Education Endowment Foundation

Maths-for-Life

Further appendices

February 2026

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BIT

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We do this by:

- **Summarising evidence**. Reviewing the best available evidence on teaching and learning and presenting in an accessible way.
- **Finding new evidence.** Funding independent evaluations of programmes and approaches that aim to raise the attainment of children and young people from socio-economically disadvantaged backgrounds. Putting evidence to use.
- **Putting evidence to use**. Supporting education practitioners, as well as policymakers and other organisations, to use evidence in ways that improve teaching and learning.

We were set-up in 2011 by the Sutton Trust partnership with Impetus with a founding £125m grant from the Department for Education. In 2022, we were reendowed with an additional £137m from government, allowing us to continue our work until at least 2032.

This report was supported by JPMorganChase. The views expressed in this report should not be taken to reflect the official position of JPMorganChase or any of its affiliates.

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Appendix E: Intervention Description

Why (rationale/theory)

The goal of Maths-for-Life[1] is to improve maths GCSE outcomes for students resitting their exams. All students who fail to gain a grade C (or grade 4) or above in their maths GCSE are required to continue working towards this goal in post-16 education until the age of 18. In 2017, the proportion of students aged 17 and above who achieved a grade C or above in GCSE maths was 24.4%.

Building on the work of Malcolm Swan[2], the Maths-for-Life intervention aims to develop a more student-centred classroom, focussed on problem solving and dialogic teaching. Carefully designed activities create cognitive conflict, expose common mathematical misconceptions and improve dialogue between students and teachers. Pictorial representations are also used to support problem solving. This approach is designed to deepen student understanding of mathematical concepts, increase their ability to solve problems and increase their sense of mathematical self-efficacy.

Who (recipients)

There are two groups of intervention recipient:

1. Teachers of maths GCSE resit students, who participate in a programme of professional development (PD) and;
2. Maths GCSE resit students, who participate in Maths-for-Life lessons as part of their resit curriculum. This group includes a small proportion of adult learners.

What (materials)

There are two sets of materials that support delivery of the intervention:

1. Lead Teacher pack: Resources for Lead Teachers to support their cohort of Maths-for-Life teachers.
2. Class Teacher pack: Resources for teachers to support the delivery of Maths-for-Life lessons, including information about the pedagogical principles, five lesson plans, lesson resources (e.g. slide decks and materials for students), clips of videos of Maths-for-Life lessons that demonstrate core concepts, and proformas for peer lesson observations.

What (procedures)

The intervention begins and ends with a launch event for Class Teachers. In between these two meetings, the intervention goes through the following lesson study cycle:

1. Clusters of Class Teachers meet to learn about and plan a Maths-for-Life lesson, supported by their Lead Teacher.
2. Class Teachers deliver a Maths-for-Life lesson to their own class
3. Class Teachers meet as a whole cluster to observe a peer from the cluster delivering the same lesson

[1] Maths-for-Life - The University of Nottingham
[2] Swan, M. (2006). Learning GCSE mathematics through discussion: what are the effects on students?. *Journal of Further and Higher Education*, *30*(3), 229-241.; Swan, M. (2007). The impact of task-based professional development on teachers' practices and beliefs: A design research study. *Journal of Mathematics Teacher Education*, *10*(4-6), 217-237.; Swan, M., & Swain, J. (2010). The impact of a professional development programme on the practices and beliefs of numeracy teachers. *Journal of further and Higher Education*, *34*(2), 165-177.

4. Clusters meet again with their Lead Teacher to reflect on the lesson delivered, and to learn about the next lesson to be delivered.

This cycle is completed five times, with a new lesson being delivered and studied each time.

Who (implementers)

There are four key roles in the delivery of the intervention:

1. Class Teachers deliver the Maths-for-Life lessons.
2. Lead Teachers are maths GCSE resit teachers from other settings that facilitate the PD programme for a cluster of Class Teachers.
3. Project Leads from the University of Nottingham support the Lead Teachers through initial training and ongoing monitoring and troubleshooting of the programme (including some lesson observations).
4. Coordination of the project is supported by an administrator from the University of Nottingham.

How (mode of delivery)

The five lessons are taught as part of the normal GCSE maths resit curriculum. The five PD sessions and peer observations are delivered during Class Teachers' professional development time.

Where (setting)

Lessons are taught in regular classrooms in schools and colleges. Cluster PD sessions take place in a range of regional locations, such as participating schools and colleges.

When and how much (duration and dosage)

The five lessons are delivered between November and April. Each lesson is designed to last for one hour. The PD requires a total of 6 days of teacher time and breaks down as follows:

- Launch event: 0.5 days
- Lesson planning and reflection: 1 day per lesson (5 days in total)
- Closing event: 0.5 days

Tailoring (adaptation)

The following adaptations are expected to take place at the classroom level:

- Lessons are planned to last 1 hour but some may last for up to 2 hours. The time taken to deliver each component of the lesson will also vary.
- Whilst questioning guides are provided for Class Teachers, the exact type and number of questions asked of students will vary substantially.
- Activities are designed for groups of students, but the size of groups will vary from two upwards. In some (rare) cases, students may work on their own.
- Some classes will be supported by Teaching Assistants / Learning Support Assistants.

The following adaptations are expected to take place at the cluster level:

- The timing of cluster PD days

- The duration of cluster PD days
- The types of location that are used for cluster PD days
- The content of PD day discussions (responding to the needs and experiences of the group)

Three core components of the intervention should not change in any setting:

1. The key pedagogical principles
2. The lesson study structure of the PD
3. The lesson materials provided to students

How well (planned)

Strategies to maximise effective implementation operate at three levels:

1. Class Teachers are given clearly defined lesson plans, supported by an in-depth programme of PD.
2. Lead Teachers monitor the delivery of lessons in their cluster through a lesson log, offering troubleshooting support where necessary.
3. Project Leads provide training, written guidelines and ongoing troubleshooting support to Lead Teachers as necessary.

How well (actual)

Effective implementation is expected to be moderated in particular by variation in:

- The ability of Lead Teachers and their level of belief in the pedagogy
- The ability of Class Teachers

Appendix F: Programme resources

Maths-for-Life

Welcome to the Maths-for-Life resources for Teachers. The materials here are intended to support a small network of teachers working as a Maths-for-Life "lesson-study" group.

Hence, the lesson resources include a description of each lesson and questions on some of the key pedagogical decisions. Anyone using these resources should at the very least consider their responses to these questions before teaching the lessons.

The Maths-for-Life programme involves:

- Local networks of teachers collaborating together providing one of the most effective forms of professional development available. Through these groups, professionals seek to better understand the learning of students, the maths we teach and their pedagogical practices.
- Dialogic learning which research shows is helpful in improving students' mathematical understanding, confidence and outcomes. It harnesses the power of talk to stimulate and extend students' thinking and advance their learning and understanding. Throughout the programme we are seeking to develop learning that is collective, reciprocal, supportive, cumulative and purposeful.
- Five key lessons that focus on some of the most fundamental mathematical concepts that underpin GCSE mathematics.
- Five key pedagogies that support students' learning of mathematics.

This file of resources is designed to support teachers adopting this Maths-for-Life approach. It is the intention that Maths-for-Life Teacher groups will be supported by a Lead Teacher and a separate file of materials is available to support them. All resources for teachers, Lead Teachers and classroom lessons are available at: https://www.nottingham.ac.uk/maths-for-life/.

We hope that you enjoy working with colleagues adopting the Maths-for-Life approach in ways that support your students enjoy maths more than in the past and importantly achieve a higher grade at GCSE.

Our thanks go to the EEF and J P Morgan for funding this project and to the Behavioural Insights Team that worked to evaluate the programme. Additionally, we thank all the Lead Teachers, teachers and students who took part in the Maths-for-Life research project (2017-18). All these groups of participants provided valuable insights and feedback which helped us improve and refine the resources.

Finally, the research team extend their heartfelt thanks to their colleagues in the research support team led by Kanchana Minson that made sure that the Maths-for-Life project was delivered on time and to a high level.

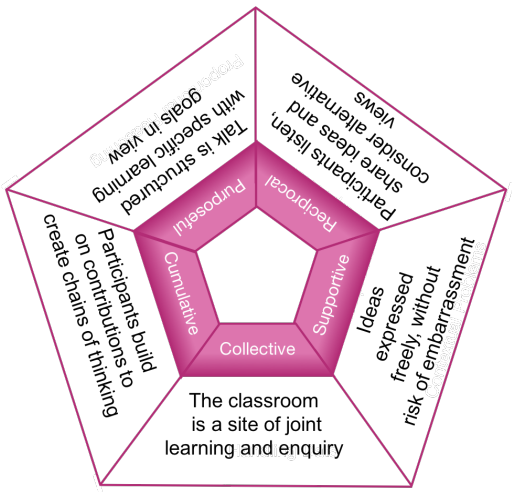
Geoff Wake, Matt Woodford, Sheila Evans, Michael Adkins and Marie Joubert

Introduction

Underpinning Principles

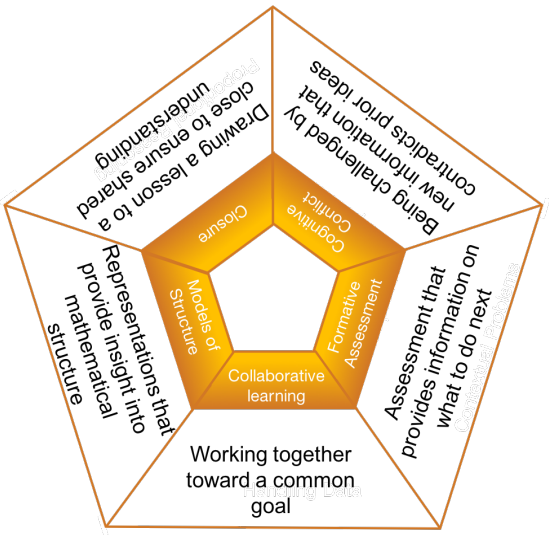
Dialogic Learning

Fundamental to these lessons is the belief that dialogic learning is essential to improving students' confidence and outcomes. The pink pentagon in Maths-for-Life summarises the five principles of dialogic learning that we are seeking to develop in classrooms. These define the behaviours that we would expect to see develop over the year in all members of the classroom – including teachers, teaching assistants and students.



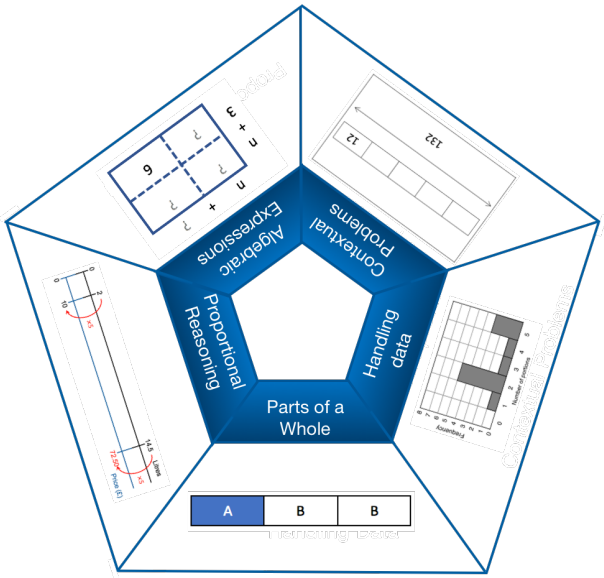
Pedagogies

Five key pedagogical ideas underpin the design of each of the five lessons. Each pedagogy will be studied in turn and the effect that it has on one of the principles of dialogic learning examined. These pedagogies are seen throughout all lessons in the actions of teachers and are supported by the design of the resources.



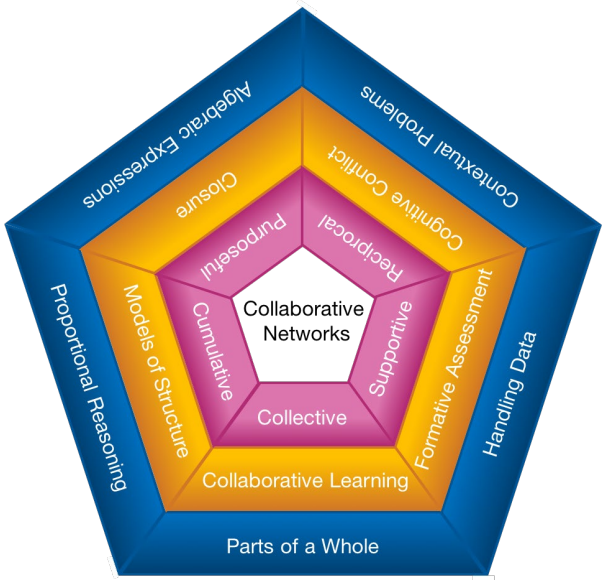
Lessons

The Maths-for-Life lessons have evolved from resources and principles used in the Improving Learning in Mathematics (Standards Unit) box. These new resources have been designed and trialled so that teachers are able to focus on exploiting anticipated learning opportunities.



The Maths-for-Life Pentagon

Together, the three individual pentagons combine to give the Maths-for-Life Pentagon. Each section could be rotated to line up with any other section. However, the orientations have been chosen by the designers working with the project's Lead Teachers as a best fit for the focus of each research lesson.

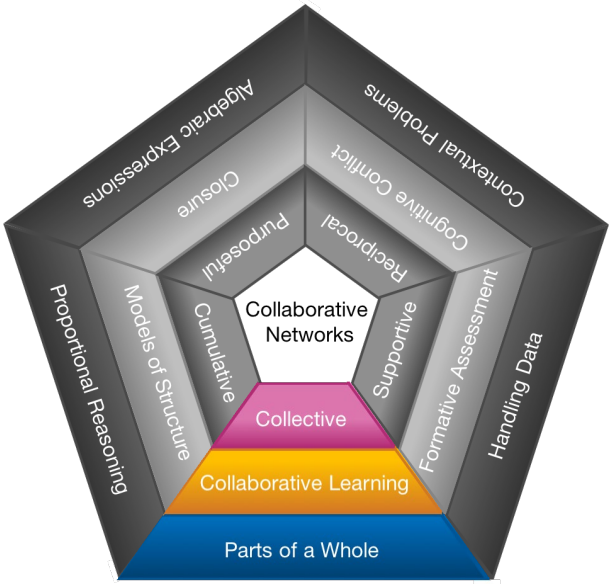


Lesson 1 Parts of a Whole

Introduction

Overview

The focus in the lesson, **Parts of a Whole**, is on how to develop **collaborative learning** and to see how this contributes towards creating a **collective** classroom.



Collaborative learning is when students work together in both pairs and small groups, and as a whole class, towards common goals.

A **collective** classroom is one in which both the students and the teacher see their lessons as being based around joint learning and enquiry.

Research Question

How does collaborative learning (through the design of resources and the actions of the teacher) promote collective endeavour?

Lesson Summary

Phase	Timings (minutes)	Notes
	**5**	The initial problem is explained, clarifying why Ali and Blair split the payment in the given ratio.
	**5 - 10**	Students match the fractions cards to the ratios on the grid. *It is important that students are given the time to follow their thinking through without teacher correction.*
	10 - 15	Students work with the representation cards. *Students resolve misconceptions and cognitive conflict through the insight that the representations provide.*
	10 - 15	Students work with the word description cards. *These cards allow students to make links between fractions, ratios and the ways that they are often described in exam questions.*
	**5 – 10**	Check understanding of the activity using the review slides in the electronic presentation
	**10 – 15**	Return to the original Ali and Blair problem. *Ensure a common understanding of the misconception and its resolution.* *Examine how given amounts can be shared using fractions and ratios.*
		Extension questions used if appropriate. *These slides allow formative assessment with a variety of possible questions and answers*

L1.1 Lesson Outline: Parts of a Whole

Mathematical goals

To help students:

- understand ways of mathematically describing a part-part relationship;
- understand ways of mathematically describing a part-whole relationship;
- understand how to use representations to give insight into solving problems.

Starting points

There is often confusion about the connections and differences between fractions and ratio. Many students assume that the ratio 1:2 is equivalent to the fraction ½.

Diagrams can be a powerful representation that allow students to understand the relationship between ratio and fraction.

Materials required

For each group of students, you will need:

- L1.2 Cards (fraction cards, diagram cards and word cards all separate);
- L1.3 Template ***enlarged*** onto A3 paper;
- glue sticks.

