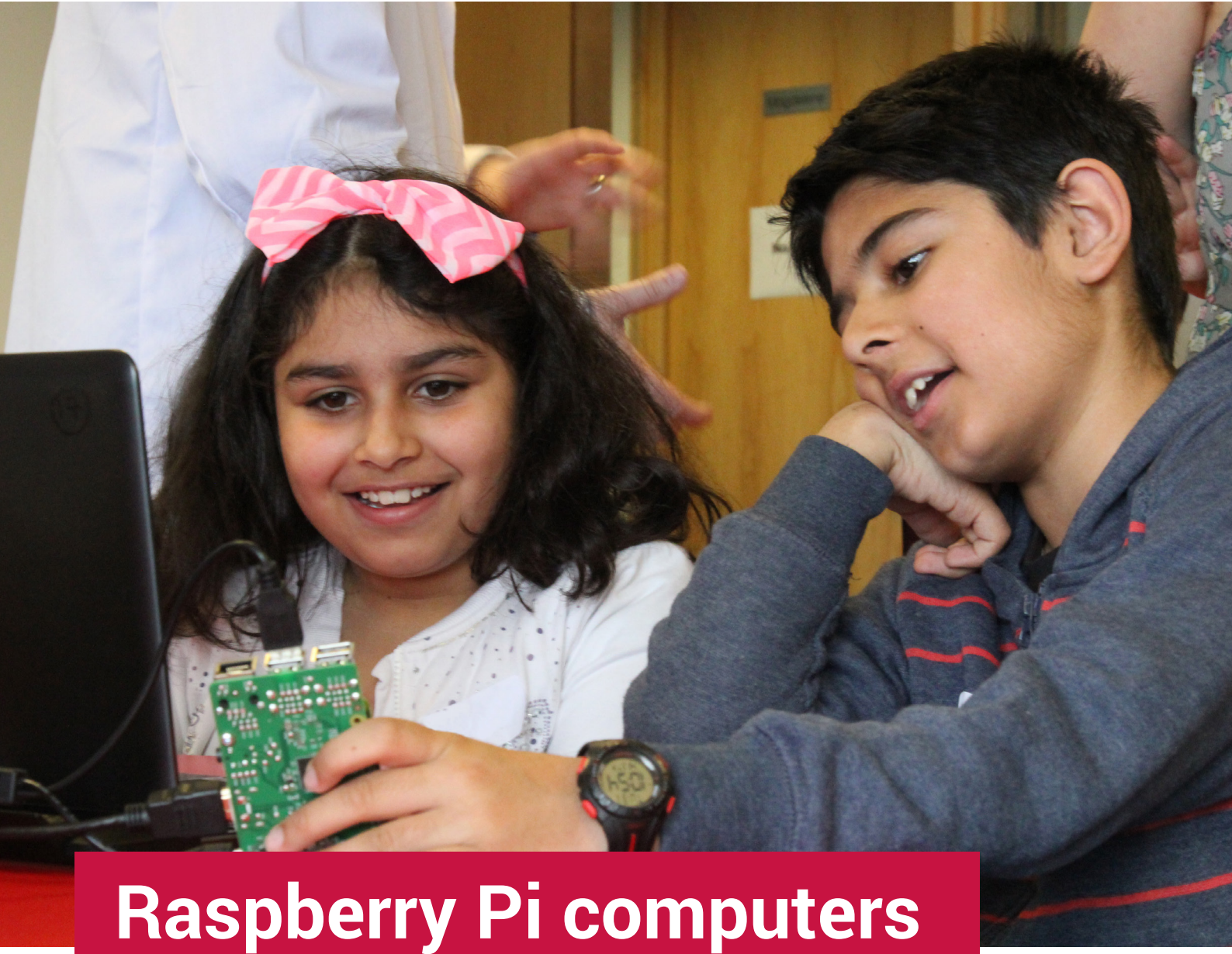

Raspberry Pi computers in schools

Oliver Quinlan and Samantha Baloro

Raspberry Pi Foundation Research
No. 5

Raspberry Pi

code club

CoderDojo

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Contents

Summary

This research project explored the use of Raspberry Pis schools to inform Raspberry Pi Trading Limited about the use of its computers in education, and to inform the educational work of the Raspberry Pi Foundation.

