

Evaluation Summary	
Age range	Year 5 and Year 6
Number of pupils	4000
Number of schools	100 primary schools
Design	RCT, school-level randomisation
Primary Outcome	KS2 Mathematics

Background

Significance

Mathematics and programming in schools have a longstanding and intertwined history. Programming in schools has been shown to have the potential to develop higher levels of mathematical thinking in relation to aspects of number linked to multiplicative reasoning; mathematical abstraction including algebraic thinking as well as problem solving abilities (Clements, 2000). More recently, attention has been paid to defining 'computational thinking' (CT) (McMaster, Rague & Anderson, 2010; Wing, 2008). Computational thinking could be considered to be a relative, or part of the 'family' of different aspects of mathematics thinking (Wing, 2008). This relationship helps to explain why programming and computer-based mathematical instruction have been found to have a positive effect on both student attitudes, and on attainment in mathematics. Such effects are particularly apparent for students with attainment that is low relative to peers (Lee, 1990).

In the first phase of its introduction to the school curriculum, programming in schools was often developed by enthusiasts who would in many cases be located in mathematics departments, or, in Primary school contexts, would identify themselves as mathematics specialists. However, the introduction of Information and Communications Technology (ICT) as a National Curriculum subject has led to programming in schools being deprioritised both in relation to computing and in the mathematics curriculum. Recent policy and curriculum changes mean that there is a renewed focus on computing being (re-)introduced into Primary schools (DfE, 2013; Furber, 2012),

New programming languages, such as "Scratch", and tools (for example, Raspberry Pi) have been developed since much of the research in computing and mathematical learning was undertaken. Scratch is a freely available programming and authoring tool developed for educational purposes at the Massachusetts Institute of Technology in the early 21st Century (Monroy-Hernandez & Resnick, 2008). Scratch is based on graphical programming blocks that can be assembled to create programmes. The appearance of the blocks are related to their function and meaning. Scratch is highly interactive allowing for changes to be made to

programmes whilst they are running. The scripting area is modelled on a physical desktop to encourage 'tinkering'. Scratch is designed to interface with multimedia allowing for applications that are meaningful to learners (Resnick et al. 2009).

Whilst Scratch is a development of earlier programming languages designed as learning environments, it represents a significant development. Thus, there is both an opportunity and a need to design and evaluate curricula and professional development programmes that can maximise the benefits of programming for students' mathematical thinking and attainment in the current context. This research will assess both quantitatively and qualitatively, how to design materials for students and teachers that directly address the learning of the skills needed in computational thinking and mathematical attainment.

Intervention

The project is an efficacy trial that will develop and evaluate the effect of learning to program on understanding computational thinking and mathematical thinking. It will compare the performance on selected tasks of students' mathematical thinking with those who do not engage with the materials and programming activities. One cohort of students in about 50 schools (100 classes) will engage in a two-year programme, the first year focusing on computational thinking and Scratch programming, and the second year on the learning of mathematical thinking through engagement with specially designed programming-mathematics curriculum and tasks. These will be aligned with both the Primary Computing and Primary Mathematics National Curriculum.

In each year of the intervention, two teachers in each school will be trained in the use of Scratch programming and the curriculum materials. Training will take place over two days. In year one of the intervention, the target group of teachers will be 2 teachers in each school, if possible one Year 5 (Y5) teacher and an ICT coordinator (if exists) alternatively another class teacher (Year 5 or Year 6) in each school. In year two, the target group where possible will be two Year 6 (Y6) teachers, who will be trained to continue the approach with the same cohort of children.

In addition to the face-to-face teacher professional development (PD), there will be an online community providing support and some optional light-touch collaborative support between nearby schools, possibly one or two twilight sessions per year.

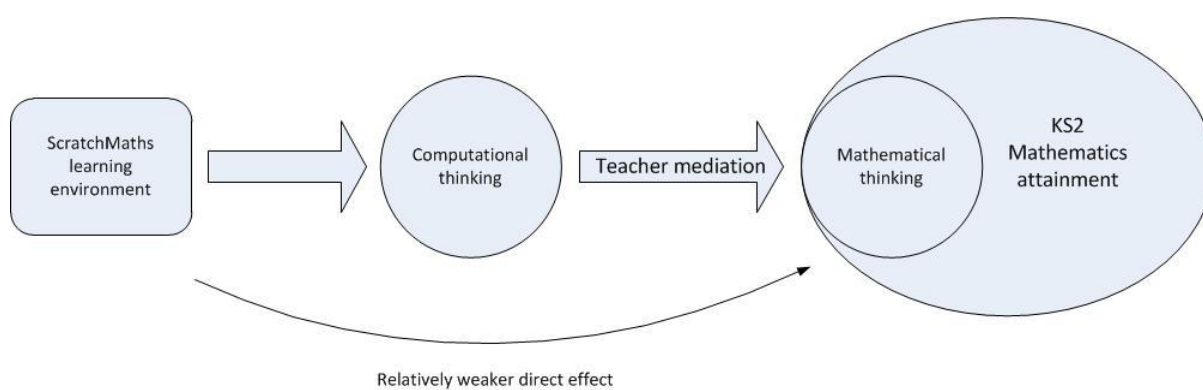
Prior to the intervention, the Institute of Education (IoE) will undertake a design phase and SHU will develop a measure of computational thinking based upon the IoE model of the construct by developing or adapting questions used in an international on-line project: Beaver computing (see below).