L1.4 PowerPoint Presentation

Time needed

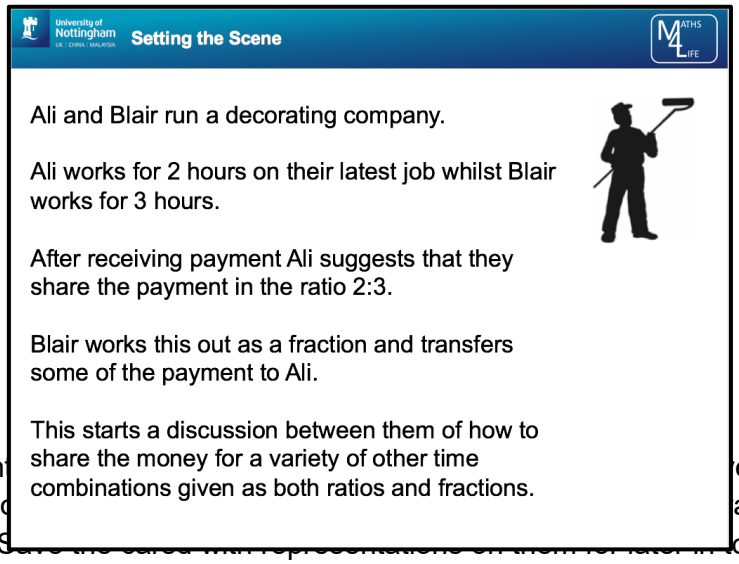
Approximately 1 to 1½ hours.

Lesson Structure

Setting the Scene

Introduce the problem using the PowerPoint presentation. This allows students to understand why there is the suggestion to share the money in the ratio 2:3.

1. What assumption must be made for the money to be shared in the ratio 2:3?

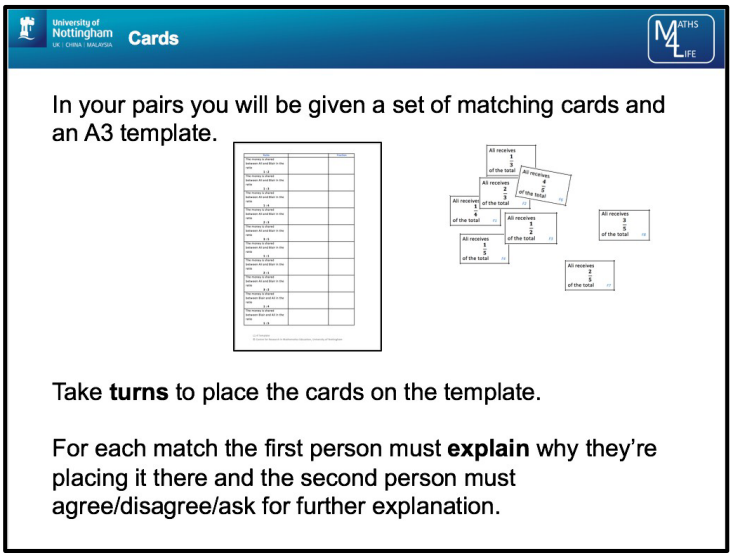


Collaborative Learning using Cards

2. Why is it important to hold on to the representation cards when the students first tackle the question?

Arrange students in[illegible]en a template and a set [illegible]action cards at this point. S[illegible]o the activity).

Students must take turns to match a pair, and to explain their reasons for putting them together. The other person in the pair must agree to the match or ask for further explanation.



3. What mistakes and difficulties do you expect?

"Don't intervene too early"

4. When is the optimum time for handing out the diagram cards?

Once students are part way through the task of matching, give them the representation cards. They should be asked to see whether the diagrams change their thinking or support it.

Remind students to complete the blank cards and to explain to one another their reasoning.

"Use mistakes and miscon-ceptions to encourage dialogue"

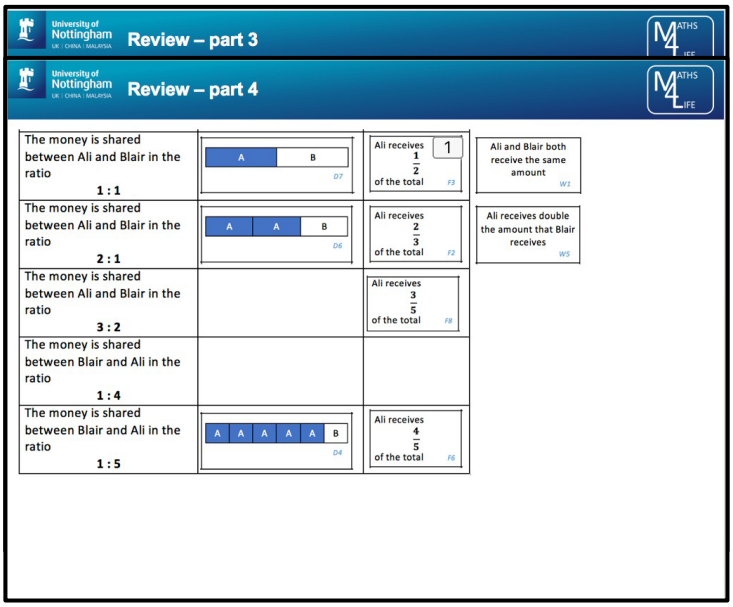
5. Which word cards will be particularly important to highlight in the whole group learning phase?

Once students have completed the ratio-diagram-fraction matchings they can be given the set of word cards. Note that these cards will have to be placed on the edge of the template. Also note that some rows have more than one word card and some rows don't have any. Students are not expected to create cards for rows that have no word cards.

To extend the task further, groups of students could be asked to calculate how much Ali and Blair receive in each situation if the total sum to be shared is £120. (Their answers could be written on the picture cards).

Review

The presentation includes slides to show how the cards should have been matched.



Before proceeding with the PowerPoint presentation examine any interesting mistakes or misconceptions that have taken place in the classroom.

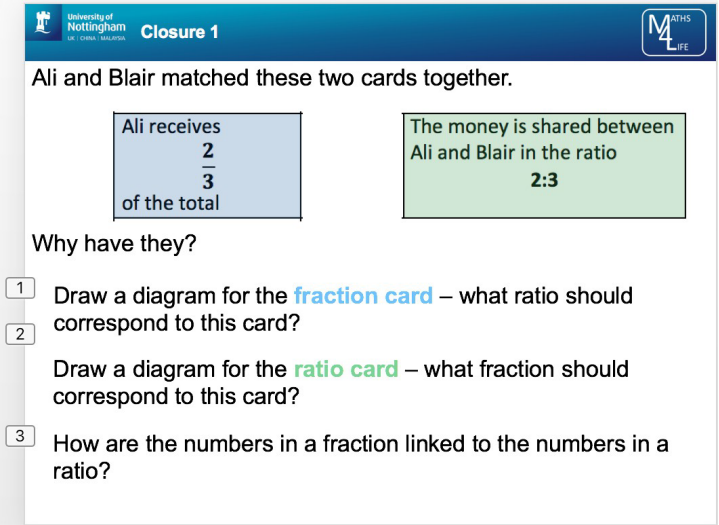
All the time, it is important to keep re-phrasing student explanations using the language of part to part and part to whole.
For example,

Ali receives 1 part for every 2 parts that Blair receives. Ali receives 1 part out of 3 parts of the whole.

Closure

Allow approximately 15 minutes for this section of the lesson. Using the PowerPoint presentation as a guide, bring closure to the lesson by asking students to work in a pair to answer the questions on the next slide.

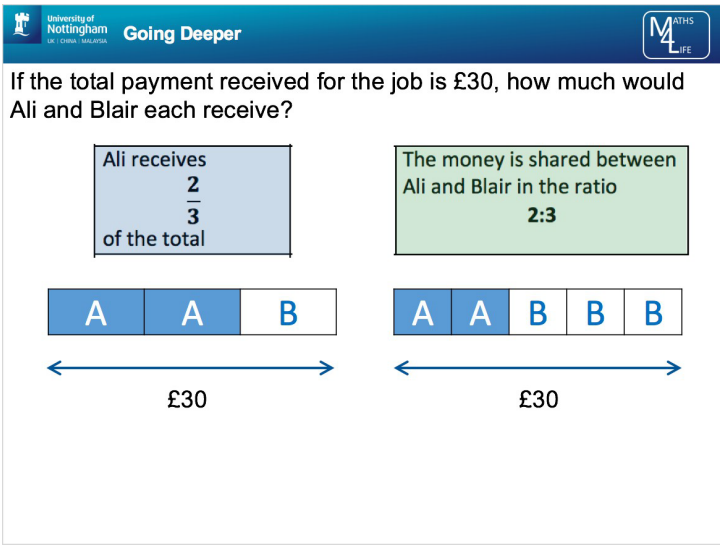
"Students need closure in a lesson"



6. How can the link between fractions and ratios be explained succinctly? What do you expect students to say?

Ask students to identify the link between information provided as a fraction and information provided as a ratio. Re-phrase student explanations to draw out an understanding of ratio showing part to part whilst fractions show a part of a whole.

Now ask students to calculate how much each person would receive if the total money paid was £30. Doing this for both the ratio 2:3 and the fraction ! emphasises the importance of understanding these calculations.

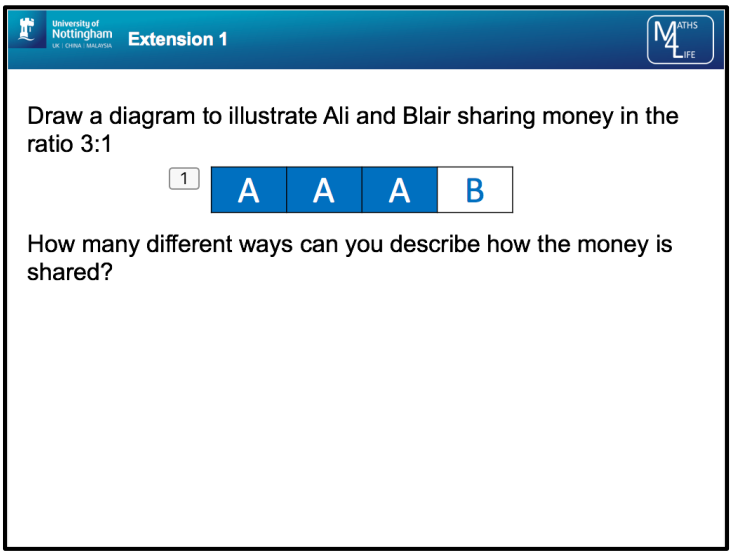


7. Which features of the representation cards are important to highlight to students?

Extension

The next slides ask open-ended questions that give the opportunity for formative assessment to take place.

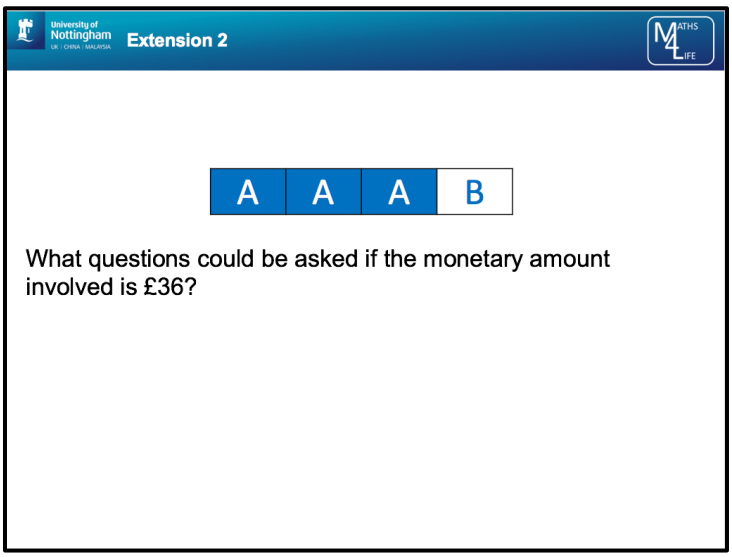
8. Which of these ways are most important to stress with your class?



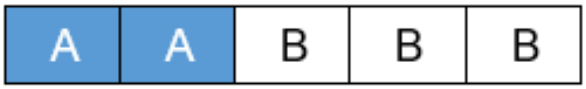
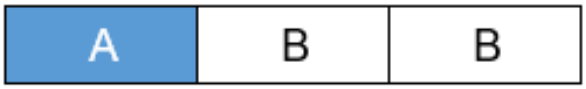
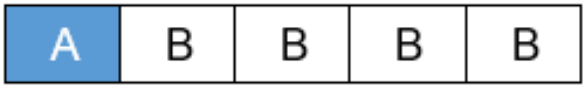
"It's about what we do and what we don't do"

"We can affect the way students work together through the way we structure a task"

9. What are the key messages from the lesson that you expect to draw out?



"We want to see students developing both questions and ideas together"

Ali receives $\frac{1}{4}$ of the total F1	 D1	Ali and Blair both receive the same amount W1
Ali receives $\frac{2}{3}$ of the total F2	 D2	Blair receives three quarters of the total W2
Ali receives $\frac{1}{2}$ of the total F3	 D3	Blair receives double the amount that Ali receives W3
Ali receives $\frac{1}{5}$ of the total F4	 D4	Ali receives half the amount Blair receives W4
Ali receives $\frac{1}{3}$ of the total F5	 D5	Ali receives double the amount that Blair receives W5
Ali receives $\frac{4}{5}$ of the total F6	 D6	Blair receives three times the amount Ali receives W6
Ali receives $\frac{2}{5}$ of the total F7	 D7	Ali receives one quarter of the amount Blair receives W7
Ali receives $\frac{3}{5}$ of the total F8	 D8	Ali receives $\frac{4}{10}$ of the total W8

One set of these cards should be printed for each group

Ali receives — of the total	To be completed
Ali receives — of the total	To be completed

One set of these cards should be printed for each group

Ali receives — of the total	To be completed
Ali receives — of the total	To be completed

One set of these cards should be printed for each group

Ali receives — of the total	To be completed
Ali receives — of the total	To be completed

Ratio		Fraction
The money is shared between Ali and Blair in the ratio **1 : 2**		
The money is shared between Ali and Blair in the ratio **1 : 3**		
The money is shared between Ali and Blair in the ratio **1 : 4**		
The money is shared between Ali and Blair in the ratio **2 : 3**		
The money is shared between Ali and Blair in the ratio **3 : 5**		
The money is shared between Ali and Blair in the ratio **1 : 1**		
The money is shared between Ali and Blair in the ratio **2 : 1**		
The money is shared between Ali and Blair in the ratio **3 : 2**		
The money is shared between Blair and Ali in the ratio **1 : 4**		
The money is shared between Blair and Ali in the ratio **1 : 5**		

Appendix G: Memorandum of Understanding

EEF Maths-for-Life

Memorandum of Understanding (MoU)

http://m4l.org.uk/

Name of College/school _____

Date_____

The Maths-for-Life project is based in the Centre for Research in Mathematics Education at the University of Nottingham. It is investigating the efficacy of a professional development programme that aims to improve outcomes in GCSE Mathematics re-sit examinations. The project is funded by the Education Endowment Foundation[3] (EEF) as part of a joint initiative with JP Morgan. EEF has appointed the Behavioural Insights Team[4] (BIT) to evaluate the project.

This document sets out the relationship between the University of Nottingham, the Behavioural Insights Team, teachers and their colleges and schools participating in the Maths-for-Life project between June 2018 and October 2020. All colleges and schools taking part in the project are asked to confirm their agreement to this relationship by signing their copy of this document. Teachers participating and an appropriate senior manager should sign this document to confirm that the college/school will fulfil the requirements of their participation in the project as identified in this document.

By signing this Memorandum of Understanding you agree to allow the University of Nottingham Maths-for-Life team to share your contact data with the project evaluation team, BIT.

Note: See attached a separate Data Sharing Agreement to be signed between your school/college and BIT covering the data sharing requirements described below.

A. All colleges/schools agree to:

At sign up
• Identify one or two members of staff who teach GCSE Mathematics resits to take part in the Maths-for-Life intervention in the period October 2018 – June 2020.

[3] http://www.educationendowmentfoundation.org.uk
[4] http://www.behaviouralinsights.co.uk/

(Throughout the project data of all GCSE resit students taught by the nominated teachers will be included).
• Securely provide BIT and the University of Nottingham with required information about the college/school.

• Share the **Student Information data** for participating students (that is all GCSE resit students taught by the nominated member(s) of staff) with BIT via a secure platform by 11th October 2018:
  • Unique Pupil Number
  • Name
  • Date of Birth
  • Free School Meal status (Ever6FSM)

• Nominated teachers will engage in a brief online pre-intervention teacher survey.

Throughout Year 1 (October 2018-September 2019) and Year 2 (October 2019-September 2020)
• Provide BIT and the University of Nottingham with updates to student and teacher information (for example, if any of the original students or teachers have left the college/school or changed classes).

• If selected as a case-study college/school facilitate researchers to:
  • observe all aspects of the 'professional development' days and collaborative teachers' communities;
  • interview teachers and students;
  • observe teaching and learning.
 	
Note that this will include gaining opt-in consent from all teachers and students participating.

• Engage in a post-intervention teacher survey.
• Support the administration of a paper-based self-efficacy survey with all participating students between April and June 2019. (BIT Researchers will attend your school/college for this purpose).

