Gender Balance in Computing

Evaluation of the Informal Learning: Code Club intervention

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Executive summary

Overview of the project

Computing has a decades-old problem with gender imbalance with limited reliable evidence of what works in closing the gap.[1] This gender imbalance begins during schooling. In 2020, only 21% of pupils taking GCSE Computer Science were female.[2] The Gender Balance in Computing Project (GBIC) aims to tackle a number of known and well-researched barriers to girls engaging with computing. For this project, The intervention being evaluated in this report focused on strengthening the links between non-formal computing learning and studying computing more formally within school (for GCSE or A-Levels). Female pupils tend to be better represented in non-formal computing clubs as opposed to within traditional classroom settings. This intervention aimed to address the barrier of female pupils not being aware of how their informal learning about computing can help them with more formal study.

The GBIC programme has been funded by the Department for Education (DfE), with the Raspberry Pi Foundation (RPF) serving as the primary delivery organisation and the Behavioural Insights Team (BIT) acting as independent evaluators. This report details the evaluation of an intervention in the Informal Learning strand of the programme, where the aim was to improve girls' attitudes towards computing. Pupils in Year 4 to Year 6 (age 8-11) attended a 12 week Code Club programme, with a focus on increasing awareness on how studying computing informally can support pupils in more formal computing study.

The Code Club programme includes a number of different modules using Scratch, HTML & CSS, Python and the micro:bit. Each module is made up of several activities all designed to develop different skills, which pupils would be encouraged to work through during their sessions. The Code Club + group's materials contained extra activities for the pupils to work through, which showcased various skills developed in computing and the skills needed for specific computing careers. The materials aimed to apply the behavioural science concept of endowed progress, as well as increasing pupils' confidence in their own abilities and skill development in relation to computing.

Evaluation approach

The intervention was evaluated using a mixed-methods approach. The quantitative impact evaluation investigated whether there was evidence that the intervention impacted (i) girls' attitudes towards computing and (ii) girls' stated intention to study computing in the future. In parallel, an implementation and process evaluation (IPE) was conducted to explain the

[1] Royal Society. (2017) After the reboot: computing education in UK schools. https://royalsociety.org/~/media/policy/projects/computing-education/computing-education-report.pdf

[2] Joint Council for Qualifications (2021) "GCSE (Full Course) Results Summer 2021 - Outcomes for key grades for UK, England, Northern Ireland & Wales, including UK age breakdowns". Available at: https://www.jcq.org.uk/wp-content/uploads/2021/08/GCSE-Full-Course-Results-Summer-2021.pdf

impact evaluation findings and explore implementation processes and possible mechanisms of change in targeted outcomes.

An initial run of this intervention and evaluation was conducted between December 2019 and March 2020, and was disrupted by COVID-19. The second run of the intervention and evaluation was launched in October 2021 through to February 2022. In both runs, the programme was delivered to English school pupils in Years 4, 5, and 6, by their teachers.

Impact evaluation

The impact evaluation design was a two-arm cluster randomised controlled trial (RCT), randomised at the school level with outcomes measured at the pupil level. The two arms of the trial were:

1. **Code Club intervention**: Schools in this arm received the standard RPF designed Code Club resources, which included five modules covering different coding languages and was designed to run over 12 weeks.
2. **Code Club + intervention**: Schools in this group received the same base materials as the Code Club group, however their resources also contained extra activities embedded within the materials, which aimed to highlight the links between non-formal and formal learning.

The primary outcome was measured using the Student Computer Science Attitude Survey (SCSAS), a survey tool for assessing attitudes toward computing for school pupils. The secondary outcome was intention to study computing in the future, measured using a self-report survey question. 143 schools were originally recruited to participate in the trial and 33 completed it (submitted endline survey data), in addition to 21 schools that had completed an initial run of this trial in 2020.

Implementation and process evaluation

The IPE was conducted alongside the impact evaluation and aimed to answer the following research questions:

1. What are the barriers and facilitators to implementation of the intervention?
2. What range of factors help and hinder girls' engagement with the intervention?
3. How does engagement with the intervention vary between girls and boys?
4. What range of factors influence girls' attitudes towards curricular computing education?
5. What range of factors influence girls' participation in curricular computing education?

BIT conducted case studies at four Code Club + primary schools during January 2022. The range of research activities varied across schools as a result of logistical challenges raised by COVID-19. Interviews were conducted with teachers leading the Code Club in all four schools, and aimed to understand their experiences of delivering the intervention and any perceived impacts on their female pupils. We were also able to observe Code Club sessions at two of the schools and conduct a pupil discussion group at one school. This allowed us to see the intervention in action and hear from pupils regarding their own experiences.

Key findings

Evidence of impact

We did not find a statistically significant effect of the Code Club + intervention on girls' attitudes towards computing or intention to study computing in the future relative to the Code Club intervention. However, the estimated treatment effect of the Code Club + intervention relative to the Code Club intervention was positive for each outcome, and the differential attrition observed suggests that this difference may be an underestimate of the true effect. However, the high rate of overall attrition does not allow us to distinguish this effect from one that could have been produced by chance.

Implementation and process evaluation

The IPE findings suggest that whilst Code Clubs were well received by teachers and pupils, the Code Club + materials may not have been delivered consistently across all schools, which may have limited impact on pupils relative to Code Clubs.

Across the four case study schools, teachers were overwhelmingly positive about the engagement their pupils showed during the Code Club sessions. This was also clear during the observations and pupil discussion group. However, of the teachers interviewed, only one was able to talk in detail about the Code Club + materials and to describe their pupils spending time on those activities. This implied that the Code Club + intervention may not have been delivered as intended within schools, limiting its potential impact on pupils.

Case studies highlighted teachers' and pupils' positive perceptions of the Code Club + sessions. They also pointed to implementation challenges and barriers which if experienced at other schools in the sample, may have limited the impact of the intervention on girls' measured outcomes. In addition to these implementation challenges, a factor that may limit the scope for impact of the Code Club + intervention is the already high engagement with Code Club intervention and pre-existing interest in computing.

It should be noted that the number of case study schools for the IPE is small and that not all case study schools were able to take part in all the research activities. The IPE findings should be viewed as an example of the range of experiences of some schools, but not generalised across all the schools involved in the programme. Further, the COVID-19 context likely posed important challenges to the delivery of the intervention.

Recommendations to refine the design and delivery of the Code Club + intervention

The following adaptations to the intervention may help to respond to the main implementation challenges identified and make it easier to implement it in a broader range of schools:

1. **Make the activities linking informal and formal learning more salient**
   Tweaking some of the Code Club + materials to require more engagement or thought from pupils could be useful; one teacher suggested that the skills sorting game

should require pupils to write out the definition of the skill before sorting it, to ensure they really understood.

2. **Allow teachers to view their pupils' progress through the Code Club materials**
   This would allow teachers to know what activities and modules their pupils had completed and ensure they engaged with the Code Club + materials.

Recommendations to support implementation of Code Clubs

The following steps could make the Code Club intervention easier for teachers to implement within schools:

3. **Ensure that teachers are familiar with the Code Club + activities ahead of launching the Code Clubs. This could be achieved by holding a mandatory training session**
   One option could be to only share the resources with teachers once they have attended a training session; this would allow teachers to understand the purpose of the extra Code Club + activities and allow them to support pupils better to complete them.

4. **Continue to share and publicise Code Club materials to school communities**
   Throughout the case study schools, teachers and pupils enjoyed their time within Code Clubs, with all the pupils sharing how fun they found it and the things they had learnt. The resources were said to be high quality and easily accessible in terms of only needing a computer to be involved, therefore a positive option to help maintain pupils' enjoyment of computing via coding. The materials also appeared to be accessible for teachers who had not come from a computing background.

5. **Incorporate more role models into the Code Clubs**
   Several teachers noted the importance of female role models who are positive towards computing, for helping female pupils feel more positive about computing. One teacher suggested asking volunteer parents to attend Code Clubs could be helpful in widening the role models pupils have.

Broader recommendations

6. **Identify strategies to measure outcomes targeted by the intervention further into the future**
   Tracking relevant behavioural outcomes (in this case, subject choice from Year 10 onwards) multiple years after the intervention requires planning, collaboration with schools, longer and more flexible evaluation timelines. However, it would also significantly improve the ability to evaluate the impact of early interventions over a time horizon in line with the mechanisms and barriers hypothesised, and thus identify the most impactful ones.

7. **Continue to refine survey tools and support schools to administer them to maximise data reliability and reduce attrition**
   While possible improvements in the COVID-19 context in schools should facilitate future evaluations, doing additional small-scale piloting of survey tools and identifying ways to support schools with data collection (e.g., appointing staff to visit schools to help administer the survey), while resource-intensive, could be a cost-effective way to reduce attrition and increase data quality, thereby enabling a more precise diagnosis of the effects of the interventions and how to maximise them.

8. **For any future adaptations or new interventions, consider additional small-scale piloting to refine delivery prior to a full-scale impact evaluation**
   Piloting interventions in school is complicated given the school staff involvement and coordination with schools it requires, particularly in the recent COVID-19 context. However, the possible improvements to the delivery of both interventions identified through the IPE illustrate the value of small-scale piloting to inform improvements to the impact potential of any intervention before moving to a full-scale impact evaluation. Where possible, strategies to evaluate interventions at incremental scale and cost should be explored to maximise learning and resource efficiency.

1. Background

1.1 Gender Balance in Computing

Computing has a decades-old problem with gender imbalance with limited reliable evidence of what works in closing the gap.[3] This gender imbalance begins during schooling. In 2020, only 21% of pupils taking GCSE Computer Science were female.[4]

The Gender Balance in Computing Project (GBIC) aims to address a number of known and well-researched barriers to girls engaging with computing, including a mismatch of teaching approaches to pupil learning styles; a lack of encouragement to study computing; a lack of familial and other role models in computing; a perceived lack of relevance of computing to pupils; and *a disconnect between extra-curricular computing activities and subject choices*. These barriers are addressed in the five intervention strands which comprise GBIC, with the common goal of increasing the number of girls who study GCSE and A Level Computer Science.

The intervention being evaluated in this report focused on the last barrier described above, addressing the **disconnect between informal and formal learning pathways.**

1.2 Informal Learning Programme

The effects of participation in after-school clubs such as Code Clubs are not well understood.[5] Nevertheless, Code Clubs already have a good gender balance (annual survey found 41% of attendees are girls) and a set of female participants who are likely to form a key part of the cohort interested in studying computing, and who have a social network of other girls who participate.[6] Therefore, understanding how to use participation in Code Clubs as a way of increasing girls' pursuit of formal computing education is a promising avenue for improving the gender balance in computing.

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[3] Royal Society. (2017) After the reboot: computing education in UK schools. https://royalsociety.org/~/media/policy/projects/computing-education/computing-education-report.pdf

[4] Joint Council for Qualifications (2021) "GCSE (Full Course) Results Summer 2021 - Outcomes for key grades for UK, England, Northern Ireland & Wales, including UK age breakdowns". Available at: https://www.jcq.org.uk/wp-content/uploads/2021/08/GCSE-Full-Course-Results-Summer-2021.pdf

[5] Straw, S., Bamford, S., & Styles, B. (2017). Randomised Controlled Trial and Process Evaluation of Code Clubs. *National Foundation for Educational Research and the Raspberry Pi Foundation.* Available at: https://www.raspberrypi.org/app/uploads/2017/03/Randomised-Controlled-Trial-and-Process-Evaluation-of-Code-Clubs.pdf

[6] Leadbetter, K., Hazeldean, D., & Quinlan, O. (2018). Code Club Annual Surveys 2017. Available at: https://www.raspberrypi.org/app/uploads/2018/05/Code-Club-Annual-Surveys-2017.pdf.

One of the key barriers identified in the logic model for the intervention evaluated in this study (see figure 4) is that *female pupils who participate in informal learning (in this case, Code Clubs) may not recognise this learning as computing* and therefore participation in informal learning may not optimally translate into choosing to study computing in formal education. The overarching aim of this trial was to explore whether exposure to Code Club lesson material that explicitly links informal learning to formal computing education can increase interest in formal computing education, relative to regular Code Club material.

Code Club intervention

The intervention evaluated focused on informal learning, which includes after-school programmes such as Code Clubs. Code Clubs are a volunteer-led programme where children aged eight to thirteen are taught practical coding skills in an informal environment outside of school. Code Clubs currently have a wide reach in primary and some secondary schools.

The solution developed by RPF to address this barrier is lesson material to be delivered via Code Clubs in primary schools, with a focus on linking participation in Code Clubs to formally studying computing. The material applies the behavioural science concept of endowed progress. By emphasising that girls have already made progress towards a goal (in this case, studying computing), they may be more likely to ultimately achieve that goal.[7] Additionally, if a girl has a lack of self-confidence and doesn't see themselves as someone who is "good at computing", then letting them know that they are already succeeding (and enjoying) elements of computing education should lead to an increase in computing confidence, which may in turn translate to an increase in the number of girls studying computing in formal settings

Regular Code Club programme ("Code Club" intervention)

The Code Club programme, developed by RPF, lasted for 12 weeks and was delivered to English school pupils in Years 4, 5, and 6, by their teachers. The Code Club programme includes a number of different modules using Scratch, HTML & CSS, Python and the micro:bit. Each module is made up of several activities all designed to develop different skills, which pupils would be encouraged to work through during their sessions. Schools are traditionally able to access these resources by launching a club and registering it with RPF. See figure 1 for an image of the Scratch module 1 homepage. Some teachers within our IPE sample were familiar with RPF resources having accessed their materials in previous Code Clubs or within lessons and training.

Teachers were provided with a welcome pack ahead of the programme launch, as well as additional support from RPF throughout. Teachers were given access to the content online and were then able to share the materials face to face with pupils during Code Club sessions.

[7] Nunes, J.C., & Dreze, X. (2006). The Endowed Progress Effect: How Artificial Advancement Increases Effort. *Journal of Consumer Research*, 32(4), 504-512.