The intervention has a number of features of effective professional development: connecting work-based learning and external expertise; potentially rich professional learning opportunities; collaborative learning, the creation of professional learning communities between schools; and a clear focus (Stoll, Harris & Handscomb, 2012).

Theory of change

The diagrams, below, represent an initial simplified theory of change of proposed intervention effect. Figure 1 represents a simplified model of the hypothesised relationship between ScratchMaths, computational thinking, mathematical thinking and KS2 mathematics attainment at the pupil level. Two aspects of simplification are the linear nature of the model without the representation of possible feedback loops and the separation of computational thinking and mathematical thinking as completely distinct. An aspect of the evaluation during the design phase will be to explore and describe in more detail the theory of change underlying the project, including feedback loops, in order to inform the process evaluation and potentially sub-analysis in the evaluation of impact through the RCT. This theory of change will be reported in the final report.

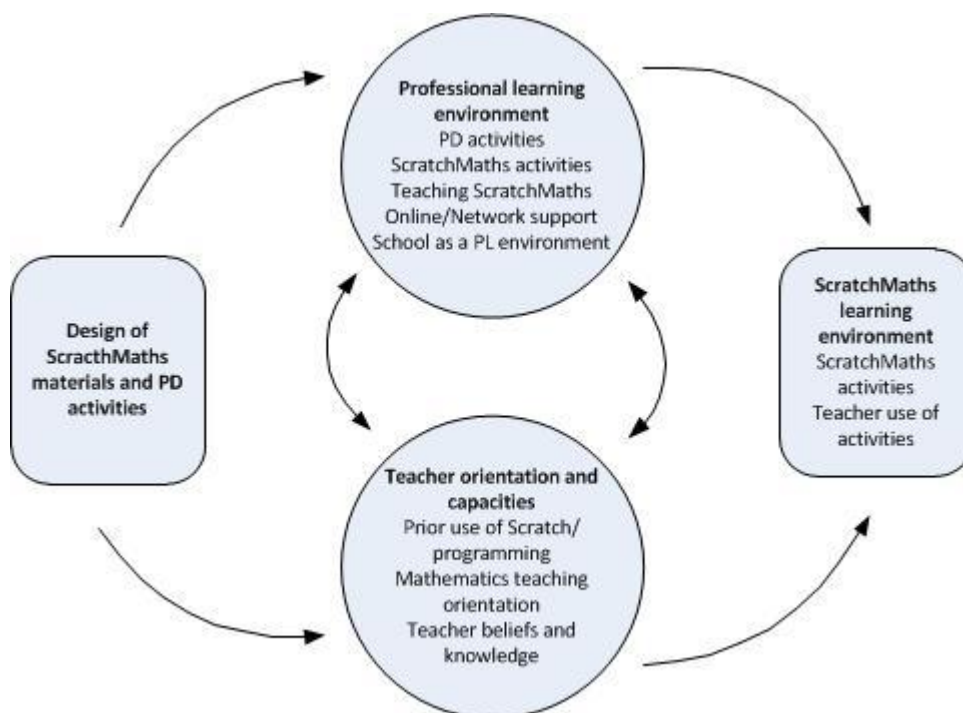
Figure 1 ScratchMaths and student learning



An important feature of the theory of change is the importance of teacher mediation. Whilst engagement in Scratch programming may lead to improvements in computational thinking, the direct effect on mathematical thinking is likely to be relatively weak. In order to enhance changes in mathematical thinking, teacher mediation is required. Teacher mediation refers to the role of teachers in making connections between computational thinking and Scratch programming and mathematics. This underlies the intervention design in which the main focus in Year 1 is on enhancing teaching in relation to programming and computational thinking, and developing materials and activities towards that goal. In Year 2 the main focus is linking programming learning and computational thinking to mathematical understanding. The project design is focused on developing mathematical thinking, which is one aspect of the capacities and knowledge that is assessed through KS2 Mathematics tests.

Figure 2 is an initial model of how the professional development and curriculum materials may lead to teacher change and create the ScratchMaths learning environment

Figure 2 ScratchMaths as a professional learning system



However, the way in which professional development and teachers' engagement in curriculum innovation leads to changes in knowledge, practice and beliefs is more complex than this. Firstly, because different aspects of the professional learning environment and the teacher orientation to this and their capacities are interconnected. Secondly, as can be seen from the diagram, the particular ScratchMaths learning environment a teacher instigates is itself an aspect of the teacher's professional learning environment. The model is of a set of nested systems (Opfer and Peddar, 2011). A more developed theory of change will be developed and explored during the project.

