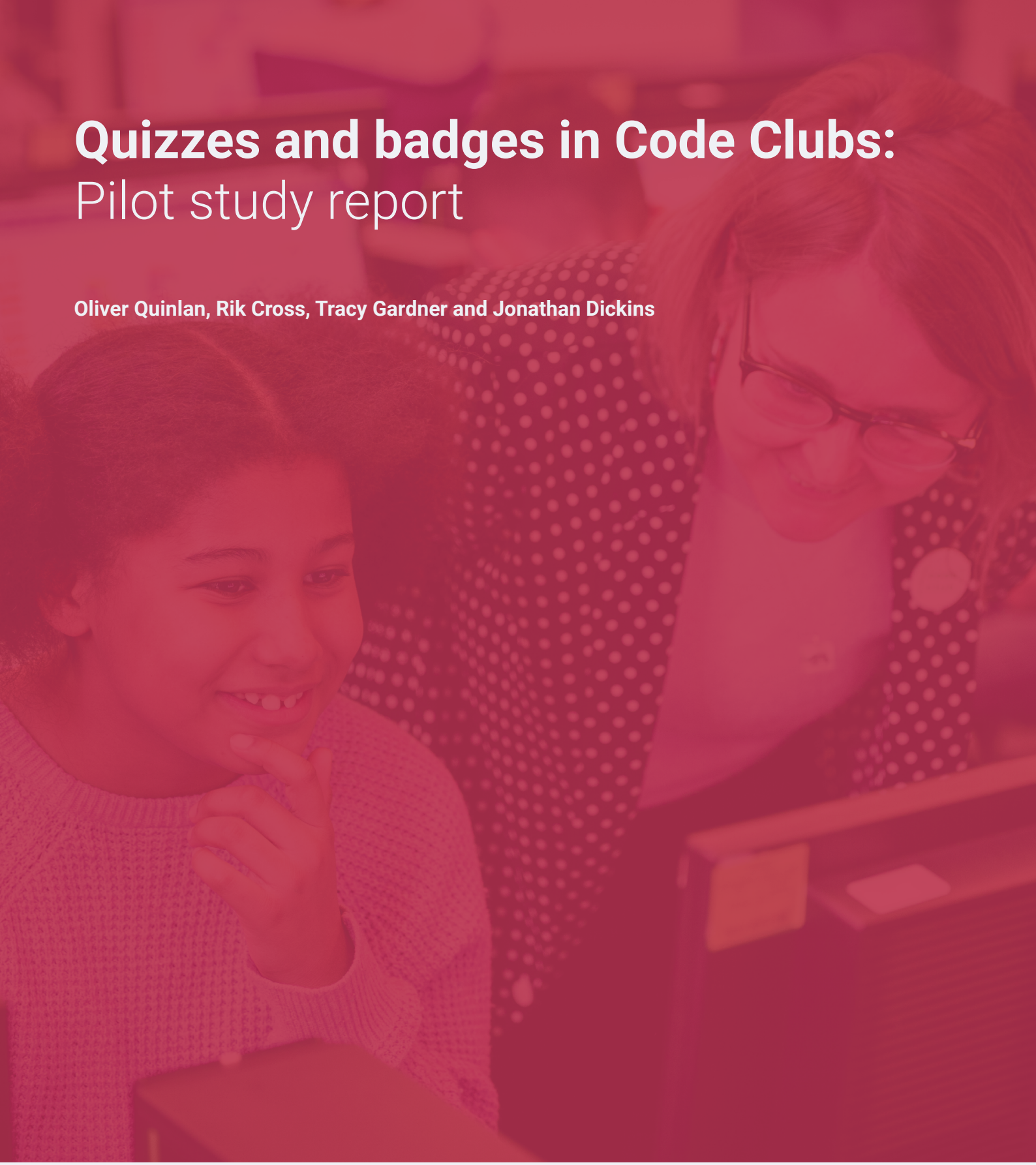
Quizzes and badges in Code Clubs:
Pilot study report

Oliver Quinlan, Rik Cross, Tracy Gardner and Jonathan Dickins



Raspberry Pi Foundation Research No.11

Raspberry Pi

code club

CoderDojo

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Pilot study report

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Executive summary

The Raspberry Pi Foundation runs programmes that help people to learn about computing and digital making. We think it is important that people who take part in our programmes have a good understanding of what they are learning, so that they can celebrate their successes, and build on them by knowing what they can do with their skills next. We also want to understand what people are learning so that we know how well we are doing in achieving our mission, and how we can continue to improve.