B. If allocated to the Maths-for-Life intervention group, colleges/schools agree to:

Year 1 (October 2018-September 2019)
• Ensure participating teachers attend a whole day project briefing in London on 19/10/2018 and take on responsibility for delivering the agreed work.
• Ensure chosen teachers participate in the local cross college/school development programme coordinated by the Maths-for-Life Lead Teacher. This will include a cycle of lesson briefings, observing the research lessons and a post-lesson discussions. These meets will take place over an equivalent of 5 days in addition to the project briefing day.
• Ensure all five Maths-for-Life lessons are taught to all of the participating GCSE resit classes by 12/04/2019.

• Share the **Student Attainment data** of all participating students (that is all GCSE resit students taught by the nominated member(s) of staff) with BIT via a secure platform by September 2019.
  ◦ GCSE Maths Uniform Mark Scores (UMS)
  ◦ GCSE grades achieved

Year 2 (October 2019-September 2020)

• Share the **Student Information data** for participating students (that is all GCSE resit students taught by the nominated member(s) of staff) with BIT via a secure platform by 31st October 2019:
  ◦ Unique Pupil Number
  ◦ Name
  ◦ Date of Birth
  ◦ Free School Meal status (Ever6FSM)

• Share the **Student Attainment data** of all participating students with BIT via a secure platform by September 2020.
  ◦ GCSE Maths Uniform Mark Scores (UMS)
  ◦ GCSE grades achieved
 	
Note that the scores provided in 2020 will be for the new students of the teachers who participated in the Maths-for-Life development programme in 2019-2020 academic year.

• Raise any concerns with the project administrator (University of Nottingham) about changes at the earliest opportunity. If concerns arise, the resolution of such will be based upon the principle of mutual respect and a desire to find a solution speedily and informally.

University of Nottingham agrees to:

• Provide ''professional development" and support from the Maths-for-Life Lead Teachers between October 2018 and March 2019 to aid with the delivery of the materials and provide the support required to complete the activities.
• Provide all Maths-for-Life teacher support and lesson materials.
• Ensure that the research has ethical clearance from the research ethics committee of the University of Nottingham and that this is adhered to throughout the project.
• Store all data safely and securely.
• Inform schools/colleges of the results of their random allocation to intervention or control group by 12/10/2018. This will ensure that there has been sufficient time to collect the required data from schools and colleges before inviting them to the project launch on 19/10/2018.

C. If allocated to the Maths-for-Life control group, colleges/schools agree to:

Year 1 (October 2018-September 2019)

• Share the **Student Attainment data** of all participating students with BIT via a secure platform by September 2019.
  ◦ GCSE Maths Uniform Mark Scores (UMS)
  ◦ GCSE grades achieved

Year 2 (October 2019-September 2020)

• Share the **Student Information data** for participating students with BIT via a secure platform by 31st October 2019:
  ◦ Unique Pupil Number
  ◦ Name
  ◦ Date of Birth
  ◦ Free School Meal status (Ever6FSM)

• Share the **Student Attainment data** of all participating students with BIT via a secure platform by September 2020.
  ◦ GCSE Maths Uniform Mark Scores (UMS)
  ◦ GCSE grades achieved
 	
Note that the scores provided in 2020 will be for the new students of the teachers who participate in 2019-2020 academic year.

University of Nottingham agrees to:

- Pay a total of £1000 to a college/school in the control group.

Payment	Amount	Expected Payment Date	Notes
1	£500	November 2019	On receipt of 2018-19 Student Information data as set out in section A.
2	£500	September 2020	On receipt of 2019-20 Student Information and Student Attainment data as set out in section C.

- Provide the support required to complete the activities mentioned above.
- Ensure that the research has ethical clearance from the research ethics committee of the University of Nottingham and that this is adhered to throughout the project.
- Store all data safely and securely.
- Inform schools/colleges of the results of their random allocation to intervention or control group by 12/10/2018.

AGREEMENT TO PARTICIPATE AND WITHDRAWAL OF PARTICIPATION

Participation in the project by your college/school is voluntary.

By completing, signing and returning this form you confirm your understanding of the project and agree to all aspects of taking part in it. Please make sure to ask any questions, by contacting the Project Administrator (University of Nottingham), about the project before signing.

If your school or an individual from your school would like to withdraw from the project they can do so at any point until the final data is collected (October 2020) by contacting the project Director in the first instance (details below):

Geoff Wake
School of Education,
Jubilee Campus,
University of Nottingham,
Nottingham
NG8 1BB

Geoffrey.wake@nottingham.ac.uk

Signatures

College/school Senior Leader	Name:

(with authority to commit human resources) By signing this form you are committing to supporting the teacher(s) identified below in pursuit of the Maths-for-Life project and supporting administrative staff in supplying the required data.	Position: Signed: Date:
Participating Teacher 1 By signing this form you are committing to taking part fully in the Maths-for-Life project.	Name: Position: Contact e-mail: Telephone number: Date:
Participating Teacher 2 **(if applicable)** By signing this form you are committing to taking part fully in the Maths-for-Life project.	Name: Position: Contact e-mail: Telephone number:

	Date:
University of Nottingham	Name: Position: Signed: Date:

Appendix H: Teacher information sheet

Information sheet for teachers

Maths-for-Life Evaluation

http://m4l.org.uk/

We would like to invite you to participate in a research project concerned with improving students' GCSE Mathematics resit grades. These grades are crucially important to young people and attaining a higher grade is often likely to make a significant difference to young people's life chances. Students in GCSE resit classes can often be from the most disadvantaged groups.

The Maths-for-Life project is based in the Centre for Research in Mathematics Education at the University of Nottingham. It is investigating the efficacy of a professional development programme that aims to improve outcomes in GCSE re-sit examinations. The project is funded by the Education Endowment Foundation[5] (EEF) as part of a joint initiative with JP Morgan. EEF has appointed the Behavioural Insights Team[6] (BIT) to evaluate the project.

The project builds on previous work by the Centre for Research in Mathematics Education in Nottingham that has developed a wide range of resources to support dialogic learning based on provoking cognitive conflict in key areas of mathematical thinking. In particular it uses materials from the Standards Unit Box (Improving Learning in Mathematics) and other resources developed over many years by Malcolm Swan and colleagues.

The focus is on five key areas of the GCSE curriculum that underpin learning of mathematics and which are proven to present students with difficulties and affect GCSE performance. It also develops five 'signature' pedagogies that support dialogic learning. The programme will encourage collaborative work with colleagues by including a modified element of lesson study. We are looking for colleges/schools to identify one or two teachers within each establishment who have a significant teaching commitment to one, or more, GCSE Mathematics resit classes. We hope that most colleges can support two teachers and schools one teacher.

Throughout 2018-2020, we will be using a randomised controlled trial, where participating colleges/schools will be split into 'treatment' and 'control' groups. This wil investigate the efficacy of the professional development programme and the use of the approach in classrooms. This will involve teachers and their students from approximately 50 colleges/schools allocated to an intervention group in the Maths-for-Life intervention programme led by twenty lead teachers. The trial will involve an equivalent number of teachers' students who will experience 'business as usual'.

The results of the students of the teachers taking part in the intervention and the students of those teachers identified in the control group will be monitored over two cohorts of students in 2018-19 and 2019-2020. The teachers in the intervention group will be involved in the Maths-for-Life professional development in the first of the two years. Results of students will be collected in both 2018-2019 and 2019-2020. The intention is to determine the efficacy of the approach in improving resit students' GCSE outcomes in mathematics and to then continue the programme beyond the trial.

[5] http://www.educationendowmentfoundation.org.uk
[6] http://www.behaviouralinsights.co.uk/

There are two main types of data that will be worked with by the evaluation team - quantitative data (including GCSE exam results and student self-efficacy data) and qualitative data from case studies of the professional development programme and a small number of colleges.

GCSE results will be collected from the National Pupil database and GCSE Awarding Bodies. For this reason we will need to have identified, as closely as possible, the students being taught by the participating teachers prior to random allocation of colleges/schools to the treatment or control groups. Given that the students in these groups will not be settling into their courses until September/October it is important that we can have all class lists of students and their unique pupil numbers by 08/10/2018. It is only when we have that data that we can carry out the random allocation. For this reason, we have some very tight and strict deadlines in September/October 2018. All teachers identified as participating should allocate in their diaries a launch meeting in either London or Birmingham on (date) and (date). The allocation to groups will be announced on 12/10/2018 and those in the treatment group should attend the meeting in London or Birmingham. Those in schools from the control group will receive £1,000 in lieu of attending the professional development programme and for providing data relating to the students of the teachers they identified as being part of the trial. Teachers will be informed of which location and date after recruitment ends on (date).

Following the launch those colleges allocated to the treatment group will work in a small cluster with some considerable flexibility in timing of meetings which will be determined by the cluster participants and their Lead Teacher.

In the second year of the project the student data will again be required for the identified teachers' classes but there will be no further organised programme. This will provide insight into outcomes after the intervention professional development programme has finished.

The student self-efficacy data will be collected by students completing a survey towards the end of the teaching of each of the 2018-2019 and 2019-2020 student cohorts. This data will be required of the students of the identified teachers in both the treatment and control groups.

Following the random allocation of colleges and schools that sign up to take part in the project the evaluation team will work with a small number of case study schools in both treatment and control groups - with an emphasis on the treatment group. This will involve observing some lessons being taught. A small sample of these teachers will be interviewed about their students and teaching approaches used. The interviews and lesson observations may be audio-recorded and transcribed. The recordings and transcripts will be shared amongst the researchers who will write reports about the research for conferences, teachers and other researchers. All data will be anonymised. It will not be possible to identify schools, teachers or students from these research reports.

We would be very grateful if you would take part in this project and help us to collect the required data. You can be assured that throughout, the project will be subject to strict ethical controls with modes of working having been overseen and given clearance by the University of Nottingham's school of Education's usual ethical procedures. These are in line with national guidance for research of the type being conducted.

If you would like more information or if you have any concerns, please get in touch with the Principal Investigator or contact: Mrs Kanchana Minson on 0115 951 4438, or email: Kanchana.Minson@nottingham.ac.uk

Thank you for reading this information sheet and for considering taking part in this research.

Geoff Wake

Principal Investigator: Maths-for-Life

Professor of Mathematics Education, University of Nottingham

geoffrey.wake@nottingham.ac.uk

Appendix I: Student information sheets and withdrawal form

Maths-for-Life: Participant Information Sheet (Trial)

Introduction

This year, your teacher is taking part in a research project called 'Maths-for-Life', which involves working with a research organisation called the Behavioural Insights Team (BIT).

As part of this project, your school/college would like to share some data about you with BIT.

Your teacher will talk you through this information sheet. Before you decide to take part, it is important that you understand the purpose of the project, why we want to share your data, and what data we're talking about.

- Please take time to ensure that you understand the activity and what might happen to the data you provide.
- You may object to your data being used at any time, without giving a reason.
- You will still be able to take part in all Maths lessons, even if you do not want your data to be used.

After hearing and reading this information, if you **do not** want to take part, you need to complete and return the form at the end of this information sheet.

What is the purpose of this project?

The Maths-for-Life programme aims to improve the way that teachers teach maths, so that students learn more and get better grades. This research project aims to understand the benefits of the programme.

What is the Maths-for-Life programme?

Maths-for-Life is a teacher training programme. This year, a group of teachers across the country have signed up to take part in the programme. Half of them will be randomly selected to participate, and this will involve trying out some new activities in class. The other half will not take part in the programme, and will continue delivering their normal Maths lessons. Both groups are a very important part of the research, as they both help researchers understand the benefits of the programme.

Why have I been chosen to take part?

You have been chosen to take part in the research, because your teacher has signed up to the project.

What does my participation involve?

If your teacher is selected to take part in the programme, all students in your class will take part in some Maths-for-Life activities as part of your normal Maths lessons. If your teacher is not selected for the programme, your class will continue with their normal lessons. If you participate in the research project, it means that we will share some data about you with the researchers at BIT.

What data will we share with the researchers?

We will share the following data about you with the researchers:

- Name
- Date of birth
- Unique pupil number (UPN)
- Gender
- Free School Meal status
- Your GCSE Maths resit score

The researchers will use this data to test the effectiveness of the Maths-for-Life programme. Your UPN will be used to access your Key Stage 2 Maths score and your GCSE Maths resit grade from the Department for Education's National Pupil Database. If you like, we can give you a record of any of your data that is shared. Anonymised data will be shared with the Education Endowment Foundation, who are funding the study, and with the Fischer Family Trust, a UK wide education research body.

How will my privacy be protected?

Your data will be shared and processed in accordance with data protection law. The data we share will be confidential. The researchers will use a random number to label and store the data instead of your name once the study is complete. Your data will ONLY be used for the purposes of this project. You will not be identifiable in any of the reports produced after the project.

The data controller for this project will be your school/college. BIT is the data processor. The legal basis for us processing your personal data is called 'legitimate interests', which requires us to appropriately balance your rights against the interests of the school and the wider public in research projects such as this one, and is why we are giving you the chance to object to being involved. Your personal data will only be processed so long as it is required for the research project. We will minimise the processing of personal data wherever possible.

Do you have to share my data?

No. If you do not want your data to be shared, please complete and return the form at the end of this information sheet. Choosing not to have your data shared will not disadvantage you in any way. If you do decide to take part, you are still free to withdraw at any time and without giving a reason.

Who do I ask for more information?

If you have any questions or are concerned about how your personal data is being processed, please talk to your teacher or contact Patrick Taylor at BIT (patrick.taylor@bi.team). If you still have questions after this, you may wish to contact the Information Commissioner's Office (ICO). Contact details, and details of data subject rights, are available on the ICO website at: https://ico.org.uk/for-organisations/data-protection-reform/overview-of-the-gdpr/individuals-rights/.

What if I change my mind?

If you change your mind, you can withdraw from the research at any time by e-mailing patrick.taylor@bi.team or by telling your Maths teacher.

Student Withdrawal from Data Processing

If you are happy for your data to be used for the research, you do not need to do anything; your data will automatically be shared with the researchers.

If you **do not** want your data to be shared, please fill out the details below and return the form to your Maths teacher.

Student Name (please write in block capitals):	
Student signature:	
Date:	

Maths for Life Research: Student Information Sheet (Interviews)

Introduction

We are a research organisation called The Behavioural Insights Team (BIT). For more information, please visit our website: https://www.behaviouralinsights.co.uk/.

You are receiving this information sheet because your teacher has signed up to a programme called 'Maths for Life' - a research project about the teaching and learning of maths. We'd like you to take part in this research.

It is important that you understand the purpose of the project and what will happen with your personal data if you agree to take part so please take a few minutes to read this information sheet carefully. Please also note:

- You may object to your data being used at any time, without giving a reason.
- Nothing will change about your maths classes, even if you do not want your data to be used for research purposes.

After reading this information, if you are happy to take part, you need to complete the form on the last page.

What is the purpose of this project?

Maths for Life aims to improve maths teaching, so that students learn more and get better grades. This research project aims to find out whether Maths for Life works and, if so, how it works.

What does my participation involve?

We would like to interview you for about 30 minutes about your experience of maths classes. We'll be coming in to your college/school to do this.

What data will we collect?

If you decide to take part, we will collect the following data about you:

- Your full name
- A digital recording of our interview

We will use your name to arrange your interview and to keep a record of your interview (in case you want to see it later). The interview recording will be used for the research, to help us understand what your experience of maths classes is like.

How will my privacy be protected?

- Your data will be processed in accordance with data protection law.
- Your data will be kept confidential and stored securely.
- BIT researchers will use a number to label and store the data instead of your name once the study is complete.

- Your personal data will be deleted as soon as it is no longer necessary for the research.
- Your data will ONLY be used for the purposes of this project.
- You will not be identifiable in any of the reports produced after the project.

BIT will be the controller of your personal data and will be processing your personal data on the basis of your consent.

Do I have to share my personal data with BIT?

No. If you do not want to be interviewed, you do not need to take any further action. If you do not want to be involved in the research, this will not disadvantage you in any way. Also, if you do decide to take part, you are still free to withdraw your data at any time before 31st December 2019 without giving a reason.

If you do want to be interviewed, please complete the consent form at the end of this document.

Who do I ask for more information?

If you have any questions, please contact the researcher, Patrick Taylor:

- Email: patrick.taylor@bi.team
- Address: 4 Matthew Parker Street, London SW1H 9NP

Details of data subject rights, are available on the Information Commissioner's Office website at: https://ico.org.uk/for-organisations/data-protection-reform/overview-of-the-gdpr/individuals-rights/.

PLEASE TURN OVER FOR CONSENT FORM

Maths for Life: Consent Form

		Tick Box
	I consent to the processing of my name and interview recording by BIT for the purposes of the Maths for Life research project.	