Research plan

Research questions

1. What has been the effect of the intervention on the development of pupils' mathematical skills as measured by a randomised control trial?
2. How can computational thinking be measured?
3. What correlation exists between measured computational thinking and mathematics attainment?
4. What has been the impact of the intervention on the development of pupils' computational thinking?
5. What conclusions can be drawn about the relationship between mathematical thinking and computational thinking?

6. To what extent does the design and delivery of curriculum materials and PD and the associated materials fit with the current knowledge base on effective PD in relation to mathematics teaching/computing?
7. What are the teachers' views on the effectiveness of the PD?
8. Were there any barriers to implementing Scratch, or were there particular conditions that needed to be in place for it to succeed?
9. In what ways can the PD delivery and materials be improved?
10. What issues of fidelity occur during the trial, and what is the security of the trial outcome (taking into account any use of Scratch in control schools?)

In addition to these research questions there will be an exploration through the process evaluation of the scalability of the trial.

Intervention pilot and development

During the first year of the project (2014/15), IoE will undertake a developmental year in order to design and trial materials for the intervention (both Y5 and Y6 materials), and associated PD. Up to five 'design schools' will be involved. The design schools will represent a range of school types and previous levels of engagement with Scratch programming. The pilot phase will involve:

- Review of the literature & available materials
- Collate, design & trial with the design schools a package of materials (teacher, student and PD) in preparation for the main trial focused on computational thinking (Y5) and mathematics and computational thinking (Y6)

Sheffield Hallam University (SHU) will not be actively involved in the trialling/design work but will be kept abreast of developments, and materials will be shared to support the final design of the trial and process evaluation.

The activities will be mostly developed before the main stage evaluation starts, although there can be some adjustment during 2015/16, following further work with the design schools. The degree of any changes will be recorded and reported as part of the process evaluation.

Development of the computational thinking measure

Parallel with development of the intervention during 2014/15, IoE will support SHU on the development of a computational thinking measure. A starting point for the development of the scale will be to draw on tasks developed for an international computing challenge – the

Beaver contest¹, an international initiative with the goal to promote informatics (Computer Science, computing) and computational thinking among pupils of primary, lower secondary and upper secondary stages. Each year the contest comprises of a set of tasks (items) of which some are directly related to computational concepts and computational practices.

Members of the SHU and IoE teams will meet in November 2014 to:

- Develop a shared understanding of IoE's operational definition of computational thinking as used in the intervention design, including identifying any discrete components to be measured
- Discuss a sample of Beaver questions. In addition, if needed, items will be drawn from relevant psychometric scales.

The CT measure design will be undertaken in 4 steps:

1. Step 1. Initial design -understanding IoE's CT approach, selection of questions from those identified with IoE, draft 1 of the scale.

2. Step 2 - trial of test items in two schools (60 Y5, 60 Y6 pupils) statistical analysis of items/scale, revise scale and revise test protocols.

3. Step 3 - test of revised scale plus focus on trial of protocols - 1 school (30 Y5, 30 Y6)

4. Step 4 - : Full test to establish the correlation between CT and KS2 with 6 schools (360 Y6 pupils). If we assume a moderate correlation (0.3) and a criterion for significance of .05 then this number gives a power of 0.80 for the analysis for the FSM pupils (which would constitute approximately 1/5 of the total pupils in the sample (approximately 65 FSM pupils). The power of the analysis for the general population would naturally be higher.

Each school in the CT design process would be offered the opportunity for two teachers to go to a one day and a separate half day professional development session run by Sheffield Hallam University on teaching computing in primary schools. There would be 9 schools in total involved. The schools will be recruited in the Sheffield City region and will not be involved in either the IoE design process or the RCT.

Randomised Control trial

Design

The research design is a Clustered Randomised Control Trial (CRCT) with 3 levels: pupils are clustered into classes which are clustered into schools. Schools will be randomised to either the treatment or a wait-list control group.

¹ Established in 2004, see <http://www.bebras.org> or <http://www.beaver-comp.org.uk> or <http://www.ibobor.sk/> it is now run in 30 countries. In 2013, more than 720,000 pupils took part in the contest.

Using details directly from participating primary schools and the Annual School Census, a stratification scheme will be used for randomisation at the school level. Detail on KS1 and KS2 Maths attainment, %FSM, whether a participating school uses setting for maths in Y5 or Y6 and the number of classes per year group will be used to create this stratification scheme. Within each of the strata, schools will be randomly selected into the treatment or wait-list control groups.

The trial will use a wait list design with the control schools Y5 teachers engaging in PD in the second year of the intervention and be free to use materials with their Y5 pupils. Children in Y6 in the control schools will not be able to receive the intervention in the second year in order that the control group is retained.