In Autumn 2018, we ran a trial with thirteen UK Code Clubs to test an approach to assessing informal learning. Ten of the clubs took place in schools and three in libraries, with seven run by staff of the venues and six run by volunteers.

The clubs were given six quizzes relating to the six 'Scratch Module 1' projects. They were also given charts to track their progress and some questions to complete on their attitudes towards programming. Around half of the clubs were given stickers relating to each project, to incentivise completing the projects and quizzes. We collected the data from the quizzes, progress charts, and surveys, as well as visiting many of the clubs and interviewing all of the club leaders either in person or on the phone.

The results of this trial suggest that assessment of this type is welcomed by Code Club leaders, with some areas to consider concerning how it is framed and implemented. The data from surveys shows that children respond positively to quizzes, and extremely positively when they are linked to badges. The data on achievement in the quizzes suggests that quizzes are useful to show us the range of learning that takes place in Code Clubs.

Headline findings

- Most adults felt that the three-question quizzes were appropriate for the ethos of their clubs.
- We had some feedback that Code Club projects are very focused on making and the end product, which children enjoy, but that the children can also benefit from a chance to recap what they have learned.
- Around half of the children who only used quizzes said that they enjoyed doing them. In the groups that also had badges, this figure was much higher, with around three quarters of the children reporting that they liked the quizzes and 89% of the children reporting that they liked earning the badges. Adults fed back that there was a range of enthusiasm to the quizzes, but that generally, children accepted them as part of Code Club.
- Enthusiasm for the quizzes did not appear to be linked to self-assessed programming ability or performance in the quizzes.
- 51% of the answers given by children in the quizzes were correct. Adults fed back that the quizzes were pitched at the right level for the children.
- Children scored much higher in the weekly coding questions (59% overall) than in the computational thinking questions asked at the end of the pathway (29% overall).
- These scores suggest that our quiz questions are differentiating between children who have mastered the particular concepts and those who have not. This is supported by the fact that children's scores in the quizzes had some correlation with their self-assessments of their skills.
- Half of the club leaders said that the quizzes helped the children by giving them an opportunity to reflect on the concepts that they had learned. However, some said that the different context of quizzes to projects made the quizzes difficult.
- The two clubs with the highest quiz scores had leaders who had discussed the answers and used quizzes as a chance for reflection. The lowest-scoring clubs had not taken this approach.
- The relatively short Code Club sessions mean that assessment activities such as quizzes are likely to eat into time available for coding. However, online quizzes will be much more efficient to manage than the paper-based ones used in this pilot.
- For some club leaders, the emphasis of Code Club is strongly on programming activities on the computers, and they are less

enthusiastic to use the limited time available in a Code Club session for an activity that is not programming.

- Feedback on future ideas for online quizzes was positive, although some adults felt that changing context and moving away from the computer was beneficial for focusing on the quizzes and reflecting on learning.

Recommendations

- Run this trial with CoderDojos to explore the practicalities in this context, and to gather feedback from adults and children in this community, which caters for a wider age range.
- If there are positive results from the CoderDojo trial, continue to develop the three-question multiple choice quizzes format, and add the quizzes to the pathways on the Projects site.
- Develop a system for celebrating achievements in these online quizzes, based on the stickers used in this pilot.
- Carefully consider how we frame the quizzes to allow an opportunity for reflection, and how we can build on the benefits of changing context that some adults attributed to the paper-based quizzes.
- Consider how we encourage adults to facilitate discussion and reflection around the quizzes into their sessions, particularly as online quizzes are likely to facilitate a more individualised approach, where children could complete different projects and therefore different quizzes during the same session.
- Create multiple questions for each learning objective, put the quizzes on the Projects site, and analyse performance in order to trial questions on a larger scale and further refine the questions. This will be particularly useful for computational thinking questions in order to grow our understanding of how these questions measure performance. We should draw on other multiple choice question initiatives that have tested questions at scale, including Project Quantum[1] and the work of Román-González.[2]

1 Peyton Jones, S. *Project Quantum: Tests worth teaching to*. Available at: https://community.computingatschool.org.uk/resources/4382/single (Accessed 30th May 2019).