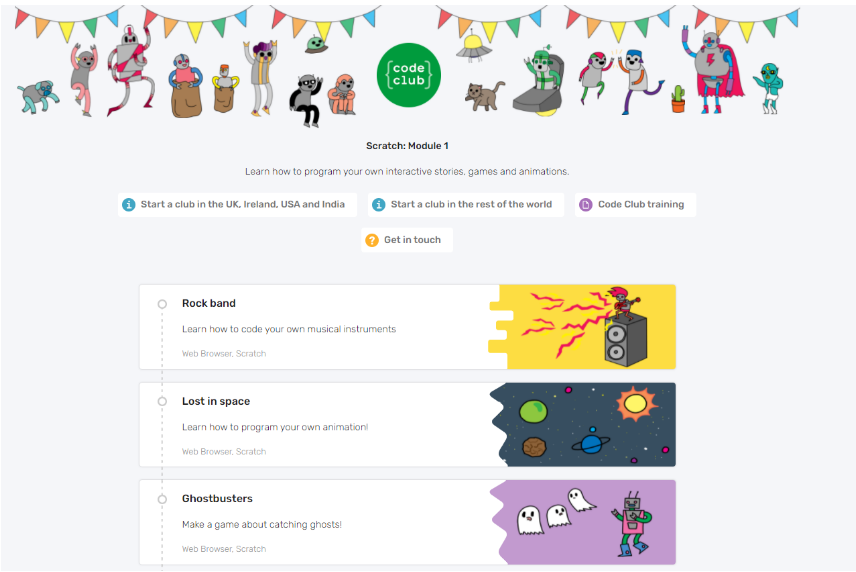

Figure 1: Screenshot of normal Scratch 1 module homepage

Code Club with added informal learning materials ("Code Club +" intervention)

RPF also developed an alternative version of the Code Club resources with additional materials aiming to more explicitly link the informal learning in Code Clubs to formal academic computing study. These materials were built into the same modules as above, but with a slightly different user interface which aimed to create more of a sense of progress between each activity. The additional materials included:

- **Starter activity**: i) An animation called 'Skills in careers that involve Computing', ii) A game called 'Skills Sorting'
- **Midway activity:** An animation called 'Skills link to Careers in Computing' (featured different careers paths within computing, each module contained information about a different career)
- **Plenary activity:** i) Repeat of the 'Skills sorting' game, ii) Postcard activity, which asked pupils to write to a friend about Code Club and what skills they have learnt (see figure 2)

Each activity was suggested to take around 20 minutes meaning the additional material took around an hour to complete in total. Other features of the intervention included a progress bar between each activity in a module, which became filled with the different skills a pupil had developed as they progressed (see figure 3).

All the activities within the modules were intended to be completed by pupils individually, apart from the 'Skills in careers that involve computing' animation, which could be watched individually or in groups. Teachers could act as facilitators, in terms of reading aloud the text to pupils if needed. The main criteria outlined by RPF was that once a pupil had selected the module, they needed to work through the activities chronologically and not skip any of the activities. Teachers' roles within the clubs was to support pupils with accessing the various modules, ensure they completed all the activities and in the correct order, and support pupils with technical coding help when needed.

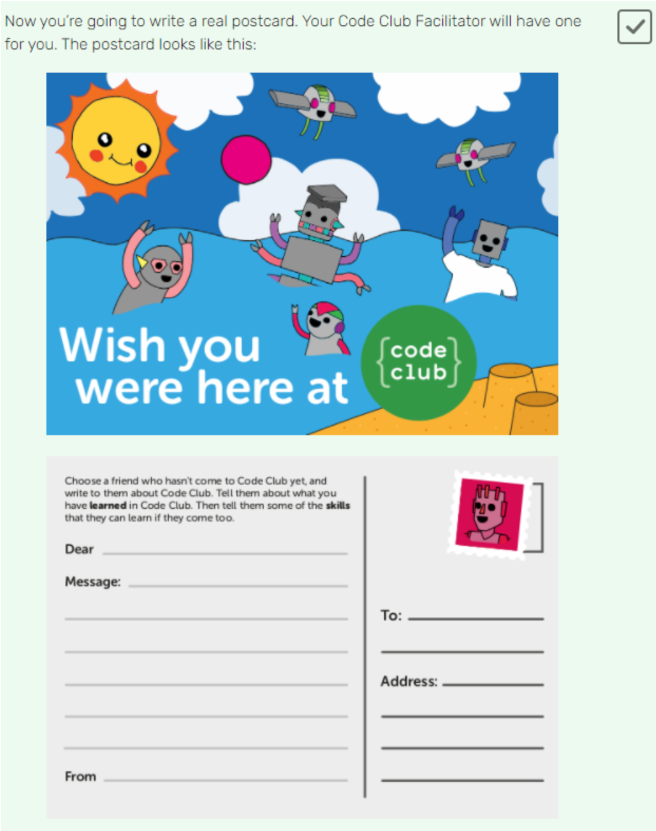

Figure 2: Screenshot of the postcard plenary activity

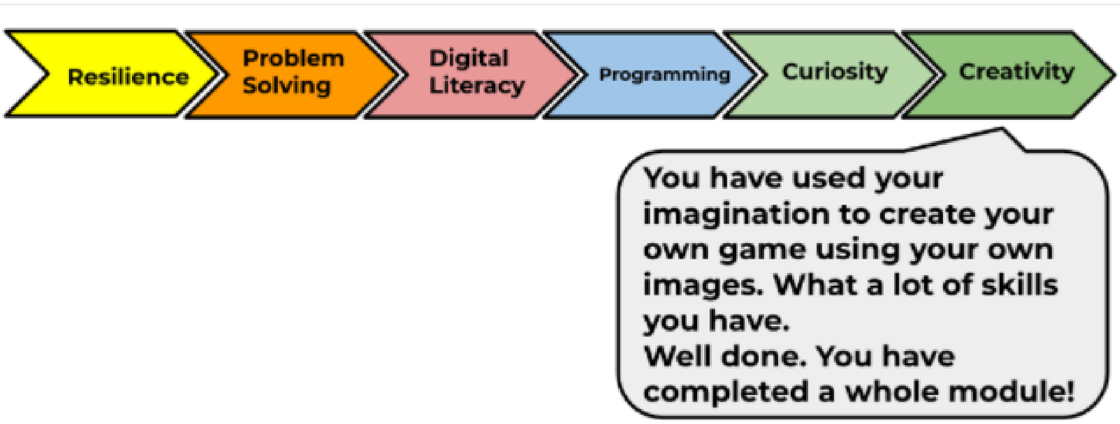

Figure 3: Screenshot of progress bar

The logic model (see Figure 4) was developed through discussions between the RPF team and BIT evaluators. It illustrates the hypothesised mechanisms through which the Informal Learning intervention (Code Club +) would affect the intended outcomes of girls' attitudes towards computing and intention to study computing. The key barrier that the intervention was designed to address is that female pupils who participate in informal learning (in this case, Code Clubs) may not recognise this learning as computing and therefore participation in informal learning may not optimally translate into choosing to study computing in formal education. The intervention aimed to strengthen the link between informal learning computing activities and formal computing study in order to address this barrier.

An initial run of this intervention and evaluation was conducted between December 2019 and March 2020, and was disrupted by COVID-19. The second run of the intervention and evaluation was launched in October 2021 through to February 2022. The IPE research activities took place within schools in January 2022.

1.3 GBIC partners

The Behavioural Insights Team (BIT) partnered with the National Centre for Computing Education – run by a consortium comprised of STEM Learning, the British Computer Society (BCS), and the Raspberry Pi Foundation (RPF) – for this project, combining the extensive experience of organisations who have computing at the core of their mission with expertise in designing and evaluating interventions. The funding body for this programme as a whole is the Department for Education (DfE), and BIT fulfils the role of an independent and external evaluator.

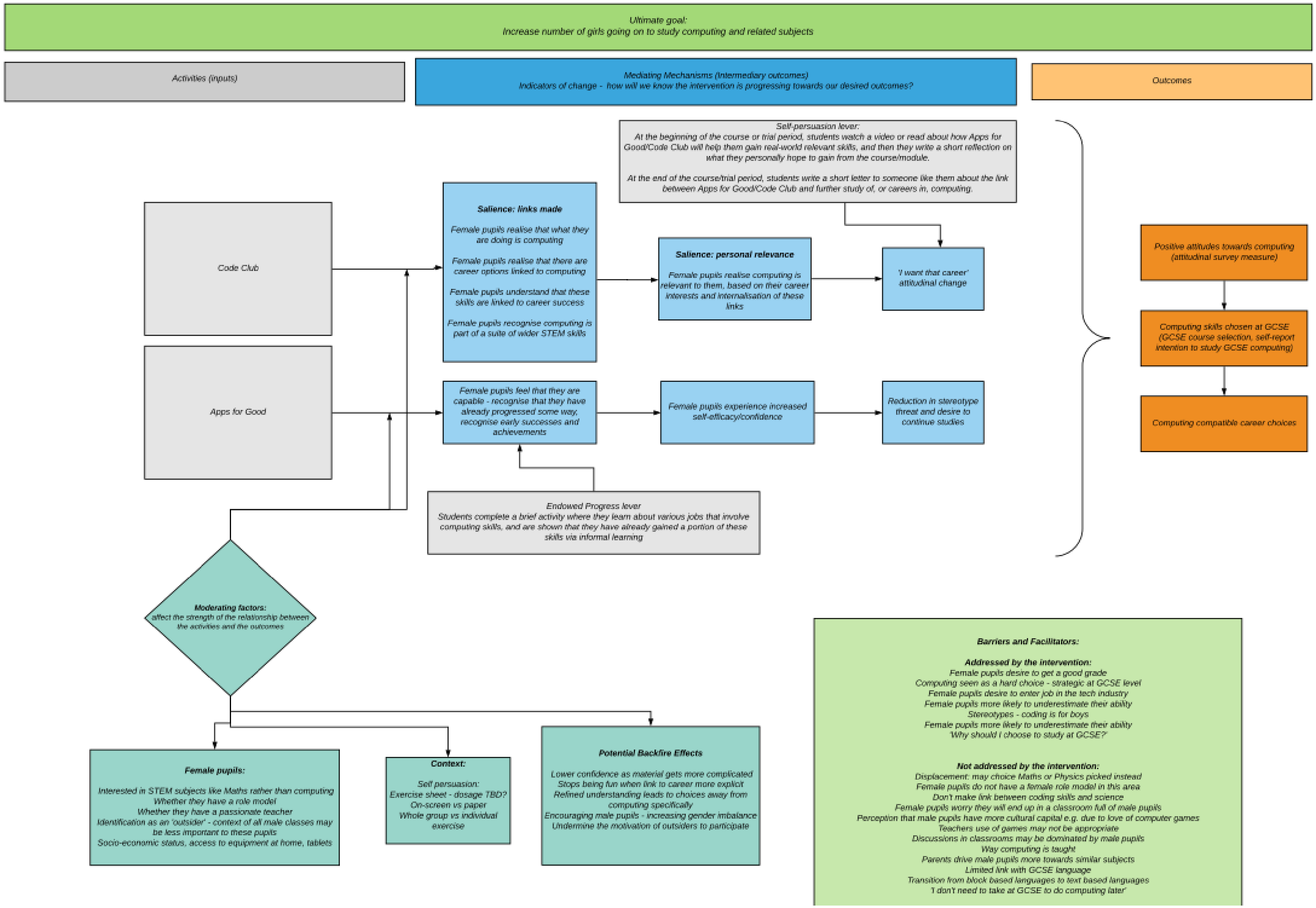

Figure 4: Logic model of the Informal Learning intervention

2. Evaluation methods

The evaluation used a mixed-methods approach. The impact evaluation was designed as a randomised controlled trial (RCT), with two arms (one Code Club, one Code Club +), and was randomised at the school level with outcomes measured at the pupil level. Quantitative data was collected via surveys distributed before and after the intervention in schools from both arms. These surveys were to be completed as part of their Code Club sessions.

We also conducted a qualitative implementation and process evaluation (IPE), which aimed to explore the mechanisms of change and to complement the quantitative survey findings.This section describes the research questions, the methods used as well as the limitations of our approach.

2.1 Impact evaluation

2.1.1 Research questions and outcome measures

The impact evaluation aimed to determine whether the Code Club + intervention (i.e. the additional Code Club module materials and the modified user interface design), relative to the Code Club intervention, led to a change in:

1. Girl pupils' attitudes towards computing as measured by the Student Computer Science Attitude Survey (SCSAS)
2. Girl pupils' stated intention to study computing in the future

These outcomes were measured through the indicators described in Table 1 (below).

Table 1: Method for collecting quantitative outcome data

Outcome measures	Data to be collected	Point of collection
Primary: General attitudes towards computing	Overall score on the Student Computer Science Attitudes Survey (All 5 constructs equally weighted: Confidence, Interest, Belonging, Usefulness, Encouragement).	RPF-administered surveys, completed on computers in class at baseline (beginning November 2021) & immediately following the culmination of the 12-week programme (beginning February 2022)
Secondary: Intention to study Computing	Single item survey measure of whether the pupil plans to continue studying computing with possible responses "Yes", "No", or "I don't know". "Yes" will be coded as 1, while "No" or "I don't know" will be coded as 0.	

The SCSAS has been developed to measure attitudes towards computing[8] (see Appendix 1 for the full survey content and adaptations that took place between baseline and endline data collection. It contains 25 questions and has 5 subcategories (5 questions per subcategory): confidence, interest, belonging, usefulness and encouragement. Within each subcategory, the 5 items are scored on a four-point Likert scale from 1 (strongly disagree) to 4 (strongly agree), and averaged to create subscores. Thus, each 5-item subscore has a potential range of 1-4. These subscores are averaged for a total score that has a potential range of 1-4, with 4 representing a very positive attitude towards computing. For the secondary outcome measures, pupils self-reported their intention to study computing. This was converted to a binary outcome measure with 1 indicating they had answered “Yes” to whether they intended to study computing and 0 indicating they had answered “No” or “I don’t know”.

2.1.2 Sampling and randomisation

Recruitment of schools was conducted by RPF. All mixed-gender or girls only primary schools in England were part of the initial recruitment population for this trial, however, only the schools that could commit to the full 12-week programme were admitted to the trial. Across the GBIC programmes, there were some instances of schools being recruited for more than one trial, and there may have thus been some pupils taking part in the current project as well as either the Belonging or the Teaching Approach trial. Given the small number of pupils from a year group taking part in extracurricular Code Clubs, this was deemed an acceptable overlap when designing the recruitment strategy. Originally, 143 schools were recruited to participate in the trial and 33 completed it (submitted endline survey data), in addition to 21 schools that had completed an initial run of this trial in 2020.

All schools that entered the sample did so voluntarily, which has implications for the external validity of the findings, as schools that volunteer are likely to be more enthusiastic than the average school, and this may interact with the treatment effect to compound any effects. However, this is less of a concern if the population of schools that this programme may potentially be rolled out to in future also fall into this category.

The evaluation was designed as a two-arm cluster RCT, and was randomised at the school level with outcomes measured at the pupil level. The two arms of the trial were:

1. **Code Club**: Schools in this arm received the standard RPF designed Code Club resources, which included five modules covering different coding languages and was designed to run over 12 weeks.
2. **Code Club +**: Schools in this group received the same base materials as the Code Club group, however their resources also contained extra activities embedded within the materials, which aimed to highlight the links between non-formal and formal learning.

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[8] Haynie, K.C. and Packman, S. (2017). *AP CS Principles Phase II: Broadening Participation in Computer Science Final Evaluation Report*. Prepared for The College Board and the National Science Foundation, February 12, 2017. Skillman, NJ.