Participants and recruitment

The trial will involve the recruitment of approximately 115 schools. It is anticipated there will be drop out at the point of agreeing to trial protocols and the design aims for 100 participating schools at the point of randomisation (50 intervention, 50 control). The trial will involve two classes of Y5 pupils per school, and the same pupils when they progress into Y6. The target recruitment is for two-form entry schools wherever possible. If one-form entry schools were recruited it would add a further complication to the RCT design and potentially reduce the Minimum Detectable Effect Sizes (MDES). Recruitment of three or greater form entries would generate issues about sampling within schools and ethical issues in relation to participant selection. In addition, having the same number of Y5 classes will simplify UPN data collection and opt out consent as the whole year group will be involved.

Recruitment will begin during the design phase with the aim of identifying all schools by March 15th 2015. This will allow for signing of Memorandum of Understanding (MOUs), collection of pupils Unique Pupil Numbers (UPNs) and National Pupil Database (NPD) data retrieval prior to randomisation. IoE will identify 5 hub locations through discussion with National Association of Advisors for Computers in Education (UK) (NAACE). Recruitment will be undertaken by IoE with support from NAACE. Once schools have been recruited, SHU will collect UPNs for the focus cohort (Y5 in 2015/16) and other school and teacher level data as needed.

SHU and IoE will co-produce information including initial recruitment information, consent forms and MOUs for use with the schools. IoE will supply SHU with information on the recruitment process using the EEF participant flow diagram².

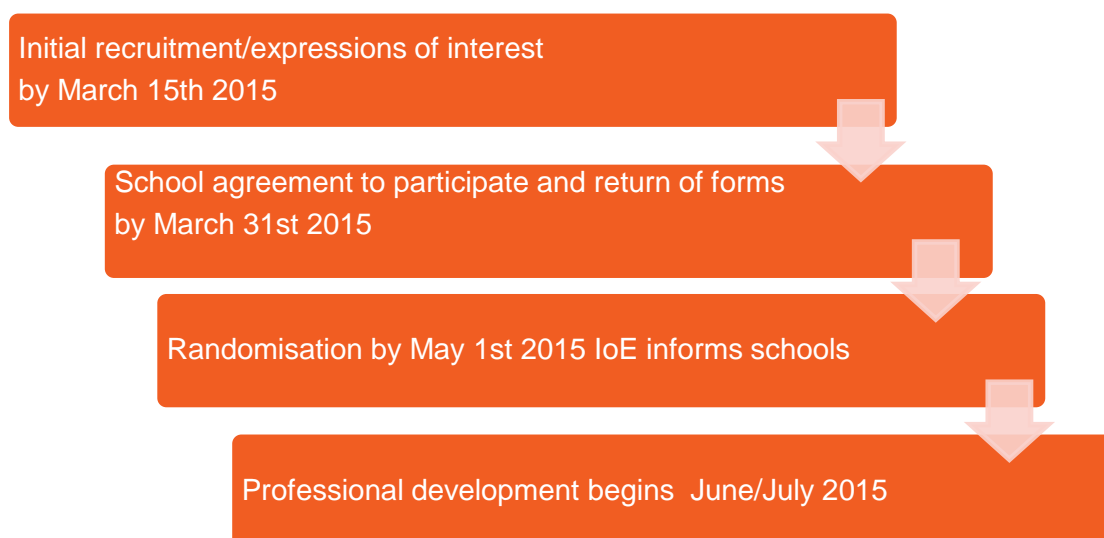
Schools will need to provide the following as a condition of being entered into the randomisation:

² http://educationendowmentfoundation.org.uk/uploads/pdf/Recruitment_pack_v2.0.docx_FINAL.pdf

- MoU signed by the head teacher. The MoU will include details of the requirements for the CT test in Summer 2016 and both IoE and SHU evaluation activities as well as information the school will be expected to supply
- Information on who would be attending the PD events if allocated to the intervention group
- Summary information on any previous use of Scratch programming, or engagement with Beaver tests (June 2015)
- Pupil lists for Y5 including UPNs
- Confirmation the school has sent out the parent opt-out consent form.

Figure 3 describes the process of recruitment to the start of professional development with dates.

Figure 3 Recruitment and allocation timeline



Outcome Measures

KS1 mathematics assessment data will be used as the pre-test, and will be retrieved from the NPD.

The primary outcome measure will be KS2 mathematics test scores at the end of Y6.

An intermediary secondary measure at the end of year 1 of the intervention will be a measure of aspects of computational thinking appropriate to the age range. This will be undertaken as an on-line test in June/July 2016. Measuring computational thinking at the end of year 1 will address the intended outcomes of the first year of the trial where the focus is on computing and computational thinking. In addition, it will allow analysis at the end of Year 2, of the relationship (if any) between measured differences in computational thinking and the impact on mathematics attainment.

The CT test will take place in June/July 2016.