Please complete the following details.

School / college name:	
Maths teacher name:	
Your full name (print in capitals):	
Your signature:	

Please hand this form to your maths teacher

Appendix J: Logistic regression analysis for GCSE maths pass/fail outcome

Table 1: Logistic regression results for the GCSE pass rate

Outcome	Model	Total n (intervention; control)	Cox Index (95% CI)	p-value	Secondary analysis Hedges' g (95% CI) using OLS
GCSE pass rate	Full sample – Logistic regression	4,372 (2,357; 2,015)	0.013 (-0.164 – 0.189)	0.888	0.014 (-0.083 – 0.111)
GCSE pass rate	Only sample from primary analysis	3,032 (1,631; 1,401)	0.001 (-0.182 – 0.185)	0.989	0.003 (-0.105 – 0.111)

Appendix K: Lesson observation guide

Lesson Observation Guide

Observation topics:

- Fidelity
- Responsiveness
- Quality
- Causal mechanisms

Fidelity
1.2 To what extent do Class Teachers adhere to the lesson plans? 1.3 What are the barriers to and facilitators of adherence? 1.4 How does non-adherence/adaptation seem to influence outcomes?
1a. Setting the scene complete: Yes/No/Partially
Notes
2a. Cards complete?: Yes/No/Partially

Notes
3a. Review complete?: Yes/No/Partially
Notes
1b. Setting the scene complete?: Yes/No/Partially
Notes
2b. Cards complete?: Yes/No/Partially

Notes
3b. Review complete?: Yes/No/Partially
Notes
4. Closure complete?: Yes/No/Partially
Notes
5. Extension complete?: Yes/No/Partially

Notes

Responsiveness

3.3 To what extent do students engage in Maths-for-Life lessons?

3.4 Are there sufficient resources for Class Teachers (e.g. extension materials for more able students) to allow for effective differentiation in lessons?

Notes

Quality

5.2 Are the five key pedagogies used effectively by Class Teachers in the delivery of Maths-for-Life lessons?:

- Cognitive conflict (the focus of Lesson 4)
- Formative assessment
- Collaborative learning
- Models of structure
- Closure

Notes

Causal mechanisms

6.1 Are the hypothesised mechanisms that arise from the lesson present?

- Teacher-student dialogue
- Student-student dialogue
- Students use representations
- Students build chains of reasoning
- Cognitive conflict
- Increase confidence
- Improved maths reasoning
- Improved verbal communication

6.3 Are there alternative or complementary mechanisms at play?

Notes

Key takeaways

Appendix L: PD observation guide

Professional Development Session Observation Guide

Observation topics:

- Fidelity
- Responsiveness
- Quality
- Causal mechanisms

Fidelity
1.1 To what extent do Lead Teachers adhere to the PD programme? 1.3 What are the barriers to and facilitators of adherence? 1.4 How does non-adherence/adaptation seem to influence outcomes?
Lesson reflection activity complete: Yes/No/Partially
Notes
Lesson prep Activity 1 complete?: Yes/No/Partially (Key resources: L5.1, PD5.0, PD5.2)
Notes
Lesson prep Activity 2 complete?: Yes/No/Partially (Key resources: PD5.1, V5.1, V5.2)
Notes
Lesson prep Activity 3 complete?: Yes/No/Partially (Key resources: L5.2)

Notes

Lesson prep Activity 4 complete?: Yes/No/Partially
(Key resources: V5.3)

Notes

Lesson prep Activity 5 complete?: Yes/No/Partially
(Key resources: V5.4)

Notes

Responsiveness

3.1 To what extent do Class Teachers engage in PD activities?

Notes

Quality

5.1 Can Lead Teachers effectively facilitate Cluster PD sessions?:

- Explaining key concepts, especially L4 and L5 content:
  - Contextual problems lesson content
  - Handling data lesson content
  - Cognitive conflict
  - Reciprocal dialogue
  - Formative assessment

    - Supportive learning
- Facilitating discussion
- Inclusion and differentiation so all teachers learn
- Managing time and resources

Notes

Causal mechanisms

6.1 Are the hypothesised mechanisms that arise from the PD present?

- Teachers exposed to teachers' practice
- Teachers are better at reflecting on their practice
- Teachers' mathematical understanding and reasoning improves
- Teachers' understanding of student learning improves
- Teachers focus more on deepening students understanding
- Teachers encourage and guide peer to peer reasoning
- Teachers strategically plan for high quality student dialogue

6.3 Are there alternative or complementary mechanisms at play?

Notes

Key takeaways

Appendix M: Lead teacher interview guide

Lead Teacher Interview Guide

Section	Purpose of section	Guide time
1. Introductions and background	Explains the purpose and ground rules for the interview	3 mins
2. Fidelity	1.3 What are the barriers to and facilitators of adherence? 1.4 How does non-adherence/adaptation seem to influence outcomes?	20 mins
3. Dosage	2.3 What factors contribute to any variation in session number and length?	5 mins
4. Responsiveness	3.1 To what extent do Class Teachers engage in PD activities?	15 mins
5. Wrap up	Thank you and close	2 mins

Topic guide

1. Introductions and background
Intro to me: ● Paddy ● Working on the evaluation of the Maths-For-Life (M4L) programme Aim of this research: ● Not impact eval ● Looking at implementation and process This interview: ● 45 mins ● Questions about your experience of M4L ● No right or wrong answers ● Just want to understand the world from your point of view Dissemination: ● Final report published on EEF website in August 2020 Anonymity and privacy: ● Will not use your name anywhere in any reports I write up

- If you feel uncomfortable answering a question we can just skip it
- Just say at any point if you want to stop altogether – no problem
- Later want to withdraw anything you said - let me know

Recording:

- Would like to take an audio recording of the interview and take notes
- Is that okay?

Begin recording

2. Fidelity - class teachers

How much do you think teachers have stuck to the plan when delivering the programme in their settings?

- Activities in the lesson plan
- Approach to teaching

If people have deviated from the plan, why do you think they have done so?

- Activities
- Approach to teaching

Are there any barriers that teachers have faced in delivering the programme?

- Understanding
- Buy-in
- Time
- …?

What things are in place to make it easy for them to stick to programme?

- Which of these things are effective?
- Which could be improved?

Thinking about the adaptations that you've described teachers making, what effect do you think this may have on student outcomes?

- Maths achievement
- Maths self-efficacy
- Communication skills

2b. Fidelity - Lead Teachers

How much have you stuck to the plan when delivering the PD?

- Activities in the plan
- Approach to teaching

If you've deviated from the plan, why?

- Activities
- Approach to teaching

Are there any barriers that you've have faced in delivering the PD?

- Understanding
- Buy-in
- Time
- …?

What things are in place to make it easy for you to stick to PD plan?

- Which of these things are effective?
- Which could be improved?

Thinking about the adaptations that you've described, what effect do you think this may have on outcomes for teachers and students?

3. Dosage

How much variation do you think there has been in the *number* of Maths-for-Life lessons each teacher has taught to a single class over the course of the project?

- What things do you think are behind this variation?

How much variation do you think there has been in the *length* of Maths-for-Life lessons?

- What things do you think are behind this variation?

4. Responsiveness

How engaged do you think the teachers have been in the PD sessions?

- How much variation between teachers?

Does engagement vary by part of the programme? (And why?):

- Lesson delivery
- Peer observation
- Reflection
- Lesson planning

Thinking about the *most* engaged teachers, what do you think is behind their higher levels of engagement?

Thinking about the *least* engaged teachers, what do you think is behind their lower levels of engagement?

5. Wrap up

Is there anything that we haven't touched on in this interview that you think would be useful to mention before we finish?

Do you have any questions?

Thank you for your time.

Appendix N: Class teacher interview guide

Class Teacher Interview Guide

Section	Purpose of section	Guide time
1. Introductions and background	Explains the purpose and ground rules for the interview	3 mins
2. Fidelity and student responsiveness	1.3 What are the barriers to and facilitators of adherence? 1.4 How does non-adherence/adaptation seem to influence outcomes? 3.3 To what extent do students engage in Maths-for-Life lessons? 3.4 Are there sufficient resources for Class Teachers (e.g. extension materials for more able students) to allow for effective differentiation in lessons?	10 mins
3. Dosage	2.3 What factors contribute to any variation in session number and length?	10 mins
4. Teacher responsiveness and PD quality	3.1 To what extent do Class Teachers engage in PD activities? 3.2 To what extent and how is Class Teachers' general practice altered by the programme? 5.1 Can Lead Teachers effectively facilitate Cluster PD sessions? 5.3 What factors contribute to variation in implementation quality?	10 mins
5. Programme differentiation	4.1 Have Class Teachers received PD of a similar nature (either in the past or during the intervention period)? 4.2 Is the Maths-for-Life teaching approach significantly different from Class Teachers' current practice? If so, how?	5 mins
6. Causal mechanisms	6.1 Are the hypothesised mechanisms that arise from the PD present? 6.2 Are the hypothesised mechanisms that arise from the Maths-for-Life lessons present? 6.3 Are there alternative or complementary mechanisms at play?	10 mins
5. Wrap up	Thank you and close	2 mins

Topic guide

1. Introductions and background

Intro to me:

- Paddy
- Working on the evaluation of the Maths-For-Life (M4L) programme

Aim of this research:

- Not impact eval
- Looking at implementation and process

This interview:

- 45 mins
- Questions about your experience of M4L
- No right or wrong answers
- Just want to understand the world from your point of view

Dissemination:

- Final report published on EEF website in August 2020

Anonymity and privacy:

- Will not use your name anywhere in any reports I write up
- If you feel uncomfortable answering a question we can just skip it
- Just say at any point if you want to stop altogether – no problem
- Later want to withdraw anything you said - let me know by end of July (2019)

Recording:

- Would like to take an audio recording of the interview and take notes
- Is that okay?

Begin recording

2. Fidelity and student responsiveness

How would you describe the Maths-for-Life programme? What is it?

- Lesson plans
- Approach to teaching - 5 pedagogies

How much have you stuck to the plan when delivering the programme?

- Activities in the lesson plan
- Approach to teaching

What are the reasons why you've deviated from the plan?

- Activities
- Approach to teaching

Are there any barriers that you've faced in delivering the programme?

What things are in place to make it easy for you to stick to programme?
- Which of these things are these things effective?
- Which could be improved?

Can you describe your M4L students briefly?
- Age range
- Maths ability
- Other subjects being taken

How do you think your students have found the M4L lessons?:
- Lesson activities
- General approach
- How does this compare to other maths lessons?

Thinking about the *most* engaged students (in M4L), what do you think is behind their higher levels of engagement?

Thinking about the *least* engaged students, what do you think is behind their lower levels of engagement?

Did you have what you needed to support differentiation?
- What was helpful?
- Anything else that would have helped?

Thinking about the adaptations that you've described, what effect do you think this may have on student outcomes?

3. Dosage

How many Maths-for-Life lessons have you taught to each of your classes?
- If not 5 - why?

How long do your M4L lessons usually last?

How much have you altered the length the sessions?
- What was behind these alterations?

4. Teacher Responsiveness and PD quality

How have you found the PD activities?:
- Lesson delivery
- Peer observation
- Reflection
- Lesson planning

Probe: good bits, less good bits

How engaged would you say you'd been?
- More/less engaged in some activities?
- Adoption of approach outside of 5 lessons?

What's influenced your engagement?

If you were a Cluster Lead next year, what would you have to do to deliver a really high quality experience for other teachers?

- What would hold you back from doing this?
- How close has your experience been to this?

5. Programme differentiation

Have you received PD of a similar nature (either in the past or during the intervention period)?

How different is the M4L approach from your normal practice?

- Describe differences

6. Causal mechanisms

What have you learned from the PD?

What are the key ingredients that have led to this learning?

What do you think students learn from the M4L lessons and approach?

What are the key ingredients of the lessons and approach that lead to this learning?

5. Wrap up

Is there anything that we haven't touched on in this interview that you think would be useful to mention before we finish?

Do you have any questions?

Thank you for your time.

Appendix O: Student interview guide

Student Interview Guide

Section	Purpose of section	Guide time
1. Introductions and background	Explains the purpose and ground rules for the interview	3 mins
2. Responsiveness and causal mechanisms	3.2 To what extent and how is Class Teachers' general practice altered by the programme? 6.1 Are the hypothesised mechanisms that arise from the PD present? 6.2 Are the hypothesised mechanisms that arise from the Maths-for-Life lessons present? 6.3 Are there alternative or complementary mechanisms at play?	15 mins
3. Quality	5.2 Are the five key pedagogies used effectively by Class Teachers in the delivery of Maths-for-Life lessons? 5.3 What factors contribute to variation in implementation quality?	10 mins
5. Wrap up	Thank you and close	2 mins

Topic guide

1. Introductions and background

Intro to me:

- Paddy
- Working on the evaluation of the Maths-For-Life (M4L) programme

Aim of this research:

- What are the M4L lessons like
- Do they help you learn

This interview:

- 30 mins
- Questions about your experience of M4L
- No right or wrong answers
- Just want to understand the world from your point of view

Dissemination:

- Final report published on EEF website in August 2020

Anonymity and privacy:

- Will not use your name anywhere in any reports I write up
- If you feel uncomfortable answering a question we can just skip it
- Just say at any point if you want to stop altogether – no problem
- Later want to withdraw anything you said - let me know by the end of Dec 2019

Recording:

- Would like to take an audio recording of the interview and take notes
- Is that okay?

Begin recording

2. Responsiveness and causal mechanisms

Do you know what Maths-for-Life is? Did you know that your teacher was trying out some new lessons?

- There were five over the year:
  - Ratios and fractions - card matching
  - Proportions - paint prices
  - Algebra - areas and card matching
  - Problem solving using box method - e.g. question on how many jelly snakes, cola bottles and gummy bears there were in a bag
  - Averages - mean, median, mode - matching barchart pictures

What are these lessons like? How would you describe them?

- What does the teacher do?
- Style of teacher interaction - way they speak to you
- Style of work/activities (groups, representations…)

How do you find these lessons?

- Likes
- Dislikes

How different is this to your other maths lessons?

- What are the differences?

Do you prefer one style over the other?

- If so, what things do you prefer?
- Why do you prefer this?

What do you find most useful from lessons and teachers in maths? What helps you learn best?

Have you learnt anything from these lessons?

- What do you feel you have learnt?

2. Quality

Do you feel like you know what you get and what you don't get in maths?

- Why? Why not?
- How do you know?

Do you feel like your teacher understands what you get and what you don't get in maths?

- Why? Why not?
- How do they find out?

How did you feel at the end of the lesson today?

- On a scale of 1-10 - how confident in the topic?
- What about the lesson made you feel that way?

On a scale of 1-10, how highly would you rate the quality of your maths lessons this year?

- What do you like about them?
- If you had a magic wand, what would you do to make them a 10?

5. Wrap up

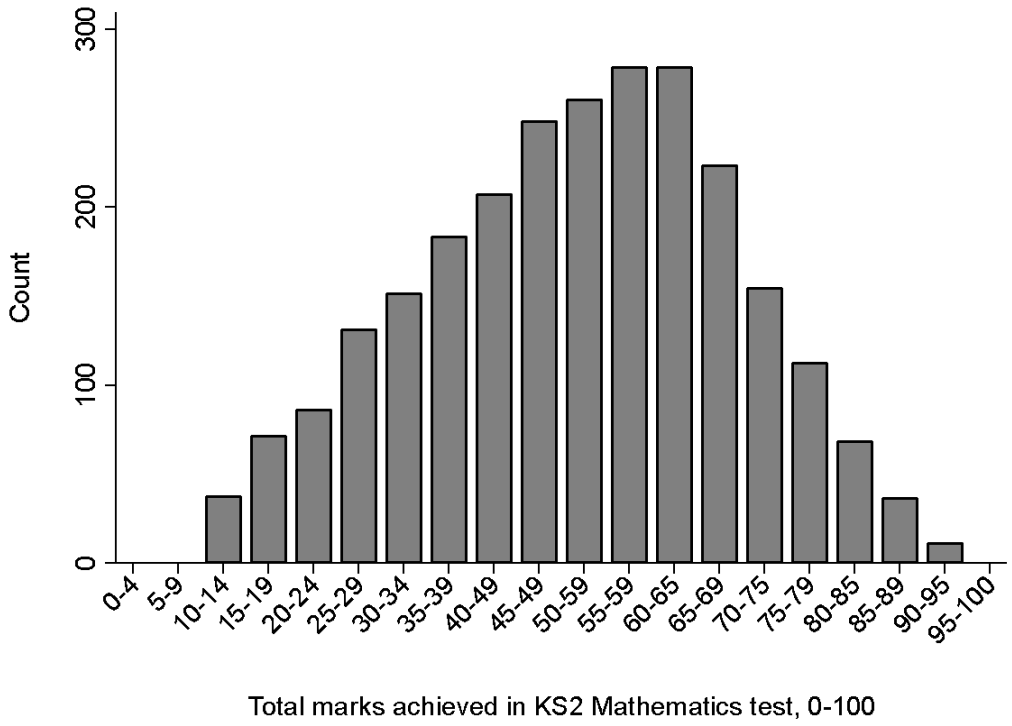
Is there anything that we haven't touched on in this interview that you think would be useful to mention before we finish?