Schools were stratified on the percentage of pupils with free school meal (FSM) status (above or below the median). Following randomisation, balance checks on other school-level variables were carried out. At the point of randomisation, the Code Club and Code Club + groups were found to be balanced in terms of Ofsted ratings (categorised as 'Outstanding', 'Good' or 'Inadequate / Requires improvement') and proportion of pupils who are girls.[9]

Pupils were blind to allocation during the programme and during outcome data collection, and thus did not know that pupils at other schools received different classes. Teachers were not blind to allocation, as they were responsible for delivering the materials, and, as the schools had registered interest in participating in the trial, the teachers may have been aware of the two different treatment groups.

Data was collected for both boys and girls, but only data from girls was analysed for the primary and secondary analyses in this evaluation[10].

2.1.3 Initial trial and description of data

An initial run of this intervention and evaluation was conducted between December 2019 and March 2020, and was disrupted by COVID-19. Baseline and endline survey data were collected for 21 schools. To maximise sample size for the overall evaluation, we combine these data (hereafter referred to as the '2020 trial schools') with the data from the current trial (hereafter referred to as the '2021 trial schools').

Table 2 presents the mean scores and standard deviation (SD) measured at baseline for primary and secondary outcome measures by trial year, for girls in the final analysis.

Table 2: Baseline survey data by trial year, for girls in the final analysis

Outcome	Values	Trial year	N pupils (non-missing)	Mean (SD)
Total SCSAS score	Mean score of likert scale questions (Strongly disagree - strongly agree) with a range of 1-4	2021	193	3.17 (0.46)
		2020	86	3.18 (0.35)
Intention to study computing in future	1 = "Yes" 0 = "No", "Don't know"[11]	2021	193	0.37 (0.48)
		2020	86	0.79 (0.41)

Table 2 shows that at baseline, the schools from the earlier trial scored much higher in intention to study computing in future, despite a similar average for the SCSAS score. This is likely due to the fact that in the 2020 trial, the survey question did not include "Don't know" as an answer option, unlike in the 2021 trial, where this answer option was available and was selected by 48% for the baseline survey sample (close to the 41% difference observed

[9] We used school unique reference numbers (URNs) as unique identifiers. BIT conducted the randomisation.
[10] Boys' data was also checked for potential backfire effects of the intervention.
[11] In the 2020 trial survey, the answer option "Don't know" was not available, only "Yes" or "No".

between the proportion of pupils having selected “Yes” in the 2020 and the 2021 trial baseline survey samples).

Table 3 presents the mean scores and standard deviation (SD) for each SCSAS subscale at baseline for the full sample (from both trial years), split by gender.

Outcome	Values	Gender	N (non-missing)	Mean (SD)
Total SCSAS score	Mean score of likert scale questions (Strongly disagree - strongly agree) with a range of 1-4	Girls	798	3.13 (0.45)
		Boys	797	3.20 (0.49)
Intention to study computing in future	1 = “Yes” 0 = “No”, “Don’t know”	Girls	800	0.53 (0.50)
		Boys	800	0.62 (0.48)
SCSAS: Confidence subscale	Mean score of likert scale questions (Strongly disagree - strongly agree) with a range of 1-4	Girls	798	2.73 (0.62)
		Boys	796	2.81 (0.63)
SCSAS: Interest subscale	Mean score of likert scale questions (Strongly disagree - strongly agree) with a range of 1-4	Girls	795	2.87 (0.56)
		Boys	797	2.89 (0.62)
SCSAS: Belonging subscale	Mean score of likert scale questions (Strongly disagree - strongly agree) with a range of 1-4	Girls	793	2.97 (0.55)
		Boys	796	2.93 (0.59)
SCSAS: Usefulness subscale	Mean score of likert scale questions (Strongly disagree - strongly agree) with a range of 1-4	Girls	792	2.85 (0.59)
		Boys	794	2.88 (0.64)
SCSAS: Encouragement subscale	Mean score of likert scale questions (Strongly disagree - strongly agree) with a range of 1-4	Girls	791	2.48 (0.70)
		Boys	793	2.50 (0.75)

Table 3 shows that at baseline, boys scored higher than girls in intention to study computing in the future (62% of boys indicating they would like to study computer science as a subject for their GCSEs compared to 53% of girls; $p<0.01$). It also shows that at baseline, boys scored higher than girls in attitudes toward computing (boys’ mean = 3.20 out of 4 compared to girls’ mean = 3.13 out of 4; $p<0.01$).

2.1.4 Attrition and final sample

Figure 5 outlines school-level attrition at the different stages between recruitment and the completion of the endline survey in each trial arm. At both baseline and endline points of pupil survey data collection, RPF attempted to minimise attrition (across both Code Club + and Code Club groups) by extending the window for data collection to account for schools that were delayed in completing surveys, and by sending reminder emails to school that had not completed the surveys by the expected time.

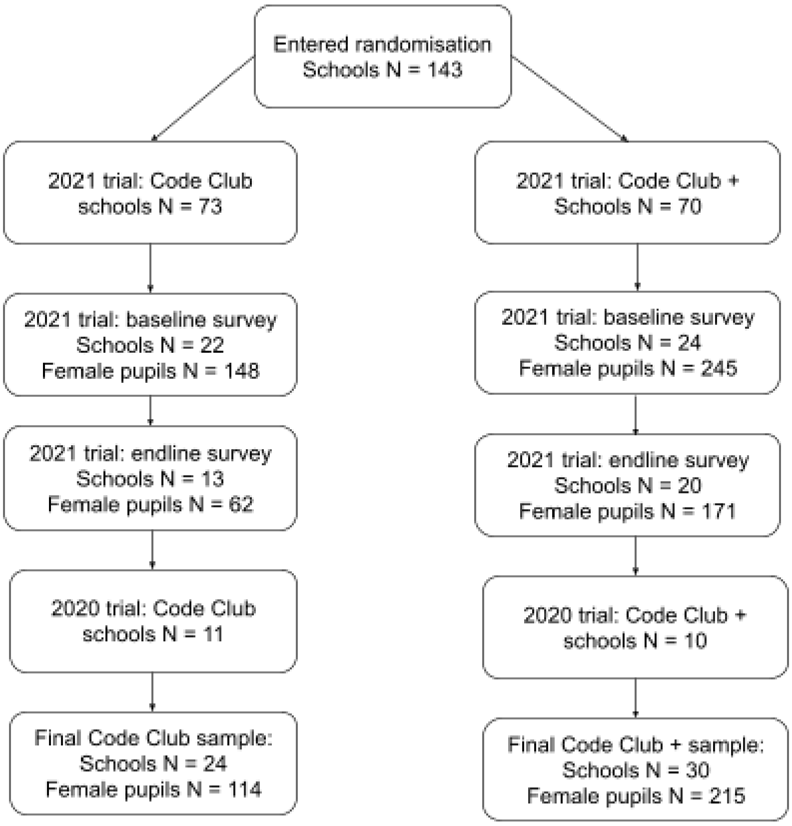

Figure 5: School level attrition

Despite these efforts, high attrition rates were observed between randomisation and completion of baseline surveys, with slightly more schools dropping out from the Code Club group than the Code Club + group (70% vs 66%). At least part of this attrition is likely due to disruption caused by the COVID-19 pandemic. In late Autumn and Winter 2021, the new Omicron strain and the resulting rise in infections likely led to many teachers and pupils self-isolating at home self-isolating, and given the extra-curricular nature of Code Clubs, many schools would have cancelled these activities entirely.

Attrition was also observed between baseline and endline, in terms of both schools as a whole failing to complete the endline and some pupils within schools not completing the endline. Again, more schools and pupils dropping out from the Code Club group (41% of schools completing the baseline survey and 58% of female pupils) than the Code Club + group (17% of schools and 30% of female pupils).

Once all survey data was collected, data cleaning was conducted to remove any data points deemed potentially unreliable. All data was dropped for pupils who had answered in a straight pattern (e.g., a survey with the answer 'Strongly disagree' for every question of the SCSAS). In cases where there were duplicate observations (the same pupil entering the survey twice), we kept only the first complete survey from the pupil. If a pupil never fully completed the survey, we retained their first partially complete entry.

Data from the 2020 trial schools was cleaned using the same process and was then added to the dataset from the 2021 trial.

The final data set consisted of (1) data from girls who had completed the endline survey matched to their baseline data and (2) data from girls who had completed only the endline survey. We used a multistep matching process to match as many baseline and endline surveys as possible. Responses were matched on a combination of school name, full name and date of birth; we also used survey completion dates when manually reviewing possible matches. To improve the number of matches we used both exact matching and 'fuzzy matching[12]' to account for the use of different name spellings or orders and data entry errors. We use an iterative process which involved loosening the matching criteria on different matching variables to identify possible matches at each stage, and manual review to confirm these possible matches. The final analytical sample consists of 329 girls: 215 in the Code Club + group and 114 in the Code Club group.

Balance in the baseline survey sample

Table 4 shows that at the point of baseline data collection, the groups were unbalanced in terms of gender, with girls taking up a slightly larger proportion of the Code Club + group, but this difference is not practically threatening to experimental validity. The groups, however, were balanced in terms of both primary and secondary outcome measures.

Table 4: Balance checks for all baseline data (combined 2020 and 2021 trial data)

Covariate	Percentage (or mean) per arm		p-value	Balanced?
	Code Club (n = 694)	Code Club + (n = 925)		
Gender				
Boys	51.0	48.2	<0.05	No
Girls	47.4	50.9		
Non-binary/Other	1.6	0.9		
SCSAS				
Baseline SCSAS score (full sample)	3.18	3.14	>0.10	Yes
Baseline SCSAS score (girls only)	3.13	3.13	>0.10	Yes
Intention to study computing				
Baseline intention (full sample)	0.585	0.569	>0.10	Yes
Baseline intention (girls only)	0.550	0.518	>0.10	Yes

Balance in the final analytical sample

Further attrition was observed between baseline and endline data collection. Table 5 shows the final groups (the composition of which is outlined in section 2.1.4) were unbalanced in

[12]Fuzzy matching refers to a matching technique which uses a matching score to identify possible matches across two datasets on a given characteristic (e.g., name), and can thereby guide manual review of possible matches.

terms of baseline attitudes towards computing and baseline intention to study computing in the future, with the difference in intention being larger.[13]

These differences are statistically significant and meaningful in size, thus suggesting a risk of bias to the results. This bias appears to be the result of differential attrition between groups between the baseline and endline points of data collection, rather than randomisation failure, as the groups were balanced on the same variables when including all pupils who completed the baseline survey. This trend of Code Club schools scoring higher in both attitudes and intentions is present for both 2020 trial and 2021 trial schools.

Table 5. Balance checks for baseline data of pupils who completed the endline survey (combined 2020 and 2021 trial data)

Covariate	Percentage (or mean) per am		p-value	Balanced?
	Code Club (n = 219)	Code Club + (n = 390)		
Gender				
Boys	47.0	43.3	>0.10	Yes
Girls	52.1	55.1		
Non-binary/Other	0.9	1.5		
SCSAS				
Baseline SCSAS score (girls only)	3.25	3.12	<0.05	No
Intention to study computing				
Baseline intention (girls only)	0.625	0.429	<0.01	No

Implications for final analysis

The imbalances and attrition rates described above carry implications for our analysis.

Firstly, the high attrition rates led to this trial no longer being powered to detect an effect of the size that was hypothesised for an intervention of this nature. Following the high attrition observed between randomisation and baseline, and based on discussions with RPF and DfE, it was agreed that the trial would be reframed as a pilot to evaluate any evidence of promise for the Informal Learning intervention, rather than trying to conclusively estimate the impact of the intervention (which the evaluation would have insufficient power to do given the high attrition).

The imbalances in baseline outcomes for the final sample, together with the differential rates of attrition between baseline and endline data collection, also suggest there could be bias in our estimates of the impact of the intervention. Compared to the full baseline sample (i.e. including those who never completed an endline survey), the final sample for the Code Club group scored relatively higher in both attitudes and intentions than the baseline sample Code Club group. Additionally, the final Code Club + group scored lower in attitudes and intentions

[13] Baseline scores for boys who completed the endline survey are not shown as the final matched sample included girls only.

compared to the baseline Code Club + group. This differential attrition suggests a risk that the estimated impact of the Code Club + intervention vs. the Code Club intervention may be biased downwards. Even though we can control for baseline values in the outcome measures at the pupil level, there may be unobserved school-level variables influencing outcomes that we cannot control for. This could lead to the results underestimating the impact on the target outcomes of the Code Club + intervention relative to the Code Club intervention.

It is difficult to infer what factors may be driving the imbalances across the two treatment groups after attrition from baseline to endline. Given the extent of attrition and the low remaining number of schools remaining relative to the initially recruited sample, it is possible that these imbalances are random and would have been less likely to emerge if the final sample size was closer to that which was targeted at the trial design stage.

2.1.5 Analytical approach

The full model is presented in Appendix 2. The primary and secondary analyses were both Intention to Treat (ITT) estimates. This means that outcomes were analysed on the basis of the groups that tutors and pupils were randomly allocated to, regardless of their compliance with the intervention. The covariates (baseline SCSAS score, school Ofsted rating, school proportion of pupils with free school meal eligibility) were chosen as they could potentially account for some variation in the outcome measures, thus controlling for these variables could increase the precision of estimates.

All planned covariates were checked for missing data pre-analysis. For some schools in the sample, we were unable to obtain an Ofsted rating due to there not being one publicly available. For these schools, we elected to assign them to an extra value of the categorical variable of Ofsted rating.[14]

Given that the endline data would likely include some pupils who did not complete the baseline survey, we specified pre-trial decision rules for dealing with missing data as baseline scores on the SCSAS were to be used as a covariate in the analysis. In the final sample, approximately 15% of pupils were missing baseline SCSAS scores (above the threshold of 5% for listwise deletion), and multiple imputation[15] was performed, whereby predicted values were substituted where data was missing.

The majority of the pupils in the endline data who could not be matched to any baseline data were from schools that did complete the survey at both time points, meaning that these pupils may have been absent or out of class when baseline survey data was collected. We believe it is very unlikely that these pupils moved into the schools after the schools were

[14] While it would have been possible to perform multiple imputation on missing Ofsted data, this was judged to be inadvisable as not all independent primary schools are inspected by Ofsted, with schools in our sample likely falling into this category. This would suggest that this data was not missing at random. Thus, using this as an extra category within the Ofsted rating covariate would be more informative than using other school-level variables to predict Ofsted rating.

[15] Rubin (2004) *Multiple imputation for nonresponse in surveys* (Vol. 81). John Wiley & Sons.

randomised to a trial arm, which means our inclusion of these pupils in the analytical sample is unlikely to bias the treatment effect estimates.

In order to fully examine the effect of multiple imputation on our estimate of the intervention's impact, we also present the results of the primary and secondary analysis whereby (i) missingness was instead addressed through missingness indicator and (ii) only complete cases (pupils who completed both baseline and endline surveys) were used. We also conduct an additional regression using the multiple imputation model where we (iii) control for whether each observation is from the 2020 trial. For both the primary and secondary analysis, these specifications are presented in order of:

1. Multiple imputation model
2. Missingness indicator model[16]
3. Complete case analysis
4. Model (1) including the trial year as a covariate

2.1.6 Limitations

Attrition

Differential attrition across experimental groups can lead to bias in treatment effect estimation. While baseline imbalance in outcome measures between groups can be partially addressed through using baseline SCSAS as a covariate in the analysis, we cannot be confident that there are not unobserved variables driving that baseline difference that we do not control for in analysis. The consequence of this would be that these unobserved variables potentially interact with attitudes and intentions, and could bias the results, as described in section 2.1.4.

