Education Endowment Foundation

SMART Spaces: Spaced Learning Revision Programme

Evaluation Report: Further Appendices

July 2023

Jeremy Hodgen, Nicola Bretscher, Mark Hardman, Jake Anders, Helen Lawson

UCL Institute of Education

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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.
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About the evaluator

The project was independently evaluated by a team from IOE, UCL's Faculty of Education and Society: Jeremy Hodgen, Nicola Bretscher, Mark Hardman, Jake Anders and Helen Lawson.

The lead evaluator was Jeremy Hodgen: jeremy.hodgen@ucl.ac.uk

Acknowledgements

The research team and authors of this report would like to thank the many teachers and their pupils who took part in the trial; both those who took part in the SMART Spaces intervention programme and those in the control group. The time and effort they gave to ensure that we had adequate data to work with was essential and we are very grateful to them.

We would also like to thank the developers at Queen's University Belfast and Hallam Teaching Schools Alliance who worked on setting up and ensuring the smooth running of the SMART Spaces intervention: their work and support has been invaluable at every stage. We are especially grateful to Liam O'Hare, Alastair Gittner, John Coats, Maria Cockerill, Patrick Stark and
Aideen Gildea

The team at EEF have also been extremely helpful, particularly Danni Mason and Diotima Rapp.

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Finally, we are grateful to colleagues at UCL, who worked on the project, particularly Katie Pepper, Haira Gandolfi and Bohan Lui.

Further appendices:

Appendix C: SMART Spaces Memorandum of Understanding (MoU) for participating schools

SMART Spaces Randomised Controlled Trial

MEMORANDUM OF UNDERSTANDING

Aims of the evaluation

The aim of this project is to evaluate the impact of *SMART Spaces* revision programme on pupil attainment on AQA GCSE Double Award Science (Chemistry content).

The project

The *SMART Spaces* programme is to be tested to see if it has an impact on AQA GCSE double award science chemistry attainment. The programme is designed to train teachers of Year 11 pupils to provide a set of evidence based revision classes. The impact of this revision programme will be evaluated using a randomised controlled trial (RCT) by comparing it with a "business as usual" control group, i.e. school conducting normal revision. During this project, you will be contacted by researchers from UCL Institute of Education (IOE) and by the *SMART Spaces* programme team from Queen's University Belfast and the Hallam Teaching School Alliance, hereafter referred to as QUB and HTSA respectively.

This memorandum of understanding (MoU) explains what your school's participation in the study will entail. If you agree to take part and accept the terms and conditions outlined, please sign a copy of this form, and return by email to **maria.cockerill@qub.ac.uk** .

Structure of the evaluation

As this is a randomised controlled trial schools will be randomly assigned to one of two school groups for the duration of the whole project (Sep 2018 – July 2019):

1. Intervention group - Schools in this group will deliver the *SMART Spaces* revision programme in Year 11 in 2018/19.
2. Control group (Business as usual) - Schools in this group will continue with usual revision in Year 11 in 2018/2019.

1. **Intervention group *(SMART Spaces):*** As indicated above all Year 11 pupils enrolled in AQA double award science in these schools will receive *SMART Spaces* as a whole class chemistry revision approach. Schools who are allocated to deliver SMART Spaces in academic year 2018/2019 will receive free half day training for all school staff delivering the chemistry element of AQA double award science (Spring term 2019), programme manuals, one follow up visit and in-school support from the *SMART Spaces* team.

2. Control group (Business as usual): Schools in the control group will be asked to continue with usual teaching and revision with Year 11 pupils in 2018/2019. These schools in the control group will receive **£1000** following the completion of all evaluation requirements with staff/school and with the required pupils in 2018 and 2019. After the evaluation has finished, the school may purchase the *SMART Spaces* programme from QUB/HTSA for use from January 2020.

Random allocation is essential to the evaluation as it is the best way of investigating what effect *SMART Spaces* has on pupils' GCSE Chemistry attainment. It is important that schools understand and consent to this process.

The Evaluation Team (IOE) will use school and pupil information provided by schools including KS2 results and GCSE scores, and information from the Nation Pupil Database to assess any impact of SMART Spaces on attainment.

Use of Data

All pupil data will be treated with the strictest confidence and will be stored in accordance with the data protection legislation, including the General Data Protection Regulation (GDPR) which comes into effect in May 2018. Personal data will be processed as per condition 6(1)e of the GDPR under public interest purposes, because the research is considered to be a "task carried out in the public interest". The GDPR therefore does not require collection of (opt-in) consent. Named data will be matched with the National Pupil Database, after the UCL ethics committee has granted ethical approval, and shared with the Department for Education and the Evaluation Team (IOE). This involves us sharing data with the Department for Education, the Education Endowment Foundation (EEF, who funded the trial), EEF's data contractors Fischer Family Trust Education, Durham University and storing the data in an anonymised form in the UK Data Archive.

All results will be anonymised so that no schools or individual pupils will be identified in any report arising from the research.

Requirements for All Schools

- Schools must have some of their pupils enrolled in AQA GCSE double award science.
- All schools will not participate in another EEF GCSE science randomised trial that would interfere with implementation of the intervention with Year 11 pupils during 2018/19 academic year.
- All schools will consent to randomised allocation and will be randomly allocated to either intervention (SMART Spaces) or control (business as usual). All schools will commit to the outcome of the randomisation process.
- Before being officially signed up to the project in July 2018, all schools are required to confirm GCSE Science examination board and specification and return student information for all Year 11 pupils who are enrolled in double award science in your school (student first and surnames, date of birth, gender, Unique Pupil Number (UPN), eligibility for FSM, KS2 mathematics and English scores, students science class and teacher, confirm entry to double award science) to the Evaluation Team in May-June 2018.
- All schools will provide the Evaluation Team with GCSE Chemistry UMS sub-score and item-level scores for students who completed the double award GSCE in 2019.
- All schools will provide the SMART Spaces programme team with contact details for their data manager to facilitate the return of the requested data to the evaluation team.
- All schools will deliver letters to parents giving them information about the study and an opportunity to opt their child out of the data gathering process, and will inform the Evaluation Team of any responses. arising.
- All schools agree to the Evaluation Team obtaining the relevant pupils' GCSE Science grade, KS2 mathematics and English scores and demographic data from the National Pupil Database, after the UCL ethics committee has granted ethical approval. The school's data manager or equivalent will provide the information requested above, i.e. pupils' names, date of birth, gender, UPNs, FSM status and KS2 scores, to enable this to be achieved (unless an opt out form has been received).
- All schools will follow UCL Institute of Education guidance on the secure transfer of data.
- **If the school has to withdraw from the project for operational or other unavoidable reasons, it will notify the Evaluation and Delivery Teams straight away and wherever possible still provide test data for the evaluation.**

Requirements for Intervention schools

- Allow all teachers delivering SMART Spaces to be available for a half day of training in October 2018-January 2019 from the SMART Spaces team prior to programme delivery.
- Allow all teachers delivering SMART Spaces to be available for one follow up support session carried out by the SMART Spaces team during January 2019-March 2019.
- Deliver the SMART Spaces revision programme to all Y11 AQA double award GCSE science classes in six lessons over a two-week period during May 2019 just before the GCSE science examination.

- Facilitate a short questionnaire for AQA GCSE double award students at the end of the two-week period of SMART Spaces programme delivery in May 2019 just before the GCSE science examination.
- All teachers will be invited to complete questionnaires at the end of the project (June 2019) and may be contacted again in June 2020 for a second questionnaire.
- The Head of Science will be invited to complete a questionnaire during the project.
- Some schools will be invited by the Evaluation Team to become case study schools during the Summer term 2019, although agreeing to do so is not a requirement of the study. Case study schools will allow the research team access to collect data (for example through observations and interviews).
- To work closely with the Evaluation Team.

Requirements for Control (business as usual) schools

- Facilitate a short questionnaire for AQA GCSE double award students in May 2019 just before the GCSE science examination.
- All teachers will be invited to complete questionnaires at the end of the project (June 2019) and may be contacted again in June 2020 for a second questionnaire.
- The Head of Science will be invited to complete a questionnaire.
- Some schools will be invited by the Evaluation Team to become case study schools during the Summer term 2019. The Head of Science in case study schools will participate in a short telephone interview.

Responsibilities of HTSA and QUB Project Team:

- To provide a half day training and programme materials for all teachers delivering SMART Spaces in the intervention group in Spring term 2019
- Provide one follow up support session to the intervention schools
- Collect participating staff and lead contact names and email details and share with the Evaluation team. Contact details will only be shared with the Evaluation Team after ethical approval has been granted by the UCL ethics committee.
- To work closely with the Evaluation Team

Responsibilities of the Evaluation Team from IOE:

- Act as the first point of contact for any questions about the evaluation
- Conduct the random allocation
- Provide information sheets and consent forms for parents/carers (via the project team)
- Provide guidance to schools on how to collect and return data safely and securely
- Collect class and pupil level data including student names, date of birth, gender, Unique Pupil Number (UPN), eligibility for FSM, KS2 mathematics and English scores, students science class and teacher, confirm entry to double award science
- Collect AQA GCSE Chemistry UMS sub-score and item-level scores for students who completed the double award GSCE in 2019.
- Request NPD data using pupil details
- Organise the distribution (to schools) and subsequent collection of a short questionnaire for AQA GCSE double award students at the end of the two-week period of SMART Spaces programme delivery in May 2019 just before the GCSE science examination
- Conduct surveys with teaching staff and Heads of Science
- Contact intervention and control schools asking them to be involved as a case study school during the Summer term 2019
- Analyse the data from the project

- Disseminate the research findings in collaboration with the Project Team
- To work closely with the Project Team

Head teacher agreement

I agree for my school to take part in the SMART Spaces study and I accept the eligibility terms and conditions.

School Name: _____

Head Teacher Name: _____

Head Teacher Signature: _____ Date: ____/____/_____

Head Teacher Email Address: _____

School Contact (if not Head Teacher): _____

School Contact Email Address (if not Head Teacher): _____

School Telephone Number: _____

Data Manager Name: _____

Data Manager Email Address: _____

Thank you for agreeing to take part in this research.

Please complete the information below and return this form to:

maria.cockerill@qub.ac.uk

Please answer the following questions about your school.

LA area and County	
School LA Establishment/DFE Number (a seven digit number)	
School admin email	
School Ofsted rating	
% FSM Ever	
% EAL pupils	

This MoU constitutes the school's agreement with Queen's University Belfast, Hallam Teaching Alliance and UCL Institute of Education to participate in the SMART Spaces study.
In the unlikely event that BOTH the % level for FSM Ever for the overall sample of 125 schools AND the % level for FSM Ever for your school fall below the national average, the delivery team MAY contact you prior to the start of the trial to be excluded from the sample.

Appendix D: Information sheets and consent forms for participants

SMART Spaces Revision Programme

Information for Students

For all students in main trial: Updated for GDPR and re-circulated February 2018

What is this about?

Queen's University Belfast and Hallam Teaching School Alliance (the "project team") are working together on SMART Spaces, a project funded by the Education Endowment Foundation (EEF) and the Wellcome Foundation, which aims to improve revision skills in chemistry and raise GCSE science grades. The effectiveness of the project will be researched by a team from UCL Institute of Education (the "evaluation team"). This research has been reviewed and approved by the research ethics committee of UCL Institute of Education. The headteacher of your school has agreed that the school will take part in the research programme.

What will the project look like?

The project investigates the effect of SMART Spaces revision programme, run by the project team. The project team will work with teachers and schools to teach a revision programme that we think will benefit your learning in science.

We plan to work with around 125 schools, and their Year 11 "double award" science classes during 2018-19. Teachers in 'intervention' schools (see below) will receive training and materials for the SMART Spaces revision programme and will then teach the programme over two weeks during May 2019 just before your GCSE science examination.

What are 'intervention' and 'comparison' schools?

An important element of EEF-funded projects is that schools are randomly chosen either to be in the intervention group, who will receive the training this year, or a comparison group, who contribute to the data required for comparison (and might choose to teach the revision programme in future).

Whether your science teacher will receive the training this year ('intervention' schools) or not ('comparison schools') will be randomly decided by evaluators from UCL Institute of Education to help them understand how effective the training has been. If your school is not selected to take part in the SMART Spaces programme this year, they will receive a payment. After the evaluation has finished, comparison schools may purchase the *SMART Spaces* programme from QUB/HTSA for use from January 2020.

What does this mean for me?

As part of measuring the success of this training programme, you will be asked to complete a survey towards the end of the year. This will take about 15 minutes. Your name and other data held by the school, alongside your KS2 test and GCSE science scores, and will be collected by the evaluation and project teams. We are collecting this information for the purposes of the research

project, to help us understand if the SMART Spaces programme helps students like yourself to revise chemistry for their GCSE science exam. No information that can identify individual students will be made available to anyone outside these teams and your school. Your data will be treated with the strictest confidence and will be kept securely under password protection. We will not use your name or the name of your school in any report arising from the research, and no information that could otherwise identify you will be made public.

We will also obtain your UPN (Unique Pupil Number) to allow us to link the data with the National Pupil Database (held by the Department for Education, part of the UK Government) and other official records in order to understand the impact of the project on GCSE grades and on other test scores. This involves us sharing data with the Department for Education, the Education Endowment Foundation (EEF, who funded the trial), EEF's data contractors Fischer Family Trust Education, Durham University and storing the data in an anonymised form in the UK Data Archive. We link the data with the National Pupil Database for the purpose of research. Further matching to National Pupil Database may take place during subsequent research. All use of data will be compliant with the GDPR and data protection legislation. We use Article 6(1)e of the GDPR as the lawful basis for processing personal data as part of this project. This is generally known as the "public task" basis.

If you have any questions, please contact Jeremy Hodgen at the UCL Institute of Education by email at **ioe.smartspaces@ucl.ac.uk** or ask your science teacher or your parent or carer to do so on your behalf.

Because we are doing this research to improve understanding about what works in improving pupils' education, **if you are happy for information about you to be used in the SMART Spaces research project you do not need to do anything.** Thank you for your help with this research, your support is much appreciated.

Although we think the project may help you, you have the right to ask us not to use your data in this way. If you **DO NOT** want your information to be used to understand whether the SMART Spaces programme can help improve revision in science, please complete the enclosed form and return it to your teacher by [INSERT DATE]. If you do this, then no information about you will be shared with the evaluation or project teams at any point during the project. In addition, you can ask for your data to be withdrawn from the project at any time until 31st August 2019, without giving a reason, by contacting us via email at ioe.smartspaces@ucl.ac.uk

We have also written to your parent / carer about this research.

SMART Spaces research programme

(If you are happy to participate in the research on whether this programme improves revision in science, you DO NOT need to return this form.)

I **DO NOT** wish my data to be collected as part of this research.

My name: ……Date of birth: ……

My Science Teacher: ……..

School:……

Signature: ……

Date ……

(Please detach and return the completed form to your science teacher by [INSERT DATE].)

SMART Spaces Revision Programme

Information for Parents/Carers

Information Sheet for All Parents in the Main Trial

[Updated GDPR: February 2018]

What is this about?

Queen's University Belfast and Hallam Teaching School Alliance (the "project team") are working together on SMART Spaces, a project funded by the Education Endowment Foundation (EEF) and the Wellcome Foundation, which aims to improve revision skills in chemistry and raise GCSE science grades. The effectiveness of the project will be researched by a team from UCL Institute of Education (the "evaluation team"). This research has been reviewed and approved by the research ethics committee of UCL Institute of Education. The headteacher of your child's school has agreed that the school will take part in the research programme.

What will the project look like?

The project investigates the effect of SMART Spaces revision programme, run by the project team. The project team will work with teachers and schools to teach a revision programme that we think will benefit your child's learning in science.

We plan to work with around 125 schools, and their Year 11 "double award" science classes during 2018-19. Teachers in 'intervention' schools (see below) will receive training and materials for the SMART Spaces revision programme and will then teach the programme over two weeks during May 2019 just before your child's GCSE science examination.

What are 'intervention' and 'comparison' schools?

An important element of EEF-funded projects is that schools are randomly chosen either to be in the intervention group, who will receive the training this year, or a comparison group, who contribute to the data required for comparison (and might choose to teach the revision programme in future).

Whether your child's teacher will receive the training this year ('intervention' schools) or not ('comparison schools') will be randomly decided by evaluators from UCL Institute of Education to help them understand how effective the training has been. If your child's school is not selected to take part in the SMART Spaces programme this year, they will receive a payment. After the evaluation has finished, comparison schools may purchase the *SMART Spaces* programme from QUB/HTSA for use from January 2020.

What does this mean for me as a parent?

As part of measuring the success of this training programme, your child will be asked to complete a survey towards the end of the year. This will take about 15 minutes. Your child's name and other data held by the school, alongside their KS2 test and GCSE science scores, will be collected by the evaluation and project teams. We are collecting this information for the purposes of the research project, to help us understand if the SMART Spaces programme helps children like yours to revise chemistry for their GCSE science exam. No information that can identify individual children will be made available to anyone outside these teams and your child's school. Your child's data will be treated with the strictest confidence and will be kept securely under password

protection. We will not use your child's name or the name of the school in any report arising from the research, and no information that could otherwise identify your child will be made public.

We will also obtain your child's UPN (Unique Pupil Number) to allow us to link the data with the National Pupil Database (held by the Department for Education, part of the UK Government) and other official records in order to understand the impact of the project on GCSE grades and on other test scores. This involves us sharing data with the Department for Education, the Education Endowment Foundation (EEF, who funded the trial), EEF's data contractors Fischer Family Trust Education, Durham University and storing the data in an anonymised form in the UK Data Archive. We link the data with the National Pupil Database for the purpose of research. Further matching to National Pupil Database may take place during subsequent research. All use of data will be compliant with the GDPR and data protection legislation. We use Article 6(1)e of the GDPR as the lawful basis for processing personal data as part of this project. This is generally known as the "public task" basis.

If you have any questions you would like to ask, please contact Jeremy Hodgen at the UCL Institute of Education by email at **ioe.smartspaces@ucl.ac.uk**

Because we are doing this research to improve understanding about what works in improving pupils' education, **if you are happy for information about your child to be used in the SMART Spaces research project you do not need to do anything.** Thank you for your help with this research, your support is much appreciated.

Although we think the project may help your child, you have the right to ask us not to use your child's data in this way. If you **DO NOT** want information about your child to be used to understand whether the SMART Spaces programme can help improve revision in science, please complete the enclosed form and return it to your child's school by [INSERT DATE]. If you do this, then no information about your child will be shared with the evaluation or project teams at any point during the project. In addition, you can ask for your child's data to be withdrawn from the project at any time until 31st August 2019, without giving a reason, by contacting us via email at ioe.smartspaces@ucl.ac.uk

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SMART Spaces research programme

(If you are happy for your child to participate in the research on whether this programme improves revision in science, you DO NOT need to return this form.)

I **DO NOT** wish my data about my child to be collected as part of this research.

Child's name: ……Date of birth: ……

Child's class Teacher: ……..

School:……

Parent name (BLOCK CAPITALS) ……

Parent signature: ……

Date ……

(Please detach and return the completed form to your child's science teacher by [INSERT DATE].)

SMART Spaces Revision Programme

Information for All Teachers in Main Trial

What is this about?

Queen's University Belfast and Hallam Teaching School Alliance (the "project team") are working together on SMART Spaces, a project funded by the Education Endowment Foundation (EEF) and the Wellcome Foundation, which aims to improve revision skills in chemistry and raise GCSE science grades. The effectiveness of the project will be researched by a team from UCL Institute of Education (the "evaluation team"). This research has been reviewed and approved by the research ethics committee of UCL Institute of Education. Your headteacher has agreed that your school will take part in the research programme.

What will the project look like?

The project investigates the effect of SMART Spaces revision programme, run by the project team. The project team will work with teachers and schools to teach a revision programme that we think will benefit pupils' learning in science.

We plan to work with around 125 schools, and their Year 11 "double award" science classes during 2018-19. Teachers in 'intervention' schools (see below) will receive training and materials for the SMART Spaces revision programme and will then teach the programme over two weeks during May 2019 just before pupils' GCSE science examination.

What are 'intervention' and 'comparison' schools?

An important element of EEF-funded projects is that schools are randomly chosen either to be in the intervention group, who will receive the training this year, or a comparison group, who contribute to the data required for comparison (and might choose to teach the revision programme in future).

Whether you will receive the training this year ('intervention' schools) or not ('comparison schools') will be randomly decided by evaluators from UCL Institute of Education to help them understand how effective the training has been. If your school is not selected to take part in the SMART Spaces programme this year, they will receive a payment. After the evaluation has finished, comparison schools may purchase the *SMART Spaces* programme from QUB/HTSA for use from January 2020.

What does this mean for me as a teacher?

As part of measuring the success of this training programme, you will be asked to complete an online survey towards the end of the year. This will take about 15 minutes. Your name and email address will be collected by the evaluation and project teams so that we can contact you about the survey. We are collecting this information for the purposes of the research project, to help us understand if the SMART Spaces programme helps pupils like yours to revise chemistry for their GCSE science exam. No information that can identify individuals will be made available to anyone outside these teams and your school. Your data will be treated with the strictest confidence and will be kept securely under password protection. We will not use your name or the name of the school in any report arising from the research, and no information that could otherwise identify you will be made public. All use of data will be compliant with the GDPR and data protection legislation.

If you have any questions you would like to ask, please contact Jeremy Hodgen at the UCL Institute of Education by email at **ioe.smartspaces@ucl.ac.uk**

Because we are doing this research to improve understanding about what works in improving pupils' education, **if you are happy for your information to be used in the SMART Spaces research project, you do not need to do anything.** Thank you for your help with this research, your support is much appreciated.

Although we think the project may help your pupils, you have the right to ask us not to use your data in this way. If you **DO NOT** want your information to be used to understand whether the SMART Spaces programme can help improve revision in science, please complete the enclosed form and return it to your school by [INSERT DATE]. If you do this, then no information about you will be shared with the evaluation or project teams at any point during the project. In addition, you can ask for your data to be withdrawn from the project at any time until 31st August 2019, without giving a reason, by contacting us via email at ioe.smartspaces@ucl.ac.uk

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SMART Spaces research programme

(If you are happy to participate in the research on whether this programme improves revision in science, you DO NOT need to return this form.)

I **DO NOT** wish my data to be collected as part of this research.

Name: ……

Your science class(es): ……..

School:……

Date ……

(Please detach and return the completed form to your school's SMART Spaces contact by [INSERT DATE].)

SMART Spaces Revision Programme

Information sheet and consent form for students in schools involved in development and validation of IPE instruments

What is this about?

Queen's University Belfast and Hallam Teaching School Alliance (the "project team") are working together on SMART Spaces, a project funded by the Education Endowment Foundation (EEF) and the Wellcome Foundation, which aims to improve revision skills in chemistry and raise GCSE science grades. The effectiveness of the project will be researched by a team from UCL Institute of Education (the "evaluation team"). This research has been reviewed and approved by the research ethics committee of UCL Institute of Education. The headteacher of your school has agreed that the school will take part in the research programme.

What's happening now?

As part of this work, we need to make sure the surveys and other methods are good enough. To do this, we are planning to ask your science class to complete a survey. We may observe a revision session in your science class. We may also interview a number of students in small groups about the sessions and how they revise in science. The interview will be no longer than 20 minutes. We want to do this in order to make sure we understand what has actually happened in schools as part of the project.

Who will be undertaking this research?

As with the rest of the project, these observations and interviews will be carried out by experienced researchers from UCL Institute of Education. All the researchers have full Disclosure and Barring Service (DBS) checks to reassure you that they are safe to work in schools.

What does this mean for me?

We want to make sure you have no problem with us observing and interviewing you as part of this project. It is very important to us not to do anything you are not happy with. As such, we will only speak to you about the research **if you have let us know that you are happy for us to do so.** There is a form attached to this letter and we would be very grateful if you could return this to your science teacher as soon as possible.

What if I do not want to take part?

We would never make you do something you do not want to do. If you do not wish to participate in the observations and discussions on the day, that's fine. In addition, if you decide afterwards that you are not happy for us to use your responses just get in touch, or ask your science teacher or your parent/carer to contact us, using the email address below and we will withdraw your data from the project. You can ask for your data to be withdrawn at any time until 31st August 2019, without giving a reason.

How is confidentiality maintained?

All data provided will be treated as highly confidential. We will not keep any information about you from these discussions other than your name (this is so that we can respect any wish to withdraw after the discussion has happened) and the responses to our questions. The only exception to this is if you tells us something that raises concerns regarding child safeguarding when, as you would expect, we are obliged to inform the school's safeguarding officer and liaise with them on appropriate action. All the data will be stored on secure, password protected computers to which only members of the research team have access, for up to 10 years in line with UCL

regulations. When we are writing up the research we will double check it is not possible to identify either students or schools from what we report. All use of data will be compliant with the GDPR and data protection legislation.

What if I have any questions?

If you have any concerns and would like to know more, or if you have any questions, please ask your science teacher or alternatively ask your parent or carer to contact Jeremy Hodgen at the UCL Institute of Education by email at **ioe.smartspaces@ucl.ac.uk**

SMART Spaces Revision Programme

CONSENT FORM

An information sheet is attached to this form. Please read it carefully before making a decision about taking part in this research. We will only involve you in the observation and interview if you have returned this form by [DATE].

SMART Spaces Revision Programme evaluation

1. I confirm that I have read the attached information sheet and have had the opportunity to consider the information, to ask questions, and (if applicable) that I have had these answered satisfactorily. ☐
2. I understand that my participation in this research is voluntary and I can request to be withdrawn from the research at any time without giving a reason. ☐
3. I understand that the classroom observation may be audio recorded. ☐
4. I understand that the interview will be audio recorded. ☐
5. I agree to the use of the anonymous use of my quoted speech. ☐
6. I agree that any data collected may be passed to other researchers in the team (at UCL Institute of Education and Queen's University Belfast). ☐
7. I agree that any data collected may be published in anonymous form in reports, books, conference papers or journal articles. ☐
8. I **AM HAPPY** to be part of a discussion about the project as part of this research. ☐

My name: ……Date of birth: …….

My Science Teacher: ……..

School:……

Signature: ……

Date ……

(Please return the completed form to your science teacher.)

SMART Spaces Revision Programme

Information sheet and consent form for students in schools involved in development and validation of IPE instruments

What is this about?

Queen's University Belfast and Hallam Teaching School Alliance (the "project team") are working together on SMART Spaces, a project funded by the Education Endowment Foundation (EEF) and the Wellcome Foundation, which aims to improve revision skills in chemistry and raise GCSE science grades. The effectiveness of the project will be researched by a team from UCL Institute of Education (the "evaluation team"). This research has been reviewed and approved by the research ethics committee of UCL Institute of Education. The headteacher of your child's school has agreed that the school will take part in the research programme

What's happening now?

As part of this work, we need to make sure that the surveys and other methods are good enough. We are planning to ask your child's science class to complete a survey. We may observe a science revision session and interview a number of students in small groups about the sessions and how they revise in science. The interview will be no longer than 20 minutes. We want to do this in order to make sure we understand what has actually happened in schools as part of the project.

Who will be undertaking this research?

These observations and interviews will be carried out by experienced researchers from UCL Institute of Education and Queen's University Belfast. All the researchers have full Disclosure and Barring Service (DBS) checks to reassure you that they are safe to work in schools.

What does this mean for me as a parent?

We want to make sure you have no problem with your child taking part in this research. It is very important to us not to do anything you are not happy with. As such, we will only speak to your child about the research **if you have let us know that you are happy for us to do so.** There is a form attached to this letter and we would be very grateful if you could return this to your child's science teacher as soon as possible.

What if my child does not want to take part?

We would never make you child do something they do not want to do. If your child does not wish to participate in the observations and discussions on the day, that's fine. In addition, if you or they decide afterwards that you are not happy for us to use your child's responses, just get in touch and we will withdraw their data from the project.

You or your child can ask for your child's responses to be withdrawn at any time until 31st August 2019, without giving a reason.

How is confidentiality maintained?

All data provided will be treated as highly confidential. We will not keep any information about your child from these discussions other than their name (this is so that we can respect any wish to withdraw after the discussion has happened) and the responses to our questions. The only exception to this is if your child tells us something that raises concerns regarding child safeguarding when, as you would expect, we are obliged to inform the school's safeguarding officer and liaise with them on appropriate action. All the data will be stored on secure, password protected computers to which only members of the research team have access, for up to 10 years in line with UCL regulations. When we are writing up the research we will double check it is not possible to identify either children or schools from what we report. All use of data will be compliant with the GDPR and data protection legislation.

What if I have any questions?

If you have any concerns and would like to know more, or if you have any questions, please contact Jeremy Hodgen at the UCL Institute of Education by email at **ioe.smartspaces@ucl.ac.uk**

SMART Spaces Revision Programme

CONSENT FORM

An information sheet is attached to this form. Please read it carefully before making a decision about letting your child take part in this research.

We will only involve children in the observation and interview if your child's school holds a completed and signed consent form by [DATE].

SMART Spaces Revision Programme evaluation

4. I confirm that I have read the attached information sheet and have had the opportunity to consider the information, to ask questions, and (if applicable) that I have had these answered satisfactorily. ☐
5. I understand that my child's participation in this research is voluntary and they or I can request for their data to be withdrawn from the research at any time until 31st August 2019 without giving a reason. ☐

6. I understand that the classroom observation may be audio recorded. ☐

9. I understand that the interview will be audio recorded. ☐

10. I agree to the anonymous use of quoted speech from my child. ☐

11. I agree that any data collected may be passed to other researchers in the team (at UCL Institute of Education and Queen's University Belfast). ☐

12. I agree that any data collected may be published in anonymous form in reports, books, conference papers or journal articles ☐

13. I **AM HAPPY** for my child to be part of a discussion about the project as part of this research.

Child's name: ……Date of birth: ……

Child's class Teacher: ……..

School:……

Parent / Carer name (BLOCK CAPITALS) ……

Parent / Carer signature: …… Date ……

(Please return the completed form to your child's science teacher.)

SMART Spaces Revision Programme

Information Sheet for All Students in the IPE Case Study Schools / Classes

What is this about?

Unless you are new to the school, we've previously let you know about an exciting project that your school is part of called *"SMART Spaces Revision Programme"*. Queen's University Belfast and Hallam Teaching School Alliance (the "project team") are working together on SMART Spaces, a project funded by Education Endowment Foundation and the Wellcome Foundation, which aims to improve revision skills in chemistry and raise GCSE science grades. The effectiveness of the project will be researched by a team from UCL Institute of Education (the "evaluation team"). This research has been reviewed and approved by the research ethics committee of UCL Institute of Education. The headteacher of your school has agreed that the school will take part in the research programme.

What's happening now?

As part of this work, we are planning to observe two or three revision sessions in your science class. We will also interview a number of students in small groups about the sessions and how they revise in science. The interview will be no longer than 20 minutes. We want to do this in order to make sure we understand what has actually happened in schools as part of the project.