Testing of pupils will be staggered, this is to accommodate schools' access to IT facilities and the potential need for support with log-in for pupils and IT support by SHU. It is envisaged that the CT test will take place over a 2 week period. The date and time of the test will be recorded and any evidence of impact of staggering the tests will be analysed. All Y5s in the schools will be tested, scoring will be undertaken through coding, and therefore the assessment will be blind. In the main trial, teachers will be responsible for invigilating the tests with a selection of schools being visited by SHU.

Outcomes of the analysis of the CT measure will be withheld from all schools and IoE until summer 2017 when the trial is complete.

The theory of change (see Fig 1) identifies that the intervention is intended to impact on mathematical thinking and this is a component of mathematical attainment, as measured by KS2 tests. Further, there will be wide variation in how closely related aspects of ScratchMaths will be to different aspects of the primary mathematics curriculum. A more fine grained analysis may be possible if a subset of KS2 tests questions were used. The KS2 tests framework³ (Standards and Testing Agency 2014). This would give a more sensitive measure of the impact of the intervention on specific areas of mathematics attainment. This could form part of an 'on treatment' analysis depending on the outcome of the trial and the availability of item by item analysis in 2017.

Sample size calculations

A power analysis was undertaken using the Optimal Design software and the findings are presented in Table 1. The research design is a multi-site (or blocked) clustered randomised control trial (MSCRT) with 3 levels (pupils nested into classes nested into schools).

The power analysis presents the Minimum Detectable Effect Size (MDES) for both the primary outcome (KS2 Maths at the end of Y6 in summer 2017) and the secondary outcome (computational thinking at the end of Y5 in summer 2016). For these MDES estimates a statistical power of 0.8 is adopted, it is assumed that 100 schools will be recruited, that two classes per school will participate in the trial and the average class size will be 20 pupils.

It is also estimated that 30% of the variation will lie at the school and class levels combined and that the stratification (or blocking) variable will account for 10% of the variation in the outcome variable.

A statistical power of 0.8 or 80% means that the research has been designed so that there is an 80% chance of detecting an effect (or difference) between the intervention and control group samples if a true effect exists. The Minimum Detectable Effect Size (MDES) is the smallest effect size that the research design would be able to detect as being statistically significant with a statistical power of 0.8. For example, an MDES of 0.23 indicates that a difference in the outcome scores of the intervention and control group of 0.23 standard deviations (or greater) would be identified as statistically significant with a statistical power of 0.8.

Table 1 sets out the estimated MDES for the primary and secondary outcomes of the Scratch programming clustered RCT.

³ Standards and Testing Agency (2014) Key stage 2 mathematics test framework: national curriculum tests from 2016. UTL

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/295174/2016_Key_stage_2_Mathematics_test_framework.pdf

Table 1: Estimated Minimal Detectable Effect Size (MDES) for planned analyses for Scratch programming RCT

Number of schools	100	
Number of classes (2 per school)	200	
Number of Pupils (20 or 30 pupils per class)	20 pupils per class (4,000 in total)	30 pupils per class (6,000 in total)
Computational Thinking Test (2015/16)		
Outcome Only	0.23	0.22
Including KS1 Maths (r=0.4)	0.21	0.20
KS2 Maths Attainment (2016/17)		
Outcome Only	0.23	0.22
Including KS1 Maths (r=0.5)	0.20	0.19
Including KS1 Maths (r=0.8)	0.15	0.14

For the secondary outcome (computational thinking at the end of Y5 in 2015/16) MDES estimates are shown for an outcome only analysis and one that includes KS1 maths attainment. The correlation between KS1 maths attainment and the computational thinking measure has been estimated as 0.4. This is a conservative estimate because the actual correlation is unknown until after the computational thinking test has been developed (by the end of 2014/15). It seems reasonable to assume that, for the secondary outcome (computational thinking) the research design will be able to detect an effect size of between 0.20 and 0.23 or greater with a statistical power of 0.8.

For the primary outcome, (KS2 maths attainment at the end of Y6 in 2016/17), MDES estimates are also shown for an outcome only analysis and one that includes KS1 maths attainment. The correlation between KS1 and KS2 attainment is estimated between $r=0.5$ (Armstrong, 1997) and $r=0.8$ (Fischer Family Trust, 2011). The value of using the KS1 maths attainment pre-test measure is evident from Table 1 when comparing the MDES for the analyses including this (g ranging between 0.14 and 0.20) with the outcome only analysis (0.22 to 0.23).

The MDES estimates in Table 1 have been conducted assuming an average class size of between 20 and 30 pupils. This provides an indication on the potential impact of attrition on the estimated MDES.

Analysis plan

Descriptive analyses of measures at baseline and the two outcome stages will be undertaken. The baseline analysis will examine how similar (or balanced) the intervention and control group samples are in terms of factors such as KS1 maths attainment, gender and FSM. To assess how attrition impacts on this balance, the baseline analyses will be replicated on the sample with complete baseline and outcome measures. For example, the average KS1 maths attainment for the control and intervention group samples might be similar at baseline but significantly different amongst the subsample completing the trial⁴.