Another implication of generally high attrition is that the analysis will not be powered to detect a change in outcome measures of the targeted effect size specified pre-trial. As described in section 2.1.4, the implications of the high attrition observed between randomisation and endline were acknowledged and discussed between RPF, DfE and BIT following the completion of the baseline survey. As such, it is understood that the impact evaluation would be underpowered to detect a statistically significant impact of the Code Club + intervention relative to the Code Club intervention, and that the findings would be analysed to determine the presence of any evidence of promise for the Code Club + intervention, rather than aiming to conclusively estimate the impact of the intervention.

Combining data from two trial runs

As explained in section 2.1.3, both runs of this intervention and associated evaluation, in 2020 and 2021, were disrupted by the COVID-19 context, limiting their scale. As a result, and following discussions with RPF and DfE, we decided to combine the data from both trials to maximise sample size and the evaluation's ability to detect a statistically significant effect of the Code Club + intervention relative to the Code Club intervention. Schools from both trial runs were included in both intervention groups, and we added a regression specification to

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[16] In running this model, we included a binary covariate, coded as 1 if the baseline survey had been completed, and 0 if the baseline survey was incomplete. This allowed us to include all complete endline observations without using multiple imputation.

control the year in which the intervention was conducted to mitigate this limitation (see section 3). However, and while there is no clear direction for any bias introduced, it is possible that the different time of implementation between the two runs of the intervention may have affected the results.

Pupil survey outcome measures

Given the nature and objectives of the intervention, defining and measuring outcome indicators were challenges inherent to the evaluation. The intervention aims to reduce gender gaps in school subject choices from Year 10 onwards by intervening in earlier years, in Years 4, 5 and 6. While this early intervention approach may offer important benefits in terms of reducing barriers that may arise or increase in later years of education, it also creates a need to rely on short-term 'proxy' indicators that can be measured within the evaluation period (in this case directly after the intervention completion), yet could predict school subject choices in Year 10. This is particularly challenging as some of the barriers to girls choosing computing as a subject in later years (and that the intervention aims to prevent) may arise after Year 4 or 6 and before Year 10 factors; this would imply a risk that the effect of these barriers are not captured in the data collected while the pupils are in Year 4 to 6.

Additionally, the absence of reliable observable proxy indicators requires relying on pupil self-reported data, which may introduce biases related to social desirability bias or limited respondent attention. This risk is particularly high for the indicator capturing self-reported intention to continue studying computing measures. Given that the Year groups this intervention was aimed at are both at primary level, these pupils do not face a choice over studying computing in the near future. This could introduce some measurement error as pupils may select 'Yes' because they know that they will be continuing to study computing by default, resulting in baseline rates of intention much higher than what that rate would be if the girls in the sample actually did face a choice over studying computing.

To address this dual challenge, the evaluation approach focused on attitudes towards computing as the primary outcome, and hypothesised that these could be measured and predict future subject choice. The survey tool used, the SCSAS, was cognitively tested to increase its reliability in measuring these attitudes with a small group of KS2 pupils from schools outside of this intervention. While these efforts should help, they are unlikely to fully address these challenges.

The possible implications of these measurement challenges for the results are discussed in section 3.

2.2 Implementation and process evaluation

Alongside the impact evaluation, a qualitative IPE was conducted. The IPE examined the mechanisms of change and the diversity of implementation and programme delivery.

2.2.1 Research questions

The IPE aimed to address the following research questions:

1. What are the barriers and facilitators to implementation of the intervention?
2. What range of factors help and hinder girls' engagement with the intervention?
3. How does engagement with the intervention vary between girls and boys?
4. What range of factors influence girls' attitudes towards curricular computing education?
5. What range of factors influence girls' participation in curricular computing education?

2.2.2 Research design

We planned and implemented a case study design, conducting a range of qualitative research activities with teachers and pupils from the same schools where possible. We were interested in understanding more about the experiences of teachers and pupils in regards to the Code Club intervention.

Our initial research plan involved recruiting 4 case study schools and conducting the same range of activities within all of them. However, due to the challenging COVID-19 context schools were facing and their implications for their ability to run extracurricular school clubs, we had to adapt our research activities in line with individual school requests. Throughout this section, we note how the planned activities were adapted in response to COVID-19 restrictions.

2.2.3 Sampling and recruitment

We used a two-fold sampling approach, initially employing a purposive sampling strategy with the aim of obtaining a diverse sample of case study schools. The second aspect of our sampling strategy involved the pupils selected to take part in focus groups, once again we wanted to ensure we captured the view of a diverse sample of pupils. In both stages of sampling, we aimed to follow our recruitment criteria, split into primary (pre-defined characteristics in line with representation we required) and secondary (relevant characteristics but greater flexibility in regards to representation requirement).

The impact of COVID-19 on school capacity to take part in research and allow visitors on site meant that we had to be much more flexible with our sampling strategy and requirements. We had very limited interest from schools to take part as a result of staff and pupil absence, high workload and bans from external visitors to school sites. We therefore made a decision to relax our sampling criteria, switching to a convenience sampling approach. This change was deemed necessary in order to continue with the qualitative research.

Case study school sampling

We chose to only include schools in the case study who had received the Code Club + intervention materials, as we felt this was the most effective sampling to evaluate the schools' experience of Code Clubs as well as the added informal learning material.

Our primary sampling criteria for schools included i) region and ii) proportion of pupils eligible for free school meals. Secondary criteria included the school's Ofsted rating. We retrieved information on FSM eligibility and Ofsted rating from the DfE national information about schools.[17]

We were able to recruit 1 school from the Midlands, and the remaining 3 from the South or London, unfortunately no schools from the North of England were able to take part. We were able to achieve some diversity in the sample in relation to the proportion of FSM eligible pupils; 2 schools had above average FSM and 2 schools were below average.

Staff sampling

For teachers within the case study schools, our primary criteria was their gender and secondary criteria was teaching experience. We were aiming to get this information during the recruitment process. Unfortunately, due to the limited interest from schools in taking part, we had to relax this criteria. We recruited four teachers, one from each of the case study schools, and one senior leadership team member from one of the case study schools. (For a full breakdown of characteristics, please see table 6 below).

Pupil sampling

We aimed to recruit a sample of between six to eight key stage two pupils from each of the four case study schools to take part in pupil focus groups. We were interested in including at least two boys in each focus group to explore any effects of the intervention on their own attitudes towards computing, as well as their comparable experience of the intervention. Unfortunately, we were only able to conduct a focus group at one of our schools, due to limited teacher resources within the other schools to oversee both a Code Club and a discussion group at the same time. Another school had last minute technical difficulties during the visit, which meant the Code Club was unable to happen.

We asked the teachers for support in selecting the sample of pupils to take part in the focus group. Our primary criteria shared with teachers was the overall number of pupils and the inclusion of some male pupils. We also asked where possible to include a range of ability and computing confidence, however we were aware this may be skewed due to the nature of it being an optional after-school club with a likelihood that the pupils had an interest in computing. Please see table 6 for a full breakdown of the sample.

[17] https://www.gov.uk/school-performance-tables

Table 6: Achieved case study sample

School	Profile	Sampled individuals	Data collection
S01	-Located in Midlands -Below average FSM -Ofsted rating: Good	-Code Club teacher (T02) -7 Year 6 pupils (during observation)	-Teacher interview -Code Club observation
S02	-Located in London -Above average FSM -Ofsted rating: Good	-Code Club teacher (T04) - 13 pupils (during observation)	-Teacher interview -Observation
S03	-Located in Midlands -Average FSM -Ofsted rating: Good	-Code Club Teacher (T01) - 8 pupils -1 SLT	-Teacher interview -SLT interview -Pupil discussion group
S04	-Located in London -Above average FSM -Ofsted rating: Good	-Code Club teacher (T03)	-Teacher interview

School recruitment

We used RPF as gatekeepers for recruiting schools to take part in the IPE. Once we had identified schools that fit our sampling criteria, we asked RFP to reach out to schools and make the initial introduction to us and asked whether they had interest in taking part in the evaluation. Once a school had responded, BIT took over recruitment and scheduling of research activities. BIT staff set up calls with teachers of Code Club schools to explain the research in more detail, including practicalities and potential dates.

We proposed a recruitment strategy in waves, whereby we reached out to 20 schools at a time via the above method. Due to limited initial interest and 2 schools having to drop out of the IPE, as a result of staff illness, we were only able to secure our 4 sample schools after the Christmas break in January, in our second wave of recruitment.

2.2.4 Data collection methods

Code Club observations

We were able to conduct in-person observations of Code Clubs at two of our case study schools (a third observation in one school had to be cancelled on the day due to technical issues at the school). The aim of the observations was to independently assess pupil engagement, Code Club fidelity and facilitators and barriers to the delivery of Code Clubs. We conducted observations prior to the interverviews to ensure we could refer back to what we had seen in the club sessions.

Pupil focus groups

Group discussions were held with groups of pupils at one of the case study schools. The session lasted around twenty minutes and included 8 pupils (6 females, 2 males) across Year 4 to Year 6. Pupils were asked a number of statements related to their view of computing (e.g. “I like computing”, “I want to have a job in computing when I’m older”), which they had to describe as true or false. They were then given a worksheet, which included a number of "finish the sentence" statements related to Code Clubs and their experiences. There was a brief discussion over the kind of skills pupils felt they needed or had developed in relation to Code Clubs. Finally pupils were asked to draw an image of "someone who works in computing".

All these activities were designed to get a better understanding of the pupils' perception of computing and coding in general, as well as learn more about their experiences of the Code Clubs.

Teacher interviews

Individual, semi-structured interviews were conducted with a teacher who ran the Code Club at each of the case study schools. The aim of the interviews was to learn more about the teachers' experiences of implementing the Code Clubs intervention and any factors which facilitated or hindered the implementation. We were able to conduct four interviews with one teacher from each of our case study schools. We were also able to conduct an extra interview with the assistant headteacher at one of the schools, which helped to provide a holistic overview of computing within their school.

2.2.5 Analytical approach

Case study data

Interview transcripts and fieldnotes were managed using the Framework Approach[18]. This involved summarising transcripts and notes into a matrix organised by themes and sub-themes (columns) as well as by individual cases (rows). The managed data was then interpreted with the aim of identifying and categorising the range of phenomena present in each of the sampling groups. We conducted case and theme analysis to focus on providing rich descriptions of participant experiences, whilst looking for explanation and linkages within and across participant groups.

There are several consideration to keep in mind when interpreting the data:

1. The case study approach means that findings should not be generalised across all participants, but rather understood as conveying some of the range and diversity of participant experiences.
2. The teachers who responded to our invitation to take part in the evaluation might have been the teachers who felt most confident in the success of their Code Clubs; therefore the findings may not reflect the full breadth of experiences of teachers implementing the intervention.
3. This intervention involved an extracurricular club, which was optional for pupils to attend. It is worth noting that the pupils involved may already have a certain level of enthusiasm or enjoyment towards computing, and that the findings may thus not be applicable in a more general school setting.

[18] Ritchie, J., Lewis, J., Nicholls, C. M., & Ormston, R. (Eds.). (2013). *Qualitative research practice: A guide for social science pupilsand researchers*. sage.

4. Due to the challenges surrounding COVID-19, we were unable to conduct Code Club observations and pupil focus groups at each of our case study schools. However by working with teachers, we were still able to speak to pupils of different genders and different levels of confidence with computing.

3. Impact evaluation findings

Key findings:

- We did not find a statistically significant effect of the Code Club + intervention on girls' positive attitudes towards computing or intention to study computing in the future relative to the Code Club intervention.
- While the estimated effect of the Code Club + intervention on each outcome was positive, it was not statistically significant and small in magnitude. The differential attrition observed suggests that this difference may be an underestimate of the true effect of the Code Club + intervention, though the high rate of overall attrition makes it difficult to distinguish this effect from one that could have been produced by chance.

3.1 Primary analysis: Effect of the Code Club + intervention on attitudes towards computing

The results of the primary and secondary analysis are presented in Tables 7 and 9. Primary and secondary model specifications, along with full regression tables, can be found in Appendix 2.

The impact evaluation revealed no evidence that the Code Club + intervention impacted girls' attitudes towards computing relative to the Code Club intervention, as measured by scores on the SCSAS. The mean score on the SCSAS scale (range 1-4) for the full analytical sample was 3.14 (SD=0.41). For the Code Club + group it was 3.13 (SD=0.42) and for the Code Club group it was 3.17 (SD=0.40). After adjusting for differences in observed baseline characteristics, the pre-specified multiple imputation model suggests that the Code Club + intervention is associated with a 0.02 point increase in scores relative to the Code Club intervention, on a 1-4 scale, which is not statistically significant (p=0.729). This finding was consistent across all regression model specifications.

As explained in section 2.1.4, the differential attrition observed in this trial, whereby the final sample had lower means for the outcome variables at baseline, suggests a risk that the difference in scores at endline between the Code Club + group and the Code Club group may be biassed downwards, thus obscuring a positive effect of the Code Club + intervention relative to the Code Club intervention.

Unlike some evaluations other interventions within the GBIC programme, this intervention is not specifically tied to any of the five subscales of the SCSAS (confidence, interest, belonging, usefulness and encouragement). Because of this, and concerns over performing a large number of comparisons between the two treatment groups, we did not conduct analysis relating to these subscales.

Table 7: Impact evaluation results for primary outcome

Outcome: Total SCSAS Score	(1) Multiple imputation model	(2) Baseline missingness indicator	(3) Complete case analysis	(4) Trial year robustness check
Code Club group unadjusted mean	3.17		3.18	3.17
Code Club + group unadjusted mean	3.13		3.13	3.13
Estimated treatment effect (standard error)	0.02 (0.059)	0.03 (0.057)	0.02 (0.057)	0.02 (0.064)
N	328	328	279	328

Figure 6 shows the raw Code Club mean and treatment effect of the Code Club + intervention relative to the Code Club intervention estimated using the pre-specified model. The 'Code Club +' bar shows the average outcome that the model predicts would have been observed in the Code Club group had those schools received the additional Code Club + materials. The 95% confidence interval of this treatment effect is also shown on the bar of the Code Club + group.