2 Román-González, M., Moreno-León, J. and Robles, G. (2017), *Complementary Tools for Computational Thinking Assessment*. Available at: https://www.researchgate.net/publication/318469859_Complementary_Tools_for_Computational_Thinking_Assessment (Accessed 30th May 2019).

Detailed report

Aims

1. Explore how adults and children respond to quizzes and badges, including whether they find them motivating, fun, interesting, and helpful to understand learning.
2. Test assessment questions and collect data on progress, judging the appropriateness of questions and the usefulness of the data to understand impact.

Approach

We ran two versions of this project, one using quizzes and badges, and one just using quizzes. We hoped that this would help us to understand the practicalities and views of adults and children towards both assessment and accreditation in these forms. Clubs were randomly allocated to one of the two groups: six clubs ran the project with quizzes only, and seven clubs ran the project with quizzes and badges. Clubs that used badges were given a set of six stickers, one relating to each project, and a sticker chart for each child to collect them on.

We created a set of six quizzes to correspond to the projects in the 'Scratch Module 1' pathway. We chose this pathway because it was designed for beginners who are new to Code Club, which meant that we could recruit clubs with children who had similar programming abilities. For each project, we identified learning objectives and created a three-question multiple choice quiz that addressed these objectives.

We chose to use multiple choice quizzes because there is a body of work that suggests that well-constructed multiple choice questions are an effective tool for assessing understanding[3]. There is also potential to embed such quizzes in our Projects site in the future, and to automatically mark the answers. We chose to create questions based on the learning objectives, but in a different context to the actual projects. The quizzes therefore tested the children's understanding of the learning objectives, but did not test their use of Scratch itself.

[3] Little, J., Bjork, E., Bjork, R, Angello, G. (2012). 'Multiple-Choice Tests Exonerated, at Least of Some Charges: Fostering Test-Induced Learning and Avoiding Test-Induced Forgetting', in *Psychological Science 23(11)* pp.1337-1344.
Available at: https://pdfs.semanticscholar.org/1a3f/09cb1baa861e92978433e5daa2082881dbc2.pdf (Accessed 30th May 2019).

We decided to do this so that we could assess the children's ability to transfer what they had learned to different contexts, and we based our approach on the precedent of the independent evaluation of Code Club carried out by the National Foundation for Educational Research.[4]

As well as a three-question quiz at the end of each project, we included an additional three questions for the children to complete once they had finished the module, to test the children's computational thinking skills. These are foundational skills that are addressed throughout the six projects.

Project:	Learning objectives:
Rock band	• Add sprites and backgrounds to a Scratch project • Change a sprite's costume • Make sprites react when they are clicked • Play sounds in Scratch
Lost in space	• Animate a sprite using a loop • Change the appearance of a sprite
Ghostbusters	• Use random numbers to animate sprites • React to mouse clicks • Create a timer
Chatbot	• Get input from a user • Use the `if`, `then`, `else` Scratch block
Paint box	• Use the Pen extension in Scratch • Use broadcasts to communicate between sprites • Detect mouse events
Boat race	• Use conditional selection to create branches in programs • Use a variable to keep track of time • Use infinite loops in a program
Computational thinking quiz	• Identify the instruction needed to achieve a particular goal • Trace an algorithm and work out its outcome • Debug a program

[4] National Foundation for Education Research (NFER), (2017). *Randomised Controlled Trial and Process Evaluation of Code Clubs*. Available at: https://www.raspberrypi.org/app/uploads/2017/03/Randomised-Controlled-Trial-and-Process-Evaluation-of-Code-Clubs.pdf (Accessed 30th May 2019).

Clubs were provided with printed copies of the six quizzes for each club member. We envisage that quizzes could be delivered at scale electronically, but used paper for this small-scale trial to test the concept. Clubs were also provided with a printed 'project log' for each child, designed to record which projects the children completed each session, and to gather the children's views on how enjoyable and how challenging each project was. The reverse of this project log contained survey questions about the children's attitudes to the quizzes and an opportunity for the children to rate their skills in five areas:

- "Following instructions and patterns"
- "Solving problems"
- "Making things with code"
- "Finding errors and correcting them"
- "Checking what I have done and improving it"

There was also a free text question asking the children what they thought of having quizzes and badges at Code Club.