Visits were conducted to 21 primary, secondary, and other schools across England and Scotland; 15 of these employed a teacher who is a Raspberry Pi Certified Educators, and the other six had received Raspberry Pi computers as part of the Google giveaway in 2014. The group included some schools that had been given computers but had not used them. Establishing a dialogue with schools was sometimes difficult due to their workload, and this and the relatively small sample size should be considered when considering the findings of this report. However, many of the themes discussed here did come up during several of our schools visits.

The schools mainly used the Raspberry Pi computer for extracurricular and informal group sessions that were optional for students. At some schools, these sessions were a first step for teachers to develop skills and gain experience with a view to embedding Raspberry Pis in their formal lessons. Other schools appeared to view the informal sessions as the best way to use Raspberry Pis. Some schools were using Pis in their lessons, but this use may have been limited by lack of funding for equipment and lack of time to develop Pi-related projects. At present, it appears that the Raspberry Pi is well placed to support extracurricular clubs for computing and technology enthusiasts in schools. Further development of software and support is needed for use in more formal lessons. There are also structural factors that result in challenges for teachers with regards to implementing the approaches to teaching and learning that we encourage.

Key takeaways

- In the schools we visited, Raspberry Pi computers were mostly being used to enable physical computing projects. Students were working on a wide variety of projects, but these tended to be fairly simple and reliant on instructions. So that more students can experience open-ended projects, teachers need examples of how such projects can be achieved within the constraints of lessons and clubs.

- Most schools we visited had less than a class set of Raspberry Pi computers (12 on average), and usually they set these up by replacing desktop computers. This meant the Pis were usually used for informal learning. In order to be able to use Pis to support physical computing within formal lessons, schools would need the funding to purchase more of them.

- Management and tech support of Raspberry Pi computers was often the responsibility of teachers, not technicians. While experience of setup and troubleshooting can be beneficial for students, it does take up time in lessons that some teachers needed for other content.
- Teachers valued and used our learning resources, and they largely wanted more of the same, including more in the format of lesson plans.
- Picademy addresses the need for face-to-face training of teachers who are not using Raspberry Pi computers.

Recommendations

- Develop Raspbian software to make the process for using Raspbian with proxy servers as easy as possible
- Plan to influence providers of school network filtering to allow access to our software updates
- Produce more troubleshooting guides in a format that students can use to quickly set up Raspberry Pis
- Produce an education-focused hardware kit with accessories and add-ons needed for a defined set of projects
- Position the Raspberry Pi as a replacement for general-purpose desktop computers in schools
- Improve how we communicate the unique benefits of using Raspberry Pi computers to schools
- Through channels such as Hello World magazine, post-Picademy resources, and the Raspberry Pi Learn newsletter, share examples of how teachers are securing funding, and encourage other teachers to take such an entrepreneurial approach
- Create a range of resources that can each be completed within a one-hour lesson
- Explicitly link our resources to national curricula through tagging
- Improve the discoverability of our resources for teachers

- Crowdsource resources and help teachers to share their own resources at scale
- Create more physical computing resources explicitly for primary school–age students
- Through channels such as our website, Hello World magazine, post-Picademy resources, and the Raspberry Pi Learn newsletter, share more positive and realistic stories of how educators are successfully using Raspberry Pis in their lessons
- Continue to develop resources for a wide range of contexts, including more help for educators to build professional networks

Findings

Introduction

This research project was designed to further our understanding of the perception, adoption, and embedding of Raspberry Pi computers in UK schools, in order to reveal examples of both success and challenges. Our aim was to find out how we can better inform our work of supporting teachers, creating educational resources, and developing the Raspberry Pi computer and software.