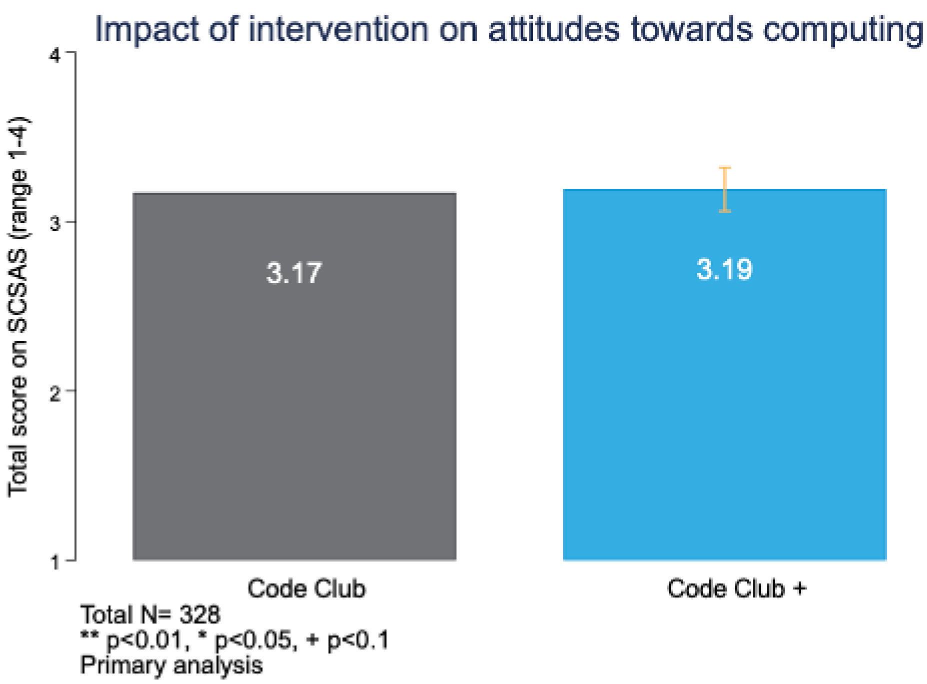

Figure 6: Model-adjusted SCSAS scores by treatment group

For a more detailed overview of endline survey responses, Table 8 describes the baseline and endline mean score of each SCSAS subscale by treatment group, for the girls who completed both the baseline and endline survey, and whose data was thus used in the complete case analysis model specification.

Table 8: Baseline and endline SCSAS subscale and overall scores by treatment group for girls who completed both surveys

Subscale	Survey	Group	N (non-missing)	Mean (SD)
Confidence	Baseline	Code Club	104	2.76 (0.58)
	Baseline	Code Club +	175	2.51 (0.61)
	Endline	Code Club	114	3.17 (0.46)
	Endline	Code Club +	214	3.09 (0.53)
Interest	Baseline	Code Club	104	2.95 (0.49)
	Baseline	Code Club +	175	2.66 (0.54)
	Endline	Code Club	114	3.30 (0.49)
	Endline	Code Club +	213	3.21 (0.56)
Belonging	Baseline	Code Club	104	3.05 (0.49)
	Baseline	Code Club +	175	2.78 (0.50)
	Endline	Code Club	114	3.25 (0.45)
	Endline	Code Club +	212	3.30 (0.47)
Usefulness	Baseline	Code Club	104	2.91 (0.52)
	Baseline	Code Club +	175	2.61 (0.53)
	Endline	Code Club	114	3.23 (0.50)
	Endline	Code Club +	211	3.17 (0.56)
Encouragement	Baseline	Code Club	104	2.50 (0.67)
	Baseline	Code Club +	175	2.29 (0.66)
	Endline	Code Club	114	2.90 (0.67)
	Endline	Code Club +	210	2.89 (0.66)
Overall SCSAS score	Baseline	Code Club	104	3.25 (0.36)
	Baseline	Code Club +	175	3.12 (0.46)
	Endline	Code Club	114	3.17 (0.40)
	Endline	Code Club +	214	3.13 (0.42)

3.2 Secondary analysis: Effect of the Code Club + intervention on stated intention to study computing in the future

The impact evaluation provides no clear evidence that the Code Club + intervention positively impacted girls' intention to study computing in the future relative to the Code Club intervention. The proportion of girls stating they intended to study computing for the full sample of girls was 66%. For the Code Club + group it was 65% and for the Code Club group it was 68%. After adjusting for differences in observed baseline characteristics, the pre-specified multiple imputation model suggests that the Code Club + intervention is associated with a 3.0 percentage points difference in the outcome relative to the Code Club intervention, which is not statistically significant (p=0.760).

Compared to the primary analysis, this effect size (while not statistically significant) is larger, but given the high p-values, we cannot be confident that this is indicative of an impact of the additional Code Club + materials rather than random chance. The direction and significance level of this finding was consistent across all regression model specifications. That being said, as explained in section 2.1.4, the differential attrition observed in this trial, whereby the final sample had lower means for the outcome variables at baseline, suggests a risk that the difference in the outcome mean at endline between the Code Club + group and the Code Club group may be biassed downwards.

Table 9: Impact evaluation results for secondary outcome

Outcome: Intention to study computing	(1) Multiple imputation model	(2) Baseline missingness indicator	(3) Complete case analysis	(4) Trial year robustness check
Code Club group mean	0.684		0.673	0.684
Code Club + group mean	0.647		0.617	0.647
Estimated treatment effect (in percentage points)	3.0pp	6.4pp	1.4pp	4.3pp
N	328	329[19]	279	328

[19] There is one additional observation in this specification relative to specification (1) and (4). This observation has a missing value for the primary outcome (endline SCSAS score). The value for this variable is used to impute the baseline SCSAS score for specifications (1) and (4), which is used as a covariate for the regression for the secondary outcome (intention to study computing), thus for these specifications this observation cannot be used and is excluded from the analysis. In specification (2), we use a missingness indicator for baseline SCSAS score instead, thus this observation can be included.

4. Implementation and process evaluation findings

The findings from the IPE are split into two main sections; looking at implementation and intervention. Firstly our Implementation section will discuss how the intervention was delivered in practice, focusing on i) fidelity, and ii) feasibility. The Intervention section will follow and focus on i) quality of the intervention, ii) engagement of teachers and pupils to the intervention and iii) the mechanisms through which the intervention may have affected the target outcomes.

In regards to our sampling of schools for case studies, we decided to focus our recruitment efforts on Code Club + schools, as this would allow us to collect data about Code Clubs and the additional materials simultaneously. An overarching finding from the IPE is that teachers and pupils had limited knowledge of the intervention activities added to the Code Club material, which had been designed to link informal learning to formal computing education. This means that there is limited data available on the Code Club + specific elements of the programme.

However, teachers and pupils were overwhelmingly positive about Code Clubs in general. We therefore chose to include in this section findings on both Code Clubs in general and the additional materials (Code Club +). The majority of the findings relate to the shared components of the two interventions (regular Code Clubs and Code Club +), with flags when any findings are linked to the Code Club + materials alone.

Throughout the findings it is worth keeping in mind that the sample size of the case study schools is small (four) and that not all case study schools were able to take part in all the research activities. The IPE findings should be viewed as an example of the range of experiences of some schools, but caution should be taken if trying to generalise across all the schools involved in the programme.

4.1 Implementation

4.1.1 Fidelity

Key findings:

- Three out of the four teachers interviewed had not spent much time looking through the Code Club training resources ahead of launching the clubs. This suggests that these schools may have not closely followed the project implementation guidelines, especially in relation to the Code Club + materials.
- Teachers' approach to the Code Club sessions varied; some allowed the clubs to be pupil led and acted as support for pupils when needed, other sessions felt more similar to a regular classroom setting.

Key finding for Code Club + intervention: The majority of teachers interviewed were uncertain of the purpose of the extra intervention materials and activities, and found their pupils tended to rush through them or choose not to complete them. This suggests that pupils are unlikely to have received the intervention as it was intended.

This section explores to what extent the implementation of the intervention within case study schools matched what was expected by RPF, as outlined in the resources and welcome pack.

Code Club recruitment

The demographic makeup of the clubs varied between schools, with some choosing to reduce the number of male pupils or restrict to female only. This was in line with the programme requirements, whereby the only restriction was that all-boys schools were excluded. Some schools made a point of ensuring there was a higher proportion of female pupils, seemingly as their own nod to the GBIC programme aims. Of the case study schools, two had previous experience of running Code Clubs within their schools, however all the schools had launched the current club as a result of taking part in the current trial.

One of the case study schools chose to open the club to female pupils only, with a view to continue the club and open to both genders if the initial run was successful. They hoped that a girls only club would help to build confidence amongst the female pupils and give them a safe space to explore and develop their computing skills and interest further.

"I think starting them off first and making them the monitors and making them the people who know what's happening, that will hopefully readdress that balance in the class when the boys come in" (T04)

Some schools were able to open up the club for all ages (Year 4 to Year 6), whilst others focused on one year only. This appeared to be driven by interest from the pupils, the schools' own computing curriculum and school resources. One school had previously run simultaneous code clubs across their school, one aimed at Year 6's and another for younger year groups (in KS1), previous experience therefore influenced the age groups the school opened the current club to.

Recruitment for the Code Clubs varied across schools. Several teachers spoke about not wanting to have to restrict access to the club, but that teacher availability and school resources did mean they had to cap numbers. During one school observation, a couple of pupils discussed how it was seen as an "*honour*" or *"big deal"* to be picked to join the Code Club and that there was a waitlist.

One school initially invited pupils to join on the basis of how well they had done in the end of Year maths assessment the previous year. They also ensured there was a balance of genders. This school had run several extra curricular computing programmes in the past and during the observations, it was clear the high ability of several of the pupils.

"We made the decision that even though we'd looked at the maths scores and what they achieved, we also made sure that there was a balance of both gender plus ethnicity as well, where possible" (T02)

Other schools' recruitment was less structured. In one school, pupils were signed up mainly as a result of showing some interest and as a result of their parents needing them to attend an after school club. Another school ran the Code Club during lunchtime and allowed any female pupil who wished to attend to come along.

"I said, 'Hands up, who wants to be part of this club?' Everyone put their hands up but not everyone stayed. Some people were like, 'Not really for me.' That's fine, I think there should be a bit of attrition, some people just won't want to do it." (T04)

Structure of Code Club sessions

The structure of the Code Clubs varied across the schools, with most clubs running for less time than the one hour outlined in the programme plan. Every school faced the same challenges around pupils arriving on time and the extra time spent setting up laptops or computers and getting logged on. In terms of covering all the content and progressing through the modules, it was clear that some pupils struggle with the tighter time frames. This was especially clear in the schools that only had half an hour of time available and pupils were unable to progress and complete their work before the session was over.

One teacher said that they had to restructure the session as one hour of coding in an after school session could be quite a big ask of pupils' attention. They decided to keep the Code Club material to forty minutes and then gave pupils free computer time for the remainder of the session. When given the choice, some pupils continued with the coding project from the Code Club, whilst others switched to alternative computing projects, such as finishing a power-point from another subject. The teacher did recall that all the boys in attendance would continue with the Code Club materials, whilst more of the female pupils switched to something else.

“Quite a lot of them would carry on coding. Some of them would try and create a Power-point about puppies. So because they've got their stuff on the computers, they might go back and do something that we've been doing before.” (T03)

Both the observations and discussion groups with pupils highlighted their enthusiasm for the clubs and their reluctance to stop and pack away at the end of each session. The time constraints appeared more of an issue for teachers who had set out objectives of what they wanted to get through, at the beginning of the session, if they were not met. Across the majority of the schools, both teachers and pupils noted that some of the pupils would access and keep working on the coding materials when they went home.

"No, I want to do this first before we go home, can we not get this done? Can I take a picture at least?" (Pupil from observation)

Code Club +

Where pupils were very enthusiastic about the computing projects themselves and finishing the module activities within the session, it may well be that the Code Club + materials were less of a priority for them when faced with time constraints. During one observation, where pupils were being asked to go back and make sure they had completed all the activities within a module, pupils did appear to leave the extra materials until last in order to try and finish the coding activities first.

Teacher approach

Teachers appeared to approach their delivery of the Code Clubs to pupils in two distinct ways; either a teacher led approach (similar to that of a traditional lesson format) or pupil led (with the pupils given choice over what they wished to focus on each session). Across all approaches, the pupil survey at the beginning of the Code Club was completed first and pupils were told to complete the survey before moving onto the modules.

One teacher saw the code clubs as distinct from lessons and an opportunity for the pupils to explore, problem solve and work on projects that they enjoyed and were interested in. pupils were given freedom to pick what they wanted to work on in each session and whether they wanted to work individually, in pairs or groups. This meant that within one Code Club session, each pupil could be focusing on a different module from the overall programme.

“The only thing I did was rather than direct them as, 'You do this one now, you do that one now.' When I felt that they had the idea of what to do, I then let them get on because then I just went and thought, well, okay some of them are going to be happy with it some of them might want to go and do something else within it.” (T02)

Of the two approaches, this led by the pupil approach did appear to result in a more collaborative environment. During one of the observations, pupils chose to work together from the offset and were quick to help support and provide problem solving ideas to each other. However, the flipside of this approach meant that the teachers had less of a clear view of which activities pupils had done and what proportion of each module had been completed. This had resulted in some pupils needing to go back and review the sections across the programme in order to check things off. In relation to the Code Club + activities themselves, it was not always clear to the teachers whether pupils had engaged or completed those activities.

Application of Code Club + materials

Teachers appeared to approach the Code Club + materials in different ways and to different degrees of completion. It is therefore hard to draw firm conclusions on the dosage of the intervention, which the pupils received during the Code Club programme.

Teachers were mostly able to recall some of the plenary activities (skill content, careers content, skills game and postcard activity), but did not appear to be aware of the significance of the activities. As a result, across the case study schools, it is unclear the extent to which pupils actively engaged with the intervention materials. It is possible that the Code Club + intervention was not delivered as intended within schools, which ultimately would have limited its potential impact on pupils.

A couple of teachers were a little confused as to what the purpose of the activities were and felt that the pupils were also unsure of what they were meant to be doing. One teacher felt that their pupils were expecting a game or an activity when they observed the video around careers in computing as opposed to just reading, which resulted in their pupils slipping through it quickly without focusing on the content.

"I think some of them got a bit confused and thought that it was something that it wasn't. I think some of them might have skipped through it a little bit quickly and gone onto the next thing would be the only thing with those ones." (T03)

Another teacher recalled observing their pupils rushing through the skills sorting game and having to stop them and get them to really think about what they were being asked. Ths teacher found that their pupils were quick to say they knew what each word of skill meant, when in reality they were unable to explain if asked to. One suggestion was to include a task as part of the game, whereby pupils had to type in a definition before sorting the skill, to help solidify the meaning. This behaviour of rushing through the activities was witnessed during one of the Code Club observations. When asked, the pupils said that they preferred the coding activities and wanted to focus on them.