Who will be undertaking this research?

As with the rest of the project, these observations and interviews will be carried out by experienced researchers from UCL Institute of Education. All the researchers have full Disclosure and Barring Service (DBS) checks to reassure you that they are safe to work in schools.

What does this mean for me?

We want to make sure you have no problem with us observing and interviewing you as part of this project. It is very important to us not to do anything you are not happy with. As such, we will only speak to you about the research **if you have let us know that you are happy for us to do so.** There is a form attached to this letter and we would be very grateful if you could return this to your science teacher as soon as possible.

What if I do not want to take part?

We would never make you do something you do not want to do. If you do not wish to participate in the observations and discussions on the day, that's fine. In addition, if you decide afterwards that you are not happy for us to use your responses just get in touch, or ask your science teacher or your parent/carer to contact us, using the email address below and we will withdraw your data from the project. You can ask for your data to be withdrawn at any time until 31st August 2019, without giving a reason.

How is confidentiality maintained?

All data provided will be treated as highly confidential. We will not keep any information about you from these discussions other than your name (this is so that we can respect any wish to withdraw after the discussion has happened) and the responses to our questions. The only exception to this is if you tells us something that raises concerns regarding child safeguarding when, as you would expect, we are obliged to inform the school's safeguarding officer and liaise with them on appropriate action. All the data will be stored on secure, password protected computers to which only members of the research team have access, for up to 10 years in line with UCL regulations. When we are writing up the research we will double check it is not possible to identify either students or schools from what we report. All use of data will be compliant with the GDPR and data protection legislation.

What if I have any questions?

If you have any concerns and would like to know more, or if you have any questions, please ask your science teacher or alternatively ask your parent or carer to contact Jeremy Hodgen at the UCL Institute of Education by email at **ioe.smartspaces@ucl.ac.uk**

SMART Spaces Revision Programme

CONSENT FORM

An information sheet is attached to this form. Please read it carefully before making a decision about taking part in this research.

We will only involve you in the observation and interview if you have returned this form by [DATE].

SMART Spaces Revision Programme evaluation

7. I confirm that I have read the attached information sheet and have had the ☐ opportunity to consider the information, to ask questions, and (if applicable) that I have had these answered satisfactorily.
8. I understand that my participation in this research is voluntary and I can request to ☐ be withdrawn from the research at any time without giving a reason.
9. I understand that the classroom observation may be audio recorded. ☐

14. I understand that the interview will be audio recorded. ☐

15. I agree to the use of the anonymous use of my quoted speech. ☐

16. I agree that any data collected may be passed to other researchers in the team (at ☐ UCL Institute of Education and Queen's University Belfast).
17. I agree that any data collected may be published in anonymous form in reports, ☐ books, conference papers or journal articles.
18. I **AM HAPPY** to be part of a discussion about the project as part of this research. ☐

My name: ……Date of birth: ……

My Science Teacher: ……..

School:……

Signature: ……

Date ……

(Please return the completed form to your science teacher.)

SMART Spaces Revision Programme

Information Sheet for All Parents of Students in the IPE Case Study Schools / Classes

What is this about?

Unless your child is new to the school, we've previously let you know about an exciting project that they are part of called *"SMART Spaces Revision Programme"*. Queen's University Belfast and Hallam Teaching School Alliance (the "project team") are working together on SMART Spaces, a project funded by Education Endowment Foundation and the Wellcome Foundation, which aims to improve revision skills in chemistry and raise GCSE science grades. The effectiveness of the project will be researched by a team from UCL Institute of Education (the "evaluation team"). This research has been reviewed and approved by the research ethics committee of UCL Institute of Education. The headteacher of your child's school has agreed that the school will take part in the research programme.

What's happening now?

As part of this work, we are planning to observe two or three revision sessions in your child's science class. We will also interview a number of students in small groups about the sessions and how they revise in science. The interview will be no longer than 20 minutes. We want to do this in order to make sure we understand what has actually happened in schools as part of the project.

Who will be undertaking this research?

As with the rest of the project, these observations and interviews will be carried out by experienced researchers from UCL Institute of Education. All the researchers have full Disclosure and Barring Service (DBS) checks to reassure you that they are safe to work in schools.

What does this mean for me as a parent?

We want to make sure you have no problem with us observing and interviewing your child as part of this project. It is very important to us not to do anything you are not happy with. As such, we will only speak to your child about the research **if you have let us know that you are happy for us to do so.** There is a form attached to this letter and we would be very grateful if you could return this to your child's science teacher as soon as possible.

What if my child does not want to take part?

We would never make your child do something they do not want to do. If your child does not wish to participate in the observations and discussions on the day, that's fine. In addition, if you or they decide afterwards that you are not happy for us to use your child's responses, just get in touch and we will withdraw their data from the project. You or your child can ask for your child's responses to be withdrawn at any time until 31st August 2019, without giving a reason.

How is confidentiality maintained?

All data provided will be treated as highly confidential. We will not keep any information about your child from these discussions other than their name (this is so that we can respect any wish to withdraw after the discussion has happened) and the responses to our questions. The only exception to this is if your child tells us something that raises concerns regarding child safeguarding when, as you would expect, we are obliged to inform the school's safeguarding officer and liaise with them on appropriate action. All the data will be stored on secure, password protected computers to which only members of the research team have access, for up to 10 years in line with UCL regulations. When we are writing up the research we will double check it is not possible to identify either children or schools from what we report. All use of data will be compliant with the GDPR and data protection legislation.

What if I have any questions?

If you have any concerns and would like to know more, or if you have any questions, please contact Jeremy Hodgen at the UCL Institute of Education by email at **ioe.smartspaces@ucl.ac.uk**

SMART Spaces Revision Programme

CONSENT FORM

An information sheet is attached to this form. Please read it carefully before making a decision about letting your child take part in this research.

We will only involve children in the observation and interview if your child's school holds a completed and signed consent form by [DATE].

SMART Spaces Revision Programme evaluation

10. I confirm that I have read the attached information sheet and have had the ☐ opportunity to consider the information, to ask questions, and (if applicable) that I have had these answered satisfactorily.
11. I understand that my child's participation in this research is voluntary and they or I ☐ can request to be withdrawn from the research at any time until 31st August 2019 without giving a reason.
12. I understand that the classroom observation may be audio recorded. ☐

19. I understand that the interview will be audio recorded. ☐

20. I agree to the anonymous use of quoted speech from my child. ☐

21. I agree that any data collected may be passed to other researchers in the team (at ☐ UCL Institute of Education and Queen's University Belfast).
22. I agree that any data collected may be published in anonymous form in reports, ☐ books, conference papers or journal articles.
23. I **AM HAPPY** for my child to be part of a discussion about the project as part of this ☐ research.

Child's name: ……Date of birth: ……

Child's class Teacher: ……..

School:……

Parent / Carer name (BLOCK CAPITALS) ……

Parent / Carer signature: …… Date ……

(Please return the completed form to your child's science teacher.)

SMART Spaces Revision Programme

Information Sheet for All Teachers in the IPE Case Study Schools / Classes

What is this about?

As you will know, your school is taking part in an exciting project called *"SMART Spaces Revision Programme"*. Queen's University Belfast and Hallam Teaching School Alliance (the "project team") are working together on SMART Spaces, a project funded by Education Endowment Foundation and the Wellcome Foundation, which aims to improve revision skills in chemistry and raise GCSE science grades. The effectiveness of the project will be researched by a team from UCL Institute of Education (the "evaluation team"). This research has been reviewed and approved by the research ethics committee of UCL Institute of Education. The headteacher of your school has agreed that the school will take part in the research programme.

What's happening now?

As part of this work, we are planning to observe training you receive, and two or three revision sessions in your science class. We may also interview you about the sessions and your approaches to revision in science. The interview will be no longer than 30 minutes. We want to do this in order to make sure we understand what has actually happened in schools as part of the project.

Who will be undertaking this research?

As with the rest of the project, these observations and interviews will be carried out by experienced researchers from UCL Institute of Education. All the researchers have full Disclosure and Barring Service (DBS) checks to reassure you that they are safe to work in schools.

What does this mean for me?

We want to make sure you have no problem with us observing and interviewing you as part of this project. As such, we will only involve you in the research **if you have let us know that you are happy for us to do so.** There is a form attached to this letter and we would be very grateful if you could return this to us as soon as possible.

What if I do not want to take part?

Your participation in this research is voluntary. In addition, you can request for your data to be withdrawn from the research at any time until 31st August 2019 without giving a reason. Just get in touch, using the email address below and we will withdraw your data from the project.

How is confidentiality maintained?

All data provided will be treated as highly confidential. We will not keep any information about you from these discussions other than your name (this is so that we can respect any wish to withdraw after the discussion has happened) and the responses to our questions. The only exception to this is if you tells us something that raises concerns regarding child safeguarding when, as you would expect, we are obliged to inform the school's safeguarding officer and liaise with them on appropriate action. All the data will be stored on secure, password protected computers to which only members of the research team have access, for up to 10 years in line with UCL regulations. When we are writing up the research we will double check it is not possible to identify either students or schools from what we report. All use of data will be compliant with the GDPR and data protection legislation.

What if I have any questions?

If you have any concerns and would like to know more, or if you have any questions, please contact Jeremy Hodgen at the UCL Institute of Education by email at **ioe.smartspaces@ucl.ac.uk**

SMART Spaces Revision Programme

CONSENT FORM

An information sheet is attached to this form. Please read it carefully before making a decision about taking part in this research.

We will only involve you in the observation and interview if you have returned this form by [DATE].

SMART Spaces Revision Programme evaluation

1. I confirm that I have read the attached information sheet and have had the opportunity to consider the information, to ask questions, and (if applicable) that I have had these answered satisfactorily. ☐
2. I understand that my participation in this research is voluntary and I can request for my data to be withdrawn from the research at any time until 31st August 2019 without giving a reason. ☐
3. I understand that training and lesson observations may be audio recorded. ☐
4. I understand that the interview will be audio recorded. ☐
5. I agree to the use of my anonymised quotes. ☐
6. I agree that any data collected may be passed to other researchers in the team (at UCL Institute of Education and Queen's University Belfast). ☐
7. I agree that any data collected may be published in anonymous form in reports, books, conference papers or journal articles. ☐

Name: …….

School:……

Signature: ……

Date ……

(Please return the completed form to the UCL Institute of Education Evaluation team at the training on 12th March)

Appendix E: Privacy notice, statement of the lawful basis and public tasks assessment for data processing

UCL's privacy notice is available here:
https://www.ucl.ac.uk/legal-services/privacy/ucl-general-research-participant-privacy-notice

Lawful Basis Processing Pupils' Personal Data: Evaluation of SMART Spaces Revision and Teaching versions

As part of this project, we process pupils' personal data. For this reason, it is important that we process this data lawfully, following the principles laid out in the Data Protection Act 1998 (DPA) until May 2018 and the General Data Protection Regulation (GDPR) thereafter. We explain the lawful basis below with respect to the GDPR but there are equivalent regulations in the DPA for the justifications set out below.

We use Article 6(1)e of the GDPR as the lawful basis for processing personal data as part of this project. This is generally known as the "public task" basis. UCL has reviewed current ICO guidance available here: **https://ico.org.uk/for-organisations/guide-to-the-general-data-protection-regulation-gdpr/lawful-basis-for-processing/public-task/**, and has determined that this research forms part of its performance of a task in the public interest, as one of its core purposes provided for in its Charter and Statutes.

We do not believe that any of the data we process falls within the definition of special category data under the GDPR. This would require an additional justification under Article 9(2) of the GDPR.

Because pupils will be under the age of 16, but over the age of 13, we will inform both pupils and their parents or carers of the proposed data processing and give them opportunity to object to this. If a parent/carer or pupil objects, then that pupil's data will not be passed to us by schools. If a parent/carer or pupil objects at a later stage, we will destroy that pupil's data. The data controllers are named in the privacy information provided as part of this and contact details provided should they have any queries about the data we hold about them, including provision and deletion of their data.

The information provided to parents/carers and pupils explains in clear and plain language the lawful basis for processing (although we keep the use of technical terms in the interests of keeping the language simple), the purpose to which we will put the data, that they can object to this data and this will be respected, contact details of the organisation, and categories of data that we will be processing.

Data will kept until the end of the research project, including academic paper writing and dissemination (and certainly not longer than 10 years in line with UCL's policy on data retention). When it is deleted, it will be securely destroyed. Some data, for example that provided by the DfE from the National Pupil Database, may need to be destroyed sooner in line with agreements with the organisation supplying the data.

Useful reference:

Lee Shailer: Data Protection & Freedom of Information Officer (x58726) l.shailer@ucl.ac.uk responsible for Data Protection and FOI queries.

NPD Access:

When applying for NPD data the relevant lawful reason for requesting that data will be that our task is specified in the Education (Individual Pupil Information) (Prescribed Persons) (England) Regulations 2009: Regulation 3 (1)(b) and (6)(d), including as amended by the Education (Individual Pupil Information) (Prescribed Persons) (England) (Amendment) Regulations 2013. You can find these at http://www.legislation.gov.uk/uksi/2009/1563/contents/made and http://www.legislation.gov.uk/uksi/2013/1193/contents/made.

Jeremy Hodgen, PI, 30th April 2018

Public task assessment: Evaluation of SMART Spaces Revision and Teaching versions

UCL uses Article 6(1)e of the GDPR as the lawful basis for processing personal data as part of this project. This is generally known as the "public task" basis. UCL has reviewed current ICO guidance available here: https://ico.org.uk/for-organisations/guide-to-the-general-data-protection-regulation-gdpr/lawful-basis-for-processing/public-task/, and has determined that this research forms part of its performance of a task in the public interest, as one of its core purposes provided for in its Charter and Statutes.

In order to use this basis we set out below how this is a task in the public interest and demonstrate that the processing is necessary to achieve the purpose of the processing.

Public benefit

Use of pupil's personal data as part of this evaluation is to understand the benefits to pupils, teachers and schools of participating in the SMART Spaces programmes in chemistry education in terms of academic attainment, improved pedagogy and other related benefits. This has public benefits that we believe are significant in terms of understanding whether this programme has the potential to benefit children in schools across England. If we could not do this then it would not be possible to provide this new evidence. Our proposed research has been reviewed by the UCL Institute of Education research ethics committee [Insert REFs when available] and the UCL Data Protection team [Insert REFs when available], meaning we believe our use of the data to be ethical and lawful.

Necessity

This processing does help to further the interest of providing evidence on what works in promoting academic attainment among pupils in English schools by providing high-quality evidence based on a sufficiently robust design.

For the evaluation of the SMART Spaces Revision version, we do this using a randomised controlled trial (RCT) together with a mixed-methods implementation and process evaluation (IPE) to gather evidence about *inter alia* the necessary conditions for success. This is a recognised high-quality research design applied internationally to provide evidence of this type, meaning we consider this is a reasonable approach.

For the evaluation of the SMART Spaces Teaching version, we propose a pilot study that will collect evidence of the promise, feasibility and scalability of the intervention, which we consider to be a reasonable approach.

It would not be practical in either case to provide this quality of evidence without processing pupils' and teachers' data.

Jeremy Hodgen, PI, 29th April 2018

Appendix F: Process for equating Chemistry and other scores across different tiers and specifications of AQA Combined Science Award

Table 1: Distribution of pupils by examination entry shows the distribution of examination entries across the sample. It can be seen that most pupils were entered for the Trilogy examination with around a third entered for the higher tier and two-thirds entered for the lower tier. The distribution across the treatment and control groups was reasonably balanced. Very few pupils were entered for the Synergy examination (105 pupils from just one school, representing 1% of the sample of pupils).

Table 1: Distribution of pupils by examination entry

		Treatment		Control		Total	
		n	%	n	%	n	%
Trilogy	Higher	1716	32	2474	37	4190	35
	Foundation	3593	68	4088	61	7681	64
Synergy	Higher	0	0	16	<0.5%	16	<0.5%
	Foundation	0	0	89	1	89	1
	Total	5309	100	6667	100	11976	100

In this appendix, we outline the process by which the scores were equated for the Trilogy examinations. A similar process was adopted for the Synergy scores and to equate the Trilogy and Synergy scores.

Primary outcome: Total score on AQA Chemistry papers 1 and 2

For Trilogy scores:

A linear equation was generated for each of Chemistry Paper 1 and 2 from a least-squares regression on the three pairs of equated component grade boundary scores for June 2019 i.e. at grades 3, 4 and 5.

Paper 1: $y = 1.90x + 2$

Paper 2: $y = 1.85x + 6.38$

where y = Foundation score; x = Higher score.

These equations were used to map scores on the Higher tier to scores on the Foundation tier for each paper.

The total scaled Chemistry score was then calculated by summing the scaled scores for Chemistry papers 1 and 2.

Secondary outcome: Total score on AQA GCSE Combined Science

For Trilogy scores:

A linear equation was generated from a least-squares regression on the four pairs of equated boundary scores i.e. at grades 4-3, 4-4, 5-4 and 5-5.

$y = 1.467x + 65.113$

where y = Foundation score; x = Higher score.

This equation was used to map scores on the Higher tier to scores on the Foundation tier.

Max score on Higher (420) → scaled score 681.3

Min score on Higher (0) → scaled score 65.1

Max score Foundation 420

Min score Foundation 0

Secondary outcome: AO1, 2 and 3 scores

Chemistry Papers 1 and 2 were coded by question and mark for AO1-3 and so the maximum AO1-3 score calculated for each paper tier.

For each paper and tier, component grade boundaries were scaled to find AO1-3 notional grade boundaries using scale factor = (AO total max score for Chemistry paper/total max score for Chemistry paper).

For each AO and for each paper, a linear equation was generated from a least-squares regression on the three pairs of equated notional boundary scores i.e. at grades 3, 4 and 5 to scale Higher tier to Foundation tier scores.

For Chemistry Paper 1:

For AO1, this was $y = 2.4591x + 0.8857$

For AO2, this was $y = 1.9673x + 0.8857$

For AO3, this was $y = 0.9519x + 0.2286$

For Chemistry Paper 2:

For AO1, this was $y = 2.188x + 2.9187$

For AO2, this was $y = 1.6x + 2.3714$

For AO3, this was $y = 1.7041x + 1.0945$

In each case, x = AO score on Higher tier, y = corresponding AO score on Foundation tier

The scaled AO scores were them totalled across papers 1 and 2 to produce an overall scaled AO score.

Appendix G: Additional histograms

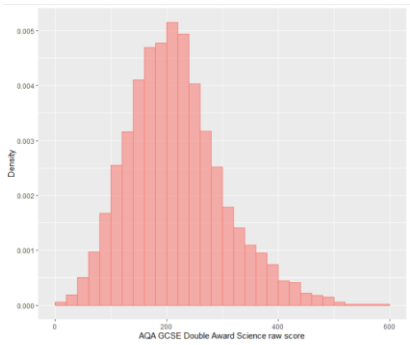

Figure 1: Histogram of secondary outcome: GCSE raw score

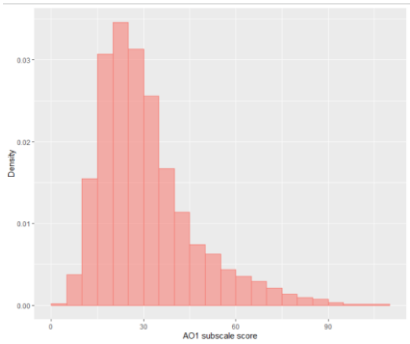

Figure 2: Histogram of secondary outcome: AO1 subscale score

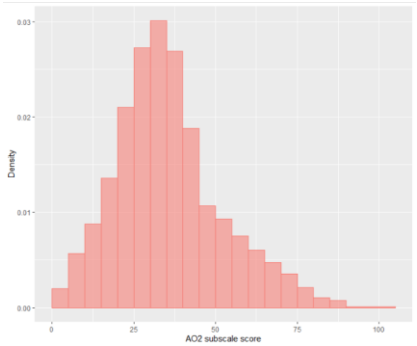

Figure 3: Histogram of secondary outcome: AO2 subscale score

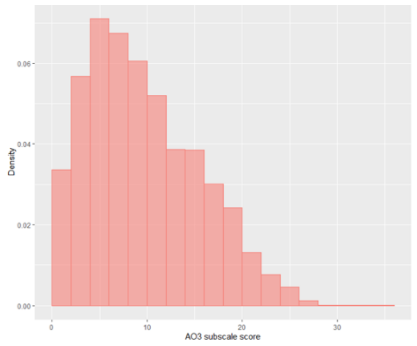

Figure 4: Histogram of secondary outcome: AO3 subscale score

Appendix H: Randomisation syntax

Simulation code in Stata

The syntax set out below is essentially the same as the Batch 1 randomisation code except that, after defining the randomisation program, there is simulation code rather than a direct call on the program:

```
set more off
cap log close
clear
cd "S:\SMART_Spaces_Evaluation\Data Confirmed"
log using pairedrandomisation.log, replace

// Set a random seed.
set seed 99823


// Import the list of schools from the Data Return Record list
import excel using "SMART_Spaces_Data_Return_Record.xlsx", ///
	sheet("Sheet1") cellrange(A1:AF115) firstrow

// Drop unless it is confirmed that we've received the dataset
keep if Readyforrandomisation=="YES"
// Drop unless School SMART ID and LAESTAB are present and in right format
keep if SchoolSMARTID!=""
keep if LAEstabDfENumber!=.


// Loop through all observations grabbing the KS2 mean and school size data
//from individual school data spreadsheets
local N = _N
quietly generate ks2_schoolmean = .
quietly generate school_size = .
quietly generate sheet_laestab = .
quietly generate sheet_doubleaward = .
quietly generate sheet_withdrawn = .
quietly generate fsmprop = .


forvalues i=1/`N' {
	local schoolid = SchoolSMARTID[`i']

	preserve // Preserve the overall data file
	clear
	capture import excel using "School Data - ready for randomisation/`schoolid'.xlsx",
	/// Open the spreadsheet provided by the school identified with their URN
		sheet(School and teacher information) cellrange(B6:B23)
	if _rc!=0 {
		di "Import failed for `schoolid'"
		exit
		}
	di "Currently processing data for `schoolid'"
	local sheet_laestab = B[1] //Grab LAESTAB
	local sheet_doubleaward = B[16] //Grab number of double award students
	local sheet_withdrawn = B[17] //Grab number of withdrawn students
	local sheet_confirm = ""
	local sheet_confirm = B[18] // Grab Confirmation

	if "`sheet_confirm'" != "Yes" & "`sheet_confirm'" != "YES" & "`sheet_confirm'" != "yes" {
		di "Withdrawal procedures not confirmed for school `schoolid'"
		// Check the resulting log for any schools where withdrawal procedures have not been confirmed
		}

	restore

	quietly replace sheet_doubleaward = `sheet_doubleaward' if _n==`i' // Put no. of DA students into main
dataset
	quietly replace sheet_withdrawn = `sheet_withdrawn' if _n==`i' // Put no of withdrawn students into main
dataset
```

```
	quietly replace sheet_laestab = `sheet_laestab' if _n==`i' // Put LAESTAB into main dataset

	preserve
	clear
	capture import excel using "School Data - ready for randomisation/`schoolid'.xlsx", /// Import pupil data from the same school spreadsheets
		sheet(Pupil information) firstrow

	drop if UniquePupilNumberUPN=="" // Only keep lines with UPNs (drops lines that are not people)

	local pupilnum = .
		local pupilnum = _N //number of data rows i.e. number of pupils with data submitted in that school
	di _N

	keep KS2PupilAverage EvereligibleforFSMYN //only keep pupils average KS2 level and ever FSM

	cap tostring EvereligibleforFSMYN, replace
	quietly gen FSM = 0 // Lots of blanks for FSM and have verified that these are intended as meaning they are not FSM
	quietly replace FSM = 1 if EvereligibleforFSMYN=="Y"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="y"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="Yes"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="YES"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="yes"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="T"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="t"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="True"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="TRUE"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="true"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="1"
	local fsmprop ""
	quietly sum FSM // Work out the proportion flagged as FSM
	local fsmprop = r(mean) // Save it as a macro to put back into main spreadsheet

	local ks2_schoolmean = .
	quietly summarize KS2PupilAverage //work out school average KS2 level
	local ks2_schoolmean = r(mean) //save it as a macro to put back into main spreadsheet

	restore
	quietly replace school_size = `pupilnum' if _n==`i' // Put no of data rows into main spreadsheet
	quietly replace ks2_schoolmean = `ks2_schoolmean' if _n==`i' // Put school average KS2 into main spreadsheet
	quietly replace fsmprop = `fsmprop' if _n==`i' // Put proportion FSM into main spreadsheet
	}

assert Numberofstudents==sheet_doubleaward - sheet_withdrawn  // Verification checks on the no of pupils we have recorded on our sheets and their sheets to force manual verification if there are anomalies
assert Numberofstudents==school_size //verification that data rows is equal to the number of students
//assert LAEstabDfENumber==sheet_laestab // Verification checks on the LAEstabs we have recorded on our sheets and their sheets to force manual verification if there are anomalies
assert school_size<. //Check school size has been successfully produced for all schools
assert ks2_schoolmean<. //Chack KS2 school mean has been successfully produced for all schools
assert fsmprop<. // Check that an EAL proportion has been successfully produced for all schools

xtile ks2_schoolmean16 = ks2_schoolmean, nq(16)
xtile ks2_schoolmean16_wt = ks2_schoolmean [fw=school_size], nq(16)

*** STANDARDISE  KS2 AND FSM VARS
cap sum ks2_schoolmean, de
gen std_ks2_schoolmean = (ks2_schoolmean - r(mean))/r(sd)

cap sum ks2_schoolmean [fw=school_size], de
gen stdwt_ks2_schoolmean = (ks2_schoolmean - r(mean))/r(sd)

cap sum fsmprop, de
```

```
gen std_fsmprop = (fsmprop - r(mean))/r(sd)

cap sum fsmprop [fw=school_size], de
gen stdwt_fsmprop = (fsmprop - r(mean))/r(sd)

*** DEFINE RANDOMISATION PROGRAMME
cap program drop randomise
program define randomise, rclass

        cap drop random
        cap drop treatment

        gen double random = runiform()

        sort ks2_schoolmean16 random
        egen treatment = fill(1 0 1 0 0 1 0 1 0 0)

        regress stdwt_ks2_schoolmean treatment [aw=school_size]
        return scalar balance_ks2_weight = _b[treatment]

        regress std_ks2_schoolmean treatment
        return scalar balance_ks2_unweight = _b[treatment]

        regress stdwt_fsmprop treatment [aw=school_size]
        return scalar balance_fsm_weight = _b[treatment]

        regress std_fsmprop treatment
        return scalar balance_fsm_unweight = _b[treatment]

        regress school_size treatment
        return scalar balance_school_size_unweight = _b[treatment]

        sum treatment
        return scalar treat_prop = r(mean)

        end

*** RUN SIMULATIONS
preserve
simulate treat_prop = r(treat_prop) balance_ks2_unweight=r(balance_ks2_unweight)
balance_ks2_weight=r(balance_ks2_weight) balance_fsm_unweight = r(balance_fsm_unweight)
balance_fsm_weight=r(balance_fsm_weight) balance_school_size_unweight = r(balance_school_size_unweight),
reps(1000): randomise
sum balance_ks2_weight balance_ks2_unweight balance_fsm_weight balance_fsm_unweight
balance_school_size_unweight, de
restore
exit
```

Batch 1 randomisation code in Stata

This includes seed incrementation for re-randomisation 1-6:

```
set more off
cap log close

clear
cd "S:\SMART_Spaces_Evaluation\Data Confirmed"
log using pairedrandomisation.log, replace

// Set a random seed. Never run more than once without restarting Stata or risk it won't be replicable
//set seed 8148 // Value of 1 GBP to Thai Baht at 6.21pm 16-10-18
//set sortseed 52048 //Value of 1 GBP to Turkish Lira at 6.21pm 16-10-18

//Randomisation 2
//set seed 8149 // Add 1 to seed above
//set sortseed 52049 //Add 1 to sortseed above

//Randomisation 3
//set seed 8150 // Add 1 to seed above
//set sortseed 52050 //Add 1 to sortseed above

//Randomisation 4
//set seed 8151 // Add 1 to seed above
//set sortseed 52051 //Add 1 to sortseed above

//Randomisation 5
//set seed 8152 // Add 1 to seed above
//set sortseed 52052 //Add 1 to sortseed above

//Randomisation 6
set seed 8153 // Add 1 to seed above
set sortseed 52053 //Add 1 to sortseed above

// Import the list of schools from the Data Return Record list
import excel using "SMART_Spaces_Data_Return_Record.xlsx", ///
        sheet("Sheet1") cellrange(A1:AF115) firstrow

// Drop unless it is confirmed that we've received the dataset
keep if Readyforrandomisation=="YES"
// Drop unless School SMART ID and LAESTAB are present and in right format
keep if SchoolSMARTID!=""
keep if LAEstabDfENumber!=.


// Loop through all observations grabbing the KS2 mean and school size data from individual school data
spreadsheets
local N = _N
quietly generate ks2_schoolmean = .
quietly generate school_size = .
quietly generate sheet_laestab = .
quietly generate sheet_doubleaward = .
quietly generate sheet_withdrawn = .
quietly generate fsmprop = .


forvalues i=1/`N' {
        local schoolid = SchoolSMARTID[`i']

        preserve // Preserve the overall data file
        clear
        capture import excel using "School Data - ready for randomisation/`schoolid'.xlsx",
        /// Open the spreadsheet provided by the school identified with their URN
                sheet(School and teacher information) cellrange(B6:B23)
```

```
	if _rc!=0 {
		di "Import failed for `schoolid'"
		exit
		}
	di "Currently processing data for `schoolid'"
	local sheet_laestab = B[1] //Grab LAESTAB
	local sheet_doubleaward = B[16] //Grab number of double award students
	local sheet_withdrawn = B[17] //Grab number of withdrawn students
	local sheet_confirm = ""
	local sheet_confirm = B[18] // Grab Confirmation

	if "`sheet_confirm'" != "Yes" & "`sheet_confirm'" != "YES" & "`sheet_confirm'" != "yes" {
		di "Withdrawal procedures not confirmed for school `schoolid'"
		// Check the resulting log for any schools where withdrawal procedures have not been confirmed
		}

	restore


	quietly replace sheet_doubleaward = `sheet_doubleaward' if _n==`i' // Put no. of DA students into main
dataset
	quietly replace sheet_withdrawn = `sheet_withdrawn' if _n==`i' // Put no of withdrawn students into main
dataset
	quietly replace sheet_laestab = `sheet_laestab' if _n==`i' // Put LAESTAB into main dataset

	preserve
	clear
	capture import excel using "School Data - ready for randomisation/`schoolid'.xlsx",
	/// Import pupil data from the same school spreadsheets
		sheet(Pupil information) firstrow

	drop if UniquePupilNumberUPN=="" // Only keep lines with UPNs (drops lines that are not people)

	local pupilnum = .
	local pupilnum = _N //number of data rows i.e. number of pupils with data submitted in that school
	di _N

	keep KS2PupilAverage EvereligibleforFSMYN //only keep pupils average KS2 level and ever FSM

	cap tostring EvereligibleforFSMYN, replace
	quietly gen FSM = 0 // Lots of blanks for FSM and have verified that these are intended as meaning they are
not FSM
	quietly replace FSM = 1 if EvereligibleforFSMYN=="Y"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="y"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="Yes"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="YES"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="yes"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="T"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="t"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="True"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="TRUE"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="true"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="1"
	local fsmprop ""
	quietly sum FSM // Work out the proportion flagged as FSM
	local fsmprop = r(mean) // Save it as a macro to put back into main spreadsheet

	local ks2_schoolmean = .
	quietly summarize KS2PupilAverage //work out school average KS2 level
	local ks2_schoolmean = r(mean) //save it as a macro to put back into main spreadsheet

	restore
	quietly replace school_size = `pupilnum' if _n==`i' // Put no of data rows into main spreadsheet
	quietly replace ks2_schoolmean = `ks2_schoolmean' if _n==`i' // Put school average KS2 into main
spreadsheet
```

```
	quietly replace fsmprop = `fsmprop' if _n==`i' // Put proportion FSM into main spreadsheet

	}

assert Numberofstudents==sheet_doubleaward - sheet_withdrawn  // Verification checks on the no of pupils we have recorded on our sheets and their sheets to force manual verification if there are anomalies
assert Numberofstudents==school_size //verification that data rows is equal to the number of students
//assert LAEstabDfENumber==sheet_laestab // Verification checks on the LAEstabs we have recorded on our sheets and their sheets to force manual verification if there are anomalies
assert school_size<. //Check school size has been successfully produced for all schools
assert ks2_schoolmean<. //Chack KS2 school mean has been successfully produced for all schools
assert fsmprop<. // Check that an EAL proportion has been successfully produced for all schools


xtile ks2_schoolmean16 = ks2_schoolmean, nq(16)
xtile ks2_schoolmean16_wt = ks2_schoolmean [fw=school_size], nq(16)

*** STANDARDISE  KS2 AND FSM VARS
cap sum ks2_schoolmean, de
gen std_ks2_schoolmean = (ks2_schoolmean - r(mean))/r(sd)

cap sum ks2_schoolmean [fw=school_size], de
gen stdwt_ks2_schoolmean = (ks2_schoolmean - r(mean))/r(sd)

cap sum fsmprop, de
gen std_fsmprop = (fsmprop - r(mean))/r(sd)

cap sum fsmprop [fw=school_size], de
gen stdwt_fsmprop = (fsmprop - r(mean))/r(sd)


*** DEFINE RANDOMISATION  PROGRAMME
cap program drop randomise
program define randomise, rclass

	cap drop random
	cap drop treatment

	gen double random = runiform()

	sort ks2_schoolmean16 random
	egen treatment = fill(1 0 1 0 0 1 0 1 0 0)

	regress stdwt_ks2_schoolmean treatment [aw=school_size]
	return scalar balance_ks2_weight = _b[treatment]

	regress std_ks2_schoolmean treatment
	return scalar balance_ks2_unweight = _b[treatment]

	regress stdwt_fsmprop treatment [aw=school_size]
	return scalar balance_fsm_weight = _b[treatment]

	regress std_fsmprop treatment
	return scalar balance_fsm_unweight = _b[treatment]

	regress school_size treatment
	return scalar balance_school_size_unweight = _b[treatment]

	sum treatment
	return scalar treat_prop = r(mean)

	end


randomise
```

```
// Just check that has worked and we have intended treatment allocation
label define treatment 0 "Control" 1 "Treatment", replace
label val treatment treatment
tab treatment

rename ks2_schoolmean16 KS2Blocks
rename treatment Treatment
rename random Random

// Export a spreadsheet for internal records
export excel using "Randomisation Outcome.xlsx", ///
        replace firstrow(variables) cell(A1) sheet("Allocation")

// Remove some extraneous detail that doesn't need to be in the spreadsheet shared with project grop
keep SchoolSMARTID SchoolName Headteacheremail  Schoolcontactname Schoolco ntactemail DataManagername
DataManageremail  LAEstabDfENumber Treatment

// Export a spreadsheet to share with the project team
export excel using "Randomisation Outcome to Project Team.xlsx", ///
        replace firstrow(variables) cell(A1) sheet("Allocation")

log close
exit
```

*Batch 2 randomisation code in Stat*a.