Do you have any questions?

Thank you for your time.

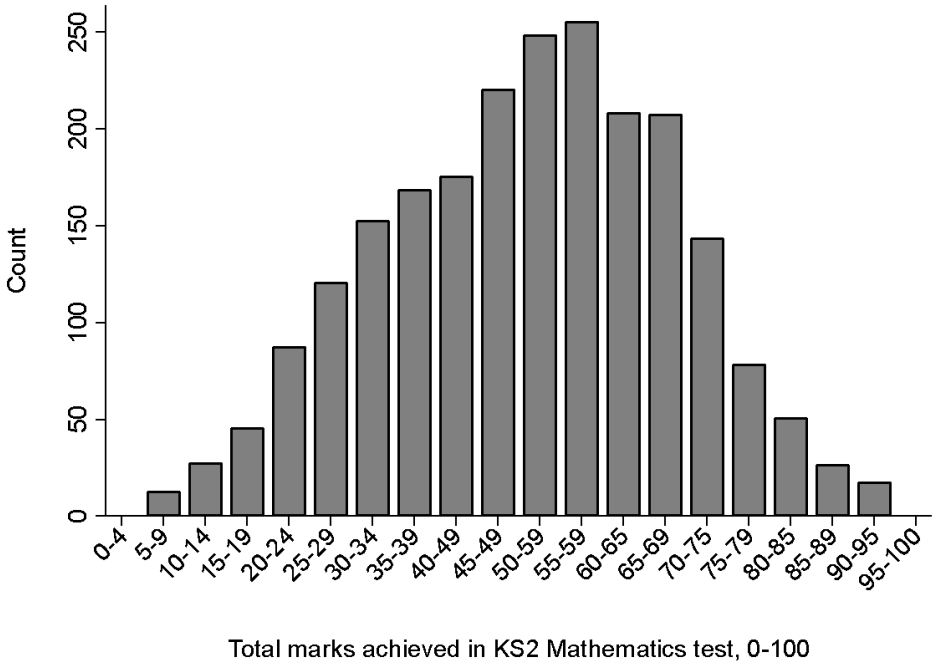
Appendix P: Histograms of pre-test results

Figure 1: Distribution of KS2 SATs Mathematics attainment in the sample at randomisation, in the treatment group[7]



[7] The counts below 10 and above 95 have been censored to comply with ONS disclosure guidelines.

igure 2: Distribution of KS2 SATs Mathematics attainment in the sample at randomisation, in the control group[8]



[8] The counts below 5 and above 95 have been censored to comply with ONS disclosure guidelines.

Figure 3: Distribution of KS2 SATs Mathematics attainment in the primary analysis sample, in the treatment group[9]

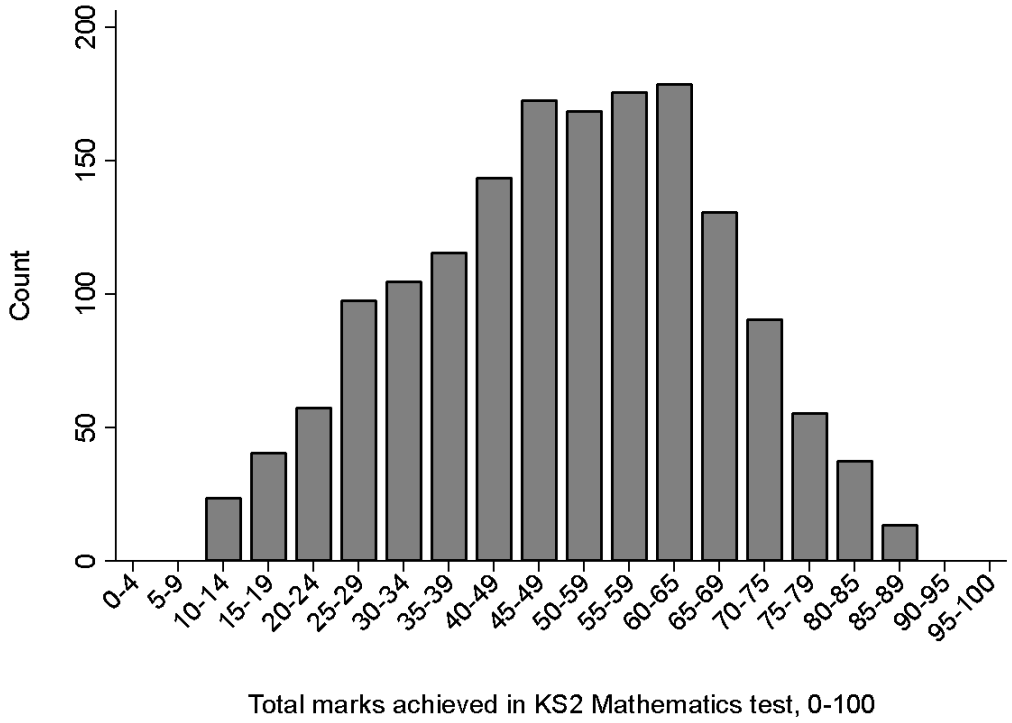
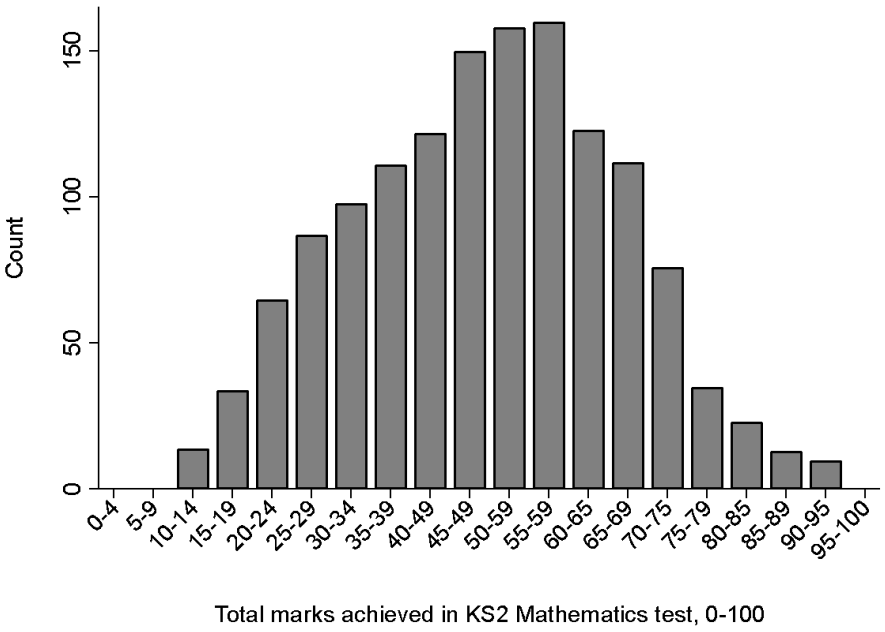


Figure 4: Distribution of KS2 SATs Mathematics attainment in the primary analysis sample, in the control group[10]



[9] The counts below 10 and above 90 have been censored to comply with ONS disclosure guidelines.
[10] The counts below 10 and above 95 have been censored to comply with ONS disclosure guidelines.

Figure 5: Distribution of KS4 GCSE Mathematics grade in the randomisation sample, in the treatment group

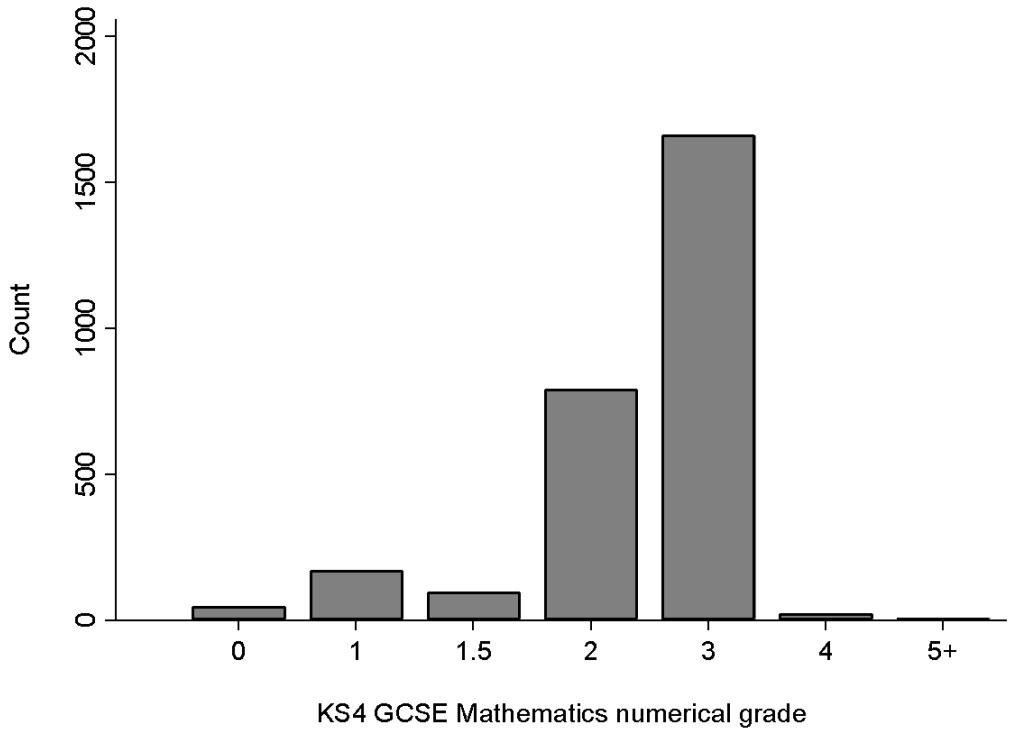


Figure 6: Distribution of KS4 GCSE Mathematics grade in the randomisation sample, in the control group

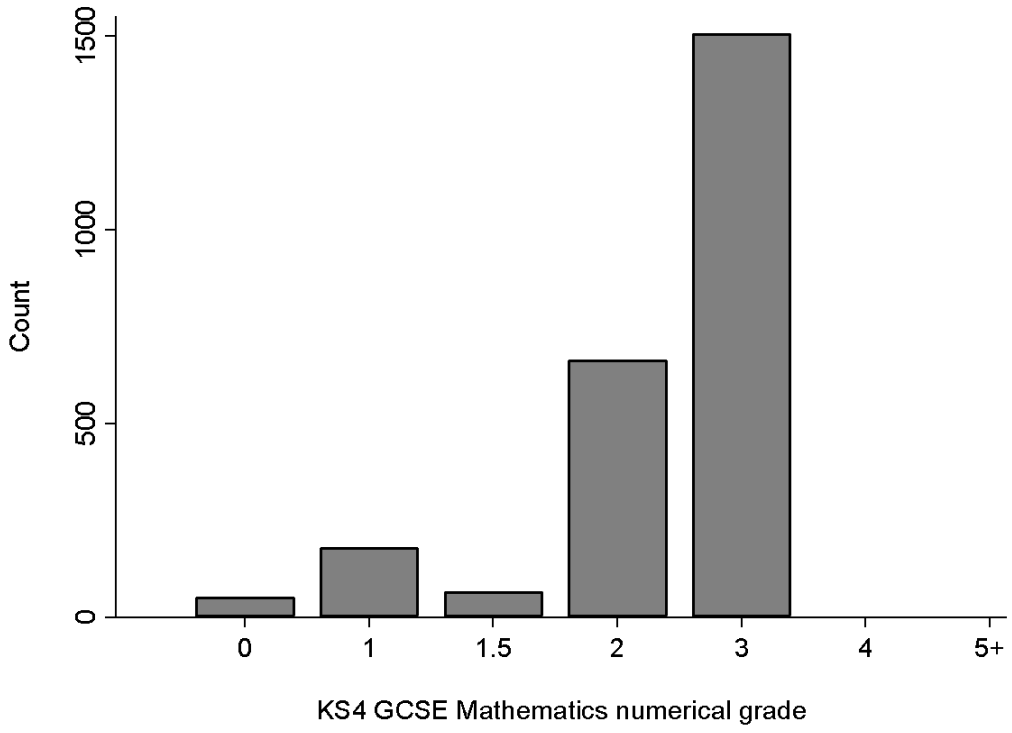


Figure 7: Distribution of KS4 GCSE Mathematics grade in the primary analysis sample, in the treatment group[11]

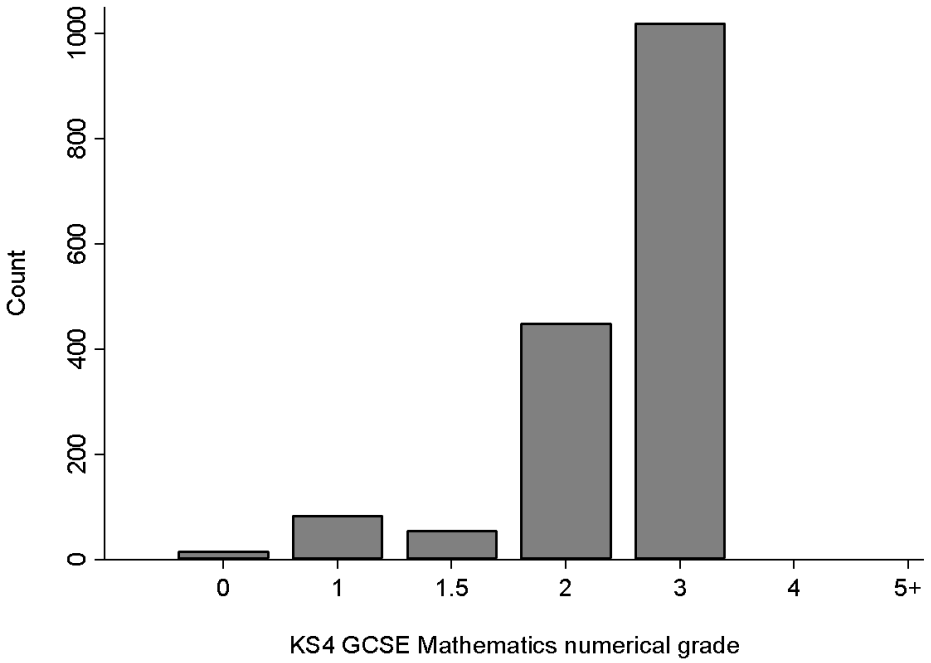
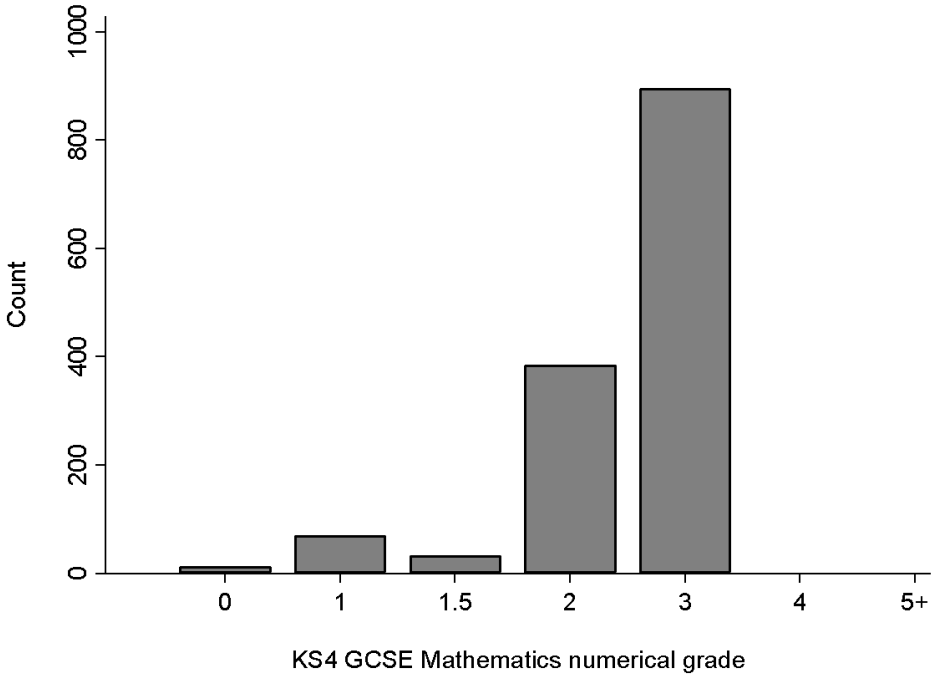


Figure 8: Distribution of KS4 GCSE Mathematics grade in the primary analysis sample, in the control group[12]



[11] The counts of grades 4 and above have been censored to comply with ONS disclosure guidelines.
[12] See previous footnote.