"When I was able to catch one of them doing it, I would say, 'Well, just hand on a second, have you actually thought about what that word means? How do you actually know what it means, and have you actually read that text?' sometimes they will just go, 'Yes, I know what that means.' Where actually it doesn't quite mean what they think. That's the only thing and I think somehow it needs an explanation before they did it or maybe getting them to type something in what they think it might mean, just something." (T02)

There were stronger views towards the postcard activity, with several teachers struggling to understand its purpose and experience challenges from a logistical

point. In terms of sharing the postcard with pupils, there were some issues when they tried to print it off or open as a Word document, ultimately these were solved once they got in touch with RPF and were sent updated emails with the documents attached. It is worth noting that as a result of COVID-19 restrictions, RPF were unable to send out hard copy postcards for the second Code Club run. Therefore, both RPF and schools involved had to adapt to the digital option for the postcard, which was not what was initially intended.

I think that was difficult because it was either done as a PDF where you had to print it off and then get them to do it, or it was as a Word document but the Word document then because obviously it wasn't done within the controlled boxes so you could just - and everything just flipped." (T02)

One teacher felt strongly that they didn't think their pupils would actually share such a postcard with their friends in reality and got a negative response from pupils when they showed them it. This resulted in them choosing not to make them do it.

"Would they honestly do it? Would they honestly give it to a friend? Really give it to a friend, I don't think so."; "Yes, that was at the end, wasn't it? They really did not want to do that! So we didn't." (T03)

One teacher who did complete the exercise with their pupils said they were able to explain its purpose by linking it to similar activities they do in other subjects. They felt by giving it some context as a task to discuss what they have learnt and enjoyed, it was easier for pupils to complete. Another teacher could see its benefit as an exercise for recruiting new members to join their next code club, and framing it to pupils in that way.

"We do activities very similar in certain subjects anyway. In RE where you have a letter or something like that, so I think putting it in that context, they understood what they needed to do. I think it was a little bit different for them and it got to show their learning in a way. It was kind of like that, 'What have I learnt now,' and things like that, so it was quite a nice way of doing it." (T01)

4.1.2 Feasibility

Key findings (both groups):

- Schools found it challenging to find enough time within their schedules to run Code Clubs for an hour each week, as intended by RPF. This may have impacted the amount of content pupils were able to cover and time available to spend on Code Club and Code Club + activities
- Teachers were appreciative of the high quality of the resources, which meant they did not have to spend excess time preparing for Code Club sessions. The sessions could also be run with minimal computing equipment, suggesting they would be appropriate for schools with less resources.
- There were some minor frustrations felt by teachers and pupils related to not being able to save work or view their progress through the modules between sessions.
- Overall, the implementation of the interventions were not hugely impacted by COVID-19, other than some pupils being off sick. The main impact of COVID-19 on the intervention was in relation to the recruitment of schools to take part in the IPE.

This section discusses the factors which affected how easy or challenging it was for teachers in case study schools to implement the intervention.

Time and practical challenges

Length of session

It was challenging for schools to run an hour long Code Club as intended by RPF. Observations were conducted towards the end of the Code Club programme, by which time it was clear that the teachers and pupils had established routines, and could turn up, locate and logon to their computers with relative ease. It's unclear how much time may have been used up getting set up in the earlier weeks

A benefit of running a club over lunchtime was that the school did not need to charge pupils to attend. This was an important consideration for the teacher at this school based on the demographic of the pupils at their school. The teacher also noted the benefit of holding lunchtime clubs for pupils who tended to struggle whilst out on the playground, in terms of giving them something to do. Ultimately, the teacher was able to recognise that the time allowance was possibly a little too short to fit all the material, but also felt that their pupils were aware and responded accordingly in terms of getting settled and set up quickly. This was also reflected during the observation, whereby pupils were well behaved and got ready quickly.

“Maybe it was a little bit short but to be honest, so long as it was regular and we got down to work fairly quickly, which they did, it was fine I think.” (T04)

Teacher preparation

When asked about preparation time for the code clubs, all teachers felt it had required minimal preparation ahead of each session, making it an attractive extracurricular activity for resource strapped schools. This was mainly due to the high quality of the RPF materials and the nature of letting pupils decide themselves what they wanted to focus on each week. Set-up ahead of each session mainly involved checking what pupils had done the previous week and running through anything pupils had got stuck on. One teacher shared that sometimes they would need to go searching on youtube or online for a tutorial, but that this was part of their role as a teacher.

"Need to do the homework yourself sometimes" (T04)

Across the case study schools, teachers were very enthusiastic about computing and their code clubs in general meaning they were willing to put the time and effort in to make the clubs as useful as possible for their pupils. As reflected earlier, the nature of agreeing to be a case study school, may mean that these teachers are naturally more enthusiastic and therefore the running and experiences of their club may not reflect the breadth of experiences of other teachers implementing the intervention.

Practical challenges

Teachers did identify some minor frustrations with the resources, mainly around pupils being unable to set up pupil accounts on the RPF website to save their work and progress. One teacher noted that it would have been useful to have a way to view what modules and sections pupils had completed so as to observe their progress and ensure that all key parts of the programme were finished (including plenary activities). One teacher reflected they could create pupil accounts and a shared classroom with scratch and would have liked to have done the same for all the modules.

"They had to remember and one of the girls took a screenshot of where she was and what she'd done. I think that that really if they'd been able or if it'd been able to create their accounts, as you can do with Scratch, it would have been so much easier for them, and they would have been able to keep track" (T02)

Another teacher said it was tricky for pupils to save their work sometimes, which resulted in work being lost and pupils feeling demotivated. They would have liked to have been able to download the resources and put them into a project folder within their own school systems. This would also allow them to understand pupil progress and give them time to review their work outside of the Code Club sessions.

"It would be quite good if they could easily download as a project into a folder. From a school perspective and running it within a school where they have a folder" (T04)

School resources

A key benefit of Code Club styled programmes highlighted by teachers was the minimal amount of equipment needed to run a successful club. The case study schools varied in terms of their computer resources; some still had dedicated computer labs containing both desktops and laptops, whilst others used laptops within classrooms. Pupils only needed some form of computer (desktop, laptop, tablet) and an internet connection in order to access the materials. The online nature of the materials also meant pupils could continue their learning outside of the Code Club setting by logging in at home.

“Code club's quite good about that. You don't really need that many resources, do you? You can access it from a tablet or a laptop, or a really cruddy old computer.” (T04)

One school noted how they had made a conscious decision to keep their digital learning hub, as opposed to switching to more laptop based classroom learning, in order to protect computing as a subject. During the observations, one clear benefit of having a separate computer suite was that pupils did not need to spend time finding and setting up laptops at the start of each session, and putting them away at the end. This saved pupils around five minutes at the start of each club session, which could instead be put towards the content.

Having a separate space for computing also meant teachers could make the displays in the room relevant to coding and gender. One teacher in another school had put up two posters in their computer hub, focused on ethnicity and gender in computing, with the hope that it would help boost female pupils’ engagement.

“I sent away for these two posters, and they actually came a couple of days ago so it was good. I put those two posters up and it is more ethnicity than opposed to gender but there are two women that they had, and they gave a little bumf explanation about what they do” (T02)

Although the teacher viewed the separate computer space as a positive, they did appreciate that this had restricted the number of pupils able to take part in the Code Club as they were limited by the number of desktop computers.

A common point of discussion amongst teachers was the lack of funding for computing experiences and technology for pupils and that the scale of computing within schools was often dependent on their SLT and down to budget. They reflected that the lockdown had made it clear the variation in technology available to their pupils at home and that for some pupils, computing lessons or extra curricular activities at school is the only time they will get access. One teacher noted that their computing resources had improved as a result of lockdown and accessing COVID-19 funding, which occurred prior to the Code Club programme. They were unsure if they would have been able to be involved in the project without that previous funding.

Impact of COVID-19

It is worth reflecting on the potential challenges of COVID-19 on the running of the Code Clubs and any impact on the feasibility of the intervention. Interestingly, the case study schools did not talk in great detail of COVID-19 having a direct impact on the Code Club + intervention, other than pupils occasionally missing a session due to being off sick or isolating. This is likely to do with the timings of when the Code Club occurred (November 2021 - February 2022) and the specific teachers involved not being off school.

The only real impact of COVID-19 was observed during the recruitment phase of the IPE, when looking for case study schools to be involved. It was clear during September-November 2021, that many schools were restricting external visitors or faced issues with teacher availability and could not commit to being a case study school.

4.2 Intervention

4.2.1 Perceived quality

Key findings (both groups):

- Teachers and pupils were impressed with the quality of the Code Club materials and the range of activities on offer, which were attractive to different pupils' interests and helped with engagement.

This section explores teachers' and pupils' perceptions of the quality of the Code Club materials.

Quality of resources

Teachers and pupils were overwhelmingly impressed with the quality of the RPF resources and Code Club materials. They were detailed enough so that pupils could work through the activities independently, which allowed for the club as a whole to work at their own pace and the teacher could support as needed. The variety in the range of activities within each module and the array of different themes meant the activities were attractive to different pupils' interests. When asking pupils what their favourite activity was, there was a range of responses from ghostbusters to a boat race to an alien invasion.

"I think it's the variety of different projects and how they can then make it their own and go at their own pace as well." (T03)

4.2.2 Engagement

This section will explore the levels of engagement pupils and teachers showed in relation to the Code Club programme.

Key findings (both groups):

- Across all the schools, pupils were very engaged with the Code Club, often showing reluctance for each session to be finished. This was observed during the Code Club observations as well as from the teacher interviews. They were interested in the modules and keen to support one another and show each other their work.
- Some teachers felt that female pupils preferred the more creative modules and activities, whilst their male pupils enjoyed solving coding challenges.
- There was overwhelming enthusiasm from all teachers interviewed to continue running a Code Club in some form within their schools, either reusing the same resources or expanding the clubs to cover more topics.

Key finding for Code Club + intervention: Due to the lack of engagement of pupils with the Code Club + materials, it was difficult to see how they alone specifically impacted pupils' attitude towards computing and intention to continue studying.

Engagement with Code Clubs

Pupil enjoyment of the Code Clubs

Pupils were very enthusiastic and engaged with the Code Clubs in general.
This was evidenced during the Code Club observations, pupils discussion and also throughout the teacher interventions. During one school visit, the Code Club needed to be cancelled on that day and it was clear by the pupils' disappointment how much they were looking forward to attending it. During observations at another two schools, the end of each session drew further disappointment over them not lasting for longer. The pupils were reluctant to leave the classrooms and were desperately trying to finish what they were working on. They also talked about what they would continue to work on when they got home and accessed materials remotely.

When asked about their favourite part of the code club, pupils offered a number of ideas. Several pupils enjoyed the creative aspects of coding, in terms of being able to decide what they wanted to create and using their own imagination to bring their ideas to life.

"My favourite part about Code Club is… That you can let your imagination run wild" (Pupil at S03)

Other pupils focused more on the sense of achievement when they were able to create their own games successfully and then enjoy playing them. One pupil especially enjoyed the challenges around being faced with a difficult code and how good they felt when they were able to solve the problem and learn more. pupils also liked being able to share their creations with friends and family and show them what they had been able to make. One female pupil shared how she liked being able to code with her brother at home and keep up with what he was doing, whereas previously before attending the clubs, she wouldn't have been able to do so.

Gender differences in engagement

Teachers were unable to consistently find any gender differences in terms of pupil's engagement with the clubs, however they did identify some more general differences in what they enjoyed the most. One teacher had made the observation that their male pupils tended to enjoy Python based materials more, whereas their female pupils preferred HTML activities. The teacher felt this was due to differences in their pupils' creativity; stating that their male pupils preferred solving and writing code and their female pupils enjoyed the design elements of the activities. During one of the Code Club observations, there was a general trend of girls tending to spend more time on the design choices they were making, around what colour they wanted objects to be, whereas the male pupils focused more on getting the code correct and finished and moving onto the next module or activity.

"Yes, they like projects where they can do their own designs… there's always been more enthusiasm amongst females. The male pupils like Python. They just like the challenge of writing their own code, which is - and the girls seem to prefer HTML" (T03)

Female pupils were also thought to be more engaged in terms of finishing the whole module before moving onto a new module or activity to start and would persevere more so than their male counterparts until they got it correct.

"The females were definitely more engaged, definitely more willing to work with it". (T02)

One teacher felt that some of the modules were too long, which tended to impact the male pupils more. They tended to get bored and want to skip onto a new activity, their teacher felt this was especially true when their male pupils were completing some of the plenary activities. This was reflected during one of the Code Club observations, where the researcher saw that some of the male pupils were flicking through the materials quickly and were more likely to skip around and move to new modules or activities. The female pupils spent much longer on what activity making sure they had finished all of it to a standard they were happy with.

"It needed shorter modules. Not so long because some of them went on for quite a while and I think that's where the idea of, 'I'm only doing this bit,' and then getting bored for want of a better word and then moving on to something else. So rather than it being such a long module but even splitting it into smaller chunks. That's where some of them struggled. I think they had to be really focused on that to be able to go from one start to the end. Some of them were able to do it, but I do know that some of the boys struggled with that, whereas I think it was mostly girls that were easier to just get on." (T02)

Intentions to continue with Code Clubs

There was overwhelming enthusiasm from all teachers interviewed to continue running a Code Club in some form within their schools. One teacher was relaunching the club later the same week and actively trying to widen participation, to allow more pupils to make use of the RPF materials. Another teacher was keen to introduce more parent volunteers, with computing experience, into the club to help broaden the role models pupils were exposed to.

The main consideration for teachers in relation to the future of code clubs within their school was funding and their own capacity. One teacher referenced that a funding decision would need to be made as to whether their role as a computing specific lead would continue for another year. They had lots of ideas over how they would like to expand the club, broaden the curriculum to include more types of coding, but reflected that they would be giving up their own time to drive it forward.

"Code Club, I mean there's no reason why that shouldn't keep going and that I think is good. Would I change it, do things differently? Yes, I would. I think one of the things is now having these two Lego kits, for example and the extension pack. I'm looking forward to doing that." (T02)

Engagement with Code Club + material

During the interviews, teachers were unable to recall many details about the extra activities and their descriptions of how pupils interacted with them was limited. Some schools had chosen not to complete all the activities and other teachers flagged how they saw pupils rushing through the skill sorting game without really paying attention to what they were doing.

During the various IPE activities (interviews, observations, pupil discussions), it was unclear whether pupils had engaged with features related to the concept of endowed progress. The progress bars along the webpages for each module was one visual example of such features. However, teachers were unable to reference them when asked, and pupils also showed little engagement with them during observations. It is worth noting that engagement with the endowed progress concepts may have been impacted by some schools giving pupils freedom to move between the modules in the order they chose, and teachers being unable to view what activities and modules their pupils had completed.

As highlighted in section 4.1.1, there was one teacher who was more familiar with the activities and was able to recall pupils completing the activities and engaging with them. During the pupil discussion at this school, when asked about the skills needed for computing, the pupils were able to name some of the skills highlighted in the animations and progress bar, including creativity, resilience and problem solving. This suggested that the learnings may have translated for pupils who completed the activities as intended. Unfortunately, as we were unable to complete pupil discussion groups in the other schools, we're unable to make any comparisons regarding engagement with skills. It is also worth remembering that our findings represent the experience of only four schools from the overall Code Club + programme.