Club leaders were provided with detailed instructions as to how to use the materials. We left it up to them to decide when to complete the quizzes, although we specified that the children needed to do them at some point after completing the project. We also did not tell club leaders to address a different project every week, as we were aware that some clubs run so that children have time to finish a project completely before they move on to the next.

We also provided the adults with the answers to the quizzes, but we did not specify whether or how they should use these. A key part of this work was to understand how adults wanted to use assessment in their club, and this included choosing how they wanted to use the answers.

During the project, we visited six clubs — a mixture of clubs using just the quizzes and clubs using the quizzes and badges — to observe the club taking place and interview the club leader. For the clubs that we did not visit, we carried out telephone interviews with the club leaders,

covering the same questions that we asked in the face-to-face interviews.

Once completed, the quizzes, progress logs, and surveys were sent back to us by club leaders. We kept the data anonymous by asking club leaders to instruct the children to use a nickname for these documents, so we were able to link feedback forms and all of the quizzes to an individual, but only had their age and gender, and no other personally identifying information. To ensure permission for us to collect this data, club leaders gave out letters to all parents/guardians, which also offered them an opportunity to opt out. Where parents/guardians had opted out, children completed all of the activities, but the club leader was asked not to return their data to us.

Findings

Adults' views of quizzes

Most adults involved in the trial emphasised that their clubs are informal, and that they try to make the club sessions distinct from school lessons. Of the sessions that we observed, some had more 'lesson-like' features, such as adult-led introductions or whole group explanations, while others were very informal and child-led, with children choosing how they engaged with activities.

Quizzes could be seen as a more formal, 'lesson-like' feature that would not fit with this ethos. However, the feedback from adults did not suggest that this was the case. Many said that the length, format, and complexity of the quizzes was appropriate in their Code Club environment.

Only one adult said that the quizzes were too formal for the ethos of their club, but they took copies of them to use in their computing lessons. A small number said that they would ideally like less frequent quizzes, but this was related to issues with time and logistics, rather than the ethos of the club.

Issues with time

Of the thirteen club leaders interviewed, five reported some challenges around having time to complete the quizzes. The Code Clubs that we worked with generally ran for around an hour, including setting up computers or logging in and packing away, which leaves a short session for coding. One leader found that it took longer than they would have liked to administer the paper resources, and the other four found that the quizzes took more time than they would have liked from their sessions. One club that did not report these challenges had arranged additional time at the end of their club for children to complete the quizzes. Some leaders said that online quizzes would be more time-efficient and would mitigate these challenges. Several leaders said that they welcomed the quizzes, but for reasons of time, would like them less frequently than after every project.

Two club leaders expressed the view that the paper quizzes took up some of the time available for coding, which was already limited. For them, it was important that children spent the time in Code Club programming, rather than away from the computer. While online

quizzes would mean they were working on a computer, this shows that some leaders prioritise coding, and for them, any assessment activity would need to be closely linked to this core focus.

Children's responses to quizzes and badges

In general, the adults involved in the trial said that children were happy to undertake the quizzes. Some adults noted children's enthusiasm, and others said that the children treated the quizzes as a normal part of the club, but some fed back that the children didn't like them. In clubs with fewer positive responses, adults often put this down to some of the quizzes being seen as too challenging. In some cases, the adults felt that this was because the context of the questions was different to the context of the project that they had just completed.