Appendix Q: Technical note on how the UMS scores were obtained

The uniform mark scale is the mechanism that exam bodies in the UK used to convert the 'raw marks' to 'uniform marks' in the GCSE exams. This is a scale used to smooth out any variations in levels of difficulty of units sat by candidates in different examination series', or by different examination boards. The difficulty of exam questions can change slightly from year to year, so the raw marks needed to achieve a particular grade can also differ. The uniform mark allows for comparability across years and exam boards.

Each examination board sets their own grade boundaries, and they have a different set of boundaries for each exam tier. In the GCSE there are two tiers, higher and foundational. The exams in the foundational tier are of lower difficulty, but the maximum grade that a student can achieve is capped at grade C or 5. The higher tier is more difficult and a student can achieve up to a grade A* or 9.

The uniform mark score is calculated by converting the raw exam score into a standardised scale using grade boundaries set by the education board:

- The raw score is matched to the grade band it falls into. See Table 2 for an example below.
- Within that band, the uniform mark is adjusted proportionally based on how close the raw score is to the boundaries of the band.
- If the raw score is below the lowest boundary, the uniform mark is scaled directly from the raw score.

This ensures fairness and consistency in marking across exams.

Table 2 contains the grade boundaries for the EDUQAS board as an example. In this case, a raw score of 83 in a Higher tier exam is between 74 (the boundary of grade 5) and 105, the next grade boundary, so the grade will be 5. The UMS will be determined by the linear function corresponding to that boundary.

Table 2: Grade boundaries

	Higher tier		Foundation tier	
Grade boundaries	Raw score boundaries	Uniform	Raw score boundaries	Uniform
max	240	100	240	59
9	206	90		
8	171	80		
7	136	70		
6	105	60		
5	74	50	140	50
4	43	40	110	40
3	27	30	80	30
2			51	20
1			22	10
zero	0	0	0	0

Equation 1 below represents the **piecewise function** used to calculate the uniform mark score for the Foundation tier exams, for each boundary:

Equation 1

$$y(X) = \begin{cases} 50 + (X - B_5) \cdot \frac{59-50}{B_{\text{Max}} - B_5}, & B_5 \leq X < B_{\text{Max}} \\ 40 + (X - B_4) \cdot \frac{50-40}{B_5 - B_4}, & B_4 \leq X < B_5 \\ 30 + (X - B_3) \cdot \frac{40-30}{B_4 - B_3}, & B_3 \leq X < B_4 \\ 20 + (X - B_2) \cdot \frac{30-20}{B_3 - B_2}, & B_2 \leq X < B_3 \\ 10 + (X - B_1) \cdot \frac{20-10}{B_2 - B_1}, & B_1 \leq X < B_2 \\ X \cdot \frac{10}{B_1}, & X < B_1. \end{cases}$$

where:

- y(X) is the **uniform mark score**
- X is the **raw exam score**, the original score achieved by the candidate.
- B_i are the **grade boundaries**, predefined raw score thresholds that determine the transitions between uniform mark bands. As this is the Foundation tier, grade boundaries (i) only go from 1 to 5.
- The numerical values (e.g., 50, 40, 30, etc.): The **uniform marks** assigned at each grade boundary.

The piecewise function for the Higher tier exams is slightly different, due to the difference in boundaries:

Equation 2

$$y(X) = \begin{cases} 90 + (X - B_{\text{Max}}) \cdot \frac{100-90}{B_{\text{Max}} - B_9}, & B_{\text{Max}} \leq X < B_9 \\ 80 + (X - B_9) \cdot \frac{90-80}{B_9 - B_8}, & B_9 \leq X < B_8 \\ 70 + (X - B_8) \cdot \frac{80-70}{B_8 - B_7}, & B_8 \leq X < B_7 \\ 60 + (X - B_7) \cdot \frac{70-60}{B_7 - B_6}, & B_7 \leq X < B_6 \\ 50 + (X - B_6) \cdot \frac{60-50}{B_6 - B_5}, & B_6 \leq X < B_5 \\ 40 + (X - B_5) \cdot \frac{50-40}{B_5 - B_4}, & B_5 \leq X < B_4 \\ 30 + (X - B_4) \cdot \frac{40-30}{B_4 - B_3}, & B_4 \leq X < B_3 \\ X \cdot \frac{30}{B_3}, & X < B_3. \end{cases}$$

Table 3 below shows the grade boundaries for all four education boards, for the GCSE Maths exams of 2019.

Table 3: Grade boundaries for all boards

Paper Tier	Foundation				Higher			
Exam Board	AQA	EDUQAS	OCR	Pearson Edexcel	AQA	EDUQAS	OCR	Pearson Edexcel
Max Score	240	240	300	240	240	240	300	240
Grade 9 Boundary	-	-	-	-	206	195	256	198
Grade 8 Boundary	-	-	-	-	171	158	213	167
Grade 7 Boundary	-	-	-	-	136	122	171	137

Grade 6 Boundary	-	-	-	-	105	93	136	108
Grade 5 Boundary	157	140	189	184	74	64	102	80
Grade 4 Boundary	122	110	144	149	43	36	68	52
Grade 3 Boundary	89	80	104	111	27	22	51	38
Grade 2 Boundary	57	51	64	73	-	-	-	-
Grade 1 Boundary	25	22	24	36	-	-	-	-
Grade U Boundary	0	0	0	0	0	0	0	0

The grade boundaries were published by the education boards at the following links:

AQA:

- https://filestore.aqa.org.uk/over/stat_pdf/AQA-GCSE-GDE-BDY-JUN-2019.PDF

EDUQAS:

- https://www.eduqas.co.uk/media/v4ufo04r/eduqas-gcse-grade-points-june-2019.pdf
- https://www.wjecservices.co.uk/MarkToUMS/default.aspx

OCR:

- https://www.ocr.org.uk/Images/552370-gcse-9-1-grade-boundaries-june-2019.pdf

Pearson Edexcel:

- https://qualifications.pearson.com/content/dam/pdf/Support/Grade-boundaries/GCSE/1906-GCSE-9--1-subject-grade-boundaries.pdf

Appendix R: Part E of the Teleprism survey - example question

How confident are you that you are able to solve problems of the kind given in each case?

Please circle one response for each task.

[PLEASE DO NOT TRY TO COMPLETE THE TASKS]

1. How confident are you to **calculate the range of a set of numbers** such as:

A rugby team played 7 games.

Here is the number of points they scored in each game.

3 5 8 9 12 12 16

(a) Work out the range.

.....

(2)

Not confident at all **Not very confident** **Fairly confident** **Very confident**

Appendix S: Deviations from the protocol

Protocol section	Specified analysis	Changes made	Justifications for changes
Outcomes and analysis	The TP specified that we would use the variable KS4_L2BASICS_94 from the NPD KS4 dataset to calculate the KS5 GCSE pass rate.	Data on GCSE resit exams was obtained through a combination of KS5, YPMAD (NPD), and ILR Learning Aims datasets. We used data on the exam grades, exam season and exam subject in each of the datasets to code whether they had passed the exam or not.	KS4_L2BASICS_94 indicates whether a pupil achieved a standard pass in both English and Maths, while we only required the Maths attainment. The KS4 dataset does not include results for post-16 students and those from FE colleges, sixth forms, and training providers, whose data is instead available in the KS5, YPMAD (NPD), and ILR Learning Aims datasets.
Outcomes and analysis	The SAP specified we would use Deviance Information Criterion to assess the multilevel model fit.	Bayesian Information Criteria (BIC) was used instead.	The multilevel model was estimated with the Stata software using frequentist statistics (maximum likelihood). The BIC is a frequentist criterion and is designed to work with maximum likelihood estimation, while DIC is designed for Bayesian inference.
Analysis in the presence of non-compliance	Initially, compliance was defined as the number of Maths-for-Life lessons delivered by a participating teacher to each class they taught, ranging from 0 to 5 per class (group).	Compliance was redefined as a binary variable, set to 1 if all teachers in a student's setting delivered at least 3 Maths-for-Life lessons.	Challenges during data collection, including missing data on class keys and discrepancies in class identifiers for half of the treatment group schools, made it unfeasible to link individual students to their teachers using class identifiers. Consequently, compliance was redefined at the setting level to address these data limitations.
Missing data analysis	In the SAP we specified that, if more than 5% of the sample was missing, we would perform the following analyses: 1. Logistic regression to investigate missingness of pre-treatment covariates 2. If coefficients from (1) are significant, do multiple imputation (MI) using Markov Chain Montecarlo (or HLM if missingness is correlated with setting) 3. If point estimates from the MI model are >0.05 SD different from the primary analysis model with complete cases, do sensitivity analysis including and excluding covariates in the logistic regressions modelling missingness	As more than 5% of the primary outcome sample had missing covariates, we estimated the logistic regression to model missingness. However we did not conduct MI. In its place, we performed a descriptive analysis of all the documented reasons for attrition, and did an exploratory analysis re-restimating the secondary outcome GCSE pass rate with the subsample of students	The trial experienced 35% attrition in the primary outcome. By applying Multiple Imputation, the sample would increase from 53% to 65% of the original sample at randomisation. An alternative analysis, which examined the reasons for attrition and conducted robustness checks to assess the impact of attrition on the treatment estimates, was considered more valuable and relevant for interpreting the results, given the unusually high attrition rate in the trial.

	4. If coefficients from (1) are not significant, perform sensitivity analysis including and excluding covariates from the model, as well as using null imputation	included in the primary outcome analysis. We also conducted null imputation with a missing indicator method, and a sensitivity analysis of estimating the primary and secondary outcome models with no covariates.	