4.2.3 Mechanisms and perceived outcomes

Key findings:

- Code Clubs created a safe environment for pupils to get things wrong and make mistakes, which can easily be fixed. They learnt this was a part of the coding process and ultimately allowed them to feel more confident in giving things a go.
- Teaches frequently mentioned negative attitudes towards computing held by other female teaching staff as a barrier towards encouraging female pupils to engage with computing.

Key finding for Code Club + intervention:

- There was limited evidence to support the mechanisms outlined in the logic model, mainly due to pupil's limited engagement with the Code Club + materials, as described by teachers, which contained the key information increasing the link between formal and informal learning.
- There was some evidence of pupils being able to recall the skills for computing from the Code Club + materials, suggesting that they were making links between skills in coding and computing.
- There was a consistent view amongst teachers that they did not observe much attitude change in pupils after attending Code Clubs, due to pupils already showing a positive attitude when they began.
- Teachers did not perceive much effect of the Code Club + materials on pupils' intent to continue studying computing.
- These findings represent the experiences of four case study schools, therefore may not be representative of other schools experiences of the Code Club + programme.

The Code Club + intervention aimed to increase female pupils' awareness of the link between informal computing learning (via Code Clubs) with broader more formalised computing education. This would in turn help improve girls' attitudes towards computing and their intention to continue to study the subject. The section of the logic model in Figure 7 sets out the hypothesised mechanisms through which the intervention was designed to affect the intended outcomes. This section explores the extent to which the data from the IPE support the hypothesised mechanisms within the logic model.

These mechanisms include i) Increased awareness of the link between coding and more formal computing study and the skills developed, ii) female pupils realise that computing is relevant to them as a result of links between coding and computing being made more salient.

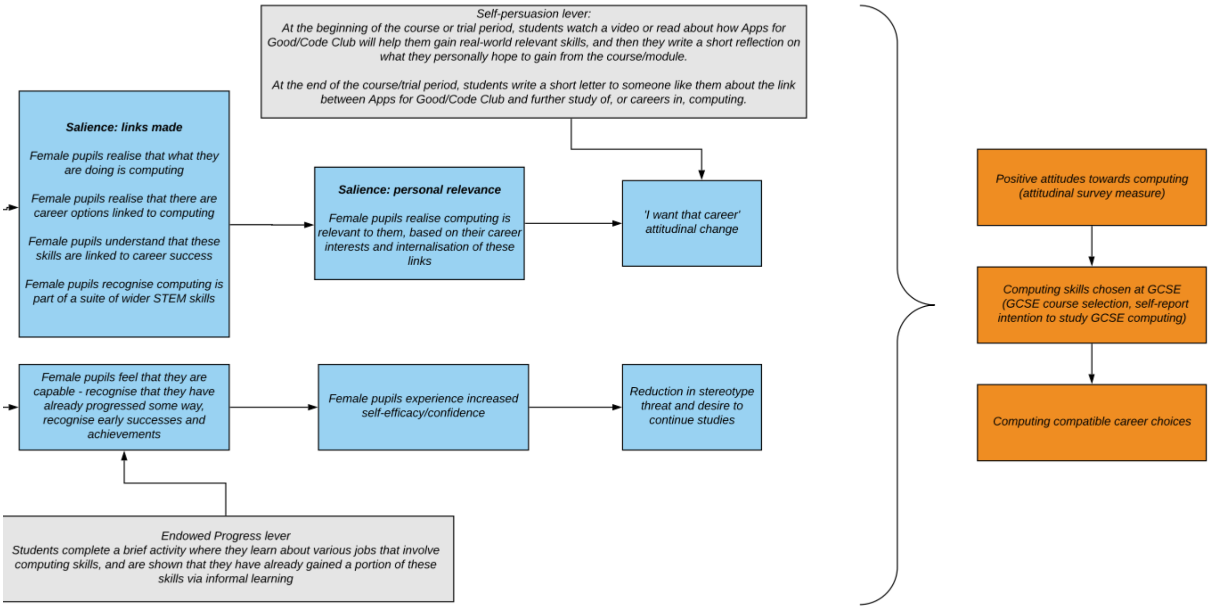

Figure 7: Informal Learning logic model mechanisms and proximal outcomes

Mechanisms for the Code Club + intervention leading to improved attitudes towards computing

Within the case study schools, there was limited evidence to support the mechanisms discussed in the logic model; this is likely as a result of limited teacher and pupil engagement with the Code Club + materials. These materials were the main examples of the link between informal learning and formal academic study being made.

Increased awareness of the links between coding and computing skills

> *Female pupils realise what they are doing is computing, and realise there are career options linked to computing. Female pupils understand that these skills are linked to career success. Female pupils recognise computing is part of a suite of wider STEM skills.*

It is unclear how impactful the career links made throughout the Code Club + materials were on pupils' awareness of computing careers. The career options were shown throughout the modules as part of the extra activities, however no pupils were able to reference these types of careers during the discussion group, which implies they may have had limited impact on the pupils' knowledge of STEM careers.

Although pupils were not able to link the development of skills to a specific career in computing, they were able to recall some of the skills mentioned in the Code Club + materials. Teachers were also able to observe changes in pupils' skill development, notably their creativity and willingness to collaborate together to problem solve.

Increasing the relevance of computing to female pupils

Female pupils realise computing is relevant to them, based on their career interests and internalisation of these links

Teachers reflected that their female pupils already had a positive attitude towards computing ahead of attending the Code lubs. A lot of the material within the Code Clubs (specific coding languages) may have been covered during classes previously. Teachers therefore felt that female pupils already believed computing to be relevant to them.

Teachers felt that being able to link the content and activities within code clubs and coding with real life situations, was more beneficial for female pupils' engagement. One teacher felt it was the most effective way of getting pupils to consider continuing to study computing in the future. This again linked back to the ideas around creativity, whereby pupils could see a wider use for coding skills beyond that of doing maths for example.

"I think the girls really like it when you're talking about the wide range of uses for coding, and not just sitting in an office doing maths....So it's interesting when you're talking to them about how they can use it in the future, and I think that's the thing that makes them more interested in doing it." (T03)

Several teachers shared the view that having positive female role models within computing was beneficial for female pupils in seeing what opportunities they could have in relation to computing in the future. One school's previous Code Club had parent volunteers, who came from a technology or computing background, help out and found it was useful in widening pupils' horizons in terms of what computing could look like in the future.

Mechanisms observed for Code Clubs encouraging positive attitudes towards computing

Increased self-efficacy

Female pupils realise their computing capability and experience increased self-efficacy and confidence as a result

Code Clubs created a safe environment for pupils to get things wrong and make mistakes, which can easily be fixed. They learnt this was a part of the coding process and ultimately allowed them to feel more confident in giving things a go. One teacher described how they often see female pupils becoming disengaged in a subject after getting something wrong and believing it to be a reflection on their overall ability. The teacher felt Code Clubs challenged that and allowed female pupils to learn that it was fine to get things wrong and part of the process.

"They do stuff, and they find it really hard if they make mistakes, so it's really focusing on… In computing, it's fine, because in our lesson, you know you can make mistakes, because you can really easily fix them, as well" (T03)

Teachers also felt this safe environment was linked to collaboration, as working in groups allows for the ‘mistake’ to be shared amongst each other and lessened the impact of that mistake on belief in their individual abilities.

The school, which chose to only allow female pupils into the club initially, partly did so as a way to help create a safe space for them to practise coding and build their confidence up. This was influenced by some of the wider cultural markers within the school and community in terms of expectations of female pupils within the home.

“In our school culturally our girls are more quiet, they have less to say, they are less confident. There is an inequality in terms of how they are treated at home sometimes by their parents." (T04)

The teacher hoped that by inviting the female pupils into the Code Clubs, where they would have the opportunity to experience some of the coding curriculum, which would then be covered during their lessons, that would help them to feel more confident and redress some of the balance between boys and girls within the school.

"I think starting them off first and making them the monitors and making them the people who know what's happening, that will hopefully readdress that balance in the class when the boys come in.” (T04)

Additional possible mechanisms

The role of creativity and collaboration in improving attitude towards computing

The creative elements of coding and the opportunity to use their imagination was frequently mentioned by pupils as one of the things they enjoyed the most. During the discussion group, pupils were also able to remember creativity as one of the main skills needed for computing. The pupils also referred to the creative elements of the Code Club activities, with several linking being able to be creative as the thing they were most proud of from the sessions.

Teachers repeatedly noted creativity as a driver for female pupils’ enjoyment. They recalled that female pupils tended to focus and spend more time on the colour changes and more aesthetic aspects of the activities.

"I think it's the variety of different projects and how they can then make it their own and go at their own pace as well. I think it's that… It's different from the computing lessons where we have to stick to that as we move on. I think they really enjoy that freedom. As well, they've still got that project, but they can really get creative with it as well." (T01)

Learning how to collaborate successfully appeared to be another positive emerging from the Code Club programme. This was also one of the skills discussed during the intervention specific materials (skill sorting game). One teacher felt that the nature of the Code Club set-up was beneficial for females to build confidence when working collaboratively. They explained that often they find girls struggle to work together successfully once they get to around Year 5, yet this was not the case within the code clubs. The teacher was not able to expand further on what they thought it was about Code Clubs that facilitated this collaboration benefit for female pupils.

“I thought it was very good for them to work together actually. Especially girls, after a certain age, after Year 5, they can find it a bit tricky, and they worked together really well.” (T03)

It was however clear to see collaboration between pupils in practice during the observation sessions. All the teachers give pupils choice over where they sat during the clubs and who they worked nearby. The researchers were able to observe a mixture of different groupings of pupils and ways of working together. There appeared to be no gender differences in terms of which pupils choose to lead on problem solving; it tended to be more influenced by pupils of higher ability at coding or who had more confidence within the classroom environment.

Distal outcomes

Throughout the case study activities, it was clear there was a high level of enjoyment and engagement with the Code Clubs as a whole, alongside praise for the quality of the materials developed by RPF. However, when asked about specific features of the Code Club + materials against the business as usual resources (addition of skill sorting game, skills videos, careers video & postcards), teachers were fairly apathetic towards the materials, often remembering them but not recalling specific details.

Improved attitudes towards computing

There was a recurring view amongst teachers that they did not observe much attitude change in pupils after attending Code Clubs, due to pupils already showing a positive attitude when they began. All four of the teachers interviewed felt that the majority of pupils attending their clubs enjoyed computing and had not really observed any gender differences in regards to that attitude. One teacher raised the point that all children seem to love computing and the opportunity to go on the computers within school time.

"I think they really already loved it. Children love computing, it's not very often to find a child who does not want to use a computer." (T01)

“The children are so excited when they get to use a computer and it's something that so many children are so good at - even the children who really struggle with everything else.” (T04)

This positive attitude towards computing was evident during the pupil discussion group, whereby all the pupils said they enjoyed computing and coding, believed that girls were good at computing and would like to continue attending their code club. Interestingly, when asked whether girls and boys can both equally have computing as a favourite subject, two female pupils disagreed, with one saying that boys love it a lot in comparison to girls. This answer was a slight contrast to their others, in terms of feelings towards computing and coding.

"Because boys might love it lots but girls don't like it much" Pupils from S03

It is worth noting that due to the nature of this intervention taking place within an extra curricula setting, it is likely that the sample of pupils involved are likely to be more interested in computing, therefore the findings may not be reflective of a large pupil sample.

Intention to study computing

Whilst pupils were quick to say they would like to continue studying computing at secondary school, their teachers were more reserved, reflecting that often their pupils say what they thought they wanted to hear. When asked to elaborate on why they would like to continue studying, pupils tended to focus on the fun elements of the Code Clubs as well as their enjoyment of computing in general.

Some teachers were able to identify specific pupils (maybe one or two within their class), who they knew would go on to have a career in computing, namely as a result of their computing abilities and interest in the subject, which tended to pre-date the Code Club project itself.

"They do, but I think they're saying that to make me happy. I still don't think it's… I don't know. I think it depends what they are studying." (T03)

Code Club +

During the pupil discussion groups, a couple of pupils directly referenced a potential career interest in computing, either to make games or to be an illustrator. Neither of these jobs were referenced in the animation covering skills in computing careers, however it could be that seeing some career ideas in general prompted these pupils to think about what they would like to do. Unfortunately, we don't have any further information as to whether these pupils viewed that activity.

Other barriers influencing attitudes towards computing

Teacher attitude towards computing

Teaches frequently mentioned negative attitudes towards computing held by other female teaching staff as a barrier towards encouraging female pupils to engage with computing. One teacher recalled their school having to integrate teaching effective computing lessons into their school development plans to ensure that teachers made use of computing resources. They found that some teachers were still reluctant to use computers and would struggle with basic programmes such as paint or word. They understood that computing and computers can feel daunting for teachers who are less familiar with them, often due to the fear of what happens if something goes wrong. However, they felt this had a knock on effect on female pupils, who witnessed their female teachers, who are often theri role models, dismissing technology as something they can't do or aren't good at. This could ultimately reinforce negative stereotypes.

" We've had to put in to teach effective computing lessons in all year groups on our school development plan because some people just don't teach it, they just don't. I have been talking to some teachers for 3 years and today was one of the first lessons that some of them have taught and then still needed help." (T04)

"I thought there was a massive barrier, especially with female teachers, and actually computing teaching seems to be quite male gendered, and often the heads of computing in primary schools are male." (T03)

5. Conclusions and recommendations

5.1 Summary and interpretation of findings

We observe no meaningful impact on measured attitudes or intentions.
We did not find a statistically significant effect of the Code Club + intervention on girls' attitudes towards computing or intention to study computing in the future relative to the Code Club intervention. However, the estimated treatment effect of the Code Club + intervention relative to the Code Club intervention was positive for each outcome, and the differential attrition observed suggests that this difference may be an underestimate of the true effect. However, the high rate of overall attrition does not allow us to distinguish this effect from one that could have been produced by chance.

The IPE findings suggest that whilst Code Clubs were well received by teachers and pupils, the Code Club + materials may not have been delivered consistently across all schools, which may have limited impact on pupils relative to Code Clubs.
Across the four case study schools, teachers were overwhelmingly positive about the engagement their pupils showed during the Code Club sessions. This was also clear during the observations and pupil discussion group. However, of the teachers interviewed, only one could talk in detail about the Code Club + materials and could describe their pupils spending time on those activities as intended.

As before, it is worth keeping in mind that the IPE only involved a small sample size of case study schools. Therefore, findings should be viewed as an example of the range of experiences of some schools, but not generalised across all the schools involved in the programme. Further, the COVID-19 context likely posed important challenges to the delivery of the intervention.