The code is the same as for Batch 1 randomisation except that randomisation was successful at the first attempt (so no need for seed incrementation), eight blocks are specified based on KS2 school average and allocation to treatment and control was in turn:

```
set more off

cap log close

clear
cd "S:\SMART_Spaces_Evaluation\Data Confirmed"
log using pairedrandomisation_batch2_1.log, replace

//Set a random seed. Never run more than once without restarting Stata or risk it won't be replicable
set seed 7568 // Value of 1 GBP to Thai Baht at 10.28am on 5-12-18
set sortseed 85416 //Value of 1 GBP to Turkish Lira at 10.28am on 5-12-18


// Import the list of schools from the Data Return Record list
import excel using "SMART_Spaces_Data_Return_Record.xlsx", ///
	sheet("Sheet1") cellrange(A1:AG145) firstrow

// Drop unless it is confirmed that we've received the dataset
keep if Readyforrandomisation=="YES"
// Drop unless school is allocated to randomisation batch 2
keep if Randomisationbatch==2
// Drop unless School SMART ID and LAESTAB are present and in right format
keep if SchoolSMARTID!=""
keep if LAEstabDfENumber!=.


// Loop through all observations grabbing the KS2 mean and school size data from individual school data
spreadsheets
local N = _N
quietly generate ks2_schoolmean = .
quietly generate school_size = .
quietly generate sheet_laestab = .
quietly generate sheet_doubleaward = .
quietly generate sheet_withdrawn = .
quietly generate fsmprop = .


forvalues i=1/`N' {
	local schoolid = SchoolSMARTID[`i']

	preserve // Preserve the overall data file
	clear
	capture import excel using "School Data - ready for randomisation/`schoolid'.xlsx",
	/// Open the spreadsheet provided by the school identified with their URN
		sheet(School and teacher information) cellrange(B6:B23)
	if _rc!=0 {
		di "Import failed for `schoolid'"
		exit
		}
	di "Currently processing data for `schoolid'"
	local sheet_laestab = B[1] //Grab LAESTAB
	local sheet_doubleaward = B[16] //Grab number of double award students
	local sheet_withdrawn = B[17] //Grab number of withdrawn students
	local sheet_confirm = ""
	local sheet_confirm = B[18] // Grab Confirmation

	if "`sheet_confirm'" != "Yes" & "`sheet_confirm'" != "YES" & "`sheet_confirm'" != "yes" {
		di "Withdrawal procedures not confirmed for school `schoolid'"
```

```
		// Check the resulting log for any schools where withdrawal procedures have not been confirmed
		}

	restore


	quietly replace sheet_doubleaward = `sheet_doubleaward' if _n==`i' // Put no. of DA students into main dataset
	quietly replace sheet_withdrawn = `sheet_withdrawn' if _n==`i' // Put no of withdrawn students into main dataset
	quietly replace sheet_laestab = `sheet_laestab' if _n==`i' // Put LAESTAB into main dataset

	preserve
	clear
	capture import excel using "School Data - ready for randomisation/`schoolid'.xlsx", /// Import pupil data from the same school spreadsheets
		sheet(Pupil information) firstrow

	drop if UniquePupilNumberUPN=="" // Only keep lines with UPNs (drops lines that are not people)

	local pupilnum = .
	local pupilnum = _N //number of data rows i.e. number of pupils with data submitted in that school
	di _N

	keep KS2PupilAverage EvereligibleforFSMYN //only keep pupils average KS2 level and ever FSM

	cap tostring EvereligibleforFSMYN, replace
	quietly gen FSM = 0 // Lots of blanks for FSM and have verified that these are intended as meaning they are not FSM
	quietly replace FSM = 1 if EvereligibleforFSMYN=="Y"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="y"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="Yes"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="YES"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="yes"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="T"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="t"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="True"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="TRUE"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="true"
	quietly replace FSM = 1 if EvereligibleforFSMYN=="1"
	local fsmprop ""
	quietly sum FSM // Work out the proportion flagged as FSM
	local fsmprop = r(mean) // Save it as a macro to put back into main spreadsheet

	local ks2_schoolmean = .
	quietly summarize KS2PupilAverage //work out school average KS2 level
	local ks2_schoolmean = r(mean) //save it as a macro to put back into main spreadsheet

	restore
	quietly replace school_size = `pupilnum' if _n==`i' // Put no of data rows into main spreadsheet
	quietly replace ks2_schoolmean = `ks2_schoolmean' if _n==`i' // Put school average KS2 into main spreadsheet
	quietly replace fsmprop = `fsmprop' if _n==`i' // Put proportion FSM into main spreadsheet

	}

assert Numberofstudents==sheet_doubleaward - sheet_withdrawn  // Verification checks on the no of pupils we have recorded on our sheets and their sheets to force manual verification if there are anomalies
assert Numberofstudents==school_size //verification that data rows is equal to the number of students
assert LAEstabDfENumber==sheet_laestab // Verification checks on the LAEstabs we have recorded on our sheets and their sheets to force manual verification if there are anomalies
assert school_size<. //Check school size has been successfully produced for all schools
assert ks2_schoolmean<. //Chack KS2 school mean has been successfully produced for all schools
assert fsmprop<. // Check that an FSM proportion has been successfully produced for all schools
```

```
xtile ks2_schoolmean8 = ks2_schoolmean, nq(8)

*** STANDARDISE  KS2 AND FSM VARS
cap sum ks2_schoolmean, de
gen std_ks2_schoolmean = (ks2_schoolmean - r(mean))/r(sd)

cap sum ks2_schoolmean [fw=school_size], de
gen stdwt_ks2_schoolmean = (ks2_schoolmean - r(mean))/r(sd)

cap sum fsmprop, de
gen std_fsmprop = (fsmprop - r(mean))/r(sd)

cap sum fsmprop [fw=school_size], de
gen stdwt_fsmprop = (fsmprop - r(mean))/r(sd)


*** DEFINE RANDOMISATION  PROGRAMME
cap program drop randomise
program define randomise, rclass

	cap drop random
	cap drop treatment

	gen double random = runiform()

	sort ks2_schoolmean8 random
	egen treatment = fill(0 1 0 1)

	regress stdwt_ks2_schoolmean treatment [aw=school_size]
	return scalar balance_ks2_weight = _b[treatment]

	regress std_ks2_schoolmean treatment
	return scalar balance_ks2_unweight = _b[treatment]

	regress stdwt_fsmprop treatment [aw=school_size]
	return scalar balance_fsm_weight = _b[treatment]

	regress std_fsmprop treatment
	return scalar balance_fsm_unweight = _b[treatment]

	regress school_size treatment
	return scalar balance_school_size_unweight = _b[treatment]

	sum treatment
	return scalar treat_prop = r(mean)

	end

randomise

// Just check that has worked and we have intended treatment allocation
label define treatment 0 "Control" 1 "Treatment", replace
label val treatment treatment
tab treatment

rename ks2_schoolmean8 KS2Blocks
rename treatment Treatment
rename random Random

// Export a spreadsheet for internal records
export excel using "Batch 2 Randomisation Outcome.xlsx", ///
	replace firstrow(variables) cell(A1) sheet("Allocation")

// Remove some extraneous detail that doesn't need to be in the spreadsheet shared with project grop
```

```
keep SchoolSMARTID SchoolName Headteacheremail  Schoolcontactname Schoolcontactemail DataManagername
DataManageremail  LAEstabDfENumber Treatment

// Export a spreadsheet to share with the project team
export excel using "Batch 2 Randomisation Outcome to Project Team.xlsx", ///
        replace firstrow(variables) cell(A1) sheet("Allocation")

log close
exit
```