To study this, we conducted 21 semi-structured interviews with teachers during May and June 2017. These ranged in length from 30 minutes to an hour, either in person at the teacher's school or via telephone. One interview was conducted in the Raspberry Pi Cambridge office during a Raspberry Jam.

Teachers in this study were asked about:

- The kinds of educational activities they used Raspberry Pi computers for
- The 'out-of-box' experience with the Pis in their school, including setup and day-to-day use
- The decision-making process for purchasing Raspberry Pi computers
- How Pis were managed and who they were supported by in their school
- How aware they were of our educational resources and of those provided by others
- The feasibility of the approaches to teaching and learning that we encourage, and how practicable teachers thought physical computing and project-based learning approaches were in their schools
- How they had successfully used Raspberry Pi computers in their teaching and learning
- The challenges they had faced using Raspberry Pi computers, and how they overcame these

Selection of participants

This project aimed to reach beyond the types of schools that usually contact the Raspberry Pi Foundation in order to explore the use of our computers a wider variety of schools. Initially, we used data from the Google Raspberry Pi giveaway in 2014 to contact schools we knew owned our computers. We asked them to complete a very brief survey on how much they were using the Pis, with the intention of selecting a number of interview candidates based on levels of use.

Survey results

Total responses: 29	
School types	
Primary	9
Secondary	18
All-through	2

Adoption levels of Pis	
Successful adoption	5
Semi-adoption	12
No adoption	12

Regularity of use	
Weekly	3
Every term	2
A few times a year	11
Other (not using)	13

Difficulty level of adoption	
1 (Easy)	4
2	2
3	7
4	1
5 (Very difficult)	2
Average: 3.2	

Number of Raspberry Pis in the school	
2–4	8
5–10	5
10–15	0
16–30	2

The survey had a very limited number of responses, but we were able to categorise 29 schools based on how much they used Raspberry Pi computers. Contacting the candidates to arrange visits and interviews was more difficult, especially in the case of schools that had not managed to make use of the computers. We offered phone interviews to some of these, which we felt they may have found more accessible. Due to the challenges with organising visits, we also used visits to Raspberry Pi Certified Educators that we were undertaking for another project to explore how our computers were being used in their schools. This was less faithful to our ambition to reach beyond our established connections, but we were careful to choose a range of Certified Educators, and their use of the Pis varied enough to allow us to explore both successes and challenges related to this.

Locations of study participants

About the schools and teachers in the study

School	Phase	Students	Level of adoption	No Pis	How set up	Responsibility	Visit or call	Region	RCE
A	Primary	324	Medium	5	Unplugging PCs	Computing Coordinator & year 4 teacher	Visit	North West	Y
B	Primary	106	Medium	3 (owned by teacher)	Unplugging PCs	Head teacher	Visit	South West	Y
C	Primary	420	Medium	10 (some owned by teacher)	Permanently installed	Computing coordinator & year 5 teacher	Visit	London	Y
D	Primary	472	Low	1	Unplugging PCs (Not used regularly)	Year 5 teacher	Visit	South East	N
E	Primary	210	None	Unknown	Not used	Teaching assistant	Call	South East	N
F	Secondary	1425	High	60	Unplugging PCs (with KVM switch)	Computer Science teacher	Visit	South West	Y