Following descriptive analyses, a multilevel analysis will be undertaken for both primary and secondary outcomes. For the main, impact analyses, three pupil-level explanatory variables (KS1 maths attainment, FSM and gender) will be included along with the school-level variable identifying the intervention and control groups. The MDES estimates in Table 1 relate to these main effects models.

Following the main effects models, interaction terms will be included to explore evidence of the programme having a differential impact amongst pupil groups (specifically, FSM / not FSM and male / female.) Separate subgroup analyses will be run on FSM and non-FSM subsamples regardless of whether the interaction term is significant. Similar male and female subgroup analyses will be undertaken if the gender intervention interaction term is found to be statistically significant.

Finally, a fidelity analysis will be undertaken amongst the intervention school sample. Measures of fidelity will be collected at the teacher level and include attendance of PD events and use of materials. Multilevel models will examine whether fidelity significantly accounted for variation in the outcome variables. Depending on the outcome of the fidelity analyses, additional 'on-treatment' analyses may be undertaken. For example, if engagement with the intervention (as captured by the measures of fidelity) was found to have a statistically significant impact on the outcome variable, an 'on-treatment' analysis would be included in addition to the main 'intention to treat' impact analyses.

Process evaluation methods

IoE will conduct a 'curriculum design'⁵ evaluation, and SHU will conduct a process evaluation. Regular contact between SHU and IoE will ensure that evaluation activities will be co-ordinated. The IoE's design evaluation will focus on how the curriculum materials are used by teachers and engaged with by students as well as observed qualitative outcomes of this. In addition, teachers engagement' with professional development and the outcomes of

⁴That is, excluding pupils who might 'opt out' of participating in the trial.

⁵ The curriculum design evaluation refers to the project as a whole and not only to the design year.

this will be identified by IoE. The focus of the curriculum design evaluation will be to inform the refinement of the intervention and to understand its effects.

The SHU process evaluation will examine how the intervention is conducted and also develop an independent view of the materials and the PD, including teachers' views on it. The process evaluation will validate the IoE's analysis of professional learning. It will also address issues of fidelity, validity of the trial and scalability of the intervention.

The process evaluation aims during the design year: to provide an independent view on the process of the design of the curriculum materials and associated PD activities and the IoE's evaluation of these, and to provide guidance to the project team on ensuring that the intervention approaches, materials and training will be replicable and testable through a randomised control trial.

The process evaluation aims during the Intervention year are to evaluate the reliability and validity of any identified impact through a process evaluation that will identify issues of fidelity and scaleability, in particular the barriers and necessary conditions for successful implementation.

At a meeting in November 2014, SHU and IoE teams will meet in order that SHU understands IoE's plan for the 'curriculum design' evaluation to inform the process evaluation and ensure there is no replication and that schools are not overburdened. In addition, the teams will review and further develop the theory of change to inform the process evaluation

SHU will draw on IoE's data and evaluation where possible, and provide an external view on the conclusions drawn from it, using this to inform an assessment of the validity and reliability of the RCT outcome.

The following data/materials will be required from IoE to support the process evaluation:

- The summary design evaluation report at the end of the design year
- Copies of training and curriculum materials for Y5 and Y6 teachers by Sep 2015 ,the start of 2015/16 (and any adjustments to the Y6 materials by the start of 2016/17)
- Information on recruited schools and teachers prior to randomisation: address, head teacher, chair of governors.
- Information before start of intervention of the 2 teachers participating in the first year of the trial and the 2 teachers participating in Year 2. In addition base line information about existing use of Scratch should be collected.
- Attendance records of teachers at PD events

- Notes on notable issues related to delivery of PD
- Records of any issues that might affect fidelity: e.g. any changes to the teachers who deliver the interventions; record of teacher use of the materials (quantitative summary, this would include information on whether the materials are taught by someone other than the class teacher)
- Summaries of participation in on-line activity (quantitative data on who, when, frequency).

The table below gives detail of process evaluation methods.

Table 2

Year	Activity	Details
Pilot and design 2014/15	Review of IoE design evaluation	Summary outcomes of data collected during the design phase by IoE will be reviewed. This will inform design of the process evaluation tools, Collection of data on school and teacher profiles during recruitment phase.
Intervention with Y5 2015/16	<p>Visit to two Professional Development events - first and second day of training in two separate hubs.</p> <p>Telephone interviews with 10 teachers in intervention schools.</p> <p>Survey of all teachers in the intervention and control schools.</p> <p>In MOU?</p>	<p>Observation of PD, informal discussion if possible with teachers and PD leaders - key foci fidelity in use of PD materials, the nature of the PD used.</p> <p>Semi-structured interviews focused on: experience of PD, key professional learning outcomes, use of curriculum materials, changes in practice. Key foci on fidelity in use of curriculum materials.</p> <p>Collect data on any other practices/activities that might influence computational thinking and/or mathematics e.g. other interventions. For intervention teachers, evaluation of PD and curriculum materials, affordances and barriers to engagement.</p>