Appendix I: Analysis syntax

```
lib_base="P:\\Input\\R4_1014986_lib"

assign(".lib.loc", lib_base, envir = environment(.libPaths))

# This enables parallel runs
Sys.setenv("R_LIBS_USER"=lib_base)

# Loading libraries
library(lme4)
library(lattice)
library(rstanarm)
library(ggplot2)
library(dplyr)
library(arm)
library(brms)
library(ggpubr)
library(bayesplot)
library(tidybayes)
library(rstan)
library(stringr)
library(foreign)
library(sjPlot)
library(bayestestR)
library(margins)
library(mice)
library(lfe)
library(plm)

options(scipen = 10)
options(mc.cores = parallel::detectCores())

arrow <- arrow(length = unit(0.2, "cm"), type = "closed")

smart_data <- read.dta("P:/Working/SMART full dataset/SMART_data_stata12_230721.dta")

summary(smart_data)

#############################################################
#############################################################
#
# Tidying up data after import
# e.g. specifying categorical variables as factors
#

smart_data$Random_Unique_PupilID  <- as.factor(smart_data$Random_Unique_PupilID)
smart_data$Random_Unique_ClassID  <- as.factor(smart_data$Random_Unique_ClassID)
smart_data$Random_Unique_SchoolID  <- as.factor(smart_data$Random_Unique_SchoolID)

smart_data$Allocation <- recode(smart_data$Allocation, Treatment = 1 , Control = 0)
smart_data$Allocation <- as.factor(smart_data$Allocation)

smart_data$ks4_gender <- recode(smart_data$ks4_gender, M = 0, F = 1)
smart_data$ks4_gender <- as.factor(smart_data$ks4_gender)
```

```
smart_data$Randomisation_Batch <- as.integer(smart_data$Randomisation_Batch)
smart_data$KS2Blocks <- as.integer(smart_data$KS2Blocks)
smart_data$Randomisation_block <- 100*smart_data$Randomisation_Batch + smart_data$KS2Blocks
smart_data$Randomisation_block <- as.factor(smart_data$Randomisation_block)

pretest_SG <- smart_data %>% mutate(pretest_tertile = ntile(pretest, 3))

smart_data$pretest_tertile <- pretest_SG$pretest_tertile
smart_data$pretest_tertile <- as.factor(smart_data$pretest_tertile)

smart_data$everfsm_6_p_spr19 <- as.factor(smart_data$everfsm_6_p_spr19)

attach(smart_data)

############################################################
############################################################
#
# Specifying data sets for primary, secondary analyses
#

# Create primary sample: Chemistry sub-scale
smart_data$primary_sample <- 0
smart_data$primary_sample[is.na(primary_outcome) == FALSE & is.na(Allocation) == FALSE & is.na(pretest) ==
FALSE & is.na(Randomisation_block)== FALSE & is.na(Random_Unique_SchoolID)==FALSE] <-1
primary_data <- subset(smart_data, smart_data$primary_sample == 1)

# Create secondary sample: GCSE Double Award Science raw score
smart_data$secondary_sampleGCSE <- 0
smart_data$secondary_sampleGCSE[is.na(secondary1_total_score) == FALSE & is.na(Allocation) == FALSE &
is.na(pretest) == FALSE & is.na(Randomisation_block)== FALSE & is.na(Random_Unique_SchoolID)==FALSE] <-1
secondary_dataGCSE <- subset(smart_data, smart_data$secondary_sampleGCSE == 1)

# Create secondary sample: AO1 score
smart_data$secondary_sampleAO1 <- 0
smart_data$secondary_sampleAO1[is.na(total_AO1_score) == FALSE & is.na(Allocation) == FALSE & is.na(pretest)
== FALSE & is.na(Randomisation_block)== FALSE & is.na(Random_Unique_SchoolID)==FALSE] <-1
secondary_dataAO1 <- subset(smart_data, smart_data$secondary_sampleAO1 == 1)

# Create secondary sample: AO2 score
smart_data$secondary_sampleAO2 <- 0
smart_data$secondary_sampleAO2[is.na(total_AO2_score) == FALSE & is.na(Allocation) == FALSE & is.na(pretest)
== FALSE & is.na(Randomisation_block)== FALSE & is.na(Random_Unique_SchoolID)==FALSE] <-1
secondary_dataAO2 <- subset(smart_data, smart_data$secondary_sampleAO2 == 1)

# Create secondary sample: AO3 score
smart_data$secondary_sampleAO3 <- 0
smart_data$secondary_sampleAO3[is.na(total_AO3_score) == FALSE & is.na(Allocation) == FALSE & is.na(pretest)
== FALSE & is.na(Randomisation_block)== FALSE & is.na(Random_Unique_SchoolID)==FALSE] <-1
secondary_dataAO3 <- subset(smart_data, smart_data$secondary_sampleAO3 == 1)

# Create FSM only sample
smart_data$fsm_sample <- 0
smart_data$fsm_sample[everfsm_6_p_spr19 == 1 & is.na(primary_outcome) == FALSE & is.na(Allocation) == FALSE
& is.na(pretest) == FALSE & is.na(Randomisation_block)== FALSE & is.na(Random_Unique_SchoolID)==FALSE] <-1
fsm_primary_data <- subset(smart_data, smart_data$fsm_sample == 1)
```

```
writeLines(c("Number of pupils at randomisation", nrow(smart_data),
        "Number of pupils in primary analysis", nrow(primary_data),
        "Number of pupils in secondary analysis: GCSE Double Award Science raw score",
nrow(secondary_dataGCSE),
        "Number of pupils in secondary analysis: AO1 score", nrow(secondary_dataAO1),
        "Number of pupils in secondary analysis: AO2 score", nrow(secondary_dataAO2),
        "Number of pupils in secondary analysis: AO3 score", nrow(secondary_dataAO3)))

nrow(subset(smart_data,is.na(primary_outcome) == FALSE )) # number of pupils, post-test data collected
nrow(subset(smart_data,is.na(primary_outcome) == FALSE & Allocation == 1 )) # number of treatment pupils, post-
test data collected
nrow(subset(smart_data,is.na(primary_outcome) == FALSE & Allocation == 0 )) # number of control pupils, post-test
data collected

############################################################
############################################################
#
# Calculating descriptives - Attrition, Balance
#

############################################################
# As randomised

ntreat_randomised <- nrow(subset(smart_data, smart_data$Allocation == 1))
ncontrol_randomised <- nrow(subset(smart_data, smart_data$Allocation == 0))
ntotal_randomised <- nrow(smart_data)

#FSM count and % as randomised
fsm_table_randomised <- table(everfsm_6_p_spr19, Allocation, useNA = "ifany")
fsm_prop.table_randomised <- prop.table(fsm_table_randomised, 2)

#Gender count and % as randomised
sex_table_randomised <- table(ks4_gender, Allocation, useNA = "ifany")
sex_prop.table_randomised <- prop.table(sex_table_randomised, 2)

#Pre-test balance as randomised
pretest_table_randomised <- smart_data %>% group_by(Allocation)%>% summarise(n = n(),
                                    pretest_missing = sum(is.na(pretest)),
                                    pretest_mean = mean(pretest, na.rm = TRUE),
                                    pretest_sd = sd(pretest, na.rm = TRUE))

pretest_es_randomised <- abs((pretest_table_randomised[2,4] -
pretest_table_randomised[1,4])/((pretest_table_randomised[2,5]^2 + pretest_table_randomised[1,5]^2)/2)^0.5)

#School-level descriptives continuous: pre-test, fsmprop, clustersize as randomised

school_level_randomised <- smart_data %>% group_by(Random_Unique_SchoolID, cat = Allocation) %>%
summarise(n=n(),
                                    pretest_missing = sum(is.na(pretest)),
                                    pretest_mean = mean(pretest, na.rm = TRUE),
                                    fsmprop_missing = sum(is.na(fsmprop)),
                                    fsmprop_mean = mean(fsmprop, na.rm = TRUE),
                                    cluster_missing = sum(is.na(school_size)),
                                    cluster_mean = mean(school_size, na.rm = TRUE))

sch_cts_descrip <- school_level_randomised %>% group_by(cat) %>%summarise(n = n(),
                                                    pre_mean = mean(pretest_mean, na.rm = TRUE),
```

```
                                                    pre_sd = sd(pretest_mean, na.rm = TRUE),
                                                    pre_miss = sum(is.na(pretest_mean)),
                                                    fsm_mean = mean(fsmprop_mean, na.rm = TRUE),
                                                    fsm_sd = sd(fsmprop_mean, na.rm = TRUE),
                                                    fsm_miss = sum(is.na(fsmprop_mean)),
                                                    size_mean = mean(cluster_mean, na.rm= TRUE),
                                                    size_sd = sd(cluster_mean, na.rm = TRUE),
                                                     size_miss = sum(is.na(cluster_mean)))

pre_es_sch_ran <- abs((sch_cts_descrip$pre_mean[1] -
sch_cts_descrip$pre_mean[2])/((sch_cts_descrip$pre_sd[1]^2 + sch_cts_descrip$pre_sd[2]^2)/2)^0.5)
fsm_es_sch_ran <- abs((sch_cts_descrip$fsm_mean[1] -
sch_cts_descrip$fsm_mean[2])/((sch_cts_descrip$fsm_sd[1]^2 + sch_cts_descrip$fsm_sd[2]^2)/2)^0.5)
size_es_sch_ran <- abs((sch_cts_descrip$size_mean[1] -
sch_cts_descrip$size_mean[2])/((sch_cts_descrip$size_sd[1]^2 + sch_cts_descrip$size_sd[2]^2)/2)^0.5)

############################################################
# As analysed

ntreat_primary <- nrow(subset(primary_data, primary_data$Allocation == 1))
ncontrol_primary <- nrow(subset(primary_data, primary_data$Allocation == 0))
ntreat_primary_miss <- ntreat_randomised - ntreat_primary
ncontrol_primary_miss <- ncontrol_randomised - ncontrol_primary
ntotal_primary <- ntreat_primary + ncontrol_primary
ntotal_primary_miss <- ntotal_randomised - ntotal_primary

treat.pc.attrition_primary <- 100*(ntreat_primary_miss/ntreat_randomised)
cont.pc.attrition_primary <- 100*(ncontrol_primary_miss/ncontrol_randomised)
total.pc.attrition_primary <- 100*(ntotal_primary_miss/ntotal_randomised)

#FSM count and % as analysed
fsm_table_primary <- table(primary_data$everfsm_6_p_spr19, primary_data$Allocation, useNA = "ifany")
fsm_prop.table_primary  <- prop.table(fsm_table_primary, 2)

#Gender count and % as analysed
sex_table_primary  <- table(primary_data$ks4_gender, primary_data$Allocation, useNA = "always")
sex_prop.table_primary  <- prop.table(sex_table_primary , 2)

#Exam entry count and % as analysed
entrycode_table_primary <- table(primary_data$Entry_Code, primary_data$Allocation)

#Pre-test balance as analysed
pretest_table_analysed <- primary_data %>% group_by(Allocation)%>% summarise(n = n(),
                                                    pretest_missing = sum(is.na(pretest)),
                                                    pretest_mean = mean(pretest, na.rm = TRUE),
                                                    pretest_sd = sd(pretest, na.rm = TRUE))

pretest_es_analysed <- abs((pretest_table_analysed[2,4] -
pretest_table_analysed[1,4])/((pretest_table_analysed[2,5]^2 + pretest_table_analysed[1,5]^2)/2)^0.5)

#School-level descriptives continuous: pre-test, fsmprop, clustersize as analysed

school_level_analysed <- primary_data %>% group_by(Random_Unique_SchoolID, cat = Allocation) %>%
summarise(school_size=n(),
                                                                pretest_missing = sum(is.na(pretest)),
                                                                pretest_mean = mean(pretest, na.rm = TRUE))
```

```
school_fsm_analysed <- primary_data %>% group_by(Random_Unique_SchoolID, cat = Allocation) %>%
count(everfsm_6_p_spr19)
school_fsm_analysed <- filter(school_fsm_analysed, everfsm_6_p_spr19 == 1)
school_level_analysed <- full_join(school_level_analysed, school_fsm_analysed, by = "Random_Unique_SchoolID")
school_level_analysed <- rename(school_level_analysed, fsm_n = n)
school_level_analysed <- rename(school_level_analysed, Allocation = cat.x)
school_level_analysed$fsm_prop <- school_level_analysed$fsm_n/school_level_analysed$school_size

sch_cts_descrip_anal <- school_level_analysed %>% group_by(Allocation) %>%summarise(n = n(),
                                                    pre_mean = mean(pretest_mean, na.rm = TRUE),
                                                    pre_sd = sd(pretest_mean, na.rm = TRUE),
                                                    pre_miss = sum(is.na(pretest_mean)),
                                                    fsm_mean = mean(fsm_prop, na.rm = TRUE),
                                                    fsm_sd = sd(fsm_prop, na.rm = TRUE),
                                                    fsm_miss = sum(is.na(fsm_prop)),
                                                    size_mean = mean(school_size, na.rm= TRUE),
                                                    size_sd = sd(school_size, na.rm = TRUE),
                                                    size_miss = sum(is.na(school_size)))

pre_es_sch_anal <- abs((sch_cts_descrip_anal$pre_mean[1] -
sch_cts_descrip_anal$pre_mean[2])/((sch_cts_descrip_anal$pre_sd[1]^2 +
sch_cts_descrip_anal$pre_sd[2]^2)/2)^0.5)
fsm_es_sch_anal <- abs((sch_cts_descrip_anal$fsm_mean[1] -
sch_cts_descrip_anal$fsm_mean[2])/((sch_cts_descrip_anal$fsm_sd[1]^2 +
sch_cts_descrip_anal$fsm_sd[2]^2)/2)^0.5)
size_es_sch_anal <- abs((sch_cts_descrip_anal$size_mean[1] -
sch_cts_descrip_anal$size_mean[2])/((sch_cts_descrip_anal$size_sd[1]^2 +
sch_cts_descrip_anal$size_sd[2]^2)/2)^0.5)

#counts and missing for secondary analyses
ntreat_secondary <- nrow(subset(secondary_dataGCSE, secondary_dataGCSE$Allocation == 1))
ncontrol_secondary <- nrow(subset(secondary_dataGCSE, secondary_dataGCSE$Allocation == 0))
ntreat_secondary_miss <- ntreat_randomised - ntreat_secondary
ncontrol_secondary_miss <- ncontrol_randomised - ncontrol_secondary
ntotal_secondary <- ntreat_secondary + ncontrol_secondary

ntreat_AO1 <- nrow(subset(secondary_dataAO1, secondary_dataAO1$Allocation == 1))
ncontrol_AO1 <- nrow(subset(secondary_dataAO1, secondary_dataAO1$Allocation == 0))
ntreat_AO1_miss <- ntreat_randomised - ntreat_AO1
ncontrol_AO1_miss <- ncontrol_randomised - ncontrol_AO1
ntotal_AO1 <- ntreat_AO1 + ncontrol_AO1

ntreat_AO2 <- nrow(subset(secondary_dataAO2, secondary_dataAO2$Allocation == 1))
ncontrol_AO2 <- nrow(subset(secondary_dataAO2, secondary_dataAO2$Allocation == 0))
ntreat_AO2_miss <- ntreat_randomised - ntreat_AO2
ncontrol_AO2_miss <- ncontrol_randomised - ncontrol_AO2
ntotal_AO2 <- ntreat_AO2 + ncontrol_AO2

ntreat_AO3 <- nrow(subset(secondary_dataAO3, secondary_dataAO3$Allocation == 1))
ncontrol_AO3 <- nrow(subset(secondary_dataAO3, secondary_dataAO3$Allocation == 0))
ntreat_AO3_miss <- ntreat_randomised - ntreat_AO3
ncontrol_AO3_miss <- ncontrol_randomised - ncontrol_AO3
ntotal_AO3 <- ntreat_AO3 + ncontrol_AO3

ntreat_fsm <- nrow(subset(fsm_primary_data, fsm_primary_data$Allocation == 1))
ncontrol_fsm <- nrow(subset(fsm_primary_data, fsm_primary_data$Allocation == 0))
```

```
fsm_school_level_analysed <- fsm_primary_data %>% group_by(Random_Unique_SchoolID, cat = Allocation) %>%
summarise(n=n(),
                                                                    pretest_missing = sum(is.na(pretest)),
                                                                    pretest_mean = mean(pretest, na.rm = TRUE),
                                                                    fsmprop_missing = sum(is.na(fsmprop)),
                                                                fsmprop_mean = mean(fsmprop, na.rm = TRUE),
                                                                    cluster_missing = sum(is.na(school_size)),
                                                                    cluster_mean = mean(school_size, na.rm =
TRUE))

#################################################################
#################################################################
#
# Investigating distributions of variables
#

ggplot(primary_data, aes(pretest, alpha = 0.2, color = "black", fill = "black", after_stat(density))) +
  geom_histogram(breaks = c(0,  30,  40,  50,  60,  70,  80,  90, 100, 110, 120, 130, 140, 150, 160, 170, 180,190,  200))
+
  xlab("Aggregate KS2 English and Maths raw score") +
  ylab("Density") +
  guides(colour = 'none',fill = 'none',alpha='none')

ggplot(primary_data, aes(primary_outcome, alpha = 0.2, colour = "black", fill = "black", after_stat(density))) +
     geom_histogram(breaks = c( 0,  10,  20,  30,  40,  50,  60,  70,  80,  90, 100, 110, 120, 130, 140, 150, 160, 170,
180, 190, 200, 210, 240)) +
     xlab("Chemistry sub-scale of AQA GCSE Double Award Science") +
     ylab("Density") +
     guides(colour = 'none',fill = 'none',alpha='none')

ggplot(secondary_dataGCSE, aes(secondary1_total_score, alpha = 0.2, colour = "black", fill = "black",
after_stat(density))) +
  geom_histogram(breaks = c(0, 20, 40,  60,  80, 100, 120, 140, 160, 180, 200, 220, 240, 260, 280, 300, 320, 340,
360, 380, 400, 420, 440, 460, 480, 500, 520, 600)) +
  xlab("AQA GCSE Double Award Science raw score") +
  ylab("Density") +
  guides(colour = 'none',fill = 'none',alpha='none')

ggplot(secondary_dataAO1, aes(total_AO1_score, alpha = 0.2, colour = "black", fill = "black", after_stat(density))) +
  geom_histogram(breaks = c( 0,  5,  10,  15,  20,  25,  30,  35,  40,  45,  50,  55,  60,  65,  70,  75,  80,  85,  90,  95,
110)) +
  xlab("AO1 subscale score") +
  ylab("Density") +
  guides(colour = 'none',fill = 'none',alpha='none')

ggplot(secondary_dataAO2, aes(total_AO2_score, alpha = 0.2, colour = "black", fill = "black", after_stat(density))) +
  geom_histogram(breaks = c( 0,  5,  10,  15,  20,  25,  30,  35,  40,  45,  50,  55,  60,  65,  70,  75,  80,  85,  90, 105))
+
  xlab("AO2 subscale score") +
  ylab("Density") +
  guides(colour = 'none',fill = 'none',alpha='none')

ggplot(secondary_dataAO3, aes(total_AO3_score, alpha = 0.2, colour = "black", fill = "black", after_stat(density))) +
  geom_histogram(breaks = c(0,  2,  4,  6,  8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 36)) +
  xlab("AO3 subscale score") +
  ylab("Density") +
  guides(colour = 'none',fill = 'none',alpha='none')
```

```
hist1 <- hist(primary_data$primary_outcome, breaks = c(0, 20, 40, 60, 80, 100, 120, 140, 160, 180, 200, 240))
hist1 <- hist(primary_data$primary_outcome, breaks = c( 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120,
130, 140, 150, 160, 170, 180, 190, 200, 210, 240))
hist2 <-hist(secondary_dataGCSE$secondary1_total_score, breaks = c(0, 20, 40, 60, 80, 100, 120, 140, 160, 180,
200, 220, 240, 260, 280, 300, 320, 340, 360, 380, 400, 420, 440, 460, 480, 500, 520, 600))
hist3a<-hist(secondary_dataAO1$total_AO1_score, breaks = c( 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60,
65, 70, 75, 80, 85, 90, 95, 110))
hist3b<-hist(secondary_dataAO2$total_AO2_score, c( 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70,
75, 80, 85, 90, 105))
hist3c<-hist(secondary_dataAO3$total_AO3_score, breaks = c(0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28,
36))

hist1$counts
hist2$counts
hist3a$counts
hist3b$counts
hist3c$counts

hist_pretest<- hist(primary_data$pretest, breaks = c(0, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150,
160, 170, 180,190, 200))
hist_pretest$counts

detach(smart_data)
attach(primary_data)

#############################################################
#############################################################
#
# Models for primary analysis
#

#############################################################
# In lme4 - Models for primary analysis

#empty model for ICC
m.1.lme.empty <- lmer(primary_outcome ~ 1 + (1|Random_Unique_SchoolID), data = primary_data)
summary(m.1.lme.empty)

vc <- VarCorr(m.1.lme.empty)
residual_var <- attr(vc, "sc")^2
random_effect_var <- vc$Random_Unique_SchoolID[1,1]
icc <- random_effect_var/(residual_var+random_effect_var)
icc

#treat only for unadjusted means
m.1.lme.unadj <- lm(primary_outcome ~ 1 + Allocation, data = primary_data)
summary(m.1.lme.unadj)

#full primary analysis model in lme
m.1.lme.full <- lmer(primary_outcome ~ 1 + Allocation + pretest + Randomisation_block +
(1|Random_Unique_SchoolID), data = primary_data)

summary(m.1.lme.full)

#############################################################
# In rstanarm - Models for primary analysis
```

```
#empty model for ICC
m.1.stan.empty <- stan_glmer(primary_outcome ~ 1 + (1|Random_Unique_SchoolID), data = primary_data, family =
gaussian(), cores = 4,
                    prior_intercept = normal(0,10, autoscale = TRUE),
                    prior_aux = cauchy(0,5, autoscale = TRUE),
                    warmup = 1000, iter = 3000, seed = 123)

summary(m.1.stan.empty, pars = c("(Intercept)", "sigma", "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]"),
      probs = c(0.025,0.975), digits = 3)

#treat only for unadjusted means
m.1.stan.unadj <- stan_glm(primary_outcome ~ 1 + Allocation , data = primary_data, cores = 4,
                           prior_intercept = normal(0,10, autoscale = TRUE),
                           prior = normal(0,10, autoscale = TRUE),
                            prior_aux = cauchy(0,5, autoscale = TRUE),
                           warmup = 1000, iter = 3000, seed = 123)

#full primary analysis model in rstanarm
m.1.stan.full <- stan_glmer(primary_outcome ~ 1 + Allocation + pretest + Randomisation_block +
(1|Random_Unique_SchoolID), data = primary_data, family = gaussian(), cores = 4,
                      prior_intercept = normal(0,10, autoscale = TRUE),
                      prior = normal(0,10, autoscale = TRUE),
                      prior_aux = cauchy(0,5, autoscale = TRUE),
                      warmup = 1000, iter = 2000, seed = 123)

detach(primary_data)
attach(secondary_dataGCSE)

############################################################
############################################################
#
# Models for secondary analysis: GCSE Double Award Science raw score
#

############################################################
# In lme4 - Models for secondary analysis: GCSE Double Award Science raw score

#empty model for ICC
m.2.lme.empty <- lmer(secondary1_total_score ~ 1 + (1|Random_Unique_SchoolID), data = secondary_dataGCSE)
summary(m.2.lme.empty)

#treat only for unadjusted means
m.2.lme.unadj <- lm(secondary1_total_score ~ 1 + Allocation , data = secondary_dataGCSE)
summary(m.2.lme.unadj)

#full secondary analysis model in lme
m.2.lme.full <- lmer(secondary1_total_score ~ 1 + Allocation + pretest + Randomisation_block +
(1|Random_Unique_SchoolID), data = secondary_dataGCSE)

summary(m.2.lme.full)

############################################################
# In rstanarm - Models for secondary analysis: GCSE Double Award Science raw score

#empty model for ICC
```

```
m.2.stan.empty <- stan_glmer(secondary1_total_score ~ 1 + (1|Random_Unique_SchoolID), data =
secondary_dataGCSE, family = gaussian(), cores = 4,
                         prior_intercept = normal(0,10, autoscale = TRUE),
                         prior_aux = cauchy(0,5, autoscale = TRUE),
                         warmup = 1000, iter = 3000, seed = 123)

summary(m.2.stan.empty, pars = c("(Intercept)", "sigma", "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]"),
        probs = c(0.025,0.975), digits = 3)

#treat only for unadjusted means
m.2.stan.unadj <- stan_glm(secondary1_total_score ~ 1 + Allocation , data = secondary_dataGCSE, cores = 4,
                         prior_intercept = normal(0,10, autoscale = TRUE),
                         prior = normal(0,10, autoscale = TRUE),
                         prior_aux = cauchy(0,5, autoscale = TRUE),
                         warmup = 1000, iter = 3000, seed = 123)

#full secondary analysis model in rstanarm
m.2.stan.full <- stan_glmer(secondary1_total_score ~ 1 + Allocation + pretest + Randomisation_block +
(1|Random_Unique_SchoolID),
                         data = secondary_dataGCSE, family = gaussian(), cores = 4,
                         prior_intercept = normal(0,10, autoscale = TRUE),
                         prior = normal(0,10, autoscale = TRUE),
                         prior_aux = cauchy(0,5, autoscale = TRUE),
                         warmup = 1000, iter = 2000, seed = 123)

detach(secondary_dataGCSE)
attach(secondary_dataAO1)

#############################################################
#############################################################
#
# Models for secondary analysis: A01 score
#

#############################################################
# In lme4 - Models for secondary analysis: A01 score

#empty model for ICC
m.3.lme.empty <- lmer(total_AO1_score ~ 1 + (1|Random_Unique_SchoolID), data = secondary_dataAO1)
summary(m.3.lme.empty)

#treat only for unadjusted means
m.3.lme.unadj <- lm(total_AO1_score ~ 1 + Allocation , data = secondary_dataAO1)
summary(m.3.lme.unadj)

#full primary analysis model in lme
m.3.lme.full <- lmer(total_AO1_score ~ 1 + Allocation + pretest + Randomisation_block +
(1|Random_Unique_SchoolID), data = secondary_dataAO1)

summary(m.3.lme.full)

#############################################################
# In rstanarm - Models for secondary analysis: A01 score

#empty model for ICC
m.3.stan.empty <- stan_glmer(total_AO1_score ~ 1 + (1|Random_Unique_SchoolID), data = secondary_dataAO1,
family = gaussian(), cores = 4,
```

```
                        prior_intercept = normal(0,10, autoscale = TRUE),
                        prior_aux = cauchy(0,5, autoscale = TRUE),
                        warmup = 1000, iter = 3000, seed = 123)

summary(m.3.stan.empty, pars = c("(Intercept)", "sigma", "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]"),
        probs = c(0.025,0.975), digits = 3)

#treat only for unadjusted means
m.3.stan.unadj <- stan_glm(total_AO1_score ~ 1 + Allocation , data = secondary_dataAO1, cores = 4,
                        prior_intercept = normal(0,10, autoscale = TRUE),
                        prior = normal(0,10, autoscale = TRUE),
                        prior_aux = cauchy(0,5, autoscale = TRUE),
                        warmup = 1000, iter = 3000, seed = 123)

#full secondary analysis model in rstanarm
m.3.stan.full <- stan_glmer(total_AO1_score ~ 1 + Allocation + pretest + Randomisation_block +
(1|Random_Unique_SchoolID),
                        data = secondary_dataAO1, family = gaussian(), cores = 4,
                        prior_intercept = normal(0,10, autoscale = TRUE),
                        prior = normal(0,10, autoscale = TRUE),
                        prior_aux = cauchy(0,5, autoscale = TRUE),
                        warmup = 1000, iter = 2000, seed = 123)

detach(secondary_dataAO1)
attach(secondary_dataAO2)

#############################################################
#############################################################
#
# Models for secondary analysis: A02 score
#

#############################################################
# In lme4 - Models for secondary analysis: A02 score

#empty model for ICC
m.4.lme.empty <- lmer(total_AO2_score ~ 1 + (1|Random_Unique_SchoolID),  data = secondary_dataAO2)
summary(m.4.lme.empty)

#treat only for unadjusted means
m.4.lme.unadj <- lm(total_AO2_score ~ 1 + Allocation , data = secondary_dataAO2)
summary(m.4.lme.unadj)

#full primary analysis model in lme
m.4.lme.full <- lmer(total_AO2_score ~ 1 + Allocation + pretest + Randomisation_block +
(1|Random_Unique_SchoolID),  data = secondary_dataAO2)

summary(m.4.lme.full)

#############################################################
# In rstanarm - Models for secondary analysis: A02 score

#empty model for ICC
m.4.stan.empty <- stan_glmer(total_AO2_score ~ 1 + (1|Random_Unique_SchoolID),  data = secondary_dataAO2,
family = gaussian(), cores = 4,
                        prior_intercept = normal(0,10, autoscale = TRUE),
                        prior_aux = cauchy(0,5, autoscale = TRUE),
```

```
                        warmup = 1000, iter = 3000, seed = 123)

summary(m.4.stan.empty, pars = c("(Intercept)", "sigma", "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]"),
        probs = c(0.025,0.975), digits = 3)

#treat only for unadjusted means
m.4.stan.unadj <- stan_glm(total_AO2_score ~ 1 + Allocation , data = secondary_dataAO2, cores = 4,
                         prior_intercept = normal(0,10, autoscale = TRUE),
                         prior = normal(0,10, autoscale = TRUE),
                         prior_aux = cauchy(0,5, autoscale = TRUE),
                         warmup = 1000, iter = 3000, seed = 123)

#full secondary analysis model in rstanarm
m.4.stan.full <- stan_glmer(total_AO2_score ~ 1 + Allocation + pretest + Randomisation_block +
(1|Random_Unique_SchoolID),
                        data = secondary_dataAO2, family = gaussian(), cores = 4,
                        prior_intercept = normal(0,10, autoscale = TRUE),
                        prior = normal(0,10, autoscale = TRUE),
                        prior_aux = cauchy(0,5, autoscale = TRUE),
                        warmup = 1000, iter = 2000, seed = 123)

detach(secondary_dataAO2)
attach(secondary_dataAO3)

############################################################
############################################################
#
# Model for secondary analysis: A03 score
#

############################################################
# In lme4 - Models for secondary analysis: A03 score

#empty model for ICC
m.5.lme.empty <- lmer(total_AO3_score ~ 1 + (1|Random_Unique_SchoolID),  data = secondary_dataAO3)
summary(m.5.lme.empty)

#treat only for unadjusted means
m.5.lme.unadj <- lm(total_AO3_score ~ 1 + Allocation, data = secondary_dataAO3)
summary(m.5.lme.unadj)

#full primary analysis model in lme
m.5.lme.full <- lmer(total_AO3_score ~ 1 + Allocation + pretest + Randomisation_block +
(1|Random_Unique_SchoolID),  data = secondary_dataAO3)

summary(m.5.lme.full)

############################################################
# In rstanarm - Models for secondary analysis: A03 score

#empty model for ICC
m.5.stan.empty <- stan_glmer(total_AO3_score ~ 1 + (1|Random_Unique_SchoolID),  data = secondary_dataAO3,
family = gaussian(), cores = 4,
                         prior_intercept = normal(0,10, autoscale = TRUE),
                         prior_aux = cauchy(0,5, autoscale = TRUE),
                         warmup = 1000, iter = 3000, seed = 123)
```

```
summary(m.5.stan.empty, pars = c("(Intercept)", "sigma", "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]"),
        probs = c(0.025,0.975), digits = 3)

#treat only for unadjusted means
m.5.stan.unadj <- stan_glm(total_AO3_score ~ 1 + Allocation, data = secondary_dataAO3, cores = 4,
                           prior_intercept = normal(0,10, autoscale = TRUE),
                           prior = normal(0,10, autoscale = TRUE),
                           prior_aux = cauchy(0,5, autoscale = TRUE),
                           warmup = 1000, iter = 3000, seed = 123)

#full secondary analysis model in rstanarm
m.5.stan.full <- stan_glmer(total_AO3_score ~ 1 + Allocation + pretest + Randomisation_block +
(1|Random_Unique_SchoolID),
                        data = secondary_dataAO3, family = gaussian(), cores = 4,
                        prior_intercept = normal(0,10, autoscale = TRUE),
                        prior = normal(0,10, autoscale = TRUE),
                        prior_aux = cauchy(0,5, autoscale = TRUE),
                        warmup = 1000, iter = 2000, seed = 123)

detach(secondary_dataAO3)

attach(fsm_primary_data)

############################################################
############################################################
#
# Models for sub-group analysis: everFSM pupils
#

#in lme first, FSM check for interaction then run for everFSM_6_P sub-group - primary analysis
m.6.lme.full <- lmer(primary_outcome ~ 1 + Allocation + pretest + Randomisation_block +
Allocation:everfsm_6_p_spr19 + everfsm_6_p_spr19 + (1|Random_Unique_SchoolID), data = primary_data)
summary(m.6.lme.full) #interaction term is not significant in lmer model.

#in lme first, FSM check for interaction then run for everFSM_6_P sub-group - secondary analyses
m.6.2.lme.full <- lmer(secondary1_total_score ~ 1 + Allocation + pretest + Randomisation_block +
Allocation:everfsm_6_p_spr19 + everfsm_6_p_spr19 + (1|Random_Unique_SchoolID), data = secondary_dataGCSE)
summary(m.6.2.lme.full) #interaction term is not significant in lmer model.

m.6.2a.lme.full <- lmer(total_AO1_score ~ 1 + Allocation + pretest + Randomisation_block +
Allocation:everfsm_6_p_spr19 + everfsm_6_p_spr19 + (1|Random_Unique_SchoolID), data = secondary_dataAO1)
summary(m.6.2a.lme.full) #interaction term IS SIGNIFICANT  in lmer model but only just.

m.6.2b.lme.full <- lmer(total_AO2_score ~ 1 + Allocation + pretest + Randomisation_block +
Allocation:everfsm_6_p_spr19 + everfsm_6_p_spr19 + (1|Random_Unique_SchoolID), data = secondary_dataAO2)
summary(m.6.2b.lme.full) #interaction term is not significant in lmer model.

m.6.2c.lme.full <- lmer(total_AO3_score ~ 1 + Allocation + pretest + Randomisation_block +
Allocation:everfsm_6_p_spr19 + everfsm_6_p_spr19 + (1|Random_Unique_SchoolID), data = secondary_dataAO3)
summary(m.6.2c.lme.full) #interaction term is not significant in lmer model.

#FSM check for interaction then run for everFSM_6_P sub-group - primary analysis
m.6.stan.full <- stan_glmer(primary_outcome ~ 1 + Allocation + pretest + Randomisation_block +
Allocation:everfsm_6_p_spr19 + everfsm_6_p_spr19 + (1|Random_Unique_SchoolID),
                        data = primary_data,
                        family = gaussian(), cores = 4,
                        prior_intercept = normal(0,10, autoscale = TRUE),
```

```
                        prior = normal(0,10, autoscale = TRUE),
                        prior_aux = cauchy(0,5, autoscale = TRUE),
                        warmup = 1000, iter = 2000, seed = 123)

m.6.stan.full.post <- as.data.frame(m.6.stan.full)
m.6.stan.full.post <- rename(m.6.stan.full.post, Intercept = "(Intercept)",
                         Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]",
                         interaction = "Allocation1:everfsm_6_p_spr19")
m.6.stan.full.post <- mutate(m.6.stan.full.post, effect_size = interaction/(sigma^2 + Sigma)^0.5)

fsm.effect.size_primary <- median(m.6.stan.full.post$effect_size)
fsm.effect.size.CI_primary <- hdi(m.6.stan.full.post$effect_size)
fsm.effect.size.rope_primary <- rope(m.6.stan.full.post$effect_size)

#FSM check for interaction then run for everFSM_6_P sub-group - SECONDARY ANALYSES
m.6.2.stan.full <- stan_glmer(secondary1_total_score ~ 1 + Allocation + pretest + Randomisation_block +
Allocation:everfsm_6_p_spr19 + everfsm_6_p_spr19 + (1|Random_Unique_SchoolID),
                        data = secondary_dataGCSE,
                        family = gaussian(), cores = 4,
                        prior_intercept = normal(0,10, autoscale = TRUE),
                        prior = normal(0,10, autoscale = TRUE),
                        prior_aux = cauchy(0,5, autoscale = TRUE),
                        warmup = 1000, iter = 2000, seed = 123)

m.6.2.stan.full.post <- as.data.frame(m.6.2.stan.full)
m.6.2.stan.full.post <- rename(m.6.2.stan.full.post, Intercept = "(Intercept)",
                         Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]",
                         interaction = "Allocation1:everfsm_6_p_spr19")
m.6.2.stan.full.post <- mutate(m.6.2.stan.full.post, effect_size = interaction/(sigma^2 + Sigma)^0.5)

fsm.effect.size_secondary <- median(m.6.2.stan.full.post$effect_size)
fsm.effect.size.CI_secondary <- hdi(m.6.2.stan.full.post$effect_size)
fsm.effect.size.rope_secondary <- rope(m.6.2.stan.full.post$effect_size)

m.6.2a.stan.full <- stan_glmer(total_AO1_score ~ 1 + Allocation + pretest + Randomisation_block +
Allocation:everfsm_6_p_spr19 + everfsm_6_p_spr19 + (1|Random_Unique_SchoolID),
                         data = secondary_dataAO1,
                         family = gaussian(), cores = 4,
                         prior_intercept = normal(0,10, autoscale = TRUE),
                         prior = normal(0,10, autoscale = TRUE),
                         prior_aux = cauchy(0,5, autoscale = TRUE),
                         warmup = 1000, iter = 2000, seed = 123)

m.6.2a.stan.full.post <- as.data.frame(m.6.2a.stan.full)
m.6.2a.stan.full.post <- rename(m.6.2a.stan.full.post, Intercept = "(Intercept)",
                          Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]",
                          interaction = "Allocation1:everfsm_6_p_spr19")
m.6.2a.stan.full.post <- mutate(m.6.2a.stan.full.post, effect_size = interaction/(sigma^2 + Sigma)^0.5)

fsm.effect.size_AO1 <- median(m.6.2a.stan.full.post$effect_size)
fsm.effect.size.CI_AO1 <- hdi(m.6.2a.stan.full.post$effect_size)
fsm.effect.size.rope_AO1 <- rope(m.6.2a.stan.full.post$effect_size)

m.6.2b.stan.full <- stan_glmer(total_AO2_score ~ 1 + Allocation + pretest + Randomisation_block +
Allocation:everfsm_6_p_spr19 + everfsm_6_p_spr19 + (1|Random_Unique_SchoolID),
                         data = secondary_dataAO2,
                         family = gaussian(), cores = 4,
```

```
                        prior_intercept = normal(0,10, autoscale = TRUE),
                        prior = normal(0,10, autoscale = TRUE),
                        prior_aux = cauchy(0,5, autoscale = TRUE),
                        warmup = 1000, iter = 2000, seed = 123)

m.6.2b.stan.full.post <- as.data.frame(m.6.2b.stan.full)
m.6.2b.stan.full.post <- rename(m.6.2b.stan.full.post, Intercept = "(Intercept)",
                         Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]",
                         interaction = "Allocation1:everfsm_6_p_spr19")
m.6.2b.stan.full.post <- mutate(m.6.2b.stan.full.post, effect_size = interaction/(sigma^2 + Sigma)^0.5)

fsm.effect.size_AO2 <- median(m.6.2b.stan.full.post$effect_size)
fsm.effect.size.CI_AO2 <- hdi(m.6.2b.stan.full.post$effect_size)
fsm.effect.size.rope_AO2 <- rope(m.6.2b.stan.full.post$effect_size)

m.6.2c.stan.full <- stan_glmer(total_AO3_score ~ 1 + Allocation + pretest + Randomisation_block +
Allocation:everfsm_6_p_spr19 + everfsm_6_p_spr19 + (1|Random_Unique_SchoolID),
                        data = secondary_dataAO3,
                        family = gaussian(), cores = 4,
                        prior_intercept = normal(0,10, autoscale = TRUE),
                        prior = normal(0,10, autoscale = TRUE),
                        prior_aux = cauchy(0,5, autoscale = TRUE),
                        warmup = 1000, iter = 2000, seed = 123)

m.6.2c.stan.full.post <- as.data.frame(m.6.2c.stan.full)
m.6.2c.stan.full.post <- rename(m.6.2c.stan.full.post, Intercept = "(Intercept)",
                         Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]",
                         interaction = "Allocation1:everfsm_6_p_spr19")
m.6.2c.stan.full.post <- mutate(m.6.2c.stan.full.post, effect_size = interaction/(sigma^2 + Sigma)^0.5)

fsm.effect.size_AO3 <- median(m.6.2c.stan.full.post$effect_size)
fsm.effect.size.CI_AO3 <- hdi(m.6.2c.stan.full.post$effect_size)
fsm.effect.size.rope_AO3 <- rope(m.6.2c.stan.full.post$effect_size)

############################################################
############################################################
#
# Models for sub-group analysis: Sex
#

#in lme first, Sex check for interaction then run for Girls sub-group if necessary - primary analysis