School	Phase	Students	Level of adoption	No Pis	How set up	Responsibility	Visit or call	Region	RCE
G	Secondary	830	High	12	Permanently installed	Computing teacher	Call	South East	N
H	Secondary	1366	High	19	Unplugging PCs	Computing teacher	Visit	N'hampton	Y
I	Secondary	1115	Medium	22	Unplugging PCs (Not used regularly)	Head of Computing	Call	South East	Y
J	Secondary	1300	Medium	5	Unplugging PCs	Head of Computing Science	Visit	Scotland	Y
K	Secondary	1470	Medium	6 (on loan)	Unplugging PCs	Chaplain, Maths teacher	Visit	North West	Y
L	Secondary	1300	Medium	15	Portable screens & keyboards, headless in server cabinet	Computing lead (not head of ICT dept)	Visit	West Midlands	Y
M	Secondary	1300	Low	15	Portable with official touchscreens, HATs, CamJam kits	Head of Computing Science	Visit	Scotland	Y
N	Secondary	1982	Low	6	Unplugging PCs	Computer Science teacher	Call	South West	Y
O	Secondary	135	Low	4	Unplugging PCs	Digital Learning leader	Visit	London	N
P	Secondary	1147	None		Not used	Computing teacher	Visit	East Midlands	N
Q	All-through	1730	Low	17	Portable with dedicated monitors	Lead teacher Computer Science, Lead practitioner STEM	Visit	South West	Y
R	All-through	830	None	2	Not used	Lead teacher Computer Science	Call	London	N
S	SEN	110	Medium	12	Unplugging PCs	Technician/IT Manager	Visit	South West	Y
T	SEN	260	Medium	13	Unplugging PCs	Maths & Science teacher, STEM lead	Visit	South West	Y
U	Defence School		High	12	As needed in electronics lab with dedicated monitor and accessories		Visit	South West	Y

How Raspberry Pi computers were used

Most schools we visited were using Raspberry Pi computers because of their capacity to interface with electronics and accessories in physical computing projects. In some cases, they used them exclusively for on-screen projects, but these tended to revolve around software perceived to be restricted to Raspbian, such as Minecraft Pi and Sonic Pi (although the latter is available cross-platform, many teachers first experienced it on a Raspberry Pi).

In general, schools already had computers that could be used for less specialist work such as internet research and creating documents, and the Raspberry Pi computers were used in ways seen as unique to them.

The types of projects we saw included:

- Experimenting with hardware
  - Lighting LEDs using Python and GPIO Zero
  - Raspberry Pi Camera Module and image effects
  - Experimenting with ultrasonic sensors to trigger actions on screen

- Projects following guides or instructions
  - Creating traffic lights using simple electronics or traffic light GPIO add-ons
  - Reaction game
  - Water detector
  - Wheel of fortune
  - Christmas tree (project from The MagPi)
  - Sense HAT projects from the Raspberry Pi website
  - Simple robots with motors and wheels

- Screen-based projects
  - Customising Minecraft with Minecraft Pi and Python
  - Making music with Sonic Pi
  - Creating a stand-alone network and communicating across it
  - Turing tests using Python

- Complex/open-ended projects
  - Environmental monitoring system
  - RetroPie arcade tables
  - Twitter cam monitoring a bird box (project made by a teacher but explained to his young students)
  - Software-defined radios
  - Power management system for a military camp

Projects were sometimes limited by the fact that many schools did not have their Raspberry Pi computers connected to a network or the internet. This eliminated any network functionality of projects, and also meant that students often required another device to access online guides or to search for answers to problems they encountered.

Most of these projects were focused on learning specific skills such as using the GPIO pins, or on completing projects based on guides. Few involved a challenge for students to address, or open-ended making based on an interest. The latter approaches are more complex, and may develop with time.

Key takeaway:

- Raspberry Pi computers were mostly used in these schools for their potential in physical computing. Students worked on a wide variety of projects, but these tended to be the simpler and more instruction-led type. So that more can students experience open-ended projects, teachers need examples of how these can be implemented within the constraints of lessons and clubs.

Equipment

Most schools we visited that used Raspberry Pi computers had five or fewer devices available for use with students. The schools with small numbers of Pis tended to use them in clubs rather than in lessons. In order to use Pis in lessons, most teachers need enough so that students can use them in small groups of no more than four, or usually in pairs. Four schools we visited had enough Pis for entire classes. One school had twelve Pis set up in dedicated stations that could be used by small groups. Another had two whole class sets (30 per set) for use by individual students. These were used with a KVM switch attached to the Windows PCs in their computer labs. One of the secondary schools had 15 Raspberry Pis split between a headless installation in their server room and the classroom. Another had just purchased 15 Raspberry Pis with touch screens but not made use of them yet.