	Review of IoE design evaluation data.	<p>Identify any issues that might affect balance. Also use of online or additional support.</p> <p>Additional data sources on fidelity will inform design of evaluation tools for the following year.</p>
<p>Intervention with Y6 2016/17</p>	<p>Visits to 3 PD events (hubs not visited the previous year).</p> <p>Telephone interviews with 10 teachers in intervention schools.</p> <p>Survey of all teachers in the intervention and control schools.in Mou</p>	<p>Observation of PD, informal discussion if possible with teachers and PD leaders - key foci fidelity in use of PD materials and the nature of the PD used.</p> <p>Semi-structured interviews focused on: experience of PD, key professional learning outcomes, use of curriculum materials, changes in practice. Key foci on fidelity in use of curriculum materials. Identify issues of school level professional learning community.</p> <p>Collect data on any other practices/activities that might influence computational thinking and/or mathematics e.g .other interventions. For intervention teachers: evaluation of PD and curriculum materials, affordances and barriers to engagement. Identify any issues that might affect balance. Also use of online or additional support.</p>

Personnel

Institute of Education

Professor Richard Noss: Principal Investigator

Overall Project Investigator and responsibility for delivery of all outcomes. Overseeing project to ensure recruitment, quality of provision and implementation, CPD. consistency of

aims and methods for CT and for Mathematics, ensuring the design research and work in schools provides evidence of the key pedagogical and teachers factors that underlie any success

Professor Celia Hoyles: Co-Principal Investigator

Particular responsibility for mathematics CPD; qualitative outcomes & reports, managing (with NAACE) the (complex) logistics of training in hubs, outward-facing liaison with schools, teachers, dissemination in general (e.g. with policy-makers)

Professor Ivan Kalas: Co-Investigator

Responsible for literature review (in particular Beaver texts published in Slovak or Czech languages), responsible for design & drafting all Scratch tasks, build a selection of Beaver tasks (used in previous years) and extend this selection by several Beaver-like tasks, validation of Beaver tasks; participate in the development of the pilot 'computational thinking measure', co-ordination of design evaluation,

Professor Dave Pratt: Co-Investigator

Responsible for literature review of a research with Scratch, responsible for final design & validation of Scratch tasks (& design of maths Scratch tasks, both with IK); aligning the design evaluation and the process evaluation, in relation to fidelity measures and school level data collection drafting qualitative reports of first intervention

Research Assistant tba

Provisional: Responsible for day-to-day liaison with schools, data collection, analysis under supervision, implementation of training as designed for treatment & control, alignment of tasks and activities with school curricula and practice, assistance to teachers in CPD sessions for technical and organizational issues

James O'Toole, Project Manager

Responsible for financial control, maintenance of databases, design of website and maintenance, organization of school visits, liaison with external bodies, coordination of staffing.

IOE PhD students:

Piers Saunders

Johanna Carvajal

Naace

Mark Chambers: CEO

Responsible for recruitment & leading the design of training & the training team (for all treatment teachers and for control teachers)

Advisory Group members

Professor Janet Ainley, University of Leicester

Miles Berry, University of Roehampton

Joe Halloran, Lambeth City Learning Centre

Gillian Ingram, Manager, Camden City Learning Centre

Debbie Morgan, Director for Primary, National Centre for Excellence in the Teaching of Mathematics

Dr. Mary Webb, King's College London

Sheffield Hallam University

Dr Mark Boylan: Evaluation Project director/PI

Sean Demack: Lead statistician

John Reidy: CT measure design

Anna Stevens: analysis of pupil progress, trial management of the CT measure

Claire Wolstenholme: Project manager.

Professor Hilary Povey: Programming in Mathematics advisor and process evaluator.

Phil Spencer: Computer Science in Primary advisor.

Ian Chesters, Administrator will provide administrative support.

In addition other Research Fellows will support the collection of UPNs from schools and the management of the CT test

Risks

Main issues or risks to the evaluation and how they would be addressed:

Risk	Assessment	Countermeasures and contingency plan
Intervention insufficient in scale and time to impact on pupil attainment	Likelihood: medium Impact: High	Impact evaluation designed across 2 years to minimise this impact. Ensure that scale of intervention allows for an RCT of sufficient sensitivity and power