m.7.lme.full <- lmer(primary_outcome ~ 1 + Allocation + pretest + Randomisation_block + Allocation:ks4_gender +
ks4_gender + (1|Random_Unique_SchoolID),  data = primary_data)
summary(m.7.lme.full) #interaction term is not significant in lmer model.

#in lme first, check for interaction then run for sub-group - secondary analyses
m.7.2.lme.full <- lmer(secondary1_total_score ~ 1 + Allocation + pretest + Randomisation_block +
Allocation:ks4_gender + ks4_gender + (1|Random_Unique_SchoolID), data = secondary_dataGCSE)
summary(m.7.2.lme.full) #interaction term is not significant in lmer model.

m.7.2a.lme.full <- lmer(total_AO1_score ~ 1 + Allocation + pretest + Randomisation_block + Allocation:ks4_gender +
ks4_gender + (1|Random_Unique_SchoolID),  data = secondary_dataAO1)
summary(m.7.2a.lme.full) #interaction term IS not significant in lmer model .

m.7.2b.lme.full <- lmer(total_AO2_score ~ 1 + Allocation + pretest + Randomisation_block + Allocation:ks4_gender +
ks4_gender + (1|Random_Unique_SchoolID),  data = secondary_dataAO2)
summary(m.7.2b.lme.full) #interaction term is not significant in lmer model.
```

```
m.7.2c.lme.full <- lmer(total_AO3_score ~ 1 + Allocation + pretest + Randomisation_block + Allocation:ks4_gender +
ks4_gender + (1|Random_Unique_SchoolID),  data = secondary_dataAO3)
summary(m.7.2c.lme.full) #interaction term is not significant in lmer model.

#Sex check for interaction then run for Girls sub-group if necessary - primary analysis
m.7.stan.full <- stan_glmer(primary_outcome ~ 1 + Allocation + pretest + Randomisation_block +
Allocation:ks4_gender + ks4_gender + (1|Random_Unique_SchoolID),
                        data = primary_data,
                        family = gaussian(), cores = 4,
                        prior_intercept = normal(0,10, autoscale = TRUE),
                        prior = normal(0,10, autoscale = TRUE),
                        prior_aux = cauchy(0,5, autoscale = TRUE),
                        warmup = 1000, iter = 2000, seed = 123)

m.7.stan.full.post <- as.data.frame(m.7.stan.full)
m.7.stan.full.post <- rename(m.7.stan.full.post, Intercept = "(Intercept)",
                         Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]",
                         interaction = "Allocation1:ks4_gender1")
m.7.stan.full.post <- mutate(m.7.stan.full.post, effect_size = interaction/(sigma^2 + Sigma)^0.5)

sex.effect.size_primary <- median(m.7.stan.full.post$effect_size)
sex.effect.size.CI_primary <- hdi(m.7.stan.full.post$effect_size)
sex.effect.size.rope_primary <- rope(m.7.stan.full.post$effect_size)

#Sex check for interaction then run for Girls sub-group if necessary - secondary analysis
m.7.2.stan.full <- stan_glmer(secondary1_total_score ~ 1 + Allocation + pretest + Randomisation_block +
Allocation:ks4_gender + ks4_gender + (1|Random_Unique_SchoolID),
                        data = secondary_dataGCSE,
                        family = gaussian(), cores = 4,
                        prior_intercept = normal(0,10, autoscale = TRUE),
                        prior = normal(0,10, autoscale = TRUE),
                        prior_aux = cauchy(0,5, autoscale = TRUE),
                        warmup = 1000, iter = 2000, seed = 123)

m.7.2.stan.full.post <- as.data.frame(m.7.2.stan.full)
m.7.2.stan.full.post <- rename(m.7.2.stan.full.post, Intercept = "(Intercept)",
                         Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]",
                         interaction = "Allocation1:ks4_gender1")
m.7.2.stan.full.post <- mutate(m.7.2.stan.full.post, effect_size = interaction/(sigma^2 + Sigma)^0.5)

sex.effect.size_secondary <- median(m.7.2.stan.full.post$effect_size)
sex.effect.size.CI_secondary <- hdi(m.7.2.stan.full.post$effect_size)
sex.effect.size.rope_secondary <- rope(m.7.2.stan.full.post$effect_size)

m.7.2a.stan.full <- stan_glmer(total_AO1_score ~ 1 + Allocation + pretest + Randomisation_block +
Allocation:ks4_gender + ks4_gender + (1|Random_Unique_SchoolID),
                         data = secondary_dataAO1,
                         family = gaussian(), cores = 4,
                         prior_intercept = normal(0,10, autoscale = TRUE),
                         prior = normal(0,10, autoscale = TRUE),
                         prior_aux = cauchy(0,5, autoscale = TRUE),
                         warmup = 1000, iter = 2000, seed = 123)

m.7.2a.stan.full.post <- as.data.frame(m.7.2a.stan.full)
m.7.2a.stan.full.post <- rename(m.7.2a.stan.full.post, Intercept = "(Intercept)",
                          Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]",
```

```
                        interaction = "Allocation1:ks4_gender1")
m.7.2a.stan.full.post <- mutate(m.7.2a.stan.full.post, effect_size = interaction/(sigma^2 + Sigma)^0.5)

sex.effect.size_AO1 <- median(m.7.2a.stan.full.post$effect_size)
sex.effect.size.CI_AO1 <- hdi(m.7.2a.stan.full.post$effect_size)
sex.effect.size.rope_AO1 <- rope(m.7.2a.stan.full.post$effect_size)

m.7.2b.stan.full <- stan_glmer(total_AO2_score ~ 1 + Allocation + pretest + Randomisation_block +
Allocation:ks4_gender + ks4_gender + (1|Random_Unique_SchoolID),
                        data = secondary_dataAO2,
                        family = gaussian(), cores = 4,
                        prior_intercept = normal(0,10, autoscale = TRUE),
                        prior = normal(0,10, autoscale = TRUE),
                        prior_aux = cauchy(0,5, autoscale = TRUE),
                        warmup = 1000, iter = 2000, seed = 123)

m.7.2b.stan.full.post <- as.data.frame(m.7.2b.stan.full)
m.7.2b.stan.full.post <- rename(m.7.2b.stan.full.post, Intercept = "(Intercept)",
                         Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]",
                         interaction = "Allocation1:ks4_gender1")
m.7.2b.stan.full.post <- mutate(m.7.2b.stan.full.post, effect_size = interaction/(sigma^2 + Sigma)^0.5)

sex.effect.size_AO2 <- median(m.7.2b.stan.full.post$effect_size)
sex.effect.size.CI_AO2 <- hdi(m.7.2b.stan.full.post$effect_size)
sex.effect.size.rope_AO2 <- rope(m.7.2b.stan.full.post$effect_size)

m.7.2c.stan.full <- stan_glmer(total_AO3_score ~ 1 + Allocation + pretest + Randomisation_block +
Allocation:ks4_gender + ks4_gender + (1|Random_Unique_SchoolID),
                        data = secondary_dataAO3,
                        family = gaussian(), cores = 4,
                        prior_intercept = normal(0,10, autoscale = TRUE),
                        prior = normal(0,10, autoscale = TRUE),
                        prior_aux = cauchy(0,5, autoscale = TRUE),
                        warmup = 1000, iter = 2000, seed = 123)

m.7.2c.stan.full.post <- as.data.frame(m.7.2c.stan.full)
m.7.2c.stan.full.post <- rename(m.7.2c.stan.full.post, Intercept = "(Intercept)",
                         Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]",
                         interaction = "Allocation1:ks4_gender1")
m.7.2c.stan.full.post <- mutate(m.7.2c.stan.full.post, effect_size = interaction/(sigma^2 + Sigma)^0.5)

sex.effect.size_AO3 <- median(m.7.2c.stan.full.post$effect_size)
sex.effect.size.CI_AO3 <- hdi(m.7.2c.stan.full.post$effect_size)
sex.effect.size.rope_AO3 <- rope(m.7.2c.stan.full.post$effect_size)

############################################################
############################################################
#
# Models for sub-group analysis: Prior attainment
#

#in lme first, prior attainment check for interaction then run for low attainers sub-group if necessary - primary analysis
m.8.lme.full <- lmer(primary_outcome ~ 1 + Allocation + pretest + Randomisation_block + Allocation:pretest_tertile +
pretest_tertile + (1|Random_Unique_SchoolID), data = primary_data)
summary(m.8.lme.full) #interaction term is not significant in lmer model.

#in lme first, FSM check for interaction then run for everFSM_6_P sub-group - secondary analyses
```

```
m.8.2.lme.full <- lmer(secondary1_total_score ~ 1 + Allocation + pretest + Randomisation_block +
Allocation:pretest_tertile + pretest_tertile + (1|Random_Unique_SchoolID), data = secondary_dataGCSE)
summary(m.8.2.lme.full) #interaction term is not significant in lmer model.

m.8.2a.lme.full <- lmer(total_AO1_score ~ 1 + Allocation + pretest + Randomisation_block + Allocation:pretest_tertile +
pretest_tertile + (1|Random_Unique_SchoolID), data = secondary_dataAO1)
summary(m.8.2a.lme.full) #interaction term IS not significant in lmer model .

m.8.2b.lme.full <- lmer(total_AO2_score ~ 1 + Allocation + pretest + Randomisation_block + Allocation:pretest_tertile +
pretest_tertile + (1|Random_Unique_SchoolID), data = secondary_dataAO2)
summary(m.8.2b.lme.full) #interaction term is not significant in lmer model.

m.8.2c.lme.full <- lmer(total_AO3_score ~ 1 + Allocation + pretest + Randomisation_block + Allocation:pretest_tertile +
pretest_tertile + (1|Random_Unique_SchoolID), data = secondary_dataAO3)
summary(m.8.2c.lme.full) #interaction term is not significant in lmer model.

#Prior attainment check for interaction then run for low attainers sub-group if necessary - primary analysis
m.8.stan.full <- stan_glmer(primary_outcome ~ 1 + Allocation + pretest + Randomisation_block +
Allocation:pretest_tertile + pretest_tertile + (1|Random_Unique_SchoolID),
                    data = primary_data,
                    family = gaussian(), cores = 4,
                    prior_intercept = normal(0,10, autoscale = TRUE),
                    prior = normal(0,10, autoscale = TRUE),
                    prior_aux = cauchy(0,5, autoscale = TRUE),
                    warmup = 1000, iter = 2000, seed = 123)

m.8.stan.full.post <- as.data.frame(m.8.stan.full)
m.8.stan.full.post <- rename(m.8.stan.full.post, Intercept = "(Intercept)",
                     Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]",
                     interaction1 = "Allocation1:pretest_tertile2", interaction2 = "Allocation1:pretest_tertile3")
m.8.stan.full.post <- mutate(m.8.stan.full.post, effect_size1 = interaction1/(sigma^2 + Sigma)^0.5, effect_size2 =
interaction2/(sigma^2 + Sigma)^0.5)

pa.effect.size1_primary <- median(m.8.stan.full.post$effect_size1)
pa.effect.size1.CI_primary <- hdi(m.8.stan.full.post$effect_size1)
pa.effect.size1.rope_primary <- rope(m.8.stan.full.post$effect_size1)
pa.effect.size2_primary <- median(m.8.stan.full.post$effect_size2)
pa.effect.size2.CI_primary <- hdi(m.8.stan.full.post$effect_size2)
pa.effect.size2.rope_primary <- rope(m.8.stan.full.post$effect_size2)

m.8.2.stan.full <- stan_glmer(secondary1_total_score ~ 1 + Allocation + pretest + Randomisation_block +
Allocation:pretest_tertile + pretest_tertile + (1|Random_Unique_SchoolID),
                    data = secondary_dataGCSE,
                    family = gaussian(), cores = 4,
                    prior_intercept = normal(0,10, autoscale = TRUE),
                    prior = normal(0,10, autoscale = TRUE),
                    prior_aux = cauchy(0,5, autoscale = TRUE),
                    warmup = 1000, iter = 2000, seed = 123)

m.8.2.stan.full.post <- as.data.frame(m.8.2.stan.full)
m.8.2.stan.full.post <- rename(m.8.2.stan.full.post, Intercept = "(Intercept)",
                     Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]",
                     interaction1 = "Allocation1:pretest_tertile2", interaction2 = "Allocation1:pretest_tertile3")
m.8.2.stan.full.post <- mutate(m.8.2.stan.full.post, effect_size1 = interaction1/(sigma^2 + Sigma)^0.5, effect_size2 =
interaction2/(sigma^2 + Sigma)^0.5)

pa.effect.size1_secondary <- median(m.8.2.stan.full.post$effect_size1)
```

```
pa.effect.size1.CI_secondary <- hdi(m.8.2.stan.full.post$effect_size1)
pa.effect.size1.rope_secondary <- rope(m.8.2.stan.full.post$effect_size1)
pa.effect.size2_secondary <- median(m.8.2.stan.full.post$effect_size2)
pa.effect.size2.CI_secondary <- hdi(m.8.2.stan.full.post$effect_size2)
pa.effect.size2.rope_secondary <- rope(m.8.2.stan.full.post$effect_size2)

m.8.2a.stan.full <- stan_glmer(total_AO1_score ~ 1 + Allocation + pretest + Randomisation_block +
Allocation:pretest_tertile + pretest_tertile + (1|Random_Unique_SchoolID),
                        data = secondary_dataAO1,
                        family = gaussian(), cores = 4,
                        prior_intercept = normal(0,10, autoscale = TRUE),
                        prior = normal(0,10, autoscale = TRUE),
                        prior_aux = cauchy(0,5, autoscale = TRUE),
                        warmup = 1000, iter = 2000, seed = 123)

m.8.2a.stan.full.post <- as.data.frame(m.8.2a.stan.full)
m.8.2a.stan.full.post <- rename(m.8.2a.stan.full.post, Intercept = "(Intercept)",
                         Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]",
                         interaction1 = "Allocation1:pretest_tertile2", interaction2 = "Allocation1:pretest_tertile3")
m.8.2a.stan.full.post <- mutate(m.8.2a.stan.full.post, effect_size1 = interaction1/(sigma^2 + Sigma)^0.5, effect_size2 =
interaction2/(sigma^2 + Sigma)^0.5)

pa.effect.size1_AO1 <- median(m.8.2a.stan.full.post$effect_size1)
pa.effect.size1.CI_AO1 <- hdi(m.8.2a.stan.full.post$effect_size1)
pa.effect.size1.rope_AO1 <- rope(m.8.2a.stan.full.post$effect_size1)
pa.effect.size2_AO1 <- median(m.8.2a.stan.full.post$effect_size2)
pa.effect.size2.CI_AO1 <- hdi(m.8.2a.stan.full.post$effect_size2)
pa.effect.size2.rope_AO1 <- rope(m.8.2a.stan.full.post$effect_size2)

m.8.2b.stan.full <- stan_glmer(total_AO2_score ~ 1 + Allocation + pretest + Randomisation_block +
Allocation:pretest_tertile + pretest_tertile + (1|Random_Unique_SchoolID),
                        data = secondary_dataAO2,
                        family = gaussian(), cores = 4,
                        prior_intercept = normal(0,10, autoscale = TRUE),
                        prior = normal(0,10, autoscale = TRUE),
                        prior_aux = cauchy(0,5, autoscale = TRUE),
                        warmup = 1000, iter = 2000, seed = 123)

m.8.2b.stan.full.post <- as.data.frame(m.8.2b.stan.full)
m.8.2b.stan.full.post <- rename(m.8.2b.stan.full.post, Intercept = "(Intercept)",
                         Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]",
                         interaction1 = "Allocation1:pretest_tertile2", interaction2 = "Allocation1:pretest_tertile3")
m.8.2b.stan.full.post <- mutate(m.8.2b.stan.full.post, effect_size1 = interaction1/(sigma^2 + Sigma)^0.5, effect_size2 =
interaction2/(sigma^2 + Sigma)^0.5)

pa.effect.size1_AO2 <- median(m.8.2b.stan.full.post$effect_size1)
pa.effect.size1.CI_AO2 <- hdi(m.8.2b.stan.full.post$effect_size1)
pa.effect.size1.rope_AO2 <- rope(m.8.2b.stan.full.post$effect_size1)
pa.effect.size2_AO2 <- median(m.8.2b.stan.full.post$effect_size2)
pa.effect.size2.CI_AO2 <- hdi(m.8.2b.stan.full.post$effect_size2)
pa.effect.size2.rope_AO2 <- rope(m.8.2b.stan.full.post$effect_size2)

m.8.2c.stan.full <- stan_glmer(total_AO3_score ~ 1 + Allocation + pretest + Randomisation_block +
Allocation:pretest_tertile + pretest_tertile + (1|Random_Unique_SchoolID),
                        data = secondary_dataAO3,
                        family = gaussian(), cores = 4,
                        prior_intercept = normal(0,10, autoscale = TRUE),
```

```
                        prior = normal(0,10, autoscale = TRUE),
                        prior_aux = cauchy(0,5, autoscale = TRUE),
                        warmup = 1000, iter = 2000, seed = 123)

m.8.2c.stan.full.post <- as.data.frame(m.8.2c.stan.full)
m.8.2c.stan.full.post <- rename(m.8.2c.stan.full.post, Intercept = "(Intercept)",
                         Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]",
                         interaction1 = "Allocation1:pretest_tertile2", interaction2 = "Allocation1:pretest_tertile3")
m.8.2c.stan.full.post <- mutate(m.8.2c.stan.full.post, effect_size1 = interaction1/(sigma^2 + Sigma)^0.5, effect_size2 =
interaction2/(sigma^2 + Sigma)^0.5)

pa.effect.size1_AO3 <- median(m.8.2c.stan.full.post$effect_size1)
pa.effect.size1.CI_AO3 <- hdi(m.8.2c.stan.full.post$effect_size1)
pa.effect.size1.rope_AO3 <- rope(m.8.2c.stan.full.post$effect_size1)
pa.effect.size2_AO3 <- median(m.8.2c.stan.full.post$effect_size2)
pa.effect.size2.CI_AO3 <- hdi(m.8.2c.stan.full.post$effect_size2)
pa.effect.size2.rope_AO3 <- rope(m.8.2c.stan.full.post$effect_size2)

############################################################
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#
# Models for additional analysis: Cluster size
#

m.9.lme.full <- lmer(primary_outcome ~ 1 + Allocation + pretest + Randomisation_block + school_size +
(1|Random_Unique_SchoolID),  data = primary_data)
summary(m.9.lme.full)

m.9.2.lme.full <- lmer(secondary1_total_score ~ 1 + Allocation + pretest + Randomisation_block + school_size +
(1|Random_Unique_SchoolID),  data = secondary_dataGCSE)
summary(m.9.2.lme.full)

m.9.2a.lme.full <- lmer(total_AO1_score ~ 1 + Allocation + pretest + Randomisation_block + school_size +
(1|Random_Unique_SchoolID),  data = secondary_dataAO1)
summary(m.9.2a.lme.full)

m.9.2b.lme.full <- lmer(total_AO2_score ~ 1 + Allocation + pretest + Randomisation_block + school_size +
(1|Random_Unique_SchoolID),  data = secondary_dataAO2)
summary(m.9.2b.lme.full)

m.9.2c.lme.full <- lmer(total_AO3_score ~ 1 + Allocation + pretest + Randomisation_block + school_size +
(1|Random_Unique_SchoolID),  data = secondary_dataAO3)
summary(m.9.2c.lme.full)

#cluster size for primary outcome
m.9.stan.full <- stan_glmer(primary_outcome ~ 1 + Allocation + pretest + Randomisation_block + school_size +
(1|Random_Unique_SchoolID),
                        data = primary_data,
                        family = gaussian(), cores = 4,
                        prior_intercept = normal(0,10, autoscale = TRUE),
                        prior = normal(0,10, autoscale = TRUE),
                        prior_aux = cauchy(0,5, autoscale = TRUE),
                        warmup = 1000, iter = 2000, seed = 123)

m.9.stan.full.post <- as.data.frame(m.9.stan.full)
m.9.stan.full.post <- rename(m.9.stan.full.post, Intercept = "(Intercept)",
                         Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]")
```

```
m.9.stan.full.post <- mutate(m.9.stan.full.post, effect_size = Allocation1/(sigma^2 + Sigma)^0.5)

cluster.effect.size_primary <- median(m.9.stan.full.post$effect_size)
cluster.effect.size.CI_primary <- hdi(m.9.stan.full.post$effect_size)
cluster.effect.size.rope_primary <- rope(m.9.stan.full.post$effect_size)

#cluster size for secondary outcome
m.9.2.stan.full <- stan_glmer(secondary1_total_score ~ 1 + Allocation + pretest + Randomisation_block + school_size
+ (1|Random_Unique_SchoolID),
                        data = secondary_dataGCSE,
                        family = gaussian(), cores = 4,
                        prior_intercept = normal(0,10, autoscale = TRUE),
                        prior = normal(0,10, autoscale = TRUE),
                        prior_aux = cauchy(0,5, autoscale = TRUE),
                        warmup = 1000, iter = 2000, seed = 123)

m.9.2.stan.full.post <- as.data.frame(m.9.2.stan.full)
m.9.2.stan.full.post <- rename(m.9.2.stan.full.post, Intercept = "(Intercept)",
                         Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]")
m.9.2.stan.full.post <- mutate(m.9.2.stan.full.post, effect_size = Allocation1/(sigma^2 + Sigma)^0.5)

cluster.effect.size_secondary <- median(m.9.2.stan.full.post$effect_size)
cluster.effect.size.CI_secondary <- hdi(m.9.2.stan.full.post$effect_size)
cluster.effect.size.rope_secondary <- rope(m.9.2.stan.full.post$effect_size)

#cluster size for AO1
m.9.2a.stan.full <- stan_glmer(total_AO1_score ~ 1 + Allocation + pretest + Randomisation_block + school_size +
(1|Random_Unique_SchoolID),
                         data = secondary_dataAO1,
                         family = gaussian(), cores = 4,
                         prior_intercept = normal(0,10, autoscale = TRUE),
                         prior = normal(0,10, autoscale = TRUE),
                         prior_aux = cauchy(0,5, autoscale = TRUE),
                         warmup = 1000, iter = 2000, seed = 123)

m.9.2a.stan.full.post <- as.data.frame(m.9.2a.stan.full)
m.9.2a.stan.full.post <- rename(m.9.2a.stan.full.post, Intercept = "(Intercept)",
                          Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]")
m.9.2a.stan.full.post <- mutate(m.9.2a.stan.full.post, effect_size = Allocation1/(sigma^2 + Sigma)^0.5)

cluster.effect.size_AO1 <- median(m.9.2a.stan.full.post$effect_size)
cluster.effect.size.CI_AO1 <- hdi(m.9.2a.stan.full.post$effect_size)
cluster.effect.size.rope_AO1 <- rope(m.9.2a.stan.full.post$effect_size)

#cluster size for AO2
m.9.2b.stan.full <- stan_glmer(total_AO2_score ~ 1 + Allocation + pretest + Randomisation_block + school_size +
(1|Random_Unique_SchoolID),
                         data = secondary_dataAO2,
                         family = gaussian(), cores = 4,
                         prior_intercept = normal(0,10, autoscale = TRUE),
                         prior = normal(0,10, autoscale = TRUE),
                         prior_aux = cauchy(0,5, autoscale = TRUE),
                         warmup = 1000, iter = 2000, seed = 123)

m.9.2b.stan.full.post <- as.data.frame(m.9.2b.stan.full)
m.9.2b.stan.full.post <- rename(m.9.2b.stan.full.post, Intercept = "(Intercept)",
                          Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]")
```

```
m.9.2b.stan.full.post <- mutate(m.9.2b.stan.full.post, effect_size = Allocation1/(sigma^2 + Sigma)^0.5)

cluster.effect.size_AO2 <- median(m.9.2b.stan.full.post$effect_size)
cluster.effect.size.CI_AO2 <- hdi(m.9.2b.stan.full.post$effect_size)
cluster.effect.size.rope_AO2 <- rope(m.9.2b.stan.full.post$effect_size)

#cluster size for AO3
m.9.2c.stan.full <- stan_glmer(total_AO3_score ~ 1 + Allocation + pretest + Randomisation_block + school_size +
(1|Random_Unique_SchoolID),
                        data = secondary_dataAO3,
                        family = gaussian(), cores = 4,
                        prior_intercept = normal(0,10, autoscale = TRUE),
                        prior = normal(0,10, autoscale = TRUE),
                        prior_aux = cauchy(0,5, autoscale = TRUE),
                        warmup = 1000, iter = 2000, seed = 123)

m.9.2c.stan.full.post <- as.data.frame(m.9.2c.stan.full)
m.9.2c.stan.full.post <- rename(m.9.2c.stan.full.post, Intercept = "(Intercept)",
                         Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]")
m.9.2c.stan.full.post <- mutate(m.9.2c.stan.full.post, effect_size = Allocation1/(sigma^2 + Sigma)^0.5)

cluster.effect.size_AO3 <- median(m.9.2c.stan.full.post$effect_size)
cluster.effect.size.CI_AO3 <- hdi(m.9.2c.stan.full.post$effect_size)
cluster.effect.size.rope_AO3 <- rope(m.9.2c.stan.full.post$effect_size)

############################################################
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#
# Models for additional analysis: Engagement
#

primary_data$engage_totscore[primary_data$Allocation == 0] <- 0
primary_data$engage_rmeasure[primary_data$Allocation  == 0] <- 0

m.10.lme.full <- lmer(primary_outcome ~ 1 + Allocation + pretest + Randomisation_block + Allocation:engage_totscore
+ engage_totscore + (1|Random_Unique_SchoolID), data = primary_data)
summary(m.10.lme.full)

m.10.1.lme.full <- lmer(primary_outcome ~ 1 + Allocation + pretest + Randomisation_block +
Allocation:engage_rmeasure + engage_rmeasure + (1|Random_Unique_SchoolID), data = primary_data)
summary(m.10.1.lme.full)

#engagement for primary outcome
m.10.stan.full <- stan_glmer(primary_outcome ~ 1 + Allocation + pretest + Randomisation_block +
Allocation:engage_totscore + engage_totscore  + (1|Random_Unique_SchoolID),
                        data = primary_data,
                        family = gaussian(), cores = 4,
                        prior_intercept = normal(0,10, autoscale = TRUE),
                        prior = normal(0,10, autoscale = TRUE),
                        prior_aux = cauchy(0,5, autoscale = TRUE),
                        warmup = 1000, iter = 2000, seed = 123)

m.10.stan.full.post <- as.data.frame(m.10.stan.full)
m.10.stan.full.post <- rename(m.10.stan.full.post, Intercept = "(Intercept)",
                         Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]")
m.10.stan.full.post <- mutate(m.10.stan.full.post, effect_size = engage_totscore/(sigma^2 + Sigma)^0.5)
```

```
engage_tot.effect.size <- median(m.10.stan.full.post$effect_size)
engage_tot.effect.size.CI <- hdi(m.10.stan.full.post$effect_size)
engage_tot.effect.size.rope <- rope(m.10.stan.full.post$effect_size)

m.10.1.stan.full <- stan_glmer(primary_outcome ~ 1 + Allocation + pretest + Randomisation_block +
Allocation:engage_rmeasure + engage_rmeasure  + (1|Random_Unique_SchoolID),
                        data = primary_data,
                        family = gaussian(), cores = 4,
                        prior_intercept = normal(0,10, autoscale = TRUE),
                        prior = normal(0,10, autoscale = TRUE),
                        prior_aux = cauchy(0,5, autoscale = TRUE),
                        warmup = 1000, iter = 2000, seed = 123)

m.10.1.stan.full.post <- as.data.frame(m.10.1.stan.full)
m.10.1.stan.full.post <- rename(m.10.1.stan.full.post, Intercept = "(Intercept)",
                         Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]")
m.10.1.stan.full.post <- mutate(m.10.1.stan.full.post, effect_size = engage_rmeasure/(sigma^2 + Sigma)^0.5)

engage_r.effect.size <- median(m.10.1.stan.full.post$effect_size)
engage_r.effect.size.CI <- hdi(m.10.1.stan.full.post$effect_size)
engage_r.effect.size.rope <- rope(m.10.1.stan.full.post$effect_size)

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#
# Additional robustness checks
#

primary_data <- primary_data %>% group_by(Random_Unique_SchoolID) %>% mutate(SLmean_pretest =
mean(pretest, na.rm=TRUE))

m.11.lme.full <- lmer(primary_outcome ~ 1 + Allocation + pretest + Randomisation_block + school_size + fsmprop +
SLmean_pretest + (1|Random_Unique_SchoolID), data = primary_data)
summary(m.11.lme.full)

m.11.stan.full <- stan_glmer(primary_outcome ~ 1 + Allocation + pretest + Randomisation_block + school_size +
fsmprop + SLmean_pretest + (1|Random_Unique_SchoolID),
                        data = primary_data,
                        family = gaussian(), cores = 4,
                        prior_intercept = normal(0,10, autoscale = TRUE),
                        prior = normal(0,10, autoscale = TRUE),
                        prior_aux = cauchy(0,5, autoscale = TRUE),
                        warmup = 1000, iter = 2000, seed = 123)

m.11.stan.full.post <- as.data.frame(m.11.stan.full)

m.11.stan.full.post <- rename(m.11.stan.full.post, Intercept = "(Intercept)",
                        Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]")
m.11.stan.full.post <- mutate(m.11.stan.full.post, effect_size = Allocation1/(sigma^2 + Sigma)^0.5)

robust.effect.size_primary <- median(m.11.stan.full.post$effect_size)
robust.effect.size.CI_primary <- hdi(m.11.stan.full.post$effect_size)
robust.effect.size.rope_primary <- rope(m.11.stan.full.post$effect_size)

primary_data$EC_factor <- as.factor(primary_data$Entry_Code)
```

```
m.12.lme.full <- lmer(primary_outcome ~ 1 + Allocation + pretest + Randomisation_block + EC_factor +
(1|Random_Unique_SchoolID),  data = primary_data)
summary(m.12.lme.full)

m.12.stan.full <- stan_glmer(primary_outcome ~ 1 + Allocation + pretest + Randomisation_block + EC_factor +
(1|Random_Unique_SchoolID),
                        data = primary_data,
                        family = gaussian(), cores = 4,
                        prior_intercept = normal(0,10, autoscale = TRUE),
                        prior = normal(0,10, autoscale = TRUE),
                        prior_aux = cauchy(0,5, autoscale = TRUE),
                        warmup = 1000, iter = 2000, seed = 123)

m.12.stan.full.post <- as.data.frame(m.12.stan.full)

m.12.stan.full.post <- rename(m.12.stan.full.post, Intercept = "(Intercept)",
                         Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]")
m.12.stan.full.post <- mutate(m.12.stan.full.post, effect_size = Allocation1/(sigma^2 + Sigma)^0.5)
m.12.stan.full.post <- mutate(m.12.stan.full.post, Tril_H_es = EC_factor8464H/(sigma^2 + Sigma)^0.5)
m.12.stan.full.post <- mutate(m.12.stan.full.post, Syn_F_es = EC_factor8465F/(sigma^2 + Sigma)^0.5)
m.12.stan.full.post <- mutate(m.12.stan.full.post, Syn_H_es = EC_factor8465H/(sigma^2 + Sigma)^0.5)

exambrd.effect.size_primary <- median(m.12.stan.full.post$effect_size)
exambrd.effect.size.CI_primary <- hdi(m.12.stan.full.post$effect_size)
exambrd.effect.size.rope_primary <- rope(m.12.stan.full.post$effect_size)

Tril_H_es_primary  <- median(m.12.stan.full.post$Tril_H_es)
Tril_H_es.CI_primary  <- hdi(m.12.stan.full.post$Tril_H_es)
Tril_H_es.rope_primary  <- rope(m.12.stan.full.post$Tril_H_es)

Syn_F_es_primary <- median(m.12.stan.full.post$Syn_F_es)
Syn_F_es.CI_primary  <- hdi(m.12.stan.full.post$Syn_F_es)
Syn_F_es.rope_primary <- rope(m.12.stan.full.post$Syn_F_es)

Syn_H_es_primary <- median(m.12.stan.full.post$Syn_H_es)
Syn_H_es.CI_primary  <- hdi(m.12.stan.full.post$Syn_H_es)
Syn_H_es.rope_primary <- rope(m.12.stan.full.post$Syn_H_es)



############################################################
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#
# Missing data analysis
#

# create missing indicator variables

smart_data$primary_outcome.miss <- 0
smart_data$primary_outcome.miss[is.na(smart_data$primary_outcome) == TRUE] <-1

smart_data$secondary1_total_score.miss <- 0
smart_data$secondary1_total_score.miss[is.na(smart_data$secondary1_total_score)== TRUE] <- 1

smart_data$total_AO1_score.miss <- 0
smart_data$total_AO1_score.miss[is.na(smart_data$total_AO1_score)==TRUE]  <- 1
```

```
smart_data$total_AO2_score.miss <- 0
smart_data$total_AO2_score.miss[is.na(smart_data$total_AO2_score)==TRUE]  <- 1

smart_data$total_AO3_score.miss <- 0
smart_data$total_AO3_score.miss[is.na(smart_data$total_AO3_score)==TRUE]  <- 1

smart_data$pretest.miss <- 0
smart_data$pretest.miss[is.na(smart_data$pretest)==TRUE]  <-1

# now see whether missing status of primary outcome can be predicted

prim.miss.glmer <- glmer(primary_outcome.miss ~ Allocation + pretest + Randomisation_block + everfsm_6_p_spr19
+ fsmprop + ks4_gender + secondary1_total_score + (1|Random_Unique_SchoolID) ,
                  family = binomial(logit), data = smart_data)
prim.miss.glmer.summ <- summary(prim.miss.glmer)

# results from the multi-level logistic regression show that pre-test, everfsm_6_p_spr19,  ks4_gender,
secondary1_total_score are predictive of missingness of the outcome variable.
# So we now need to add these variables into the original model and re-estimate the treatment effect where only the
outcome variable in the model is missing.

# Missing data analysis - only outcome variable missing

m.1.lme.miss <- lmerTest::lmer(primary_outcome ~ 1 + Allocation + pretest + Randomisation_block +
everfsm_6_p_spr19 + ks4_gender + secondary1_total_score + (1|Random_Unique_SchoolID), data = smart_data)
m.1.lme.miss.summ <- summary(m.1.lme.miss)
p.val.allocation <- m.1.lme.miss.summ$coefficients[2,5]

# Missing data analysis - one of the predictor variables missing

pretest.miss.glm <- glmer(pretest.miss ~ Allocation + Randomisation_block + everfsm_6_p_spr19 + fsmprop +
ks4_gender + secondary1_total_score + (1|Random_Unique_SchoolID)  ,
                  family = binomial(logit), data = smart_data)
pretest.miss.glm.summ <- summary(pretest.miss.glm)
#results from the multi-level logistic regression show that ever_fsm and GCSE score (secondary1_total_score) are
predictive of pretest missingness, so MAR assumption is reasonable.

# Multiple imputation

prim.data_for.mi <- dplyr::select(smart_data, Random_Unique_SchoolID , Allocation, primary_outcome, pretest,
Randomisation_block, everfsm_6_p_spr19, fsmprop, ks4_gender, secondary1_total_score)

#mice seems to have a problem with factor variables: it treats them as dummies
#as a result the mice code would not work with Random_Unique_SchoolID and Randomisation_block as factors.
#fix was to run them into integers and then the code works
prim.data_for.mi$Random_Unique_SchoolID <- as.integer(prim.data_for.mi$Random_Unique_SchoolID)
prim.data_for.mi$Randomisation_block <- as.integer(prim.data_for.mi$Randomisation_block)

md.pattern(prim.data_for.mi)

ini <- mice(prim.data_for.mi, maxit = 0, seed =123)

meth <- ini$meth
pred <- ini$pred

# First attempt with method norm only
meth <- c("", "", "norm", "norm", "", "logreg", "", "logreg", "norm")
```

```
pred["Random_Unique_SchoolID", ] <- c(0, 0, 0, 0, 0, 0, 0, 0, 0)
pred["Allocation", ] <- c(0, 0, 0, 0, 0, 0, 0, 0, 0)
pred["Randomisation_block", ] <- c(0, 0, 0, 0, 0, 0, 0, 0, 0)
pred["fsmprop", ] <- c(0, 0, 0, 0, 0, 0, 0, 0, 0)
#pred["primary_outcome", ] <- c(-2, 2, 0, 2, 2, 2, 2, 2, 2)

#pred["secondary1_total_score", ] <- c(0, 0, 0, 0, 0, 0, 0, 0, 0)
#pred[ ,"secondary1_total_score"] <- c(0, 0, 0, 0, 0, 0, 0, 0, 0)

#impute the data using method norm
imputed_data <- mice(prim.data_for.mi, meth=meth, pred=pred, m=20,maxit=25,print=FALSE, seed = 123)

#run the primary outcome model on the imputed data sets
with.imp <- with(imputed_data, lmer(primary_outcome ~ 1 + Allocation + pretest + Randomisation_block +
(1|Random_Unique_SchoolID)))

#extract parameter estimates and variances for Allocation ONLY to enable pooling via Rubin rules
Q <- c(with.imp$analyses[[1]]@beta[2],
      with.imp$analyses[[2]]@beta[2],
      with.imp$analyses[[3]]@beta[2],
      with.imp$analyses[[4]]@beta[2],
      with.imp$analyses[[5]]@beta[2],
      with.imp$analyses[[6]]@beta[2],
      with.imp$analyses[[7]]@beta[2],
      with.imp$analyses[[8]]@beta[2],
      with.imp$analyses[[9]]@beta[2],
      with.imp$analyses[[10]]@beta[2],
      with.imp$analyses[[11]]@beta[2],
      with.imp$analyses[[12]]@beta[2],
      with.imp$analyses[[13]]@beta[2],
      with.imp$analyses[[14]]@beta[2],
      with.imp$analyses[[15]]@beta[2],
      with.imp$analyses[[16]]@beta[2],
      with.imp$analyses[[17]]@beta[2],
      with.imp$analyses[[18]]@beta[2],
      with.imp$analyses[[19]]@beta[2],
      with.imp$analyses[[20]]@beta[2])

U <- c(with.imp$analyses[[1]]@vcov_beta[2,2],
      with.imp$analyses[[2]]@vcov_beta[2,2],
      with.imp$analyses[[3]]@vcov_beta[2,2],
      with.imp$analyses[[4]]@vcov_beta[2,2],
      with.imp$analyses[[5]]@vcov_beta[2,2],
      with.imp$analyses[[6]]@vcov_beta[2,2],
      with.imp$analyses[[7]]@vcov_beta[2,2],
      with.imp$analyses[[8]]@vcov_beta[2,2],
      with.imp$analyses[[9]]@vcov_beta[2,2],
      with.imp$analyses[[10]]@vcov_beta[2,2],
      with.imp$analyses[[11]]@vcov_beta[2,2],
      with.imp$analyses[[12]]@vcov_beta[2,2],
      with.imp$analyses[[13]]@vcov_beta[2,2],
      with.imp$analyses[[14]]@vcov_beta[2,2],
      with.imp$analyses[[15]]@vcov_beta[2,2],
      with.imp$analyses[[16]]@vcov_beta[2,2],
      with.imp$analyses[[17]]@vcov_beta[2,2],
      with.imp$analyses[[18]]@vcov_beta[2,2],
```

```
      with.imp$analyses[[19]]@vcov_beta[2,2],
      with.imp$analyses[[20]]@vcov_beta[2,2])

pool.imp <- pool.scalar(Q = Q, U = U, n = 14080)

imp.alloc.p.value <- pt(q = abs(pool.imp$qbar/pool.imp$t), df = pool.imp$df, lower.tail = FALSE)*2

# Second attempt with method 2l.norm
pred1 <- ini$pred

meth1 <- c("", "", "2l.norm", "norm", "", "logreg", "", "logreg", "norm")

pred1["Random_Unique_SchoolID", ] <- c(0, 0, 0, 0, 0, 0, 0, 0, 0)
pred1["Allocation", ] <- c(0, 0, 0, 0, 0, 0, 0, 0, 0)
pred1["Randomisation_block", ] <- c(0, 0, 0, 0, 0, 0, 0, 0, 0)
pred1["fsmprop", ] <- c(0, 0, 0, 0, 0, 0, 0, 0, 0)
pred1["primary_outcome", ] <- c(-2, 2, 0, 2, 2, 2, 2, 2, 2)

#pred1["secondary1_total_score", ] <- c(0, 0, 0, 0, 0, 0, 0, 0, 0)
#pred1[ ,"secondary1_total_score"] <- c(0, 0, 0, 0, 0, 0, 0, 0, 0)

imputed_data1 <- mice(prim.data_for.mi, meth=meth1, pred=pred1, m=20,maxit=25,print=FALSE, seed = 123)

with.imp1 <- with(imputed_data1, lmer(primary_outcome ~ 1 + Allocation + pretest + Randomisation_block +
(1|Random_Unique_SchoolID)))

#extract parameter estimates and variances for Allocation ONLY to enable pooling via Rubin rules
Q_1 <- c(with.imp1$analyses[[1]]@beta[2],
      with.imp1$analyses[[2]]@beta[2],
      with.imp1$analyses[[3]]@beta[2],
      with.imp1$analyses[[4]]@beta[2],
      with.imp1$analyses[[5]]@beta[2],
      with.imp1$analyses[[6]]@beta[2],
      with.imp1$analyses[[7]]@beta[2],
      with.imp1$analyses[[8]]@beta[2],
      with.imp1$analyses[[9]]@beta[2],
      with.imp1$analyses[[10]]@beta[2],
      with.imp1$analyses[[11]]@beta[2],
      with.imp1$analyses[[12]]@beta[2],
      with.imp1$analyses[[13]]@beta[2],
      with.imp1$analyses[[14]]@beta[2],
      with.imp1$analyses[[15]]@beta[2],
      with.imp1$analyses[[16]]@beta[2],
      with.imp1$analyses[[17]]@beta[2],
      with.imp1$analyses[[18]]@beta[2],
      with.imp1$analyses[[19]]@beta[2],
      with.imp1$analyses[[20]]@beta[2])

U_1 <- c(with.imp1$analyses[[1]]@vcov_beta[2,2],
      with.imp1$analyses[[2]]@vcov_beta[2,2],
      with.imp1$analyses[[3]]@vcov_beta[2,2],
      with.imp1$analyses[[4]]@vcov_beta[2,2],
      with.imp1$analyses[[5]]@vcov_beta[2,2],
      with.imp1$analyses[[6]]@vcov_beta[2,2],
      with.imp1$analyses[[7]]@vcov_beta[2,2],
      with.imp1$analyses[[8]]@vcov_beta[2,2],
      with.imp1$analyses[[9]]@vcov_beta[2,2],
```

```
      with.imp1$analyses[[10]]@vcov_beta[2,2],
      with.imp1$analyses[[11]]@vcov_beta[2,2],
      with.imp1$analyses[[12]]@vcov_beta[2,2],
      with.imp1$analyses[[13]]@vcov_beta[2,2],
      with.imp1$analyses[[14]]@vcov_beta[2,2],
      with.imp1$analyses[[15]]@vcov_beta[2,2],
      with.imp1$analyses[[16]]@vcov_beta[2,2],
      with.imp1$analyses[[17]]@vcov_beta[2,2],
      with.imp1$analyses[[18]]@vcov_beta[2,2],
      with.imp1$analyses[[19]]@vcov_beta[2,2],
      with.imp1$analyses[[20]]@vcov_beta[2,2])

pool.imp1 <- pool.scalar(Q = Q_1, U = U_1, n = 14080)

imp1.alloc.p.value <- pt(q = abs(pool.imp1$qbar/pool.imp1$t), df = pool.imp1$df, lower.tail = FALSE)*2



############################################################
############################################################
#
# Compliance analysis
#

#For continuous compliance indicator
primary_data$Continuouscomplianceindicator[primary_data$Allocation == 0] <- 0

ivmodel_cts <- felm(primary_outcome ~  pretest + Randomisation_block | 0 |
(Continuouscomplianceindicator~Allocation) | Random_Unique_SchoolID , data = primary_data)

#effect size & confidence interval