There were several common solutions for setting up Raspberry Pis in the schools we visited, listed here in order of prevalence. The first is by far the most common:

- Connected to monitors, keyboards, and mice in place of desktop PCs, usually in computer suites (13 schools of 21)
- With dedicated portable screens (e.g. the official Raspberry Pi touch screen or the HDMPi), or in some cases standard monitors brought in and connected for each lesson (3 of 21)
- Installed permanently as desktop PCs (2 of 21)

Most schools that disconnected desktop PCs to use Pis simply disconnected cables. The setup was often done by the students themselves at the start of a lesson, but sometimes by the teachers, especially for younger students. One school had made the process easier and more robust by installing KVM switches on all of their machines.

One school we visited had their Raspberry Pi computers installed headless in a server cabinet physically inaccessible to the students. They were used with SSH and VNC as part of a GCSE coursework module on networking and Linux.

Key takeaway:

- Most schools we visited had fewer than a class set of Raspberry Pi computers (on average 12), and usually set these up by replacing desktop computers. This means that the Pis were usually being used for informal learning. For them to be used to support physical computing in formal lessons, schools would need the funding to purchase larger numbers.

Technical support

Management of the computers

In almost all of the schools we visited, Raspberry Pi computers were managed by teachers and not technicians; often there was one teacher leading their use. At one secondary school with a dedicated Raspberry Pi room with permanently installed computers, the school technicians were not involved in their management. Some technicians lack knowledge about the Linux operating system, which can make them unable to support Raspberry Pi computers. Some schools are also reluctant to integrate devices that are perceived as very open into school networks, in case of misuse. Wireless connectivity on newer Pi models has made network access easier for some teachers, as these networks are usually designed to connect a wide range of personal devices.

Updating software

Managing the Raspberry Pis is an additional task for busy teachers, but those we spoke to were relatively comfortable with what it entailed. The shared nature of the Pis meant that personal files and projects were stored on students' or teachers' USB sticks. Teachers described this approach to file management as not difficult but quite time-consuming. The main challenge was updating software: often this was difficult or impossible on school networks. These networks usually implement filtering and require connection to a proxy server to even access the internet. Some teachers told us that connecting to their proxy server was difficult, and that the servers needed for software updates were blocked. This resulted in most teachers updating Pis by setting up the Pis' SD cards completely new with the latest version on our operating system. Addressing the difficulties with connecting Raspberry Pi computers to school proxy servers might help to ease this process. Then teachers could update software without reinstallation, or even involve the students in this task.

Student troubleshooting

Day-to-day technical support in schools using Pis often involved troubleshooting connections to input and output devices because the Pis were usually connected and disconnected for each lesson. It also involved troubleshooting the students' use of the computer for programming. This kind of troubleshooting can take some time, but in computing lessons it was one of the reasons for using Pis, as it presented learning opportunities. However, the time necessary may also be a barrier for using Pis within classes where there is pressure to cover a challenging curriculum to prepare for exams.

Some teachers suggested that a comprehensive troubleshooting guide would be useful. This was envisaged by some as paper-based, as at the moment of troubleshooting, students often have a computer that is disconnected. It would contain a step-by-step process for common problems with the computer such as an unseated SD card or monitor cable. This could also be presented as a poster. Other teachers voiced a similar idea, and some wanted it to be even more comprehensive and cover content such as common errors in Python and IDLE error messages and how to interpret them. At the time of the visits, there was a basic Getting started guide available on our website, and this has since been updated. Making teachers aware that this exists and can be easily accessed is important.

Although the teachers we spoke to were relatively comfortable with the technical support side of using the Pis, it should be noted that these people are by their nature early adopters. Some of the challenges raised here might have a more significant impact on those teachers who have not yet adopted the Raspberry Pi.