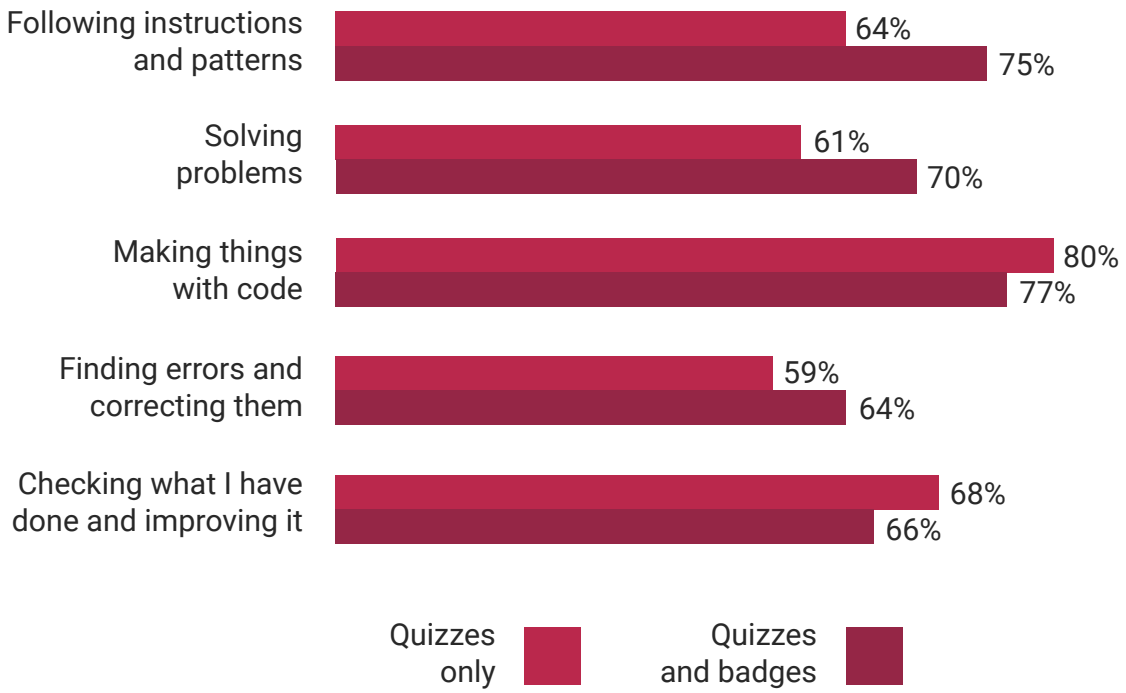
Around half (52%) of the children in the 'quizzes only' group of the pilot indicated that they liked doing the quizzes. Three quarters of the participants in the 'quizzes and badges' group indicated that they liked doing the quizzes, and almost 89% of the participants liked earning the badges.

The quizzes helped me to see what I have learned

(% that answered 'agree' or 'strongly agree')

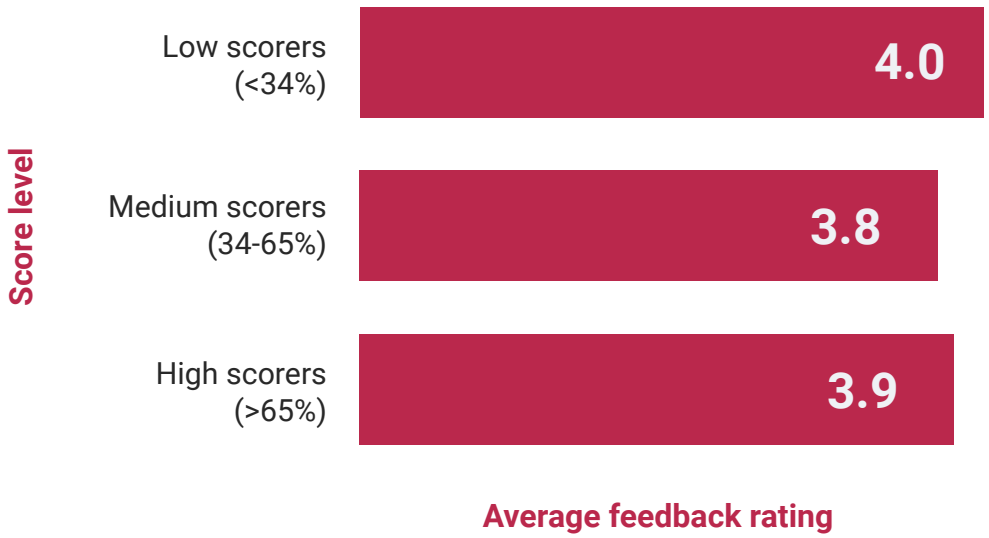
When reflecting on their learning, young people who had received badges for taking a quiz seemed to view the quizzes more positively than young people who had not.

Agreement rate with skill questions



When assessing the skills that the quizzes had helped them to develop, there didn't seem to be any big differences between young people in the 'quizzes only' group and in the 'quizzes and badges' group.