comply_cts_treatdiff <- ivmodel_cts$coefficients[26]
comply_cts_se <- ivmodel_cts$cse[26]
comply_cts_treatdiff_upperci <- comply_cts_treatdiff +1.96*comply_cts_se
comply_cts_treatdiff_lowerci <- comply_cts_treatdiff - 1.96*comply_cts_se

comply_cts_controln <- nrow(subset(primary_data, is.na(Continuouscomplianceindicator)==FALSE & Allocation == 0))
comply_cts_treatn <- nrow(subset(primary_data, is.na(Continuouscomplianceindicator)==FALSE & Allocation == 1))
comply_cts_n <- nrow(subset(primary_data, is.na(Continuouscomplianceindicator)==FALSE))

comply_cts_sd_treat <-
sd(primary_data$primary_outcome[is.na(primary_data$Continuouscomplianceindicator)==FALSE &
primary_data$Allocation == 1])
comply_cts_sd_control <-
sd(primary_data$primary_outcome[is.na(primary_data$Continuouscomplianceindicator)==FALSE &
primary_data$Allocation == 0])

comply_cts_sdpooled <- sqrt(((comply_cts_controln - 1)*(comply_cts_sd_control^2) + (comply_cts_treatn -
1)*(comply_cts_sd_treat^2))/
                      (comply_cts_controln + comply_cts_treatn - 2))

comply_cts_es <- comply_cts_treatdiff/comply_cts_sdpooled
comply_cts_es_upperCI <- comply_cts_treatdiff_upperci/comply_cts_sdpooled
comply_cts_es_lowerCI <- comply_cts_treatdiff_lowerci/comply_cts_sdpooled

#correlation between continuous compliance indicator and treatment
```

```
primary_data$Allocation <- as.numeric(primary_data$Allocation)

cts_comply_cor <- cor(primary_data$Allocation, primary_data$Continuouscomplianceindicator)

#For dichotomous compliance indicator
primary_data$Dichotomouscomplianceindicator[primary_data$Allocation == 0] <- 0
primary_data$Dichotomouscomplianceindicator <- as.factor(primary_data$Dichotomouscomplianceindicator)

ivmodel_dic <- felm(primary_outcome ~  pretest + Randomisation_block | 0 | (Dichotomouscomplianceindicator ~
Allocation) | Random_Unique_SchoolID , data = primary_data)

#effect size & confidence interval

comply_dic_treatdiff <- ivmodel_dic$coefficients[26]
comply_dic_se <- ivmodel_dic$cse[26]
comply_dic_treatdiff_upperci <- comply_dic_treatdiff +1.96*comply_dic_se
comply_dic_treatdiff_lowerci <- comply_dic_treatdiff - 1.96*comply_dic_se

comply_dic_controln <- nrow(subset(primary_data, is.na(Dichotomouscomplianceindicator)==FALSE & Allocation ==
0))
comply_dic_treatn <- nrow(subset(primary_data, is.na(Dichotomouscomplianceindicator)==FALSE & Allocation == 1))
comply_dic_n <- nrow(subset(primary_data, is.na(Dichotomouscomplianceindicator)==FALSE))

comply_dic_sd_treat <-
sd(primary_data$primary_outcome[is.na(primary_data$Dichotomouscomplianceindicator)==FALSE &
primary_data$Allocation == 1])
comply_dic_sd_control <-
sd(primary_data$primary_outcome[is.na(primary_data$Dichotomouscomplianceindicator)==FALSE &
primary_data$Allocation == 0])

comply_dic_sdpooled <- sqrt(((comply_dic_controln - 1)*(comply_dic_sd_control^2) + (comply_dic_treatn -
1)*(comply_dic_sd_treat^2))/
                        (comply_dic_controln + comply_dic_treatn - 2))

comply_dic_es <- comply_dic_treatdiff/comply_dic_sdpooled
comply_dic_es_upperCI <- comply_dic_treatdiff_upperci/comply_dic_sdpooled
comply_dic_es_lowerCI <- comply_dic_treatdiff_lowerci/comply_dic_sdpooled

#correlation between dichotomous compliance indicator and treatment
primary_data$Allocation <- as.numeric(primary_data$Allocation)
primary_data$Dichotomouscomplianceindicator <- as.numeric(primary_data$Dichotomouscomplianceindicator)

dich_comply_cor <- cor(primary_data$Allocation, primary_data$Dichotomouscomplianceindicator)




############################################################
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#
# Outcomes for primary and secondary analyses
#

#pre-post test correlation
#primary analysis
```

```
overall.pretest.corr_primary <- cor(primary_data$primary_outcome, primary_data$pretest) #overall pre/posttest
correlation

#calculate between R-sq to obtain school-level pretest/posttest correlation
school_means_primary <- primary_data %>% group_by(Random_Unique_SchoolID)%>%
summarise(mean_primary_outcome  = mean(primary_outcome, na.rm=TRUE),
                                                mean_pretest = mean(pretest, na.rm=TRUE))

SL.pretest.corr_primary <- cor(school_means_primary$mean_pretest,
school_means_primary$mean_primary_outcome)

#calculate within R-sq to obtain pupil-level pretest/posttest correlation
primary_data <- primary_data %>% group_by(Random_Unique_SchoolID) %>% mutate(SLmean_primary_outcome =
mean(primary_outcome, na.rm=TRUE),
                                                        SLmean_pretest = mean(pretest, na.rm=TRUE))

primary_data$adj_pretest <- primary_data$pretest - primary_data$SLmean_pretest
primary_data$adj_primary_outcome <- primary_data$primary_outcome - primary_data$SLmean_primary_outcome

PL.pretest.corr_primary <- cor(primary_data$adj_pretest, primary_data$adj_primary_outcome)

#plm_w_summary <- summary(plm(primary_outcome ~ pretest , index = c("Random_Unique_SchoolID"), model =
"within",data = primary_data))
#plm_b_summary <- summary(plm(primary_outcome ~ pretest , index = c("Random_Unique_SchoolID"), model =
"between",data = primary_data))

#fsm
overall.pretest.corr_fsm <- cor(fsm_primary_data$primary_outcome, fsm_primary_data$pretest) #overall fsm
pre/posttest correlation

#calculate between R-sq to obtain school-level pretest/posttest correlation
school_means_fsm <- fsm_primary_data %>% group_by(Random_Unique_SchoolID)%>%
summarise(mean_primary_outcome  = mean(primary_outcome, na.rm=TRUE),
                                                                mean_pretest = mean(pretest, na.rm=TRUE))

SL.pretest.corr_fsm <- cor(school_means_fsm$mean_pretest, school_means_fsm$mean_primary_outcome)

#calculate within R-sq to obtain pupil-level pretest/posttest correlation
fsm_primary_data <- fsm_primary_data %>% group_by(Random_Unique_SchoolID) %>%
mutate(SLmean_primary_outcome  = mean(primary_outcome, na.rm=TRUE),
                                                        SLmean_pretest = mean(pretest, na.rm=TRUE))

fsm_primary_data$adj_pretest <- fsm_primary_data$pretest - fsm_primary_data$SLmean_pretest
fsm_primary_data$adj_primary_outcome <- fsm_primary_data$primary_outcome -
fsm_primary_data$SLmean_primary_outcome

PL.pretest.corr_fsm <- cor(fsm_primary_data$adj_pretest, fsm_primary_data$adj_primary_outcome)

#fsm_plm_w_summary <- summary(plm(primary_outcome ~ pretest , index = c("Random_Unique_SchoolID"), model
= "within",data = fsm_primary_data))
#fsm_plm_b_summary <- summary(plm(primary_outcome ~ pretest , index = c("Random_Unique_SchoolID"), model =
"between",data = fsm_primary_data))

# ICC
m.1.stan.icc <- as.data.frame(m.1.stan.empty)
m.1.stan.icc <- rename(m.1.stan.icc, Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]")
m.1.stan.icc <- mutate(m.1.stan.icc, icc = (Sigma)/(sigma^2 + Sigma))
```

```
icc.primary <- median(m.1.stan.icc$icc)
icc.ci.primary <- hdi(m.1.stan.icc$icc)

m.2.stan.icc <- as.data.frame(m.2.stan.empty)
m.2.stan.icc <- rename(m.2.stan.icc, Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]")
m.2.stan.icc <- mutate(m.2.stan.icc, icc = (Sigma)/(sigma^2 + Sigma))
icc.secondary <- median(m.2.stan.icc$icc)
icc.ci.secondary <- hdi(m.2.stan.icc$icc)

m.3.stan.icc <- as.data.frame(m.3.stan.empty)
m.3.stan.icc <- rename(m.3.stan.icc, Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]")
m.3.stan.icc <- mutate(m.3.stan.icc, icc = (Sigma)/(sigma^2 + Sigma))
icc.AO1 <- median(m.3.stan.icc$icc)
icc.ci.AO1 <- hdi(m.3.stan.icc$icc)

m.4.stan.icc <- as.data.frame(m.4.stan.empty)
m.4.stan.icc <- rename(m.4.stan.icc, Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]")
m.4.stan.icc <- mutate(m.4.stan.icc, icc = (Sigma)/(sigma^2 + Sigma))
icc.AO2 <- median(m.4.stan.icc$icc)
icc.ci.AO2 <- hdi(m.4.stan.icc$icc)

m.5.stan.icc <- as.data.frame(m.5.stan.empty)
m.5.stan.icc <- rename(m.5.stan.icc, Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]")
m.5.stan.icc <- mutate(m.5.stan.icc, icc = (Sigma)/(sigma^2 + Sigma))
icc.AO3 <- median(m.5.stan.icc$icc)
icc.ci.AO3 <- hdi(m.5.stan.icc$icc)

m.6.stan.icc <- as.data.frame(m.6.stan.empty)
m.6.stan.icc <- rename(m.6.stan.icc, Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]")
m.6.stan.icc <- mutate(m.6.stan.icc, icc = (Sigma)/(sigma^2 + Sigma))
icc.fsm <- median(m.6.stan.icc$icc)
icc.ci.fsm <- hdi(m.6.stan.icc$icc)

#Unadjust means for primary outcome
m.1.stan.unadj.post <- as.data.frame(m.1.stan.unadj)
m.1.stan.unadj.post <- rename(m.1.stan.unadj.post, Intercept = "(Intercept)")
m.1.stan.unadj.post <- mutate(m.1.stan.unadj.post, treat_mean = Intercept + Allocation1)

control.1.unadj_mean <- median(m.1.stan.unadj.post$Intercept)
control.1.unadj_meanCI <- hdi(m.1.stan.unadj.post$Intercept)
treat.1.unadj_mean <- median(m.1.stan.unadj.post$treat_mean)
treat.1.unadj_meanCI <- hdi(m.1.stan.unadj.post$treat_mean)

#Effect size for primary outcome
m.1.stan.full.post <- as.data.frame(m.1.stan.full)
m.1.stan.full.post <- rename(m.1.stan.full.post, Intercept = "(Intercept)",
                             Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]")
m.1.stan.full.post <- mutate(m.1.stan.full.post, effect_size = Allocation1/(sigma^2 + Sigma)^0.5)

effect.size_primary <- median(m.1.stan.full.post$effect_size)
effect.size.CI_primary <- hdi(m.1.stan.full.post$effect_size)
effect.size.rope_primary <- rope(m.1.stan.full.post$effect_size)

#Unadjust means for secondary analysis GCSE score
m.2.stan.unadj.post <- as.data.frame(m.2.stan.unadj)
m.2.stan.unadj.post <- rename(m.2.stan.unadj.post, Intercept = "(Intercept)")
m.2.stan.unadj.post <- mutate(m.2.stan.unadj.post, treat_mean = Intercept + Allocation1)
```

```
control.2.unadj_mean <- median(m.2.stan.unadj.post$Intercept)
control.2.unadj_meanCI <- hdi(m.2.stan.unadj.post$Intercept)
treat.2.unadj_mean  <- median(m.2.stan.unadj.post$treat_mean)
treat.2.unadj_meanCI  <- hdi(m.2.stan.unadj.post$treat_mean)

#Effect size for secondary analysis GCSE score
m.2.stan.full.post <- as.data.frame(m.2.stan.full)
m.2.stan.full.post <- rename(m.2.stan.full.post, Intercept = "(Intercept)",
                             Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]")
m.2.stan.full.post <- mutate(m.2.stan.full.post, effect_size = Allocation1/(sigma^2 + Sigma)^0.5)

effect.size_secondary <- median(m.2.stan.full.post$effect_size)
effect.size.CI_secondary <- hdi(m.2.stan.full.post$effect_size)
effect.size.rope_secondary <- rope(m.2.stan.full.post$effect_size)

#Unadjust means for AO1 score
m.3.stan.unadj.post <- as.data.frame(m.3.stan.unadj)
m.3.stan.unadj.post <- rename(m.3.stan.unadj.post, Intercept = "(Intercept)")
m.3.stan.unadj.post <- mutate(m.3.stan.unadj.post, treat_mean = Intercept + Allocation1)

control.3.unadj_mean <- median(m.3.stan.unadj.post$Intercept)
control.3.unadj_meanCI <- hdi(m.3.stan.unadj.post$Intercept)
treat.3.unadj_mean  <- median(m.3.stan.unadj.post$treat_mean)
treat.3.unadj_meanCI  <- hdi(m.3.stan.unadj.post$treat_mean)

#Effect size for AO1 score
m.3.stan.full.post <- as.data.frame(m.3.stan.full)
m.3.stan.full.post <- rename(m.3.stan.full.post, Intercept = "(Intercept)",
                             Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]")
m.3.stan.full.post <- mutate(m.3.stan.full.post, effect_size = Allocation1/(sigma^2 + Sigma)^0.5)

effect.size_AO1 <- median(m.3.stan.full.post$effect_size)
effect.size.CI_AO1 <- hdi(m.3.stan.full.post$effect_size)
effect.size.rope_AO1 <- rope(m.3.stan.full.post$effect_size)

#Unadjust means for AO2 score
m.4.stan.unadj.post <- as.data.frame(m.4.stan.unadj)
m.4.stan.unadj.post <- rename(m.4.stan.unadj.post, Intercept = "(Intercept)")
m.4.stan.unadj.post <- mutate(m.4.stan.unadj.post, treat_mean = Intercept + Allocation1)

control.4.unadj_mean <- median(m.4.stan.unadj.post$Intercept)
control.4.unadj_meanCI <- hdi(m.4.stan.unadj.post$Intercept)
treat.4.unadj_mean  <- median(m.4.stan.unadj.post$treat_mean)
treat.4.unadj_meanCI  <- hdi(m.4.stan.unadj.post$treat_mean)

#Effect size for AO2 score
m.4.stan.full.post <- as.data.frame(m.4.stan.full)
m.4.stan.full.post <- rename(m.4.stan.full.post, Intercept = "(Intercept)",
                             Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]")
m.4.stan.full.post <- mutate(m.4.stan.full.post, effect_size = Allocation1/(sigma^2 + Sigma)^0.5)

effect.size_AO2 <- median(m.4.stan.full.post$effect_size)
effect.size.CI_AO2 <- hdi(m.4.stan.full.post$effect_size)
effect.size.rope_AO2 <- rope(m.4.stan.full.post$effect_size)

#Unadjust means for AO3 score
```

```
m.5.stan.unadj.post <- as.data.frame(m.5.stan.unadj)
m.5.stan.unadj.post <- rename(m.5.stan.unadj.post, Intercept = "(Intercept)")
m.5.stan.unadj.post <- mutate(m.5.stan.unadj.post, treat_mean = Intercept + Allocation1)

control.5.unadj_mean <- median(m.5.stan.unadj.post$Intercept)
control.5.unadj_meanCI <- hdi(m.5.stan.unadj.post$Intercept)
treat.5.unadj_mean  <- median(m.5.stan.unadj.post$treat_mean)
treat.5.unadj_meanCI  <- hdi(m.5.stan.unadj.post$treat_mean)

#Effect size for AO3 score
m.5.stan.full.post <- as.data.frame(m.5.stan.full)
m.5.stan.full.post <- rename(m.5.stan.full.post, Intercept = "(Intercept)",
                             Sigma = "Sigma[Random_Unique_SchoolID:(Intercept),(Intercept)]")
m.5.stan.full.post <- mutate(m.5.stan.full.post, effect_size = Allocation1/(sigma^2 + Sigma)^0.5)

effect.size_AO3 <- median(m.5.stan.full.post$effect_size)
effect.size.CI_AO3 <- hdi(m.5.stan.full.post$effect_size)
effect.size.rope_AO3 <- rope(m.5.stan.full.post$effect_size)









############################################################
############################################################
#
# Outputting tables
#

attrition_table <- data.frame(matrix(ncol = 4, nrow = 4))

colnames(attrition_table) <- c("", "Intervention" , "Control" , "Total")

attrition_table[1,] <- c("No. of pupils, Randomised", ntreat_randomised, ncontrol_randomised, ntotal_randomised)
attrition_table[2,] <- c("No. of pupils, Analysed" , ntreat_primary, ncontrol_primary, ntotal_primary)
attrition_table[3,] <- c("Pupil attrition, Number", ntreat_primary_miss, ncontrol_primary_miss, ntotal_primary_miss)
attrition_table[4,] <- c("Pupil attrition, %", treat.pc.attrition_primary, cont.pc.attrition_primary, total.pc.attrition_primary)

model_outcomes <- data.frame(matrix(ncol = 16, nrow = 5))
colnames(model_outcomes) <- c("Outcome", "n_Int", "n_Int_miss","Unadj_mean_Int",  "Unadj_mean_Int_95%lowCI",
"Unadj_mean_Int_95%highCI",
                              "n_Cont", "n_Cont_miss","Unadj_mean_Cont", "Unadj_mean_Cont_95%lowCI",
"Unadj_mean_Cont_95%highCI",
                             "n_total", "Cohen's D", "Cohen's D 95%lowCI", "Cohen's D 95%highCI", "ROPE %")

model_outcomes[1,] <- c("Primary", ntreat_primary, ntreat_primary_miss,
                                treat.1.unadj_mean, treat.1.unadj_meanCI$CI_low, treat.1.unadj_meanCI$CI_high,
                                  ncontrol_primary, ncontrol_primary_miss,
                                  control.1.unadj_mean, control.1.unadj_meanCI$CI_low, control.1.unadj_meanCI$CI_high,
                                  ntotal_primary, effect.size_primary, effect.size.CI_primary$CI_low,
effect.size.CI_primary$CI_high,
                                    effect.size.rope_primary$ROPE_Percentage)

model_outcomes[2,] <- c("Secondary GCSE", ntreat_secondary, ntreat_secondary_miss,
                        treat.2.unadj_mean, treat.2.unadj_meanCI$CI_low, treat.2.unadj_meanCI$CI_high,
```

```
                ncontrol_secondary, ncontrol_secondary_miss,
                control.2.unadj_mean, control.2.unadj_meanCI$CI_low, control.2.unadj_meanCI$CI_high,
                ntotal_secondary, effect.size_secondary, effect.size.CI_secondary$CI_low,
effect.size.CI_secondary$CI_high,
                effect.size.rope_secondary$ROPE_Percentage)

model_outcomes[3,] <- c("Secondary AO1 score", ntreat_AO1, ntreat_AO1_miss,
                treat.3.unadj_mean, treat.3.unadj_meanCI$CI_low, treat.3.unadj_meanCI$CI_high,
                ncontrol_AO1, ncontrol_AO1_miss,
                control.3.unadj_mean, control.3.unadj_meanCI$CI_low, control.3.unadj_meanCI$CI_high,
                ntotal_AO1, effect.size_AO1, effect.size.CI_AO1$CI_low, effect.size.CI_AO1$CI_high,
                effect.size.rope_AO1$ROPE_Percentage)

model_outcomes[4,] <- c("Secondary AO2 score", ntreat_AO2, ntreat_AO2_miss,
                treat.4.unadj_mean, treat.4.unadj_meanCI$CI_low, treat.4.unadj_meanCI$CI_high,
                ncontrol_AO2, ncontrol_AO2_miss,
                control.4.unadj_mean, control.4.unadj_meanCI$CI_low, control.4.unadj_meanCI$CI_high,
                ntotal_AO2, effect.size_AO2, effect.size.CI_AO2$CI_low, effect.size.CI_AO2$CI_high,
                effect.size.rope_AO2$ROPE_Percentage)

model_outcomes[5,] <- c("Secondary AO3 score", ntreat_AO3, ntreat_AO3_miss,
                treat.5.unadj_mean, treat.5.unadj_meanCI$CI_low, treat.5.unadj_meanCI$CI_high,
                ncontrol_AO3, ncontrol_AO3_miss,
                control.5.unadj_mean, control.5.unadj_meanCI$CI_low, control.5.unadj_meanCI$CI_high,
                ntotal_AO3, effect.size_AO3, effect.size.CI_AO3$CI_low, effect.size.CI_AO3$CI_high,
                effect.size.rope_AO3$ROPE_Percentage)

pupil_randomised_base_char_table <- data.frame(matrix(ncol =11, nrow = 9))

pupil_randomised_base_char_table[1,] <- c("Pupil-level (categorical)", "National-level mean","Int  n", " ", "Int count", "Int
%",
                                                                "Cont n", " ", "Cont count", "Cont %", " ")

pupil_randomised_base_char_table[2,] <- c("FSM", " ", ntreat_randomised , " ", fsm_table_randomised[2,2],
fsm_prop.table_randomised[2,2],
                                        ncontrol_randomised , " ", fsm_table_randomised[2,1],
fsm_prop.table_randomised[2,1], " " )

pupil_randomised_base_char_table[3,] <- c("Non FSM", " ", ntreat_randomised , " ", fsm_table_randomised[1,2],
fsm_prop.table_randomised[1,2],
                                ncontrol_randomised , " ", fsm_table_randomised[1,1], fsm_prop.table_randomised[1,1], " "
)

pupil_randomised_base_char_table[4,] <- c("Missing FSM", " ", ntreat_randomised , " ", fsm_table_randomised[3,2],
fsm_prop.table_randomised[3,2],
                                ncontrol_randomised , " ", fsm_table_randomised[3,1], fsm_prop.table_randomised[3,1], " "
)

pupil_randomised_base_char_table[5,] <- c("Sex, female", " ", ntreat_randomised , " ", sex_table_randomised[2,2],
sex_prop.table_randomised[2,2],
                                 ncontrol_randomised , " ", sex_table_randomised[2,1], sex_prop.table_randomised[2,1], " "
)

pupil_randomised_base_char_table[6,] <- c("Sex, male", " ", ntreat_randomised , " ", sex_table_randomised[1,2],
sex_prop.table_randomised[1,2],
                                 ncontrol_randomised , " ", sex_table_randomised[1,1], sex_prop.table_randomised[1,1], " "
)
```

```
pupil_randomised_base_char_table[7,] <- c("Missing sex", " ", ntreat_randomised , " ", sex_table_randomised[3,2],
sex_prop.table_randomised[3,2],
                                ncontrol_randomised , " ", sex_table_randomised[3,1], sex_prop.table_randomised[3,1], " " )

pupil_randomised_base_char_table[8,] <- c("Pupil-level (continuous)", "National-level mean","Int n", "Int miss", "Int
mean", "Int SD",
                                "Cont n", "Cont miss", "Cont mean", "Cont SD", "Standardised difference")

pupil_randomised_base_char_table[9,] <- c("KS2 average score", " ",ntreat_randomised,
pretest_table_randomised[2,3], pretest_table_randomised[2,4], pretest_table_randomised[2,5],
                                ncontrol_randomised, pretest_table_randomised[1,3], pretest_table_randomised[1,4],
pretest_table_randomised[1,5] , pretest_es_randomised)

school_randomised_base_char_table <- data.frame(matrix(ncol = 11, nrow = 4))

school_randomised_base_char_table[1,] <- c("School-level (continuous)", "National-level mean", "Int n", "Int miss", "Int
mean", "Int SD",
                                 "Cont n", "Cont miss", "Cont mean", "Cont SD", "Standardised difference")

school_randomised_base_char_table[2,] <- c("Average KS2 score", " ", sch_cts_descrip$n[2],
sch_cts_descrip$pre_miss[2], sch_cts_descrip$pre_mean[2], sch_cts_descrip$pre_sd[2],
                                 sch_cts_descrip$n[1], sch_cts_descrip$pre_miss[1], sch_cts_descrip$pre_mean[1],
sch_cts_descrip$pre_sd[1], pre_es_sch_ran)

school_randomised_base_char_table[3,] <- c("FSM proportion", " ", sch_cts_descrip$n[2],
sch_cts_descrip$fsm_miss[2], sch_cts_descrip$fsm_mean[2], sch_cts_descrip$fsm_sd[2],
                                 sch_cts_descrip$n[1], sch_cts_descrip$fsm_miss[1], sch_cts_descrip$fsm_mean[1],
sch_cts_descrip$fsm_sd[1], fsm_es_sch_ran)

school_randomised_base_char_table[4,] <- c("Cluster size", " ", sch_cts_descrip$n[2], sch_cts_descrip$size_miss[2],
sch_cts_descrip$size_mean[2], sch_cts_descrip$size_sd[2],
                                 sch_cts_descrip$n[1], sch_cts_descrip$size_miss[1], sch_cts_descrip$size_mean[1],
sch_cts_descrip$size_sd[1], size_es_sch_ran)

pupil_analysed_base_char_table <- data.frame(matrix(ncol =11, nrow = 9))

pupil_analysed_base_char_table[1,] <- c("Pupil-level (categorical)", "National-level mean","Int n", " ", "Int count", "Int
%",
                                "Cont n", " ", "Cont count", "Cont %", " ")

pupil_analysed_base_char_table[2,] <- c("FSM", " ", ntreat_primary , " ", fsm_table_primary[2,2],
fsm_prop.table_primary[2,2],
                                ncontrol_primary , " ", fsm_table_primary[2,1], fsm_prop.table_primary[2,1], " " )

pupil_analysed_base_char_table[3,] <- c("Non FSM", " ", ntreat_primary , " ", fsm_table_primary[1,2],
fsm_prop.table_primary[1,2],
                                ncontrol_primary , " ", fsm_table_primary[1,1], fsm_prop.table_primary[1,1], " "  )

pupil_analysed_base_char_table[4,] <- c("Missing FSM", " ", ntreat_primary , " ", fsm_table_primary[3,2],
fsm_prop.table_primary[3,2],
                                ncontrol_primary , " ", fsm_table_primary[3,1], fsm_prop.table_primary[3,1], " "  )

pupil_analysed_base_char_table[5,] <- c("Sex, female", " ", ntreat_primary , " ", sex_table_primary[2,2],
sex_prop.table_primary[2,2],
                                ncontrol_primary , " ", sex_table_primary[2,1], sex_prop.table_primary[2,1], " "  )
```

```
pupil_analysed_base_char_table[6,] <- c("Sex, male", " ", ntreat_primary , " ", sex_table_primary[1,2],
sex_prop.table_primary[1,2],
                                        ncontrol_primary , " ", sex_table_primary[1,1], sex_prop.table_primary[1,1], " "  )

pupil_analysed_base_char_table[7,] <- c("Missing sex", " ", ntreat_primary , " ", sex_table_primary[3,2],
sex_prop.table_primary[3,2],
                                        ncontrol_primary , " ", sex_table_primary[3,1], sex_prop.table_primary[3,1], " " )

pupil_analysed_base_char_table[8,] <- c("Pupil-level (continuous)", "National-level mean","Int n", "Int miss", "Int
mean", "Int SD",
                                        "Cont n", "Cont miss", "Cont mean", "Cont SD", "Standardised difference")

pupil_analysed_base_char_table[9,] <- c("KS2 average score", " ",ntreat_primary, pretest_table_analysed[2,3],
pretest_table_analysed[2,4], pretest_table_analysed[2,5],
                                        ncontrol_primary, pretest_table_analysed[1,3], pretest_table_analysed[1,4],
pretest_table_analysed[1,5] , pretest_es_analysed)

school_analysed_base_char_table <- data.frame(matrix(ncol = 11, nrow = 4))

school_analysed_base_char_table[1,] <- c("School-level (continuous)", "National-level mean", "Int n", "Int miss", "Int
mean", "Int SD",
                                         "Cont n", "Cont miss", "Cont mean", "Cont SD", "Standardised difference")

school_analysed_base_char_table[2,] <- c("Average KS2 score", " ", sch_cts_descrip_anal$n[2],
sch_cts_descrip_anal$pre_miss[2], sch_cts_descrip_anal$pre_mean[2], sch_cts_descrip_anal$pre_sd[2],
                                         sch_cts_descrip_anal$n[1], sch_cts_descrip_anal$pre_miss[1],
sch_cts_descrip_anal$pre_mean[1], sch_cts_descrip_anal$pre_sd[1], pre_es_sch_anal)

school_analysed_base_char_table[3,] <- c("FSM proportion", " ", sch_cts_descrip_anal$n[2],
sch_cts_descrip_anal$fsm_miss[2], sch_cts_descrip_anal$fsm_mean[2], sch_cts_descrip_anal$fsm_sd[2],
                                         sch_cts_descrip_anal$n[1], sch_cts_descrip_anal$fsm_miss[1],
sch_cts_descrip_anal$fsm_mean[1], sch_cts_descrip_anal$fsm_sd[1], fsm_es_sch_anal)

school_analysed_base_char_table[4,] <- c("Cluster size", " ", sch_cts_descrip_anal$n[2],
sch_cts_descrip_anal$size_miss[2], sch_cts_descrip_anal$size_mean[2], sch_cts_descrip_anal$size_sd[2],
                                         sch_cts_descrip_anal$n[1], sch_cts_descrip_anal$size_miss[1],
sch_cts_descrip_anal$size_mean[1], sch_cts_descrip_anal$size_sd[1], size_es_sch_anal)

mdes_table_analysed <- data.frame(matrix(ncol = 3, nrow = 14))

mdes_table_analysed[1,] <- c( "As analysed", "Overall", "FSM")

mdes_table_analysed[2,] <- c( "pre-post corr, L1 pupil", PL.pretest.corr_primary , PL.pretest.corr_fsm)

mdes_table_analysed[3,] <- c( "pre-post corr, L3 school", SL.pretest.corr_primary , SL.pretest.corr_fsm)

mdes_table_analysed[4,] <- c( "ICC, L3 school", icc.primary , icc.fsm)

mdes_table_analysed[5,] <- c("Alpha" , 0.05, 0.05)
mdes_table_analysed[6,] <- c("Power", 0.8, 0.8)
mdes_table_analysed[7,] <- c("One-sided or two-sided?", "Two-sided", "Two-sided")

mdes_table_analysed[8,] <- c("Average cluster size",  mean(school_level_analysed$school_size),
mean(fsm_school_level_analysed$n))

mdes_table_analysed[9,] <- c("Number of schools, Intervention ", nrow(subset(school_level_analysed, Allocation ==
1)) , nrow(subset(fsm_school_level_analysed, cat == 1)))
```

```
mdes_table_analysed[10,] <- c("Number of schools, Control", nrow(subset(school_level_analysed, Allocation == 0)) , nrow(subset(fsm_school_level_analysed, cat == 0)))

mdes_table_analysed[11,] <- c("Number of schools, Total", nrow(school_level_analysed) , nrow(fsm_school_level_analysed))

mdes_table_analysed[12,] <- c("Number of pupils, Intervention", ntreat_primary, ntreat_fsm)

mdes_table_analysed[13,] <- c("Number of pupils, Control", ncontrol_primary, ncontrol_fsm)

mdes_table_analysed[14,] <- c("Number of pupils, Total", nrow(primary_data) , nrow(fsm_primary_data))

full_sample_summary_stats_table <- data.frame(matrix(ncol = 5, nrow = 6))

full_sample_summary_stats_table[1,] <- c("Outcome", "Mean" , "SD" , "ICC" , "n")
full_sample_summary_stats_table[2,] <- c("Primary outcome" , mean(primary_data$primary_outcome), sd(primary_data$primary_outcome), icc.primary, nrow(primary_data))
full_sample_summary_stats_table[3,] <- c("Secondary outcome" , mean(secondary_dataGCSE$secondary1_total_score), sd(secondary_dataGCSE$secondary1_total_score), icc.secondary, nrow(secondary_dataGCSE))
full_sample_summary_stats_table[4,] <- c("AO1 score" , mean(secondary_dataAO1$total_AO1_score), sd(secondary_dataAO1$total_AO1_score), icc.AO1, nrow(secondary_dataAO1))
full_sample_summary_stats_table[5,] <- c("AO2 score" , mean(secondary_dataAO2$total_AO2_score), sd(secondary_dataAO2$total_AO2_score), icc.AO2, nrow(secondary_dataAO2))
full_sample_summary_stats_table[6,] <- c("AO3 score" , mean(secondary_dataAO3$total_AO3_score), sd(secondary_dataAO3$total_AO3_score), icc.AO3, nrow(secondary_dataAO3))

fsm_subgroup_table <- data.frame(matrix(ncol = 7, nrow = 6))

fsm_subgroup_table[1,] <- c( "FSM", "Outcome", "n_total", "Cohen's D for interaction", "Cohen's D 95%lowCI", "Cohen's D 95%highCI", "ROPE %" )
fsm_subgroup_table[2,] <- c( "", "Primary outcome", nrow(subset(primary_data, is.na(everfsm_6_p_spr19)==FALSE)) , fsm.effect.size_primary, fsm.effect.size.CI_primary$CI_low, fsm.effect.size.CI_primary$CI_high, fsm.effect.size.rope_primary$ROPE_Percentage )
fsm_subgroup_table[3,] <- c( "", "Secondary outcome", nrow(subset(secondary_dataGCSE, is.na(everfsm_6_p_spr19)==FALSE)) , fsm.effect.size_secondary, fsm.effect.size.CI_secondary$CI_low, fsm.effect.size.CI_secondary$CI_high, fsm.effect.size.rope_secondary$ROPE_Percentage )
fsm_subgroup_table[4,] <- c( "", "AO1 score", nrow(subset(secondary_dataAO1, is.na(everfsm_6_p_spr19)==FALSE)) , fsm.effect.size_AO1, fsm.effect.size.CI_AO1$CI_low, fsm.effect.size.CI_AO1$CI_high, fsm.effect.size.rope_AO1$ROPE_Percentage )
fsm_subgroup_table[5,] <- c( "", "AO2 score", nrow(subset(secondary_dataAO2, is.na(everfsm_6_p_spr19)==FALSE)) , fsm.effect.size_AO2, fsm.effect.size.CI_AO2$CI_low, fsm.effect.size.CI_AO2$CI_high, fsm.effect.size.rope_AO2$ROPE_Percentage )
fsm_subgroup_table[6,] <- c( "", "AO3 score", nrow(subset(secondary_dataAO3, is.na(everfsm_6_p_spr19)==FALSE)) , fsm.effect.size_AO3, fsm.effect.size.CI_AO3$CI_low, fsm.effect.size.CI_AO3$CI_high, fsm.effect.size.rope_AO3$ROPE_Percentage )

sex_subgroup_table <- data.frame(matrix(ncol = 7, nrow = 6))

sex_subgroup_table[1,] <- c( "sex", "Outcome", "n_total", "Cohen's D for interaction", "Cohen's D 95%lowCI", "Cohen's D 95%highCI", "ROPE %" )
sex_subgroup_table[2,] <- c( "", "Primary outcome", nrow(subset(primary_data, is.na(ks4_gender)==FALSE)) , sex.effect.size_primary, sex.effect.size.CI_primary$CI_low, sex.effect.size.CI_primary$CI_high, sex.effect.size.rope_primary$ROPE_Percentage )
```

```
sex_subgroup_table[3,] <- c( "", "Secondary outcome", nrow(subset(secondary_dataGCSE,
is.na(ks4_gender)==FALSE)) , sex.effect.size_secondary, sex.effect.size.CI_secondary$CI_low,
sex.effect.size.CI_secondary$CI_high, sex.effect.size.rope_secondary$ROPE_Percentage )
sex_subgroup_table[4,] <- c( "", "AO1 score", nrow(subset(secondary_dataAO1, is.na(ks4_gender)==FALSE)) ,
sex.effect.size_AO1, sex.effect.size.CI_AO1$CI_low, sex.effect.size.CI_AO1$CI_high,
sex.effect.size.rope_AO1$ROPE_Percentage )
sex_subgroup_table[5,] <- c( "", "AO2 score", nrow(subset(secondary_dataAO2, is.na(ks4_gender)==FALSE)) ,
sex.effect.size_AO2, sex.effect.size.CI_AO2$CI_low, sex.effect.size.CI_AO2$CI_high,
sex.effect.size.rope_AO2$ROPE_Percentage )
sex_subgroup_table[6,] <- c( "", "AO3 score", nrow(subset(secondary_dataAO3, is.na(ks4_gender)==FALSE)) ,
sex.effect.size_AO3, sex.effect.size.CI_AO3$CI_low, sex.effect.size.CI_AO3$CI_high,
sex.effect.size.rope_AO3$ROPE_Percentage )

prior_attainment_subgroup_table <- data.frame(matrix(ncol = 7, nrow = 11))

prior_attainment_subgroup_table[1,] <- c( "Prior attainment", "Outcome", "n_total", "Cohen's D for interaction",
"Cohen's D 95%lowCI", "Cohen's D 95%highCI", "ROPE %" )
prior_attainment_subgroup_table[2,] <- c( "", "Primary outcome, tertile2", nrow(subset(primary_data,
is.na(pretest_tertile)==FALSE)), pa.effect.size1_primary, pa.effect.size1.CI_primary$CI_low,
pa.effect.size1.CI_primary$CI_high, pa.effect.size1.rope_primary$ROPE_Percentage )
prior_attainment_subgroup_table[3,] <- c( "", "Primary outcome, tertile3", nrow(subset(primary_data,
is.na(pretest_tertile)==FALSE)), pa.effect.size2_primary, pa.effect.size2.CI_primary$CI_low,
pa.effect.size2.CI_primary$CI_high, pa.effect.size2.rope_primary$ROPE_Percentage )
prior_attainment_subgroup_table[4,] <- c( "", "Secondary outcome, tertile2", nrow(subset(secondary_dataGCSE,
is.na(pretest_tertile)==FALSE)) , pa.effect.size1_secondary, pa.effect.size1.CI_secondary$CI_low,
pa.effect.size1.CI_secondary$CI_high, pa.effect.size1.rope_secondary$ROPE_Percentage )
prior_attainment_subgroup_table[5,] <- c( "", "Secondary outcome, tertile3", nrow(subset(secondary_dataGCSE,
is.na(pretest_tertile)==FALSE)) , pa.effect.size2_secondary, pa.effect.size2.CI_secondary$CI_low,
pa.effect.size2.CI_secondary$CI_high, pa.effect.size2.rope_secondary$ROPE_Percentage )
prior_attainment_subgroup_table[6,] <- c( "", "AO1 score,tertile2", nrow(subset(secondary_dataAO1,
is.na(pretest_tertile)==FALSE)), pa.effect.size1_AO1, pa.effect.size1.CI_AO1$CI_low,
pa.effect.size1.CI_AO1$CI_high, pa.effect.size1.rope_AO1$ROPE_Percentage )
prior_attainment_subgroup_table[7,] <- c( "", "AO1 score,tertile3", nrow(subset(secondary_dataAO1,
is.na(pretest_tertile)==FALSE)), pa.effect.size2_AO1, pa.effect.size2.CI_AO1$CI_low,
pa.effect.size2.CI_AO1$CI_high, pa.effect.size2.rope_AO1$ROPE_Percentage )
prior_attainment_subgroup_table[8,] <- c( "", "AO2 score, tertile2", nrow(subset(secondary_dataAO2,
is.na(pretest_tertile)==FALSE)) , pa.effect.size1_AO2, pa.effect.size1.CI_AO2$CI_low,
pa.effect.size1.CI_AO2$CI_high, pa.effect.size1.rope_AO2$ROPE_Percentage )
prior_attainment_subgroup_table[9,] <- c( "", "AO2 score, tertile3", nrow(subset(secondary_dataAO2,
is.na(pretest_tertile)==FALSE)) , pa.effect.size2_AO2, pa.effect.size2.CI_AO2$CI_low,
pa.effect.size2.CI_AO2$CI_high, pa.effect.size2.rope_AO2$ROPE_Percentage )
prior_attainment_subgroup_table[10,] <- c( "", "AO3 score, tertile2", nrow(subset(secondary_dataAO3,
is.na(pretest_tertile)==FALSE)) , pa.effect.size1_AO3, pa.effect.size1.CI_AO3$CI_low,
pa.effect.size1.CI_AO3$CI_high, pa.effect.size1.rope_AO3$ROPE_Percentage )
prior_attainment_subgroup_table[11,] <- c( "", "AO3 score, tertile3", nrow(subset(secondary_dataAO3,
is.na(pretest_tertile)==FALSE)) , pa.effect.size2_AO3, pa.effect.size2.CI_AO3$CI_low,
pa.effect.size2.CI_AO3$CI_high, pa.effect.size2.rope_AO3$ROPE_Percentage )

cluster_size_table <- data.frame(matrix(ncol = 7, nrow = 6))

cluster_size_table[1,] <- c( "Cluster size", "Outcome", "n_total", "Cohen's D for interaction", "Cohen's D 95%lowCI",
"Cohen's D 95%highCI", "ROPE %")
cluster_size_table[2,] <- c( "", "Primary outcome", nrow(subset(primary_data, is.na(school_size)==FALSE)),
cluster.effect.size_primary, cluster.effect.size.CI_primary$CI_low, cluster.effect.size.CI_primary$CI_high,
cluster.effect.size.rope_primary$ROPE_Percentage )
```

```
cluster_size_table[3,] <- c( "", "Secondary outcome", nrow(subset(secondary_dataGCSE,
is.na(school_size)==FALSE)), cluster.effect.size_secondary, cluster.effect.size.CI_secondary$CI_low,
cluster.effect.size.CI_secondary$CI_high, cluster.effect.size.rope_secondary$ROPE_Percentage)
cluster_size_table[4,] <- c( "", "AO1 score", nrow(subset(secondary_dataAO1, is.na(school_size)==FALSE)),
cluster.effect.size_AO1, cluster.effect.size.CI_AO1$CI_low, cluster.effect.size.CI_AO1$CI_high,
cluster.effect.size.rope_AO1$ROPE_Percentage)
cluster_size_table[5,] <- c( "", "AO2 score", nrow(subset(secondary_dataAO2, is.na(school_size)==FALSE)),
cluster.effect.size_AO2, cluster.effect.size.CI_AO2$CI_low, cluster.effect.size.CI_AO2$CI_high,
cluster.effect.size.rope_AO2$ROPE_Percentage)
cluster_size_table[6,] <- c( "", "AO3 score", nrow(subset(secondary_dataAO2, is.na(school_size)==FALSE)),
cluster.effect.size_AO3, cluster.effect.size.CI_AO3$CI_low, cluster.effect.size.CI_AO3$CI_high,
cluster.effect.size.rope_AO3$ROPE_Percentage)

robust_check_table <- data.frame(matrix(ncol = 7, nrow = 2))

robust_check_table[1,] <- c("Robustness check", "Outcome", "n_total", "Cohen's D for treatment", "Cohen's D
95%lowCI", "Cohen's D 95%highCI", "ROPE %")
robust_check_table[2,] <- c("", "Primary outcome", nrow(primary_data), robust.effect.size_primary,
robust.effect.size.CI_primary$CI_low, robust.effect.size.CI_primary$CI_high,
robust.effect.size.rope_primary$ROPE_Percentage )

engagement_table <- data.frame(matrix(ncol = 7, nrow =3))

engagement_table[1,] <- c( "Engagement", "Outcome", "n_total", "Cohen's D for engagement", "Cohen's D 95%lowCI",
"Cohen's D 95%highCI", "ROPE %")
engagement_table[2,] <- c( "Total score", "Primary outcome", nrow(subset(primary_data,
is.na(engage_totscore)==FALSE)), engage_tot.effect.size, engage_tot.effect.size.CI$CI_low,
engage_tot.effect.size.CI$CI_high, engage_tot.effect.size.rope$ROPE_Percentage )
engagement_table[3,] <- c( "R-measure", "Primary outcome", nrow(subset(primary_data,
is.na(engage_rmeasure)==FALSE)),  engage_r.effect.size, engage_r.effect.size.CI$CI_low,
engage_r.effect.size.CI$CI_high,  engage_r.effect.size.rope$ROPE_Percentage )

compliance_table <- data.frame(matrix(ncol = 10, nrow =3))

compliance_table[1,] <- c( "Compliance", "Effect size", "ES lowerCI" ,"ES upperCI", "n_total", "first stage F-test
df1","first stage F-test df2", "first stage F-test", "Compliance/Treatment Correlation", "p-value of treatment variable")
compliance_table[2,] <- c( "Continuous indicator", comply_cts_es, comply_cts_es_lowerCI , comply_cts_es_upperCI ,
nrow(subset(primary_data, is.na(Continuouscomplianceindicator)==FALSE)),
ivmodel_cts$stage1$iv1fstat$Continuouscomplianceindicator["df1"],
                ivmodel_cts$stage1$iv1fstat$Continuouscomplianceindicator["df2"],
ivmodel_cts$stage1$iv1fstat$Continuouscomplianceindicator["F"], cts_comply_cor,
ivmodel_cts$cpval["`Continuouscomplianceindicator(fit)`"])
compliance_table[3,] <- c( "Dichotomous indicator", comply_dic_es , comply_dic_es_lowerCI ,
comply_dic_es_upperCI , nrow(subset(primary_data, is.na(Dichotomouscomplianceindicator)==FALSE)),
ivmodel_dic$stage1$iv1fstat$Dichotomouscomplianceindicator["df1"],
                ivmodel_dic$stage1$iv1fstat$Dichotomouscomplianceindicator["df2"],
ivmodel_dic$stage1$iv1fstat$Dichotomouscomplianceindicator["F"], dich_comply_cor,
ivmodel_dic$cpval["`Dichotomouscomplianceindicator(fit)`"])

exam_entry_table <- data.frame(matrix(ncol = 7, nrow = 5))

exam_entry_table[1,] <- c("Exam Entry inc in Primary model", "Outcome", "n_total", "Cohen's D", "Cohen's D
95%lowCI", "Cohen's D 95%highCI", "ROPE %")
exam_entry_table[2,] <- c("", "Primary outcome", nrow(primary_data), exambrd.effect.size_primary,
exambrd.effect.size.CI_primary$CI_low,exambrd.effect.size.CI_primary$CI_high,
exambrd.effect.size.rope_primary$ROPE_Percentage )
```

```
exam_entry_table[3,] <- c("Trilogy H", "Primary outcome", nrow(primary_data), Tril_H_es_primary,
Tril_H_es.CI_primary$CI_low,Tril_H_es.CI_primary$CI_high,  Tril_H_es.rope_primary$ROPE_Percentage  )
exam_entry_table[4,] <- c("Synergy H", "Primary outcome", nrow(primary_data), Syn_H_es_primary,
Syn_H_es.CI_primary$CI_low,  Syn_H_es.CI_primary$CI_high,  Syn_H_es.rope_primary$ROPE_Percentage  )
exam_entry_table[5,] <- c("Synergy F", "Primary outcome", nrow(primary_data), Syn_F_es_primary,
Syn_F_es.CI_primary$CI_low,  Syn_F_es.CI_primary$CI_high,  Syn_F_es.rope_primary$ROPE_Percentage  )

missing_data_analysis <- data.frame(matrix(ncol = 2, nrow = 3))

missing_data_analysis[1,] <- c("Missing data analysis, MAR assumption appears to hold", "p-value for treatment")
missing_data_analysis[2,] <- c("Situations where only primary outcome is missing", p.val.allocation)
missing_data_analysis[3,] <- c("Situations where any variable other than the primary outcome is missing",
imp1.alloc.p.value)

#write.csv( output.table , file = "P:/Working/Analysis output/Report_tables")
```