Technical support

We heard about a number of challenges relating to technical support:

- Managing the Pis was usually the responsibility of teachers, not the school technicians.
- Accessing the internet often took place via a proxy server, which can be challenging to configure on Raspbian.
- Software update servers were often blocked or inaccessible due to proxies, so teachers had to update their Raspberry Pis one at a time at home.
- Troubleshooting technical problems was seen by many as part of the desired learning when using Raspberry Pis, but it does take up some of the limited time available for activities.
- There often was a reluctance to connect the computers to school networks due to their open nature and perceived potential for misuse. For security reasons, connecting to a wireless network was often seen as more acceptable than to a wired one.

Key takeaway:

- Management and tech support of Raspberry Pi computers was often the responsibility of teachers, not technicians. While setup and troubleshooting is part of the learning, it does take up time in lessons that some teachers needed for other content.

Recommendations:

- Develop Raspbian software to make the process for using Raspbian with proxy servers as easy as possible
- Plan to influence providers of school network filtering to allow access to our software updates
- Produce more troubleshooting guides in a format that students can use to quickly set up Raspberry Pis

Suggestions for development of the product

We asked the teachers we visited what improvements could be made to the Raspberry Pi computer to better suit their uses. Generally this was a question they found quite hard to answer: they tended to focus more on how support for using the Pi could change rather than on how to improve the product itself. However, they did identify some ideas:

- An education-focused kit with accessories, which some teachers said would be more straightforward to purchase and therefore more desirable than the current offerings; this could include key components linked to a particular set of projects
- A fix for the challenges they had with updating the software through school networks due to proxy servers and network filtering
- Labelling of GPIO pins on the computer itself, as students often struggle with finding the right pins, particularly when putting projects back together (GPIO rulers help, but are still too easy to put on the wrong way)
- An on/off switch allowing safe shutdown when built into projects, and for a teacher to shut down an entire room of Pis quickly

Recommendations:

- Produce an education kit with accessories and add-ons needed for a specific set of projects
- Position the Raspberry Pi as a replacement for general-purpose computers in schools
- Address issues with software updates in schools

Funding

Almost all schools we visited said that low budgets and little access to funding for equipment were an issue for them. Although the Raspberry Pi computer is low-cost in comparison to other general-purpose computers, it is not seen in these terms in schools. Instead, it is seen as a curriculum resource, something that supports the teaching of a practical subject in the same way sports equipment or art supplies do. General-purpose computers are seen as part of the infrastructure of the school, and are budgeted for as such, whereas Raspberry Pi computers usually have to be bought using considerably more limited computing department budgets.

Most of the schools we visited had bought Raspberry Pi computers from their computing department budgets, but both Scottish schools found other sources of funding. Teachers in one of these schools applied to an annual call for funding for additional projects set up by their head teacher. They bought a class set of computers, touchscreens, and accessories. To secure the funding, they had to demonstrate potential for value across other subjects, hence their choice of a portable configuration.

The other Scottish school had slowly built a collection of Raspberry Pis by finding different funding sources: students won a cash prize in a competition, and their teacher sought sponsorship from local businesses and applied for various grants from external organisations. The students were also starting entrepreneurial activities to raise money for equipment.

As often happens with specialist resources in schools, some teachers brought in their own personal equipment to use with their students.

A teacher at a secondary school in England commented that if the Raspberry Pi were seen as a replacement for general-purpose computers, then it would be funded very differently. He identified the barriers to this as the Pis limitations in running standard office applications such as Microsoft Office or Google Docs, and media production software such as Photoshop and video-editing tools. With school budgets in the UK increasingly stretched, and fleets of general-purpose computers potentially ageing, schools may become more open to considering low-cost alternatives such as the Raspberry Pi, even if it means switching to using different software as long as they can get similar results.

Key takeaway:

- In schools we visited, Raspberry Pis were seen as a specialist curriculum resource rather than general-purpose computers. This has implications for how they were funded.