Case studies highlighted teachers' and pupils' positive perceptions of the Code Club + sessions. **They also pointed to implementation challenges and barriers which if experienced at other schools in the sample, may have limited the impact of the intervention on girls' measured outcomes.**
The main implementation challenges identified in the IPE were: i) teachers did not always attend information sessions or attend to the Code Club + materials and resources provided by RPF; ii) schools struggled to organise one-hour long Code Club sessions as outlined in the project plan, which meant pupils prioritised completing the coding activities over the Code Club + materials; iii) some teachers were not able to view their pupil's progress through the Code Club materials and could not check they had completed all the tasks and activities within a module (including the Code Club + material). These challenges meant it is difficult to know the full dosage of the Code Club + intervention (relative to the Code Club intervention) received by pupils. These challenges could help to explain the lack of differences found

between the Code Club and Code Club + groups in relation to changes in attitudes towards computing.

In addition to these implementation challenges, a factor that may limit the scope for impact of the Code Club + intervention is the already high engagement with Code Club intervention and pre-existing interest in computing. Due to the characteristics of the sample (schools with a teacher interested in taking part in a gender balance in computing project), the baseline level of girls' engagement with computing might be higher than in the general population. If this is the case, it is possible that there is less scope for an intervention to lead to a large improvement at such schools, especially one intended as light touch in its design. As Code Clubs were an optional extra curricular activity for pupils, it can also be expected that pupils attending are likely to be more engaged or motivated towards computing already.

The COVID-19 context likely had important negative consequences for the feasibility of the intervention, as illustrated by the high school attrition observed throughout the evaluation and some of the recruitment challenges reported in case study schools. The attrition observed also limited the evaluation's ability to detect a statistically significant impact of the Code Club + intervention on measured pupil attitudes and intentions relative to the Code Club intervention. Overall, the evaluation results suggest that refinements to the design and delivery of the intervention may be necessary for the additional components in the Code Club + intervention to have a substantive impact on the target outcomes relative to the Code Club intervention.

5.2 Recommendations

Recommendations to refine the design and delivery of the Code Club + intervention

The following adaptations to the intervention may help to respond to the main implementation challenges identified and make it easier to implement it in a broader range of schools:

1. **Make the activities linking informal and formal learning more salient**
   Although pupil engagement was high in relation to the Code Clubs overall, there was less engagement with the Code Club + materials in the case study schools, therefore it was difficult to understand the full potential of the approach. Tweaking some of the Code Club + materials to require more engagement or thought from pupils could be useful; one teacher suggested that the skills sorting game should require pupils to write out the definition of the skill before sorting it, to ensure they really understood.

2. **Allow teachers to view their pupils' progress through the Code Club materials**
   This would allow teachers to know what activities and modules their pupils had completed and ensure they engaged with the Code Club + materials.

Recommendations to support implementation of Code Clubs

The following steps could make the Code Club intervention easier for teachers to implement within schools:

3. **Ensure that teachers are familiar with the Code Club + activities ahead of launching the Code Clubs. This could be achieved by holding a mandatory training session.**
   One option could be to only share the resources with teachers once they have attended a training session; this would allow teachers to understand the purpose of the extra Code Club + activities and allow them to support pupils better to complete them.

4. **Continue to share and publicise Code Club materials to school communities**
   Throughout the case study schools, teachers and pupils enjoyed their time within Code Clubs, with all the pupils sharing how fun they found it and the things they had learnt. The resources were said to be high quality and easily accessible in terms of only needing a computer to be involved, therefore a positive option to help maintain pupils' enjoyment of computing via coding. The materials also appeared to be accessible for teachers who had not come from a computing background.

5. **Incorporate more role models into the Code Clubs**
   Several teachers noted the importance of female role models who are positive towards computing for helping female pupils feel more positive about computing. One teacher suggested that asking volunteer parents to attend Code Clubs could be helpful in widening the role models pupils have.

Recommendations for future evaluations

6. **Identify strategies to measure outcomes targeted by the intervention further into the future**
   Tracking relevant behavioural outcomes (in this case, subject choice from Year 10 onwards) multiple years after the intervention requires planning, collaboration with schools, and longer and more flexible evaluation timelines. However, it would also significantly improve the ability to evaluate the impact of early interventions over a time horizon in line with the mechanisms and barriers hypothesised, and thus identify the most impactful ones. In this case, attempting to collect and analyse data on whether pupils in the evaluation sample select computer science as a GCSE subject once the choice arises would enable the estimation of the impact of the intervention on the long-term outcomes targeted, in addition to the short-term proxy indicators used in this evaluation.

7. **Continue to refine survey tools and support schools to administer them to maximise data reliability and reduce attrition**
   The implementation and evaluation of the interventions examined in this report was

particularly difficult given the COVID-19 context, in addition to the challenges often associated with evaluating school-based interventions and attrition in particular. While possible improvements in the COVID-19 context in schools should facilitate future evaluations, doing additional small-scale piloting of survey tools and identifying ways to support schools with data collection (e.g., appointing staff to visit schools to help administer the survey), while resource-intensive, could be a cost-effective way to reduce attrition and increase data quality, thereby enabling a more precise diagnosis of the effects of the interventions and how to maximise them.

8. **For any future adaptations or new interventions, consider additional small-scale piloting to refine delivery prior to a full-scale impact evaluation**
Piloting interventions in school is complicated given the school staff involvement and coordination with schools it requires, particularly in the recent COVID-19 context. However, the possible improvements to the delivery of both interventions identified through the IPE illustrate the value of small-scale piloting to inform improvements to the impact potential of any intervention before moving to a full-scale impact evaluation. Where possible, strategies to evaluate interventions at incremental scale and cost should be explored to maximise learning and resource efficiency.

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Appendices

Appendix 1: Pupil survey for impact evaluation

Endline survey

Hello! It's time to do the survey.

Please read each question carefully and take your time to answer.

Please don't worry about people you know seeing your answers - that won't happen.

1.1	Please type your first name	Text entry		
1.2	Please type your last name	Text entry		
1.3	Please select the gender you identify with	Female	Male	Non-binary
1.4	Please select the day you were born/month you were born/Year you were born	Drag downs		
1.5	Please pick the name of your school from the list below	Drag down		
1.6	[Compliance Q] Have you completed a postcard like this (insert image) during Code Clubs?	Yes	No	
1.7	Do you want to study any of these subjects in future?			
	Computing	Yes	No	Don't know
	Science	Yes	No	Don't know
	Technology	Yes	No	Don't know
	Maths	Yes	No	Don't know

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Thanks! Now it's time for the rest of the questions.
[Not shown to students: **Subscales** - 1-5 Confidence, 6-10 Interest, 11-15 Belonging, 16-20 Usefulness, 21-25 Encouragement]

2.1	I am confident that I can do computing	Strongly disagree	Disagree	Agree	Strongly Agree
2.2	I am confident that I can solve problems by using computing	Strongly disagree	Disagree	Agree	Strongly Agree
2.3	I can learn computing skills without much help	Strongly disagree	Disagree	Agree	Strongly Agree
2.4	I am good at solving hard questions in computing lessons	Strongly disagree	Disagree	Agree	Strongly Agree
2.5	I think I will do well in computing	Strongly disagree	Disagree	Agree	Strongly Agree
2.6	I would choose more computing lessons if I could	Strongly disagree	Disagree	Agree	Strongly Agree
2.7	In the future I'd like to do more computing	Strongly disagree	Disagree	Agree	Strongly Agree
2.8	I like to use computing to solve problems	Strongly disagree	Disagree	Agree	Strongly Agree
2.9	Solving questions in computing lessons makes me feel happy	Strongly disagree	Disagree	Agree	Strongly Agree
2.10	I like computing lessons	Strongly disagree	Disagree	Agree	Strongly Agree

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Well done! Keep going - you are already half way through.

2.11	I feel happy in computing class	Strongly disagree	Disagree	Agree	Strongly Agree
2.12	I feel like I belong in computing lessons	Strongly disagree	Disagree	Agree	Strongly Agree
2.13	I have lots of friends in my computing lessons	Strongly disagree	Disagree	Agree	Strongly Agree
2.14	I know someone who uses computing in their job	Strongly disagree	Disagree	Agree	Strongly Agree
2.15	I have friends who think computing is interesting.	Strongly disagree	Disagree	Agree	Strongly Agree
2.16	Knowing about computing will help me get a job.	Strongly disagree	Disagree	Agree	Strongly Agree
2.17	To get the job I want I will need computing skills.	Strongly disagree	Disagree	Agree	Strongly Agree
2.18	I can use things I learn in computing lessons in other lessons too.	Strongly disagree	Disagree	Agree	Strongly Agree
2.19	I'll need to be good at computing for my lessons as I get older.	Strongly disagree	Disagree	Agree	Strongly Agree
2.20	Computing is an important subject.	Strongly disagree	Disagree	Agree	Strongly Agree

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Almost done!

2.21	A friend, or someone I know said I should do computing	Strongly disagree	Disagree	Agree	Strongly Agree
2.22	Someone I know has made me feel interested in computing	Strongly disagree	Disagree	Agree	Strongly Agree
2.23	Someone I know has said my work in computing is good	Strongly disagree	Disagree	Agree	Strongly Agree
2.24	I have been taught about how computing is used outside of lessons.	Strongly disagree	Disagree	Agree	Strongly Agree
2.25	Someone in my family has made me feel interested in computing	Strongly disagree	Disagree	Agree	Strongly Agree

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You have completed this survey! Thank you for taking the time to answer this survey.

Appendix 2: Regression model specification

Primary outcome: SCSAS scores

The primary outcome is continuous and therefore we used a linear regression to assess the Intention-To-Treat (ITT) effect of our treatment on this outcome. Owing to the clustered nature of the data, and because we randomised at the cluster level, we used cluster-robust standard errors in analysis, clustering at the school level.

$$Y_{is} = \alpha + \beta_1 T_s + \beta_2 BL_i + B_3 propFSM_s + B_4 Ofsted_s + \epsilon_{is}$$

Where:

- Y_{is} is the Total SCSAS survey mean score for pupil *i* in school *s*
- α is the constant
- T_s is a binary indicator of treatment assignment for pupil *i in school s*, = 1 if pupil *i* attends a Code Club + school and = 0 if attends a Code Club school
- BL_i is the baseline SCSAS score for pupil *i* in school *s* collected before the intervention
- $propFSM_s$ is the proportion of pupils eligible for Free School Meals in school *s*
- $Ofsted_s$ is a tertiary indicator of Ofsted rating in school *s* (using "Outstanding" as a , comprising (i) "Good"; (ii) "Below good" (the combination of "Requires improvement" and "Inadequate"); and (iii) Missing Ofsted rating/No rating available;
- ϵ_{is} is the error term for pupil *i* in school *s*

Table 10 below provides the full results for the primary analysis using multiple imputation (column 1), missingness indicator (column 2), complete case analysis (column 3) and multiple imputation including the trial year as a covariate (column 4).

Table 10: OLS regression coefficients for primary outcome (standard errors in parentheses)

Outcome: SCSAS score	***(1) MI***	***(2) Miss. Ind.***	***(3) CCA***	**(4) Trial year robustness check**
Treatment group (reference category is control)				
Intervention	0.020 (0.059)	0.025 (0.064)	0.018 (0.057)	0.022 (0.064)
Baseline SCSAS score	0.430** (0.076)	0.482** (0.077)	0.492** (0.075)	0.431** (0.075)
Missing Baseline SCSAS	-	1.969** (0.340)	-	-
Ofsted rating *(reference category is Outstanding)*				
Good	0.043 (0.085)	0.037 (0.087)	-0.011 (0.086)	0.041 (0.085)
Below Good	-0.146 (0.100)	-0.138 (0.094)	-0.148 (0.102)	-0.147 (0.099)
Missing	0.116 (0.087)	0.134 (0.092)	0.059 (0.088)	0.110 (0.091)
Percentage FSM	0.002 (0.002)	0.002 (0.002)	0.001 (0.001)	0.002 (0.002)
Missing percentage FSM	-	-0.028 (0.080)	-	-
Constant	1.706** (0.224)	1.544** (0.225)	1.560** (0.218)	1.700** (0.222)
Control group mean	3.17	3.17	3.18	3.17
Observations	328	328	279	328
R^2	-	0.234	0.248	-

Note: Standard errors clustered at the school level
*+ p<0.1; * p<0.05;* ** p<0.01

Secondary outcome: stated intention to study computing

The secondary outcome is binary, and therefore we will use a logistic regression to assess the Intention-To-Treat (ITT) effect of our treatment on this outcome. Owing to the clustered nature of the data, we will use cluster-robust standard errors in analysis, clustering at the school level.

$$Y_{is} \overset{indep}{\sim} = bernoulli(p_{is}); logit(p_{is}) = \alpha + \beta_1 T_s + \beta_2 BL_i + B_3 propFSM_s + B_4 Ofsted_s$$

Where:

- Y_{is} is a binary indicator for pupil *i* reflecting intention to study computing in school *s*
- p_{is} is the probability of a positive intention for pupil *i* in school *s*
- α is the constant
- T_s is a binary indicator of treatment assignment for pupil *i in school s,* = 1 if pupil *i* attends a treatment school 1 if pupil *i* attends a Code Club + school and = 0 if attends a Code Club school
- BL_i is the baseline SCSAS score for pupil *i* in school *s* collected before the intervention
- $propFSM_s$ is the proportion of pupils eligible for Free School Meals in school *s*
- $Ofsted_s$ is a tertiary indicator of Ofsted rating in school *s* (using “Outstanding” as a , comprising (i) “Good”; (ii) “Below good” (the combination of “Requires improvement” and “Inadequate”); and (iii) Missing Ofsted rating/No rating available.

Table 11 provides the full results for the secondary analysis using multiple imputation (column 1), missingness indicator (column 2), complete case analysis (column 3) and multiple imputation including the trial year as a covariate (column 4).

Table 11: Logistic regression coefficients for secondary outcome (standard errors in parentheses)

Outcome: Intention to study computing	***(1) MI***	***(2) Miss. Ind.***	***(3) CCA***	***(4) Trial year robustness check***
Treatment group (reference category is control)				
Intervention	0.143 (0.468)	0.318 (0.433)	0.066 (0.445)	0.206 (0.465)
Baseline SCSAS score	1.164** (0.395)	1.451** (0.408)	1.369** (0.411)	1.175** (0.385)
Missing Baseline SCSAS	-	6.658** (1.868)	-	-
Ofsted rating *(reference category is Outstanding)*				
Good	0.742 (0.466)	0.563 (0.418)	0.631 (0.431)	0.687 (0.450)
Below Good	-0.501 (0.545)	-0.772 (0.517)	-0.685 (0.456)	-0.550 (0.533)
Missing	1.305* (0.581)	0.722 (0.574)	1.110* (0.536)	1.110 (0.684)
Percentage FSM	0.024* (0.011)	0.039** (0.013)	0.019* (0.008)	0.028* (0.012)
Missing percentage FSM	-	1.280* (0.530)	-	-
Constant	-4.013** (1.344)	-5.378** (1.329)	-4.517** (1.367)	-4.169** (1.307)
Control group mean	0.684	0.684	0.673	0.684
Observations	328	329	279	328
R^2	-	0.121	0.091	-

Note: Standard errors clustered at the school level
*+ p<0.1; * p<0.05; *** ** p<0.01