Risk	Assessment	Countermeasures and contingency plan
Developer fails to recruit sufficient schools for control and intervention	Likelihood: medium Impact: High	Begin recruitment process at start of design year. Design year is a full year. If numbers below target, re-design RCT to have unequal number of intervention and control schools
Insufficient Beaver items or unsuitable items to construct CT measure	Likelihood Medium Impact Medium	Use items from other related psychometric scales
Delays in access to pupil data	Likelihood: Low Impact: High	Sufficient lead in ensures sufficient time for access of base line data.
Curriculum and PD design evaluation during pilot year indicates that the intervention is not workable	Likelihood: <i>low</i> Impact: High	Early identification of issues and dialogue with EEF to review continuation to intervention
Data protection and ethics issues	Likelihood: Low. Impact: High.	Robust data protection and ethical procedures are in place at SHU and CEE and data sharing protocols will be established
Staffing issues: staff leaving/unavailable	Likelihood: Low (turnover low) Impact: High.	Succession planning has been built into team roles and additional capacity within CEIR to replace all roles.
Project management and partnership working issues	Likelihood: Low Impact: High	Directors and project manager highly experienced in successful project management. Well-developed project procedures.

The trial will be subject to ethical approval by both SHU and IoE's ethics processes. NPD data will be subject to NPD protocols about data sharing.

Procedures are in place to comply with the 1998 Data Protection Act. No information about any identified individual will be reported or made available to anyone beyond the project

teams. All data will be stored anonymously and securely. Consent forms, participant information, and digital recordings will be stored separately from transcripts and case reports. In disseminating findings, names of respondents will appear as pseudonyms, and any other potentially identifying data will be anonymised. Personal data is only stored on encrypted portable media in password-protected files (and only when absolutely necessary). To the best of our knowledge, both Universities confirm to the principles of ISO/IEC 27001

Timeline

Sheffield Hallam University: external evaluation

The evaluation timeline below will be amended when more detailed information is provided on the project timeline and evaluation activities being undertaken by IoE.

	May-Jul	Aug-Oct	Nov-Jan	Feb-Apr	May-Jul	Aug-Oct	Nov-Jan	Feb-Apr	May-Jul	Aug-Oct	Nov-Jan	Feb-Apr	May-Jul	Aug-Oct	Nov-Jan
1. Evaluation of design and pilot															
Inception															
Collect and analyse internal evaluation data															
Process evaluation activity															
School MoU and data collection															
Development of CT measure: Design Wave 1															
Development of CT measure wave 2															
Development of CT measure wave 3															
CT correlation with KS2															
2. Main trial year 1															
Recruitment															
Randomisation															

2X visits to PD events					J/J											
X10 Telephone interviews with teachers in project																
Survey(s) of participants (control and intervention)																
CT Testing																
Retrieval and analysis of pupil data																
Review and analysis of internal evaluation data																
3. Main trial year 2																
3 X visits to PD events																
10X Telephone interviews with teachers in project																
Survey(s) of participants (control and intervention)																
Review and analysis of internal evaluation data																
4 Analysis and reporting																
Retrieval of pupil data																
RCT analysis																
Reporting																

IOE timeline

Sept 2014- Apr 2015	Phase 1: Setup <i>Design 1</i>	<ul style="list-style-type: none"> Project team develop the CT & ScratchMaths interventions and PD in conjunction with 5-London based 'design schools'. CT measure (finalised SHU)
Jan 2014- March 31st 2015	Phase 1: Setup <i>Recruitment</i> Inform schools as to whether trial or control between May 1st- 7 th 2015 Cont'd.	<ul style="list-style-type: none"> Recruitment of 100 2-form entry schools (115 to allow for attrition), 2 teachers per school, with 23 schools across 5 English hubs, (only one in London). Recruitment events, one per hub Set up online community in each hub Schools will be randomized by SHU into 50 treatment and 50 control schools (May 1st 2015 half-term)
June 2015	Phase 2: Training 1	<ul style="list-style-type: none"> 2 days training of treatment school teachers in each of 5 hubs, 2 teachers per school (one year 5 teacher /one ICT coordinator) trained in CT intervention. After SATS, with couple of weeks between training days.
Sept 2015 – Apr 2016	Phase 3: Delivery 1	<ul style="list-style-type: none"> Treatment schools deliver the CT intervention to Year 5 pupils, coordinated by hubs. Observation interviews to research causal mechanism.
October 2015	Phase 3: Design 2	<ul style="list-style-type: none"> ScratchMaths intervention finalized and PD.
May 2016	Phase 4: Testing 1	<ul style="list-style-type: none"> Testing using CT measure with Year 5s in treatment schools (SHU)
June 2016	Phase 4: Training 2	<ul style="list-style-type: none"> 2 days training for treatment schools. 2 Year 6 teachers per school, in ScratchMaths intervention across the 5 hubs (again with a week or so between each day) Training in CT in Control schools

Sept 2016- Apr 2017	Phase 5: Delivery 2	<ul style="list-style-type: none"> • Treatment schools deliver ScratchMaths intervention to Year 6 pupils (Y5 from last year) • Observation interviews to research causal mechanism • Control schools teach CT intervention to Year 5
May 2017	Phase 5: Testing 2	<ul style="list-style-type: none"> • Final post-test, KS2 maths in all treatment schools

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