Appendix T: Analysis code (Stata)

```
. ************************************************************
> **
.       *** Primary outcome analysis ***
. ************************************************************
> **
.
.       * Unadjusted means, counts and CI / Table 13
.
.       ci means ums if Treatment_Allocation==1 & In_Primary_Anal
> ysis==1

.       ci means ums if Treatment_Allocation==0 & In_Primary_Anal
> ysis==1



.
.               * MIssing:
.       tab Treatment_Allocation if In_Primary_Analysis==0


.
.       * Estimate regression model (page 6 in SAP), excluding pe
> ople that passed in Nov 18
.       reg ums Treatment_Allocation i.setting_type ks2_mattotmrk
>  ks4maths fsm_admin if passed_nov18_admin==0, vce(cluster School_
> ID)


.
.               * Extract all parameters
.        mat list r(table)

r(table)[9,9]

.               * Save parameters in local macros
.       scalar beta = _b[Treatment_Allocation]

.       di beta         // Adjusted difference in means for Appen
> dix table 2

.       local lowci = r(table)[5,1] // Lower limit COnfidence int
> erval

.       local upci = r(table)[6,1]              // Upper limit CO
> nfidence interval


.
.       scalar dir
```

```
.       di `lowci'

.       di `upci'


.
.       * Transform regression coefficient in means to Effect siz
> e in hedges G
.
.               * Obtain pooled sd
.               sum ums if Treatment_Allocation==0 & In_Primary_A
> nalysis==1

.                       * Store estimates to compute "effect size
> "
.               local mean_c = `r(mean)'

.               local sd_c = `r(sd)'

.               local n_c  =  `r(N)'


.
.               sum ums if Treatment_Allocation==1 & In_Primary_A
> nalysis==1


.               local mean_t = `r(mean)'

.               local sd_t = `r(sd)'

.               local n_t  =  `r(N)'


.
.       local pooled_sd = sqrt( ((`n_t'-1)*`sd_t'^2+(`n_c'-1)*`sd
> _c'^2)/(`n_t'+`n_c'-2))

.       di "Pooled variance = " `pooled_sd'^2

.               * Unadjusted difference in means and variance (Fo
> r Appendix Table 2)
.               local un_mean = `mean_t' - `mean_c'

.               local var_t = `sd_t'^2

.               local var_c = `sd_c'^2


.
.               di "Unadjusted difference in means = " `un_mean'

.               di "Variance of outcome treatment = " `var_t'
```

```
.               di "Variance of outcome control = " `var_c'


.
.               * Divide regression coefficient by pooled sd to o
> btain Hedges G
.       local hedgesg=  beta/`pooled_sd'

.       di "Difference in UMS score as effect size = " `hedgesg'

.               * COmpute the CI at 95%
.       local hedgesg_lowci = `lowci'/`pooled_sd'

.       di "Lower CI hedges G = " `hedgesg_lowci'

.       local hedgesg_upci = `upci'/`pooled_sd'

.       di "Upper CI hedges G = " `hedgesg_upci'
.
.       * Unadjusted means, counts and CI
.
.               * Tag all observations that will be used in the G
> CSE resit pass analysis:
.       gen In_Pass_Analysis=0

.       replace In_Pass_Analysis=1 if !missing(gcse_pass2) & !mis
> sing(setting_type) & !missing(fsm_admin) & !missing(ks2_mattotmrk
> ) & !missing(ks4maths) & passed_nov18_admin==0
(4,372 real changes made)


.
.       ci means gcse_pass2 if Treatment_Allocation==1 & In_Pass_
> Analysis==1

.       ci means gcse_pass2 if Treatment_Allocation==0 & In_Pass_
> Analysis==1


.
.               * MIssing:
.       tab Treatment_Allocation if In_Pass_Analysis==0


.       * Estimate regression model (page 6 in SAP)
.
.       reg gcse_pass2 Treatment_Allocation i.setting_type ks2_ma
> ttotmrk ks4maths fsm_admin if passed_nov18_admin==0 , vce(cluster
>  School_ID)

.
```

```
.               * Extract all parameters
.         mat list r(table)

.               * Save parameters in local macros
.       scalar beta = _b[Treatment_Allocation]

.       di beta         // Adjusted difference in means for Appen
> dix table 2

.       local lowci = r(table)[5,1] // Lower limit COnfidence int
> erval

.       local upci = r(table)[6,1]              // Upper limit CO
> nfidence interval


.
.       scalar dir

.       di `lowci'

.       di `upci'

.       * Transform regression coefficient in means to Effect siz
> e in hedges G
.
.               * Obtain pooled sd
.               sum gcse_pass2 if Treatment_Allocation==0 & In_Pa
> ss_Analysis==1

.                       * Store estimates to compute "effect size
> "
.               local mean_c = `r(mean)'

.               local sd_c = `r(sd)'

.               local n_c  =  `r(N)'


.
.               sum gcse_pass2 if Treatment_Allocation==1 & In_Pa
> ss_Analysis==1

.               local mean_t = `r(mean)'

.               local sd_t = `r(sd)'

.               local n_t  =  `r(N)'


.
.       local pooled_sd = sqrt( ((`n_t'-1)*`sd_t'^2+(`n_c'-1)*`sd
```

```
> _c'^2)/(`n_t'+`n_c'-2))

.
.               * Pooled variance  (For Appendix Table 2)
.               di "Pooled variance = " `pooled_sd'^2


.
.               * Unadjusted difference in means and variance (Fo
> r Appendix Table 2)
.               local un_mean= `mean_t' - `mean_c'

.               local var_t = `sd_t'^2

.               local var_c = `sd_c'^2


.
.               di "Unadjusted difference in means = " `un_mean'

.               di "Variance of outcome treatment = " `var_t'

.               di "Variance of outcome control = " `var_c'


.
.               * Divide regression coefficient by pooled sd
.       local hedgesg=  beta/`pooled_sd'

.       di "Difference in GCSE resit passing rate as effect size
> = " `hedgesg'

.               * COmpute the CI at 95%
.       local hedgesg_lowci = `lowci'/`pooled_sd'

.       di "Lower CI hedges G = " `hedgesg_lowci'

.       local hedgesg_upci = `upci'/`pooled_sd'

.       di "Upper CI hedges G = " `hedgesg_upci'


.
. ****************************************************************
> **
.       *** Secondary outcome analysis: GCSE resit pass ***
.       *** RObustness check
. ****************************************************************
> **
.       * Given the amount of attrition data and missing observat
> ions,
.       * We re-estimate the outcome in GCSE resit pass  with the
>
```

```
.       * subsample of students that were also in the primary out
> come analysis
.       * to estimate the potential bias from missing data.
.       * Unadjusted means, counts and CI
.
.               * Tag all observations that will be used in the r
> obustness check:
.       gen In_Pass_Analysis2=0

.       replace In_Pass_Analysis2=1 if !missing(gcse_pass2) & !mi
> ssing(setting_type) & !missing(fsm_admin) & !missing(ks2_mattotmr
> k) & !missing(ks4maths) & !missing(ums) & passed_nov18_admin==0
(3,032 real changes made)

.               * Check cross-tabulations make sense:
.       tab In_Pass_Analysis In_Primary_Analysis, m

.       tab In_Pass_Analysis2 In_Primary_Analysis, m



.
.       ci means gcse_pass2 if Treatment_Allocation==1 & In_Pass_
> Analysis2==1


.       ci means gcse_pass2 if Treatment_Allocation==0 & In_Pass_
> Analysis2==1



.
.               * MIssing:
.       tab Treatment_Allocation if In_Pass_Analysis2==0

.       * Estimate regression model (page 6 in SAP)
.
.       reg gcse_pass2 Treatment_Allocation i.setting_type ks2_ma
> ttotmrk ks4maths fsm_admin if In_Primary_Analysis==1, vce(cluster
>  School_ID)


.
.               * Extract all parameters
.        mat list r(table)

.               * Save parameters in local macros
.       scalar beta = _b[Treatment_Allocation]

.       di beta         // Adjusted difference in means for Appen
> dix table 2
.       local lowci = r(table)[5,1] // Lower limit COnfidence int
```

```
> erval

.       local upci = r(table)[6,1]              // Upper limit CO
> nfidence interval


.
.       scalar dir
.       di `lowci'

.       di `upci'

.       * Transform regression coefficient in means to Effect siz
> e in hedges G
.
.               * Obtain pooled sd
.               sum gcse_pass2 if Treatment_Allocation==0 & In_Pa
> ss_Analysis2==1


.                       * Store estimates to compute "effect size
> "
.               local mean_c = `r(mean)'

.               local sd_c = `r(sd)'

.               local n_c  =  `r(N)'

.
.               sum gcse_pass2 if Treatment_Allocation==1 & In_Pa
> ss_Analysis2==1


.               local mean_t = `r(mean)'

.               local sd_t = `r(sd)'

.               local n_t  =  `r(N)'

.
.       local pooled_sd = sqrt( ((`n_t'-1)*`sd_t'^2+(`n_c'-1)*`sd
> _c'^2)/(`n_t'+`n_c'-2))

.                       * Pooled variance  (For Appendix Table 2)
.               di "Pooled variance = " `pooled_sd'^2

.
.               * Unadjusted difference in means and variance (Fo
> r Appendix Table 2)
.               local un_mean= `mean_t' - `mean_c'
```

```
.               local var_t = `sd_t'^2

.               local var_c = `sd_c'^2


.
.               di "Unadjusted difference in means = " `un_mean'

.               di "Variance of outcome treatment = " `var_t'

.               di "Variance of outcome control = " `var_c'


.
.               * Divide regression coefficient by pooled sd
.       local hedgesg=  beta/`pooled_sd'

.       di "Difference in GCSE resit passing rate as effect size
> = " `hedgesg'

.               * COmpute the CI at 95%
.       local hedgesg_lowci = `lowci'/`pooled_sd'

.       di "Lower CI hedges G = " `hedgesg_lowci'

.       local hedgesg_upci = `upci'/`pooled_sd'

.       di "Upper CI hedges G = " `hedgesg_upci'


.
.
.
. ****************************************************************
> **
.       *** Secondary outcome analysis: Mathematical self-efficac
> y survey ***
. ****************************************************************
> **
.               * Tag all observations that will be used in the s
> urvey analysis:
.       gen In_Survey_Analysis=0

.       replace In_Survey_Analysis=1 if !missing(survey_score) &
> !missing(setting_type) & !missing(fsm_admin) & !missing(ks2_matto
> tmrk) & !missing(ks4maths) & passed_nov18_admin==0


.
.       ci means survey_score if Treatment_Allocation==1 & In_Sur
> vey_Analysis==1
```

```
.       ci means survey_score if Treatment_Allocation==0 & In_Sur
> vey_Analysis==1


.
.               * MIssing:
.       tab Treatment_Allocation if In_Survey_Analysis==0


.       * Estimate regression model (page 6 in SAP)
.
.       reg survey_score Treatment_Allocation i.setting_type ks2_
> mattotmrk ks4maths fsm_admin if  passed_nov18_admin==0 , vce(clus
> ter School_ID)


.
.               * Extract all parameters
.        mat list r(table)


.               * Save parameters in local macros

.       di beta         // Adjusted difference in means for Appen
> dix table 2

.       local lowci = r(table)[5,1] // Lower limit COnfidence int
> erval

.       local upci = r(table)[6,1]              // Upper limit COnfidence interval


.
.       scalar dir

.       di `lowci'

.       di `upci'

.       * Transform regression coefficient in means to Effect siz
> e in hedges G
.
.               * Obtain pooled sd
.               sum survey_score if Treatment_Allocation==0 & In_
> Survey_Analysis==1



.                       * Store estimates to compute "effect size
> "
.               local mean_c = `r(mean)'
```

```
.               local sd_c = `r(sd)'

.               local n_c  =  `r(N)'


.
.               sum survey_score if Treatment_Allocation==1 & In_
> Survey_Analysis==1


.               local mean_t = `r(mean)'

.               local sd_t = `r(sd)'

.               local n_t  =  `r(N)'


.
.       local pooled_sd = sqrt( ((`n_t'-1)*`sd_t'^2+(`n_c'-1)*`sd
> _c'^2)/(`n_t'+`n_c'-2))

.                               * Pooled variance  (For Appendix
> Table 2)
.               di "Pooled variance = " `pooled_sd'^2


.
.               * Unadjusted difference in means and variance (Fo
> r Appendix Table 2)
.               local un_mean= `mean_t' - `mean_c'

.               local var_t = `sd_t'^2

.               local var_c = `sd_c'^2


.
.               di "Unadjusted difference in means = " `un_mean'

.               di "Variance of outcome treatment = " `var_t'

.               di "Variance of outcome control = " `var_c'


.
.
.               * Divide regression coefficient by pooled sd
.       local hedgesg=  beta/`pooled_sd'

.       di "Difference in Maths self-efficacy survey score as eff
> ect size = " `hedgesg'

.               * COmpute the CI at 95%
.       local hedgesg_lowci = `lowci'/`pooled_sd'
```

```
.       di "Lower CI hedges G = " `hedgesg_lowci'

.       local hedgesg_upci = `upci'/`pooled_sd'

.       di "Upper CI hedges G = " `hedgesg_upci'



. ************************************************************
> **
.       *** Primary outcome analysis; Interaction term ***
. ************************************************************
> **
.       * Estimate regression model (page 6 in SAP) including an
> interaction term
.       reg ums Treatment_Allocation##fsm_admin i.setting_type ks
> 2_mattotmrk ks4maths if In_Primary_Analysis==1, vce(cluster Schoo
> l_ID)
.               * Extract all parameters
.        mat list r(table)
.               * Save parameters in local macros
.       local beta  = r(table)[1,8] // interaction term; row, col
> umn

.       local lowci = r(table)[5,8] // Lower limit COnfidence int
> erval

.       local upci = r(table)[6,8]              // Upper limit CO
> nfidence interval


.
.       scalar dir

.       di `lowci'
.       di `upci'
1.3683043


.
.       * Transform regression coefficient in means to Effect siz
> e in hedges G
.               * In_Primary_Analysis can also be used to tag the
>  complete case observations
.               * used in the FSM interaction model regression be
> cause the variables used
.               * are the same
.
.               * Obtain pooled sd for the interaction term
. * The guidance from the EEF is to use the unconditional SD from t
```

```
> he FSM subsample to compute the hedges G
.
.               sum ums if Treatment_Allocation==0 & fsm_admin==1
>  & In_Primary_Analysis==1

.                       * Store estimates to compute "effect size
> "
.               local mean_c = `r(mean)'

.               local sd_c = `r(sd)'

.               local n_c  =  `r(N)'


.
.               sum ums if Treatment_Allocation==1 & fsm_admin==1
>  & In_Primary_Analysis==1

.               local mean_t = `r(mean)'

.               local sd_t = `r(sd)'

.               local n_t  =  `r(N)'


.
.                       * Obtain n of analysis per arm (for annex
>  table 3)
.               tab Treatment_Allocation if fsm_admin==1 & In_Pri
> mary_Analysis==1


.                       * Obtain n of missing observations per ar
> m (for annex table 3)
.               tab Treatment_Allocation if fsm_admin==1 & In_Pri
> mary_Analysis==0


.
.       local pooled_sd = sqrt( ((`n_t'-1)*`sd_t'^2+(`n_c'-1)*`sd
> _c'^2)/(`n_t'+`n_c'-2))

.                               * Pooled variance  (For Appendix
> Table 3)
.               di "Pooled variance = " `pooled_sd'^2

.               local var_t = `sd_t'^2

.               local var_c = `sd_c'^2

.               di "Variance of outcome treatment = " `var_t'
```

```
.               di "Variance of outcome control = " `var_c'


.
.               * Unadjusted difference in means and variance (Fo
> r Appendix Table 3)
.               reg ums Treatment_Allocation##fsm_admin , vce(clu
> ster School_ID)


.               mat list r(table)



.
.               local un_mean = r(table)[1,8]

.               di "Unadjusted difference in means = " `un_mean'
.
.
.               * Divide regression coefficient by pooled sd to o
> btain Hedges G
.       local hedgesg=  `beta'/`pooled_sd'

.       di "Interaction term effect size = " `hedgesg'

.               * COmpute the CI at 95%
.       local hedgesg_lowci = `lowci'/`pooled_sd'

.       di "Lower CI hedges G = " `hedgesg_lowci'

.       local hedgesg_upci = `upci'/`pooled_sd'

.       di "Upper CI hedges G = " `hedgesg_upci'



.
. ****************************************************************
> **
.       *** Primary outcome analysis; non-FSM pupils***
. ****************************************************************
> **
.
.       * tag not FSM subsample in the regression
.       gen In_nonfsm_analysis = 0

.       replace In_nonfsm_analysis= 1 if fsm_admin==0 & In_Primar
> y_Analysis==1
.
.       * Obtain N
.       tab Treatment_Allocation if In_nonfsm_analysis==1
```

```
.       * Obtain missing N
.       tab Treatment_Allocation if fsm_admin==0 & In_nonfsm_anal
> ysis==0



.
.       * Estimate regression model (page 6 in SAP) for the subgr
> oup of non-fsm
.       reg ums Treatment_Allocation i.setting_type ks2_mattotmrk
>  ks4maths if fsm_admin==0 & In_Primary_Analysis==1, vce(cluster S
> chool_ID)

.               * Extract all parameters
.        mat list r(table)

r(table)[9,8]

.               * Save parameters in local macros
.       local beta  = r(table)[1,1] // interaction term

.       local lowci = r(table)[5,1] // Lower limit COnfidence int
> erval

.       local upci = r(table)[6,1]              // Upper limit CO
> nfidence interval


.
.       di `lowci'

.       di `upci'


.
.       * Transform regression coefficient in means to Effect siz
> e in hedges G
.
.               sum ums if Treatment_Allocation==0 & In_nonfsm_an
> alysis==1

.                       * Store estimates to compute "effect size
> "
.               local mean_c = `r(mean)'

.               local sd_c = `r(sd)'

.               local n_c  =  `r(N)'


.
.               sum ums if Treatment_Allocation==1 & In_nonfsm_an
```

```
> alysis==1

.               local mean_t = `r(mean)'

.               local sd_t = `r(sd)'

.               local n_t  =  `r(N)'

.               * Unadjusted difference in means and variance (Fo
> r Appendix Table 3)
.               local un_mean= `mean_t' - `mean_c'

.               local var_t = `sd_t'^2

.               local var_c = `sd_c'^2


.
.               di "Unadjusted difference in means = " `un_mean'

.               di "Variance of outcome treatment = " `var_t'

.               di "Variance of outcome control = " `var_c'
.
.
.       local pooled_sd = sqrt( ((`n_t'-1)*`sd_t'^2+(`n_c'-1)*`sd
> _c'^2)/(`n_t'+`n_c'-2))

.       di "Pooled variance = " `pooled_sd'^2
.
.               * Divide regression coefficient by pooled sd to o
> btain Hedges G
.       local hedgesg=  `beta'/`pooled_sd'

.       di "Non-FSM effect size = " `hedgesg'

.               * COmpute the CI at 95%
.       local hedgesg_lowci = `lowci'/`pooled_sd'

.       di "Lower CI hedges G = " `hedgesg_lowci'
.       local hedgesg_upci = `upci'/`pooled_sd'

.       di "Upper CI hedges G = " `hedgesg_upci'


. ************************************************************
> **
.       *** Primary outcome analysis; FSM pupils***
. ************************************************************
> **
```

```
.
.       * tag not FSM subsample in the regression
.       gen In_fsm_analysis = 0

.       replace In_fsm_analysis= 1 if fsm_admin==1 & In_Primary_A
> nalysis==1


.
.       * Obtain N
.       tab Treatment_Allocation if In_fsm_analysis==1


.       * Obtain missing N
.       tab Treatment_Allocation if  fsm_admin==1 & In_fsm_analys
> is==0



.
.       * Estimate regression model (page 6 in SAP) for the subgr
> oup of FSM-eligible pupils
.       reg ums Treatment_Allocation i.setting_type ks2_mattotmrk
>  ks4maths if fsm_admin==1 & In_Primary_Analysis==1, vce(cluster S
> chool_ID)
.
.               * Extract all parameters
.        mat list r(table)

r(table)[9,8]

.               * Save parameters in local macros
.       local beta  = r(table)[1,1] // interaction term

.       local lowci = r(table)[5,1] // Lower limit COnfidence int
> erval

.       local upci = r(table)[6,1]              // Upper limit CO
> nfidence interval


.
.       di `lowci'

.       di `upci'


.
.       * Transform regression coefficient in means to Effect siz
> e in hedges G
.
.               sum ums if Treatment_Allocation==0 & In_fsm_analy
> sis==1
```

```
.                       * Store estimates to compute "effect size
> "
.               local mean_c = `r(mean)'

.               local sd_c = `r(sd)'

.               local n_c  =  `r(N)'


.
.               sum ums if Treatment_Allocation==1 & In_fsm_analy
> sis==1

.               local mean_t = `r(mean)'

.               local sd_t = `r(sd)'

.               local n_t  =  `r(N)'


.
.               * Unadjusted difference in means and variance (Fo
> r Appendix Table 3)
.               local un_mean= `mean_t' - `mean_c'

.               local var_t = `sd_t'^2

.               local var_c = `sd_c'^2


.
.               di "Unadjusted difference in means = " `un_mean'

.               di "Variance of outcome treatment = " `var_t'

.               di "Variance of outcome control = " `var_c'


.
.       local pooled_sd = sqrt( ((`n_t'-1)*`sd_t'^2+(`n_c'-1)*`sd
> _c'^2)/(`n_t'+`n_c'-2))

.       di "Pooled variance = " `pooled_sd'^2


.
.               * Divide regression coefficient by pooled sd to o
> btain Hedges G
.       local hedgesg=  `beta'/`pooled_sd'

.       di "FSM effect size = " `hedgesg'
```

```
.               * COmpute the CI at 95%
.       local hedgesg_lowci = `lowci'/`pooled_sd'

.       di "Lower CI hedges G = " `hedgesg_lowci'

.       local hedgesg_upci = `upci'/`pooled_sd'

.       di "Upper CI hedges G = " `hedgesg_upci'


. ****************************************************************
> **
.       *** Secondary outcome analysis; Interaction term ***
. ****************************************************************
> **
.       * This is not in the SAP so it will count as exploratory
> analysis
.       * SInce GCSE pass rates are more complete than the primar
> y analysis,
.       * it's worth looking at the effect size for FSM-eligible
> pupils
.
.               * Tag all observations that are used int he GCSE
> resit pass analysis
.       gen In_Pass_Analysis=0

.       replace In_Pass_Analysis=1 if !missing(gcse_pass2) & !mis
> sing(setting_type) & !missing(fsm_admin) & !missing(ks2_mattotmrk
> ) & !missing(ks4maths) & passed_nov18_admin==0
(4,372 real changes made)


.
.       * Estimate regression model (page 6 in SAP) including an
> interaction term
.       reg gcse_pass2 Treatment_Allocation##fsm_admin i.setting_
> type ks2_mattotmrk ks4maths if  In_Pass_Analysis==1, vce(cluster
> School_ID)
.
.               * Extract all parameters
.        mat list r(table)

r(table)[9,15]

.               * Save parameters in local macros
.       local beta  = r(table)[1,8] // interaction term

.       local lowci = r(table)[5,8] // Lower limit COnfidence int
> erval
```

```
.       local upci = r(table)[6,8]              // Upper limit CO
> nfidence interval

.
.       scalar dir

.       di `lowci'

.       di `upci'

.
.               sum gcse_pass2 if Treatment_Allocation==0 & fsm_a
> dmin==1 & In_Pass_Analysis==1


.                       * Store estimates to compute "effect size
> "
.               local mean_c = `r(mean)'

.               local sd_c = `r(sd)'

.               local n_c  =  `r(N)'

.
.               sum gcse_pass2 if Treatment_Allocation==1 & fsm_a
> dmin==1 & In_Pass_Analysis==1


.               local mean_t = `r(mean)'

.               local sd_t = `r(sd)'

.               local n_t  =  `r(N)'

.
.                       * Obtain n of subgroup analysis per arm (
> annex table 3)
.               tab Treatment_Allocation if fsm_admin==1 & In_Pas
> s_Analysis==1


.                       * Obtain n of missing observations per ar
> m
.               tab Treatment_Allocation if fsm_admin==1 & In_Pas
> s_Analysis==0
.                       * Obtain n of subgroup analysis for the p
> ooled sample (table 19)
.               tab Treatment_Allocation if In_Pass_Analysis==1
.
```

```
.               local pooled_sd = sqrt( ((`n_t'-1)*`sd_t'^2+(`n_c
> '-1)*`sd_c'^2)/(`n_t'+`n_c'-2))

.                               * Pooled variance  (For Appendix
> Table 3)
.               di "Pooled variance = " `pooled_sd'^2
.
.               local var_t = `sd_t'^2

.               local var_c = `sd_c'^2

.               di "Variance of outcome treatment = " `var_t'

.               di "Variance of outcome control = " `var_c'


.
.               * Unadjusted difference in means and variance (Fo
> r Appendix Table 3)
.               reg gcse_pass2 Treatment_Allocation##fsm_admin ,
> vce(cluster School_ID)

.               mat list r(table)

r(table)[9,9]
.
.               local un_mean = r(table)[1,8]

.               di "Unadjusted difference in means = " `un_mean'


.
.               * Divide regression coefficient by pooled sd to o
> btain Hedges G
.       local hedgesg=  `beta'/`pooled_sd'

.       di "Interaction term effect size = " `hedgesg'

.               * COmpute the CI at 95%
.       local hedgesg_lowci = `lowci'/`pooled_sd'

.       di "Lower CI hedges G = " `hedgesg_lowci'

.       local hedgesg_upci = `upci'/`pooled_sd'

.       di "Upper CI hedges G = " `hedgesg_upci'

.
. ****************************************************************
> **
.       *** Secondary outcome analysis; Non-FSM  ***
```

```
. ************************************************************
> **
.       * tag not FSM subsample in the regression
.       gen In_Pass_nonfsm =0

.       replace In_Pass_nonfsm = 1 if In_Pass_Analysis==1 & fsm_a
> dmin==0
(2,857 real changes made)


.
.       * Obtain N
.       tab Treatment_Allocation if In_Pass_nonfsm==1


.       * Obtain missing N
.       tab Treatment_Allocation if In_Pass_nonfsm==0 & fsm_admin
> ==0

.       * Estimate regression model (page 6 in SAP) including an
> interaction term
.       reg gcse_pass2 Treatment_Allocation i.setting_type ks2_ma
> ttotmrk ks4maths if In_Pass_nonfsm==1, vce(cluster School_ID)

.               * Extract all parameters
.        mat list r(table)

r(table)[9,8]


.               * Save parameters in local macros
.       local beta  = r(table)[1,1] // interaction term

.       local lowci = r(table)[5,1] // Lower limit COnfidence int
> erval

.       local upci = r(table)[6,1]              // Upper limit CO
> nfidence interval


.
.       di `lowci'

.       di `upci'


.
.       * Transform regression coefficient in means to Effect siz
> e in hedges G
.
.               sum gcse_pass2 if Treatment_Allocation==0 & In_Pa
> ss_nonfsm==1
```

```
.                   * Store estimates to compute "effect size
> "
.               local mean_c = `r(mean)'

.               local sd_c = `r(sd)'

.               local n_c  =  `r(N)'


.
.               sum gcse_pass2 if Treatment_Allocation==1 & In_Pa
> ss_nonfsm==1

>    1

.               local mean_t = `r(mean)'

.               local sd_t = `r(sd)'

.               local n_t  =  `r(N)'


.
.                   * Unadjusted difference in means and vari
> ance (For Appendix Table 3)
.               local un_mean= `mean_t' - `mean_c'

.               local var_t = `sd_t'^2

.               local var_c = `sd_c'^2


.
.               di "Unadjusted difference in means = " `un_mean'

.               di "Variance of outcome treatment = " `var_t'

.               di "Variance of outcome control = " `var_c'


.
.       local pooled_sd = sqrt( ((`n_t'-1)*`sd_t'^2+(`n_c'-1)*`sd
> _c'^2)/(`n_t'+`n_c'-2))

.       di "Pooled variance = " `pooled_sd'^2


.
.               * Divide regression coefficient by pooled sd to o
> btain Hedges G
.       local hedgesg=  `beta'/`pooled_sd'
```

```
.       di "Non-FSM effect size = " `hedgesg'

.               * COmpute the CI at 95%
.       local hedgesg_lowci = `lowci'/`pooled_sd'

.       di "Lower CI hedges G = " `hedgesg_lowci'

.       local hedgesg_upci = `upci'/`pooled_sd'

.       di "Upper CI hedges G = " `hedgesg_upci'


. ****************************************************************
> **
.       *** Secondary outcome analysis; FSM  ***
. ****************************************************************
> **
.       * tag  FSM subsample in the regression
.
.       gen In_Pass_fsm =0

.       replace In_Pass_fsm = 1 if In_Pass_Analysis==1 & fsm_admi
> n==1


.
.       * Obtain N
.       tab Treatment_Allocation if In_Pass_fsm==1


.       * Obtain missing N
.       tab Treatment_Allocation if In_Pass_fsm==0 & fsm_admin==1


.
.       * Estimate regression model (page 6 in SAP) including an
> interaction term
.       reg gcse_pass2 Treatment_Allocation i.setting_type ks2_ma
> ttotmrk ks4maths if In_Pass_fsm==1 , vce(cluster School_ID)


.
.               * Extract all parameters
.        mat list r(table)

.               * Save parameters in local macros
.       local beta  = r(table)[1,1] // interaction term

.       local lowci = r(table)[5,1] // Lower limit COnfidence int
> erval

.       local upci = r(table)[6,1]              // Upper limit CO
```

```
> nfidence interval

.
.       di `lowci'

.       di `upci'

.
.       * Transform regression coefficient in means to Effect siz
> e in hedges G
.
.               sum gcse_pass2 if Treatment_Allocation==0 & In_Pa
> ss_fsm==1


.                       * Store estimates to compute "effect size
> "
.               local mean_c = `r(mean)'

.               local sd_c = `r(sd)'

.               local n_c  =  `r(N)'

.
.               sum gcse_pass2 if Treatment_Allocation==1 & In_Pa
> ss_fsm==1


.               local mean_t = `r(mean)'

.               local sd_t = `r(sd)'

.               local n_t  =  `r(N)'

.                       * Unadjusted difference in means and vari
> ance (For Appendix Table 3)
.               local un_mean= `mean_t' - `mean_c'

.               local var_t = `sd_t'^2

.               local var_c = `sd_c'^2

.
.               di "Unadjusted difference in means = " `un_mean'
.               di "Variance of outcome treatment = " `var_t'
.               di "Variance of outcome control = " `var_c'

.
.       local pooled_sd = sqrt( ((`n_t'-1)*`sd_t'^2+(`n_c'-1)*`sd
```