Performance in quizzes vs average feedback rating



Participants were given three 'feedback' statements and asked how much they agreed with the statements on a five-point scale. Those statements were:

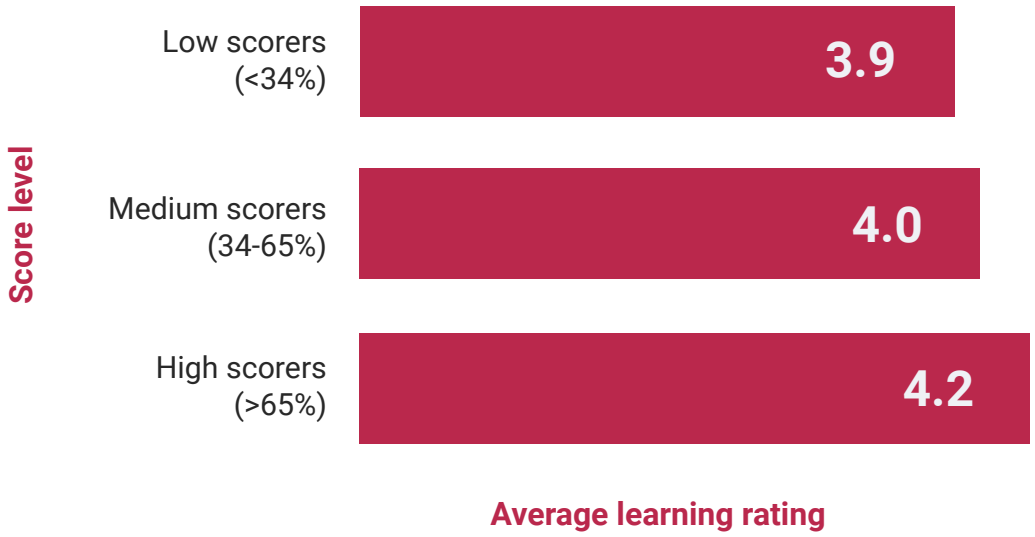
- "I liked doing the quizzes"
- "I liked earning the badges"
- "The quizzes helped me to see what I have learned"

We averaged the responses to these three questions to give an overall feedback rating.

We wanted to explore whether participants who performed well in the quiz rated the quiz more highly than those who didn't perform as well. In other words, did enjoying the quizzes depend on how well the children were able to complete them?

We counted each participant's correct answers to give an overall quiz score, and grouped them into low, medium, and high scorers. We found no evidence that high scorers rated the quizzes more highly, and feedback ratings did not vary across the three groups.

Performance in quizzes vs average learning rating



We also asked participants about how taking the quizzes had developed their skills, asking them to rate their skills in the following areas:

- "Following instructions and patterns"
- "Solving problems"
- "Making things with code"
- "Finding errors and correcting them"
- "Checking what I have done and improving it"

Similarly to the 'feedback ratings', we averaged responses to these questions for each participant, to give a 'learning rating'.

We wanted to know whether participants would rate their own skill development higher if they had done well in the test. We found that low scorers rated their own learning lowest, while high scorers rated theirs highest, although the differences between the groups were small.

It is important to point out that regardless of how well they did in the quizzes, participants tended to rate their own learning fairly highly.

These results suggest that earning a badge after a quiz makes completing a quiz a more enjoyable experience for young people.

Performance in quizzes

The general feedback from club leaders was that children found questions straightforward, and the questions were pitched at the right level. Three leaders said that the children found the questions hard or challenging at times. Some said that presenting the questions in a different context to the projects made them difficult at times, while others thought that this was a good thing, as it made the children transfer their learning to another context.

Scores in the quizzes suggest that the quizzes were relatively challenging, with 51% of the questions being answered correctly. The clubs' average scores ranged from 27% to 72%. While some clubs had higher scores than others, there was a mix of abilities in all clubs involved, and a range of quiz scores within each club.

Children scored much higher in the coding questions that they answered every week than in the computational thinking questions that came at the end of the sixth project. The average score in coding questions was 59%, whereas the average score in computational thinking questions was 29%.

These scores suggest that our quiz questions are successfully differentiating between children who have mastered the particular concepts and those who have not. The average score may be lower than we would hope, but the children were beginners to Scratch, so this may not be surprising. However, we should take care to set questions at an appropriate level of complexity so that they are not discouraging.

A lower average score in the computational thinking questions should be expected as they are more challenging, but it would be worth revisiting the specific concepts tested, and reviewing how they are addressed in the projects and whether they could be made clearer. It would be useful for us to analyse particular questions in more detail in respect of the concepts that they were testing, including how the concepts are presented in the projects, in order to determine how quiz questions and content should relate to each other in the future.