Appendix J: Implementation and process evaluation surveys and interview schedules

Student Survey – Intervention

ID: <<ID>>
Name: <<Name>>

School: <<School>>
Class: <<Class>>

Remember, you must mark the answers the RIGHT way like this: ⟼

If any of the details above, e.g. name, school or class are incorrect please mark this box ☐ and put the correct details below.

Name:	Class:
School:	

This survey should take around 10 minutes, and will help us understand if the SMART Spaces programme helps students like yourself to revise chemistry for their GCSE science exam. The responses you provide will be treated with the strictest confidence and will be kept securely. We will not use your name or the name of your school in any report arising from the research, and no information that could otherwise identify you will be made public.

Although we think the project may help you, you have the right to withdraw from the survey by simply not completing it. You can also withdraw your data any time up until the 31st August 2019. If you wish to do so, or if you have any questions, please contact the evaluation team at the UCL Institute of Education by email at ioe.smartspaces@ucl.ac.uk or ask your science teacher or your parent or carer to do so on your behalf.

Multiple Choice Section (Please mark one answer for each question)

1. How well was the idea behind Spaced Learning explained to the class by your teacher?

a. Very well ☐ b. Well ☐ c. Poorly ☐ d. Very poorly ☐

2. Was the teacher who delivered the SMART Spaces lessons your normal chemistry teacher?

a. Yes ☐ b. No ☐

3. Did the teacher cover all the slides in each lesson or skip over some?

a. Covered all the slides ☐ b. Skipped over some slides in some Spaced Learning lessons ☐

c. Skipped over some slides in every Spaced Learning session ☐

4. How many SMART Spaces lessons did you have in total (across the different GCSE chemistry papers)?

a. Less than 6 ☐ b. 6 SMART Spaces lessons ☐ c. More than 6 ☐

5. Did you ever do more than one hour of SMART Spaces lessons in one day?

a. Yes ☐ b. No ☐

6 What spacing activity or activities did you do during the SMART Spaces lessons? (tick all that apply)

a. Juggling ☐ b. Plasticine modelling ☐ c. Origami ☐ d. Plate spinning ☐

e. Balloon games ☐ f. Other ☐

7 How often did your class do the spacing activity in each lesson?

a. Twice ☐ b. Once, in the middle of the lesson ☐ c. Once, at the end of the lesson ☐

Remember, you must mark the answers the RIGHT way like this: ⟷

	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly Agree
The teacher was confident at delivering Spaced Learning	☐	☐	☐	☐	☐
I was enthusiastic to try Spaced Learning	☐	☐	☐	☐	☐
The Spaced Learning lessons helped me learn more easily than normal lessons	☐	☐	☐	☐	☐
I think Spaced Learning works well for revision	☐	☐	☐	☐	☐
The class as a whole enjoyed Spaced Learning	☐	☐	☐	☐	☐
I felt more motivated to learn during Spaced Learning than in normal classes	☐	☐	☐	☐	☐
I would be happy to try Spaced Learning again in the future	☐	☐	☐	☐	☐
I think Spaced Learning would also be useful for other subjects	☐	☐	☐	☐	☐
I found the Spaced Learning lessons fun	☐	☐	☐	☐	☐
I found the Spaced Learning lessons helpful for revision	☐	☐	☐	☐	☐

This question is about your use of spaced learning in your other science lessons: biology and physics. Spaced learning is where you do blocks of repeated practice, but have a space between them in which you do some other activity.

	Almost never	Some of the time	Most of the time	Almost always	I don't know this method
How often do you use spaced learning in your biology revision?	☐	☐	☐	☐	☐
How often do you use spaced learning in your physics revision?	☐	☐	☐	☐	☐

Remember, you must mark the answers the RIGHT way like this: ←→

These questions are about chemistry. (Please mark one answer for each question)

	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly Agree
I find chemistry difficult	[ ]	[ ]	[ ]	[ ]	[ ]
I am just not good at chemistry	[ ]	[ ]	[ ]	[ ]	[ ]
I get good marks in chemistry	[ ]	[ ]	[ ]	[ ]	[ ]
I learn chemistry quickly	[ ]	[ ]	[ ]	[ ]	[ ]
Chemistry is one of my best subjects	[ ]	[ ]	[ ]	[ ]	[ ]
Chemistry is important for society	[ ]	[ ]	[ ]	[ ]	[ ]
Chemistry makes our lives easier and more comfortable	[ ]	[ ]	[ ]	[ ]	[ ]
The benefits of chemistry are greater that the harmful effects	[ ]	[ ]	[ ]	[ ]	[ ]
Ideas in chemistry change as scientists find new evidence	[ ]	[ ]	[ ]	[ ]	[ ]

This question is about how you revise for your GCSE chemistry at home.

How often do you use the following?	Almost never	Some of the time	Most of the time	Almost always
Repeating practice of the same topics, with spaces in between	[ ]	[ ]	[ ]	[ ]
Explaining the important ideas to myself	[ ]	[ ]	[ ]	[ ]
Highlighting class notes or revision guides	[ ]	[ ]	[ ]	[ ]
Creating and using flash cards	[ ]	[ ]	[ ]	[ ]
Practising exam questions	[ ]	[ ]	[ ]	[ ]
Re-reading class notes or revision guides	[ ]	[ ]	[ ]	[ ]
Summarising class notes, revision guides or textbooks	[ ]	[ ]	[ ]	[ ]
Working with a friend or family member	[ ]	[ ]	[ ]	[ ]
Using websites which support revision	[ ]	[ ]	[ ]	[ ]

ID: <<ID>>
Name: <<Name>>

School: <<School>>
Class: <<Class>>

Student Survey – control

SMART Spaces Revision Programme — Student Survey

Education Endowment Foundation

HALLAM TEACHING SCHOOL ALLIANCE

UCL Institute of Education

QUEEN'S UNIVERSITY BELFAST

ID: <<ID>>
Name: <<Name>>

School: <<School>>
Class: <<Class>>

Remember, you must mark the answers the RIGHT way like this: ⟷

If any of the details above, e.g. name, school or class are incorrect please mark this box [ ] and put the correct details below.

Name:	Class:
School:	

This survey should take around 10 minutes, and will help us understand how people revise chemistry for their GCSE science exam. The responses you provide will be treated with the strictest confidence and will be kept securely. We will not use your name or the name of your school in any report arising from the research, and no information that could otherwise identify you will be made public.

Although we think the project may help you, you have the right to withdraw from the survey by simply not completing it. You can also withdraw your data any time up until the 31st August 2019. If you wish to do so, or if you have any questions, please contact the team at the UCL Institute of Education by email at ioe.smartspaces@ucl.ac.uk or ask your science teacher or your parent or carer to do so on your behalf.

These questions are about chemistry. (Please mark one answer for each question)

	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly Agree
I find chemistry difficult	[ ]	[ ]	[ ]	[ ]	[ ]
I am just not good at chemistry	[ ]	[ ]	[ ]	[ ]	[ ]
I get good marks in chemistry	[ ]	[ ]	[ ]	[ ]	[ ]
I learn chemistry quickly	[ ]	[ ]	[ ]	[ ]	[ ]
Chemistry is one of my best subjects	[ ]	[ ]	[ ]	[ ]	[ ]
Chemistry is important for society	[ ]	[ ]	[ ]	[ ]	[ ]
Chemistry makes our lives easier and more comfortable	[ ]	[ ]	[ ]	[ ]	[ ]
The benefits of chemistry are greater that the harmful effects	[ ]	[ ]	[ ]	[ ]	[ ]
Ideas in chemistry change as scientists find new evidence	[ ]	[ ]	[ ]	[ ]	[ ]

Remember, you must mark the answers the RIGHT way like this: ←→

This question is about spaced learning in your science lessons. Spaced learning is where you do blocks of repeated practice, but have a space between them in which you do some other activity.

	Almost never	Some of the time	Most of the time	Almost always	I don't know this method
How often do you use spaced learning in your chemistry revision?	[ ]	[ ]	[ ]	[ ]	[ ]
How often do you use spaced learning in your biology revision?	[ ]	[ ]	[ ]	[ ]	[ ]
How often do you use spaced learning in your physics revision?	[ ]	[ ]	[ ]	[ ]	[ ]

This question is about how you revise for your GCSE chemistry at home.

How often do you use the following?	Almost never	Some of the time	Most of the time	Almost always
Repeating practice of the same topics, with spaces in between	[ ]	[ ]	[ ]	[ ]
Explaining the important ideas to myself	[ ]	[ ]	[ ]	[ ]
Highlighting class notes or revision guides	[ ]	[ ]	[ ]	[ ]
Creating and using flash cards	[ ]	[ ]	[ ]	[ ]
Practising exam questions	[ ]	[ ]	[ ]	[ ]
Re-reading class notes or revision guides	[ ]	[ ]	[ ]	[ ]
Summarising class notes, revision guides or textbooks	[ ]	[ ]	[ ]	[ ]
Working with a friend or family member	[ ]	[ ]	[ ]	[ ]
Using websites which support revision	[ ]	[ ]	[ ]	[ ]

Smart Spaces Intervention Teacher Survey

This survey should take around 15 minutes to complete, and will help us understand the benefits and drawbacks of delivering the SMART Spaces chemistry revision programme within your school. The responses provided will be treated with the strictest confidence and will be kept securely on an encrypted system. We will not use your name or the name of your school in any report and no information that could otherwise identify you will be made public.