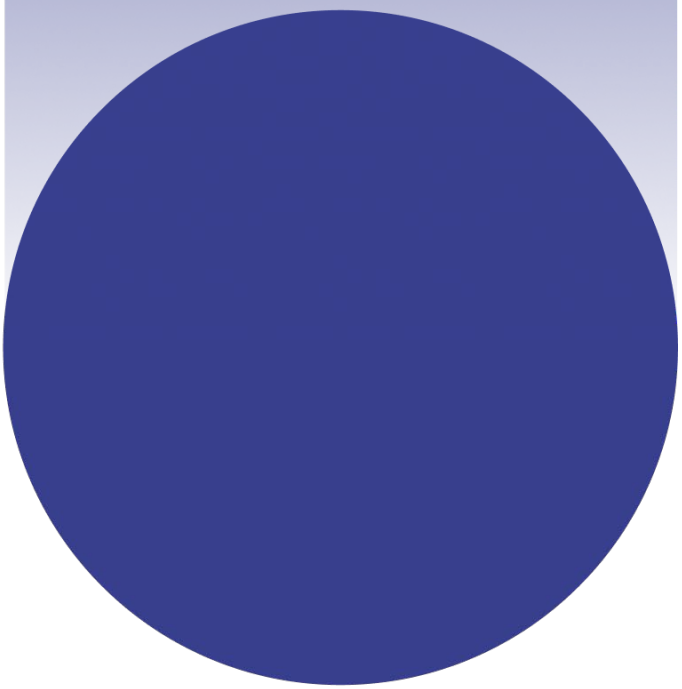
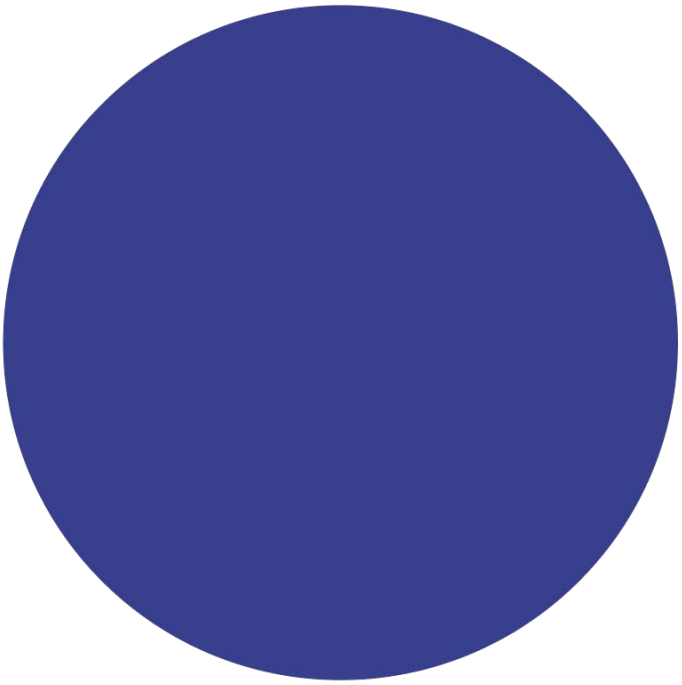
```
> _c'^2)/(`n_t'+`n_c'-2))

.       di "Pooled variance = " `pooled_sd'^2


.
.               * Divide regression coefficient by pooled sd to o
> btain Hedges G
.       local hedgesg=  `beta'/`pooled_sd'

.       di "FSM effect size = " `hedgesg'

.               * COmpute the CI at 95%
.       local hedgesg_lowci = `lowci'/`pooled_sd'

.       di "Lower CI hedges G = " `hedgesg_lowci'

.       local hedgesg_upci = `upci'/`pooled_sd'

.       di "Upper CI hedges G = " `hedgesg_upci'


.
.
. ****************************************************************
> **
.       *** Subgroup analysis by setting type , interaction term*
> **
. ****************************************************************
> **
.       * page 8 SAP
.       * Estimate regression model (page 6 in SAP) including an
> interaction term
.
.               * Get counts
.       tab  setting_type Treatment_Allocation if In_Primary_Anal
> ysis==1

.               * Get counts of missing
.       tab  setting_type Treatment_Allocation if In_Primary_Anal
> ysis==0


.
.               * Estimate regression
.       reg ums Treatment_Allocation##i.setting_type fsm_admin ks
> 2_mattotmrk ks4maths if In_Primary_Analysis==1, vce(cluster Schoo
> l_ID)


.
.               * Obtain the treatment effect in each of the 4 se
> tting types
```

```
.       margins setting_type, dydx(Treatment_Allocation)

.               * Extract all parameters
.        mat list r(table)

r(table)[9,8]

.               * Save parameters in local macros
.                       * FE college
.       local beta_FE  = r(table)[1,5] // treatment effect

.       local lowci_FE = r(table)[5,5] // Lower limit COnfidence
> interval

.       local upci_FE = r(table)[6,5]          // Upper limit CO
> nfidence interval


.
.       * School
.       local beta_school  = r(table)[1,6] // treatment effect

.       local lowci_school = r(table)[5,6] // Lower limit COnfide
> nce interval

.       local upci_school = r(table)[6,6]              // Upper
> limit COnfidence interval


.
.       * Sixth form
.       local beta_6form  = r(table)[1,7] // treatment effect

.       local lowci_6form = r(table)[5,7] // Lower limit COnfiden
> ce interval

.       local upci_6form = r(table)[6,7]               // Upper
> limit COnfidence interval


.
.       * Training provider
.       local beta_tp  = r(table)[1,8] // treatment effect

.       local lowci_tp = r(table)[5,8] // Lower limit COnfidence
> interval

.       local upci_tp = r(table)[6,8]          // Upper limit CO
> nfidence interval


.
.       * Transform regression coefficient in means to Effect siz
```

```
> e in hedges G
.
.               * Compute the pooled SD for each setting type
.
.       forvalues st = 1/4 {
  2.                sum ums if Treatment_Allocation==0 & In_Primar
> y_Analysis==1 & setting_type==`st'
  3.                      * Store estimates to compute Hedges G
>  for control and treatment
.               local sd_c = `r(sd)'
  4.                local n_c  =  `r(N)'
  5.
.               sum ums if  Treatment_Allocation==1 & In_Primary_
> Analysis==1 & setting_type==`st'
  6.                local sd_t = `r(sd)'
  7.                local n_t  =  `r(N)'
  8.
.       local pooled_sd_st`st' = sqrt( ((`n_t'-1)*`sd_t'^2+(`n_c'
> -1)*`sd_c'^2)/(`n_t'+`n_c'-2))
  9.        local var_t = `sd_t'^2
 10.        local var_c = `sd_c'^2
 11.
.       di "Pooled variance, Setting type == `st' = " `pooled_sd_
> st`st'"^2
 12.        di "Variance of outcome treatment , Setting type == `s
> t'= " `var_t'
 13.        di "Variance of outcome control , Setting type == `st'
>  = " `var_c'
 14.
.       }



.
.               * Divide regression coefficient by pooled sd to o
> btain Hedges G
.
.                     *FE college
.       local hedgesg_FE=  `beta_FE'/`pooled_sd_st1'

.       di "Treatment effect size, FE College = " `hedgesg_FE'

.               * COmpute the CI at 95%
.       local hedgesg_lowci_FE = `lowci_FE'/`pooled_sd_st1'

.       di "Lower CI hedges G, FE College = " `hedgesg_lowci_FE'
.       local hedgesg_upci_FE = `upci_FE'/`pooled_sd_st1'

.       di "Upper CI hedges G, FE College = " `hedgesg_upci_FE'
.
```

```
.                   *School
.       local hedgesg_school=  `beta_school'/`pooled_sd_st2'

.       di "Treatment effect size, School = " `hedgesg_school'

.               * COmpute the CI at 95%
.       local hedgesg_lowci_school = `lowci_school'/`pooled_sd_st
> 2'

.       di "Lower CI hedges G, School = " `hedgesg_lowci_school'
.       local hedgesg_upci_school = `upci_school'/`pooled_sd_st2'

.       di "Upper CI hedges G, School = " `hedgesg_upci_school'


.
.                   *6th form
.       local hedgesg_6form=  `beta_6form'/`pooled_sd_st3'

.       di "Treatment effect size, 6form = " `hedgesg_6form'

.               * COmpute the CI at 95%
.       local hedgesg_lowci_6form = `lowci_6form'/`pooled_sd_st3'

.       di "Lower CI hedges G, 6form = " `hedgesg_lowci_6form'
.       local hedgesg_upci_6form = `upci_6form'/`pooled_sd_st3'

.       di "Upper CI hedges G, 6form = " `hedgesg_upci_6form'


.
.               *training provider
.       local hedgesg_tp=  `beta_tp'/`pooled_sd_st4'

.       di "Treatment effect size, train prov = " `hedgesg_tp'

.               * COmpute the CI at 95%
.       local hedgesg_lowci_tp = `lowci_tp'/`pooled_sd_st4'

.       di "Lower CI hedges G, train prov = " `hedgesg_lowci_tp'

.       local hedgesg_upci_tp = `upci_tp'/`pooled_sd_st4'

.       di "Upper CI hedges G, train prov = " `hedgesg_upci_tp'


.
.       * Obtain unadjusted interaction terms for reporting Appen
> dix table 4
.       reg ums Treatment_Allocation##i.setting_type  if In_Prima
> ry_Analysis==1, vce(cluster School_ID)
```

```
.                * Obtain the treatment effect in each of the 4 se
> tting types
.          margins setting_type, dydx(Treatment_Allocation)
.                * Extract all parameters
.           mat list r(table)

r(table)[9,8]
```

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