective for addressing skills gaps in your FS Level 1 achievers? *

6. Would your answer above differ if you were thinking of those who had achieved GCSE grade 3? If so, how? *

7. Did your FS Level 1 achievers perform better at the context-based questions, or the algebraic-based questions? Did this change as you did more interventions? Please explain why you think this was the case. *

8. Did your GCSE grade 3 learners perform better at the context-based questions, or the algebraic-based questions? Did this change as you did more interventions? Please explain why you think this was the case. *

9. Overall, what impact do you think the Cycle 3 interventions, including bar modelling, had on your learners? Please compare and contrast those who have achieved FS Level 1 vs GCSE grade 3. *

10. How did your learners respond to the bar modelling interventions? *

11. Please rate the statement on a scale of 1 to 5, where 1 is strongly disagree and 5 is strongly agree. If you feel the statement is not applicable, please leave blank.
Matching tasks supported your learners with bar modelling

Strongly disagree 1 2 3 4 5 Strongly agree

12. Please rate the statement on a scale of 1 to 5, where 1 is strongly disagree and 5 is strongly agree. If you feel the statement is not applicable, please leave blank.
Matching tasks supported your learners with their mathematical understanding

1 2 3 4 5

13. Please rate the statement on a scale of 1 to 5, where 1 is strongly disagree and 5 is strongly agree. If you feel the statement is not applicable, please leave blank.
Learners sharing their methods with others supported progress and mathematical understanding for others

1 2 3 4 5
Strongly disagree ○ ○ ○ ○ ○ Strongly agree

14. Please rate the statement on a scale of 1 to 5, where 1 is strongly disagree and 5 is strongly agree. If you feel the statement is not applicable, please leave blank.
A learner sharing their methods with others their own supported progress and mathematical understanding

1 2 3 4 5
Strongly disagree ○ ○ ○ ○ ○ Strongly agree

15. Please rate the statement on a scale of 1 to 5, where 1 is strongly disagree and 5 is strongly agree. If you feel the statement is not applicable, please leave blank.
Bar modelling supported learners in the areas of maths they weren't confident with

1 2 3 4 5

16. Please rate the statement on a scale of 1 to 5, where 1 is strongly disagree and 5 is strongly agree. If you feel the statement is not applicable, please leave blank.
The bar modelling interventions helped learners to apply knowledge from the context-based questions to the algebraic-based questions or vice versa

1 2 3 4 5

17. Please rate the statement on a scale of 1 to 5, where 1 is strongly disagree and 5 is strongly agree. If you feel the statement is not applicable, please leave blank.
The bar modelling interventions had a positive impact on learner progress overall

1 2 3 4 5

18. To improve the interventions, what would you do differently next time, if anything? *

19. Please add any other relevant comments about the cycle 2 interventions here: *

Thinking about the AR project as a whole

Now, think about the AR project as a whole – we are not quite at the end of it, but please try to reflect as much as possible on your journey from September to now.

20. What difference, if any, do you now perceive there to be between a 16-19-year-old learner who has achieved GCSE maths grade 3 vs a learner who has achieved Functional Skills Maths Level 1? *

21. Thinking about your learners now, which learners this year are most likely to be successful at achieving GCSE Maths grade 4 this summer *

- ○ Those who have achieved GCSE Maths grade 3
- ○ Those who have achieved FS Maths Level 1
- ○ Other

22. Please say why you have chosen the group above. *

23. What topics have your FS Maths Level 1 achievers struggled with compared to a GCSE Maths grade 3 achiever, if any? *

24. Which of the activities, a) sharing their own methods, b) bar modelling, c) other, have your learners started to use independently? *

- [ ] Sharing their own methods
- [ ] Bar modelling
- [ ] None
- [ ] Other

25. Please select below which of the activities carried out during the action research project you will continue on with in your practice *

- [ ] Encouraging learners to share their own methods with the class
- [ ] Bar modelling
- [ ] Bar modelling for context-based to algebraic based questions
- [ ] In depth diagnostic interventions
- [ ] Using a graphics tablet within class
- [ ] Careful sequencing of questions (variation theory)
- [ ] Other

26. What other learning, if any, from the action research project as a whole will you incorporate into your teaching practice going forwards? *

AR activities through the year

Please rate the following statements on a scale of 1 to 5, where 1 is strongly disagree and 5 is strongly agree. If you feel the statement is not applicable, please leave blank.

27. Analysing baseline questionnaires in October had a positive impact on my ability to address skills gaps and support learners with the application of skillset learnt from context-based learning to other areas of the GCSE specification with mastery interventions

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

28. The diagnostic interventions carried out in December supported me to unpick reasons behind why learners were struggling with key areas

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

29. The CPD session with Martin on Bar modelling and mastery interventions in January had a positive impact on my understanding of mastery

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

30. The CPD session with Martin on Bar modelling and mastery interventions in January had a positive impact on my confidence with bar modelling

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

31. How else did the CPD session with Martin on bar modelling and mastery interventions affect you or your practice?

32. The CPD session with Martin on the Wacom training improved my confidence with using a graphics tablet in a mathematics classroom

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

33. Using the graphics tablet supported me in carrying out the bar modelling interventions

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

34. The CPD sessions positively impacted my ability to support learners with addressing their skills gaps and applying their existing knowledge to other areas of maths

	1	2	3	4	5	
Strongly disagree	○	○	○	○	○	Strongly agree

General questions about action research

The following questions are general reflections about the action research process

35. What impact has being involved in the project overall had on your teaching practice? *

36. What impact has you being involved in the project had on your learners? *

37. Outside of a formal Action Research project, will you want to carry on with your own action research informally? *

38. Do you feel that the AR CPD modules have given you enough support to carry out your own smaller scale AR project in the future? *

- ◯ Yes
- ◯ No
- ◯ Not sure

39. Please add in any other information that you feel is relevant here or other relevant reflections *