Even after submitting the survey, you have the right to withdraw your data any time up until 31st August 2019. If you wish to do so or have any questions, please contact the evaluation team at the UCL Institute of Education by e-mail at ioe.smartspaces@ucl.ac.uk

We are very grateful for your help with this research, which we hope will be of benefit to others.

Please enter your forename:	_____
Surname:	_____
School name:	_____
Are you a Head of Department and/or had responsibility for coordinating the SMART Spaces approach to chemistry revision?	◯ Yes ◯ No
Are you a chemistry specialist?	◯ Yes ◯ No
For how many years have you been teaching chemistry or science? (please use a numerical value)	_____

We would be grateful if you could answer these questions as the person with oversight of the SMART Spaces intervention in your department.

Of AQA double award chemistry/science classes, which were involved in the SMART Spaces intervention?

- ◯ All classes
- ◯ Only lower attaining classes
- ◯ Only higher attaining classes
- ◯ A mixture of classes (but not all of them)

	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly Agree
It was easy to organise revision to fit the three SMART Spaces lessons covering AQA Chemistry Paper 1 in.	◯	◯	◯	◯	◯
It was easy to organise revision to fit the three SMART Spaces lessons covering AQA Chemistry Paper 2 in.	◯	◯	◯	◯	◯
Overall, the department benefited from including SMART Spaces within revision practice.	◯	◯	◯	◯	◯
We would use SMART Spaces in the future for revision.	◯	◯	◯	◯	◯
In the future we would use SMART Spaces throughout the year as part of teaching.	◯	◯	◯	◯	◯
Senior leaders were supportive of the SMART Spaces intervention.	◯	◯	◯	◯	◯
The SMART Spaces team provided everything we needed to run the intervention as a department.	◯	◯	◯	◯	◯
There were tensions created between the chemistry revision using SMART Spaces and revision of biology and physics.	◯	◯	◯	◯	◯
SMART Spaces could become the dominant way of revising AQA Chemistry in our department.	◯	◯	◯	◯	◯

Please tell us which classes you delivered SMART Spaces to.

How many classes have you delivered the SMART Spaces intervention to?	◯ 0 ◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5 ◯ More than 5
Please name the first class that you have delivered SMART spaces to:	_____
Please name the second class that you have delivered SMART spaces to:	_____
Please name the third class that you have delivered SMART spaces to:	_____
Please name the fourth class that you have delivered SMART spaces to:	_____
Please name the fifth class that you have delivered SMART spaces to:	_____
Please name all further classes that you have delivered SMART Spaces to. You will only be asked direct questions about the first 5 classes you have named:	_____

These questions are about how you delivered SMART spaces to [class_1].

How far did you explain the idea behind SMART Spaces to [class_1]?	◯ In detail ◯ A little ◯ Not at all
Did you cover all of the slides in each lesson or skip over some with [class_1]?	◯ Covered all the slides. ◯ Skipped over some slides in some SMART Spaces lessons. ◯ Skipped over some slides in every SMART Spaces lesson.

Did you modify the slides in any of these ways for [class_1]?		
	Yes	No
Did you change the language used?	○	○
Did you change the content (text or images)?	○	○
Did you change the order of slides presented?	○	○

There are two sets of three SMART Spaces lessons: one set covering AQA Chemistry Paper 1, and another set covering AQA Chemistry Paper 2. So the SMART Spaces intervention is intended to be taught over six lessons. How many lessons did you teach to [class_1]?

- ○ 0
- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6

There are two sets of SMART Spaces slides: one covering AQA Chemistry Paper 1, and another set covering AQA Chemistry Paper 2. Each set of slides is designed to repeat content three times on separate days, over no more than a week. For [class_1]:

	True	False
I taught the lessons on separate days	○	○
I taught each set over no more than one week	○	○

How long were the lessons for [class_1]?

- ○ Less than 60 minutes.
- ○ 60 minutes.
- ○ More than 60 minutes.

These questions are about the spacing activity used within SMART Spaces lessons for [class_1].	
What spacing activity or activities did you do during the SMART spaces lessons with [class_1]? (tick all that apply)	☐ Juggling ☐ Plasticine modelling ☐ Origami ☐ Plate spinning ☐ Balloon games ☐ Other
Please specify the other spacing activity or activities you used with [class_1]:	_____
Each SMART Spaces lesson consists of three blocks of chemistry content, separated by a spacing activity. How many of the six lessons did you teach to [class_1] using the spacing activities as intended?	○ I taught all six lessons with spacing activities as intended. ○ I ommited a spacing activity for one or two lessons. ○ I ommited a spacing activity for three of more lessons.

These questions are about how you delivered SMART Spaces to [class_2].

How far did you explain the idea behind SMART Spaces to [class_2]?

- ◯ In detail
- ◯ A little
- ◯ Not at all

Did you cover all of the slides in each lesson or skip over some with [class_2]?

- ◯ Covered all the slides.
- ◯ Skipped over some slides in some SMART Spaces lessons.
- ◯ Skipped over some slides in every SMART Spaces lesson.

Did you modify the slides in any of these ways for [class_2]?

	Yes	No
Did you change the language used?	○	○
Did you change the content (text or images)?	○	○
Did you change the order of the slides presented?	○	○

There are two sets of three SMART Spaces lessons: one set covering AQA Chemistry Paper 1, and another set covering AQA Chemistry Paper 2. So the SMART Spaces intervention is intended to be taught over six lessons. How many lessons did you teach to [class_2]?

○ 0
○ 1
○ 2
○ 3
○ 4
○ 5
○ 6

There are two sets of SMART Spaces slides: one covering AQA Chemistry Paper 1, and another set covering AQA Chemistry Paper 2. Each set of slides is designed to repeat content three times on separate days, over no more than a week. For [class_2]:

	True	False
I taught the lessons on separate days	○	○
I taught each set of lessons over no more than one week	○	○

How long were the lessons for [class_2]?

- ○ Less than 60 minutes.
- ○ 60 minutes.
- ○ More than 60 minutes.

These questions are about the spacing activity used within SMART Spaces lessons for [class_2].	
What spacing activity or activities did you do during the SMART spaces lessons with [class_2]? (tick all that apply)	☐ Juggling ☐ Plasticine modelling ☐ Origami ☐ Plate spinning ☐ Balloon games ☐ Other
Please specify the other spacing activity or activities you used with [class_2]:	_____
Each SMART Spaces lesson consists of three blocks of chemistry content, separated by a spacing activity. How many of the six lessons did you teach to [class_2] using the spacing activities as intended?	○ I taught all six lessons with spacing activities as intended. ○ I ommited a spacing activity for one or two lessons. ○ I ommited a spacing activity for three of more lessons.

Please now answer the same questions for [class_3].

How far did you explain the idea behind SMART Spaces to [class_3]?	◯ In detail ◯ A little ◯ Not at all
Did you cover all of the slides in each lesson or skip over some with [class_3]?	◯ Covered all the slides. ◯ Skipped over some slides in some SMART Spaces lessons. ◯ Skipped over some slides in every SMART Spaces lesson.

Did you modify the slides in any of these ways for [class_3]?		
	Yes	No
Did you modify the language used?	○	○
Did you change the content (text or images)?	○	○
Did you change the order of slides presented?	○	○

There are two sets of three SMART Spaces lessons: one set covering AQA Chemistry Paper 1, and another set covering AQA Chemistry Paper 2. So the SMART Spaces intervention is intended to be taught over six lessons. How many lessons did you teach to [class_3]?

- ○ 0
- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6

There are two sets of SMART Spaces slides: one covering AQA Chemistry Paper 1, and another set covering AQA Chemistry Paper 2. Each set of slides is designed to repeat content three times on separate days, over no more than a week. For [class_3]:

	True	False
I taught the lessons on separate days	○	○
I taught each set over no more than one week	○	○

How long were the lessons for [class_3]?

- ○ Less than 60 minutes.
- ○ 60 minutes.
- ○ More than 60 minutes.

These questions are about the spacing activity used within SMART Spaces lessons for [class_3].	
What spacing activity or activities did you do during the SMART spaces lessons with [class_3]? (tick all that apply)	☐ Juggling ☐ Plasticine modelling ☐ Origami ☐ Plate spinning ☐ Balloon games ☐ Other
Please specify the other spacing activity or activities you used with [class_3]:	_____
Each SMART Spaces lesson consists of three blocks of chemistry content, separated by a spacing activity. How many of the six lessons did you teach to [class_3] using the spacing activities as intended?	○ I taught all six lessons with spacing activities as intended. ○ I ommited a spacing activity for one or two lessons. ○ I ommited a spacing activity for three of more lessons.

These questions are about the training and support for delivering SMART Spaces.	
Did you attend a training session for SMART Spaces (at your school or a nearby school)?	◯ Yes ◯ No
Did you receive a support visit in which a member of the SMART Spaces team provided feedback on part of a practice lesson?	◯ Yes ◯ No
Did you rehearse the SMART Spaces lessons with another class before the revision intervention?	◯ Yes ◯ No
Did you receive a handbook explaining SMART Spaces?	◯ Yes ◯ No
Did you visit the website for SMART Spaces?	◯ Yes ◯ No

How far do you agree with these statements about the training and support?					
	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly Agree
The training provided me with everything I needed to deliver SMART Spaces.	○	○	○	○	○
The support visit was useful in furthering my delivery of SMART Spaces.	○	○	○	○	○
The handbook detailed everything I needed to know about SMART Spaces.	○	○	○	○	○
The website was useful to me.	○	○	○	○	○

How far do you agree or disagree with these statements?	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly Agree
I was confident in delivering SMART Spaces	○	○	○	○	○
My class/classes were enthusiastic to try SMART Spaces	○	○	○	○	○
The SMART Spaces lessons helped the class learn more easily than normal lessons	○	○	○	○	○
I think SMART Spaces works well for revision	○	○	○	○	○
The class/classes as a whole enjoyed SMART Spaces	○	○	○	○	○
The class seemed more motivated to learn during SMART Spaces than in normal lessons	○	○	○	○	○
I would be happy to deliver SMART Spaces again in the future	○	○	○	○	○
I think SMART Spaces would be useful for other subjects, beyond chemistry	○	○	○	○	○
My class/classes found the SMART Spaces lessons fun	○	○	○	○	○
My class/classes found the SMART Spaces lessons helpful for revision	○	○	○	○	○
The evidence behind SMART Spaces was important in my wanting to use it	○	○	○	○	○

Please tell us how far you agree or disagree with these statements:					
	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree
Revision through SMART Spaces supports students to demonstrate knowledge and understanding of scientific ideas (AO1).	○	○	○	○	○
Revision through SMART Spaces supports students to demonstrate knowledge and understanding of scientific processes, techniques and procedures (AO1).	○	○	○	○	○
Revision through SMART Spaces supports students in applying their knowledge and understanding of scientific ideas (AO2).	○	○	○	○	○
Revision through SMART Spaces supports students in applying their knowledge and understanding of scientific processes, techniques and procedures (AO2).	○	○	○	○	○
Revision through SMART Spaces supports students to analyse, interpret and evaluate scientific information, ideas and evidence (AO3).	○	○	○	○	○
SMART Spaces is more useful for low attaining students	○	○	○	○	○
SMART Spaces is more useful for high attaining students	○	○	○	○	○

How far do you agree with these statements about the SMART Spaces slides for AQA Chemistry Paper 1 content?	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree	I did not deliver the Paper 1 slides
The SMART Spaces slides for Paper 1 provided a high quality revision resource.	○	○	○	○	○	○
The SMART Spaces slides for Paper 1 covered the relevant AQA chemistry content well.	○	○	○	○	○	○
The slides for Paper 1 were well timed to fit within an hour, with two spaces.	○	○	○	○	○	○

Now please tell us how far you agree with these statements about the SMART Spaces slides which covered the AQA Chemistry Paper 2 content:

	Strongly disagree	Disagree	Neither agree or disagree	Agree	Strongly agree	I did not deliver the Paper 2 slides
The SMART Spaces slides for Paper 2 provided a high quality revision resource.	○	○	○	○	○	○
The SMART Spaces slides for Paper 2 covered the relevant AQA chemistry content well.	○	○	○	○	○	○
The slides for Paper 2 were well timed to fit within an hour, with two spaces.	○	○	○	○	○	○

These questions help us to understand the costs and time commitment involved in delivering SMART Spaces.	
Did you or your school incur any financial cost for you to attend training around SMART Spaces?	◯ Yes ◯ No
Please provide an estimate of this cost:	_____
Did you or your school incur any additional cost in buying new equipment or resources in order to deliver SMART Spaces to your classes? (e.g. a powerpoint remote or resources for spacing activities).	◯ Yes ◯ No
Please provide an estimate of this cost:	_____
Did your school have to provide cover for you in order for you to train or deliver SMART Spaces?	◯ Yes ◯ No
Please tell us the approximate number of hours of cover (as a numerical value):	_____
Thinking about the total time taken to train, plan for and deliver SMART Spaces, how does this compare to planning and delivering chemistry revision usually?	◯ SMART Spaces saved time overall compared to usual chemistry revision practice. ◯ SMART Spaces took about the same time overall as usual chemistry revision practice. ◯ SMART Spaces took more time overall than usual chemistry revision practice. ◯ Not applicable (e.g. I do not normally do chemistry revision)
Approximately how many hours do you think it saved compared to normal practice? (please enter a numerical value)	_____
Approximately how many more hours do you think SMART Spaces took, saved compared to normal practice? (please enter a numerical value)	_____

Teacher survey – Revision practice – Intervention and Control

These questions will help us understand how revision is done in science departments.

These questions are about how your department supports revision.

		Yes	No	I don't know
1)	My department has a revision policy.	○	○	○
2)	We plan GCSE revision as a department.	○	○	○
3)	I can seek support from colleagues in planning revision.	○	○	○
4)	My department provides GCSE revision materials for me to use.	○	○	○

This question is about revision practices in lessons leading up to GCSE exams in Year 11. Thinking about your GCSE chemistry or science classes, how often do you use these revision practices during lessons?

		Almost never	Some of the time	Most of the time	Almost always	I don't know this method
5)	Repeated practice with intervals in between.	○	○	○	○	○
6)	Quizzes.	○	○	○	○	○
7)	Spaced revision.	○	○	○	○	○
8)	Interleaving.	○	○	○	○	○
9)	Practise exam questions.	○	○	○	○	○
10)	Mnemonics.	○	○	○	○	○
11)	Distributed practice.	○	○	○	○	○
12)	Paired work.	○	○	○	○	○
13)	Students using dedicated websites.	○	○	○	○	○

SMART Spaces Control Teacher Survey

This survey should take less than 10 minutes to complete. Answering these questions will help us compare the SMART Spaces intervention to how chemistry revision is undertaken in control schools, such as yours. There is also a £1000 payment to your school for completion of the evaluation elements.

The responses provided will be treated with the strictest confidence and will be kept securely on an encrypted system. We will not use your name or the name of your school in any report and no information that could otherwise identify you will be made public.

Even after submitting the survey, you have the right to withdraw your data any time up until 31st August 2019. If you wish to do so or have any questions, please contact the evaluation team at the UCL Institute of Education by e-mail at ioe.smartspaces@ucl.ac.uk

We are very grateful for your help with this research, which we hope will be of benefit to others.

1) Please tell us the name of your school: _____

2) How much do you know about Spaced Learning?

- ◯ Nothing
- ◯ Very little
- ◯ A small amount
- ◯ A good amount
- ◯ A great deal

Spaced Learning is where you do blocks of repeated practice, with a space between them in which you do some other activity. Please tell us how often you use such an approach in your teaching or revision.

		Almost never	Some of the time	Most of the time	Almost always	I don't know this method	I don't teach this subject
3)	How often do you use spaced learning in your chemistry teaching?	◯	◯	◯	◯	◯	◯
4)	How often do you use spaced learning in your biology revision?	◯	◯	◯	◯	◯	◯
5)	How often do you use spaced learning in your physics revision?	◯	◯	◯	◯	◯	◯

Protocol for observation of training

#	*IPE Research Questions*	*Purpose & IPE Dimensions*
RQ6	Was SMART Spaces implemented with fidelity in the trial, and to what extent can SMART Spaces be implemented with fidelity in a scaled-up version of the intervention?	Fidelity & Adherence (D1), Implementation factors (F1-4)
RQ7	Are there any barriers to implementation?	Fidelity & Adherence (D1), Adaptation (D8), Implementation factors (F1-4)
RQ8	What role do heads of science play in facilitating implementation?	Fidelity & Adherence (D1), Adaptation (D8), Implementation factors (F1-4)
RQ9	What are the most effective aspects of training teachers in SMART Spaces?	Quality (D3), (Teacher) Responsiveness (D5), Implementation factor (F2)
RQ10	Do teachers and heads of science, perceive SMART Spaces to be a useful and engaging approach to revision?	Quality (D3), (Teacher & School) Responsiveness (D5), Reach (D4)
RQ11	To what extent does teacher engagement impact on quality of delivery and pupil responsiveness?	Quality (D3), (Teacher) Responsiveness (D5), Implementation factor (F4)
RQ12a	Do teachers trial the lessons before the intervention?	Dosage (D2)
RQ12b	Do they adopt spaced learning in other chemistry revision lessons?	Dosage (D2)
RQ13a	To what extent do teachers adapt the materials and approach?	Adaptation (D8)
RQ13b	In what ways do teachers and schools adapt their approach to science revision as a result of SMART Spaces?	Adaptation (D8)
RQ14a	Are pupils responsive to SMART Spaces and does it have reach: do all pupils perceive it to be an engaging and beneficial approach to revision?	Reach (D4), (Pupil) responsiveness (D5)
RQ14c	What contributes to pupil engagement (or disengagement)?	Reach (D4), (Pupil) responsiveness (D5)
RQ15	Do some pupils adopt spacing practice within their own revision practices?	Reach (D4), Programme differentiation (D5), Dosage (D2)
RQ16	To what extent is SMART spaces distinguishable from 'business as usual' revision practice in schools?	Programme differentiation (D5), Monitoring of control group (D7), Implementation factor (F5)

Time, venue, who is present?

What experience of spaced learning do the teachers have already (as it arises in discussion)?

Survey completion – any issues arising?

How does Alastair introduce the project?

What are the considerations of the teachers? (e.g. lesson timings) e.g. discussion today about metallic bonds are positive metal *nuclei* vs *ions*.

What do they say at the end/questions?

Any other comments

Protocol for observation of support visit

Evaluation of support visit to school (main revision trial)

Context of visit

Is this a support visit, a 1st SMART spaces block (if so which day of 3?), or both?

How many teachers? Which teachers – HoD, chemistry specialists etc?

Are there any contextual issues in the school? Change of staff, leadership?

etc

Observation of SMART lesson(s).

[write a timeline of what happens, mostly to gauge timings for fidelity. Follow the developer if they move classes]

How receptive are the class? What are the indicators of this?

Are there any behavioural issues? How are these pre-empted or dealt with?

How far is the teacher embellishing what is on the slides? How far is this related to the teaching context and history of interaction with the class?

Does the teacher seem confident?

What questioning techniques does the teacher use, if any?

What happens during the spacing activity? How well planned for and organised is this?

Anything else noteworthy?

Observation of feedback to teacher(s)

[record a brief outline of feedback give and highlight any questions asked by the teacher, perceived barriers, points about fidelity and modifications made.]

Interviews (where possible) – perceptions of SMART Spaces so far.

[Where possible, draw on prompts from the lesson observed]

Your impressions of SMART Spaces so far.

<u>What do you like about SMART spaces as an approach to revision? What potential do you see in it?</u>

How important is the evidence base behind the approach?

How important are the resources supplied?

<u>Did you see yourself making any modifications to the way the SMART spaces sessions run?</u>

What; why?

What barriers do you see to making it work in your school?

How do you think it will fit with biology and physics revision?

What barriers do you see to making it work in other schools?

How has the training and support been around SMART Spaces?

What modifications might the team make to help you further?

How useful is the website?

Any other points of note for our evaluation?

Protocol for observation of intervention

Evaluation of SMART main trial intervention

IPE Research Questions

#	*IPE Research Questions*	*Purpose & IPE Dimensions*
RQ6	Was SMART Spaces implemented with fidelity in the trial, and to what extent can SMART Spaces be implemented with fidelity in a scaled-up version of the intervention?	Fidelity & Adherence (D1), Implementation factors (F1-4)
RQ7	Are there any barriers to implementation?	Fidelity & Adherence (D1), Adaptation (D8), Implementation factors (F1-4)
RQ8	What role do heads of science play in facilitating implementation?	Fidelity & Adherence (D1), Adaptation (D8), Implementation factors (F1-4)
RQ9	What are the most effective aspects of training teachers in SMART Spaces?	Quality (D3), (Teacher) Responsiveness (D5), Implementation factor (F2)
RQ10	Do teachers and heads of science, perceive SMART Spaces to be a useful and engaging approach to revision?	Quality (D3), (Teacher & School) Responsiveness (D5), Reach (D4)
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RQ12a	Do teachers trial the lessons before the intervention?	Dosage (D2)
RQ12b	Do they adopt spaced learning in other chemistry revision lessons?	Dosage (D2)
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RQ13b	In what ways do teachers and schools adapt their approach to science revision as a result of SMART Spaces?	Adaptation (D8)
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RQ16	To what extent is SMART spaces distinguishable from 'business as usual' revision practice in schools?	Programme differentiation (D5), Monitoring of control group (D7), Implementation factor (F5)

Context of visit

Which day of three is this? For which paper?

How many teachers are doing the intervention? Which teachers – HoD, chemistry specialists etc?

Are there any contextual issues in the school? Change of staff, leadership?

etc

Observation of SMART lessons.

[write a timeline of what happens, mostly to gauge timings for fidelity. You might change classes during a spacing activity (but try and see at least one full spacing). Ideally also seeing the same class on different days to also identify changes in engagement]

How receptive are the class? What are the indicators of this?

Are there any behavioural issues? How are these pre-empted or dealt with?

How far is the teacher embellishing what is on the slides? How far is this related to the teaching context and history of interaction with the class?

Does the teacher seem confident?

What questioning techniques does the teacher use, if any?

What happens during the spacing activity? How well planned for and organised is this?

Is there an effect of teacher engagement on pupil engagement?

Anything else noteworthy?

Interview of teachers – perceptions of SMART Spaces.

[Where possible, draw on prompts from the lesson observed. Ideally individual interviews but groups okay. Need to interview head of science/chemistry too, but usually also one of the teachers.]

Your impressions of SMART Spaces.

What do you like about SMART spaces as an approach to revision? What potential do you see in it?

- How important is the evidence base behind the approach?
- How important are the resources supplied?

What perceptions do you think the pupils have about SMART spaces?

- What contributes to pupil engagement (or disengagement)?
- Does it work for all pupils? Which ones, why?
- Do you think pupils use this approach at home?

[fidelity] Did you make any modifications to the way the SMART spaces sessions run?

- What; why?
- Did you adapt the materials?
- Did you do all the lessons? (3 x 2)
- How often did you fit in both spaces?
- What spacing activities did you use?

What barriers do you see to making it work in your school?

- How do you think it will fit with biology and physics revision?

What barriers do you see to making it work in other schools?

Your impressions of SMART training

How has the training and support been around SMART Spaces?

What modifications might the team make to help you further?

How useful is the website?

Did you practice the SMART spaces approach before you did it with your Y11 classes?

Did you have a coaching visit?

How useful was the coaching visit? How might it be improved?

Vs Normal revision practice

How has this changed your normal practice for revision?

Have/would you use this in other re vision lessons (e.g. physics and biology)?

Do you think you will use this in the future?

How different do you think this is from 'normal practice' around revision?

Any other points of note for our evaluation?

Interview of Head of Science/Chemistry

[if they are not available, try and arrange later telephone interview, or last resort is questions by e-mail later]

Organisation, barriers and affordances

What role do heads of science play in facilitating implementation?

What barriers have you had to overcome as a head of science?

What has been beneficial for your department in using SMART Spaces?

How easy/difficult has it been to fit the intervention (6 lessons) into your timetable?

How does this fit with the revision for physics and biology?

Perceptions of others

How have senior leaders perceived SMART Spaces?

Have they been supportive?

What is required of them to make this work?

How have teachers in your department perceived SMART Spaces?

Have you had to support or intervene to ensure the intervention is successful?

Did you observe any of the lessons? Was this useful/necessary?

(if not all teachers are doing SMART Spaces), how have those not doing the intervention perceived SMART spaces? (e.g. biology, physics, KS3 teachers)

Support from QUB/Hallam Team

How has the support been for the intervention?

In hindsight, how effective was the training?

In hindsight, how effective was the coaching visit?

What else might the team have done to support you and your science colleagues?

Anything else of note for our evaluation?

Interview of small group of pupils (if possible)?

What do you think about using SMART Spaces for revision?

What is good about it?

What do you not like about it?

What could be done to make it more engaging?

How good/useful did you find the slides?

How different is this from the way you normally revise in lessons?

In science?

In other subjects?

Has this made any difference to how you revise at home/on your own?

Have you used the slides directly?

Is there anything else you would like to say about the SMART Spaces?

Appendix K: Analysis in the presence of non-compliance

Compliance	Effect size	Effect size, lower CI	Effect size, upper CI	n	first stage F-test df1	first stage F-test df2	first stage F-test	Compliance/ Treatment Correlation	p-value of treatment variable
Continuous indicator	0.045	-0.131	0.221	11976	1	119	353.9	0.877	0.617
Dichotomous indicator	0.153	-0.451	0.757	11976	1	119	12.6	0.332	0.620

Details of the three aspects of the compliance measure: attendance at training, % of SMART lessons taught and % SMART lessons taught with spacing:

n = 54 treatment schools	At least 90%	At least 75%	At least 50%
Teachers attending CPD	44.4%	64.8%	96.3%
SMART lessons taught	48.1%	70.4%	83.3%
SMART lessons taught with spacing	61.1%	81.5%	83.3%

Note: This table includes eight schools that withdrew from the study (and, hence, taught no SMART lessons).

Uptake of spaced learning in control schools

Spaced learning uptake indicator for chemistry – school average valid response score for item "How often do you use spaced learning in your chemistry teaching?"

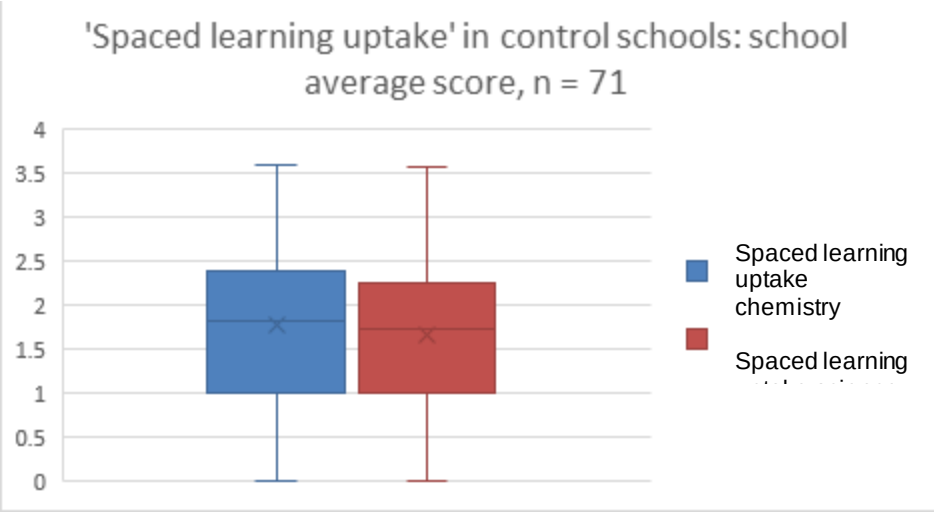
Spaced learning uptake indicator for science – school average valid response score for items

- "How often do you use spaced learning in your biology teaching?"
- "How often do you use spaced learning in your physics teaching?"

Coded as:
I don't teach this subject – missing (do not include in calculation of school average)
I don't know this method = 0, Almost never = 1, Some of the time = 2, Most of the time = 3, Almost always = 4

Summary statistics for school average 'Spaced learning uptake' score in control schools

'Spaced learning uptake' score, school average	n	Mean	SD	Min	LQ	M	UQ	Max
Chemistry	71	1.78	0.88	0.00	1.00	1.82	2.33	3.60
Science (Biology, Physics)	71	1.66	0.94	0.00	1.00	1.73	2.20	3.57



% control schools with average 'spaced learning uptake' score at least 2

At school level, teachers report doing spacing at least 'some of the time' or more on average in 34 (47.9%) of control schools for chemistry; and in 33 (46.5%) of control schools for science (physics and biology).

	Control: school average 'Spaced learning uptake' score			
	at least 2		less than 2	
Total, n = 71	**n**	%	**n**	**%**
Chemistry	34	47.9	37	52.1
Science (Biology; Physics)	33	46.5	38	53.5

Appendix L: Missing data analysis

Missing data analysis, MAR assumption appears to hold	Effect size (lower CI, Upper CI)
Situations where only primary outcome is missing	0.012 (-0.011, 0.035)
Situations where any variable other than the primary outcome is missing	-0.037 (-0.158, 0.084)

Appendix M: Additional analyses and robustness checks

Robustness check	Outcome	n	Cohen's D, treatment	Cohen's D 95% low CI	Cohen's D 95% high CI	ROPE %
	Primary outcome	11976	0.058	-0.089	0.203	72.4%

Additional analysis: engagement

	Outcome	n	Cohen's D, engagement	Cohen's D 95% low CI	Cohen's D 95% high CI	ROPE %
Total raw score, engagement	**Primary outcome**	2437	0.004	-0.001	0.008	100%
R-measure, engagement	**Primary outcome**	2437	0.015	-0.003	0.034	100%

Additional analysis: exam entry

Exam Entry inc in Primary model	Outcome	n	Cohen's D	Cohen's D 95% low CI	Cohen's D 95% high CI	ROPE %
Treatment	**Primary outcome**	11976	0.092	-0.045	0.241	0.545
Trilogy H	**Primary outcome**	11976	1.605	1.542	1.661	0
Synergy H	**Primary outcome**	11976	1.681	0.742	2.710	0
Synergy F	**Primary outcome**	11976	-0.077	-0.956	0.845	0.179

This document is available for download at https://educationendowmentfoundation.org.uk

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