Different ways of using quizzes

Clubs were asked to use the first six Code Club projects in the 'Scratch Module 1' pathway. A quiz was provided for each of these projects. Most clubs followed these projects through in sequence. In many clubs, children were allowed to progress through the projects at their own pace, completing a quiz either when they finished the project, or at the end of the session in which they completed the project.

In some clubs, quizzes were undertaken in very focused sessions, with one library-based club organising further time beyond the usual session to sit with the children and complete the quizzes away from the computer. Another school-based club also completed the quizzes away from the computer. Both leaders fed back that they thought this focus away from the computer helped children to concentrate on reviewing their learning. Children in most other clubs completed the paper quizzes at their computer stations.

Benefits to children

Half of the club leaders said that the quizzes helped the children by giving them an opportunity to reflect on the concepts that they had learned. We had some feedback that Code Club projects are very focused on making and the end product, which children enjoy, but that the children can also benefit from a chance to recap what they have learned. One club leader said that the quizzes help the children to realise what they have learned, and that they are then more able to apply what they have learned in the future. Another said that rather than just focusing on the end result of a project, the children focused on the concepts that they were using and learning, because they knew that they were going to have a quiz. They felt that this strengthened the learning experience.

This supports our decision to present the questions in a different context to the projects. However, there was some feedback that this made the quizzes challenging for some children, and that the children didn't see the link between this context and the project they had just done. Also, while the questions had all been designed to test the same core learning objectives, it seemed that some adults didn't see the link between the projects and the questions in some cases.

Four of the twelve club leaders said that they used the quizzes to instigate a discussion of the concepts that the children had learned, either by going through the answers or by discussing what the children had found challenging more generally. One club leader said that the discussion that was started was the most important and beneficial part of the project. It should be noted that it was a mixture of volunteers and teachers who gave this feedback.

Clubs whose leaders indicated that they had discussed the content of the quizzes were amongst those that had the highest average scores, and the club with the highest average score, 21% higher than the average and 14% higher than the next best average score, indicated that they had held a discussion.

Benefits to adults

Most adults did not make direct use of the quizzes by going through the answers or marking them. Several adults said that they were able to understand how well children were doing through their usual interactions and observations of them in sessions. One volunteer said that the quizzes might help volunteers who were less knowledgeable about the content to know how well children had done, but as they were comfortable with programming in Scratch, they did not need to use them in that way.

However, four leaders said that they found it useful to see how children engaged with the quizzes, and whether they found particular sessions challenging. Some showed an interest in having marked quizzes, but weren't able to make the time to mark the quizzes themselves. One leader marked the quizzes themselves and took time to discuss the answers with the children.

It is worth noting that two of those who said that they used the quizzes as adults were leaders of clubs with some of the highest average scores. The other two did not return the data from the quizzes to us.

Views on future directions

We discussed our plans to develop online quizzes in the future and most of the club leaders responded positively to this. Several leaders commented on the benefits of automatic marking and providing feedback to children immediately, although there was a little concern that children might rush through the quizzes if they stood between them and the next project — as some had seen with the paper-based quizzes.

Of the volunteers who had found the change of context to paper-based quizzes beneficial, one was relatively positive about online quizzes. The other reiterated their support for paper-based quizzes and the shift in focus that they provided. One leader said that the quizzes should be more infrequent and should not be done after every project, and another said that they would still like to have lots of discussion around the quizzes.

Given the time constraints noted by many, the volunteers generally welcomed anything that made the process quicker and more efficient, and required less practical organisation on the day.

Conclusions

Code Club leaders and children involved in this trial responded positively to the model of quizzes and badges, with children responding much more positively in clubs that used badges than in clubs that did not. We received useful feedback on how this kind of model fits with how leaders run their clubs, and noted considerations for further developing and scaling up this approach.

Headline findings

- Most adults felt that the three-question quizzes were appropriate for the ethos of their clubs.
- We had some feedback that Code Club projects are very focused on making and the end product, which children enjoy, but that the children can also benefit from a chance to recap what they have learned.
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- Feedback on future ideas for online quizzes was positive, although some adults felt that changing context and moving away from the computer was beneficial for focusing on the quizzes and reflecting on learning.

Recommendations

- Run this trial with CoderDojos to explore the practicalities in this context, and to gather feedback from adults and children in this community, which caters for a wider age range.
- If there are positive results from the CoderDojo trial, continue to develop the three-question multiple choice quizzes format, and add the quizzes to the pathways on the Projects site.
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