Recommendations:

- Through channels such as Hello World magazine, post-Picademy resources, and the Raspberry Pi Learn newsletter, share examples of how teachers are securing funding, and encourage other teachers to take such an entrepreneurial approach
- Position the Raspberry Pi as a replacement for general-purpose computers in schools

Our resources

Almost all the teachers used our educational resources and spoke highly of them. The straightforward introductory projects on our website, e.g. for turning an LED on and off, were widely used, and teachers found them an accessible way to get students involved with physical computing. One teacher made use of the videos from our online training courses with her students to introduce them to activities.

We asked about the challenges they faced and how our resources could be developed further to address these.

Time constraints

A few educator stressed that the time needed to work through projects could be challenging, as they only have one-hour lessons and lunchtime sessions with their students. The need for more resources and guides that can be completed within 50 minutes to one hour (including setting up and packing away) was mentioned.

Recommendation:

- Create a range of resources that can be worked through end to end within a one-hour lesson.

Curriculum links

The need for explicit curriculum guides and links was stressed by many. Teachers said they did not always have the time or headspace to do this on their own, and therefore Raspberry Pis and physical computing may be seen as extra 'fun' activities to do with learners outside the curriculum. Making explicit curriculum links would reduce the work teachers have to do in order to use our resources in lessons. It could also allow teachers to better understand the potential of Raspberry Pis in the classroom. To achieve this, a few educators suggested having a section on our website where educators can upload and share their lesson plans with others.

Recommendation:

- Link our resources to national curricula

Resource requests

When questioned about the type of resources they would appreciate from the Foundation, most educators stated that they would like more of the same. Teachers who were not using Raspberry Pis mentioned that they would appreciate more guides and lesson plans that help them teach the curriculum in generali. One teacher suggested resources teaching binary and representation without it being boring for learners, and two teachers stated that they would like Raspberry Pi resources on

teaching network topologies, network protocols, and cybersecurity. Additionally, one educator stated that the Google AIY Projects Voice Kit was a good example of a physical computing project that could be completed with three to nine students, and this person would like more of the same.

Key takeaway:

- Our resources are valued and used by teachers, who largely want more of the same, including in the form of lesson plans

Lack of awareness

When asked about unserved needs teachers might have with regards to resources, many described things that we already provided. Troubleshooting guides for the Raspberry Pi computer was one such resource that was regularly mentioned. One teacher expressed that he knew we had a lot more resources than he was aware of, and felt he needed to make the time to explore them. Teachers have many demands on their time and therefore need very clear guidance to resources in order to be aware of and make use of them. Even the educators we have strong relationships with did not always discover the resources they felt they needed and that we already provided.

Recommendation:

- Improve the discoverability of our resources for teachers

Resource sharing

Teachers were aware that many other educators are creating and sharing resources such as lesson ideas and plans. Some said they would benefit for a place to find and share lesson plans on Raspberry Pi and physical computing. The models for this were the Computing At School resources site and TES Resources. The lesson plans in Hello World magazine go some way towards meeting this need, again pointing towards a lack of awareness. However, individual plans in a magazine may inspire, but these teachers were looking for a large repository they could search based on the areas of the curriculum they needed to teach each week.

Recommendation:

- Crowdsource resources and facilitate the sharing of teachers' own resources at scale

Primary school–focused resources

Some primary teachers asked for more focus on primary school project resources for Raspberry Pi computers. They felt that Raspberry Pi projects are possible for younger students, but that many of the provided projects are more complex or presented in a way that is more appropriate for older students. One primary teacher said that he spends time adapting projects for his students, and that he completes

projects with students as young as 8. Another saw Raspberry Pi projects primarily as something for his oldest students (10–11) after he had built their basic programming skills using Scratch and LEGO Mindstorms.

Recommendation:

- Create more physical computing resources explicitly for primary school–age students

Challenges in adopting Raspberry Pi computers

Desktop computers

Among those schools not making use of Raspberry Pi computers, the most common cause was that teachers did not understand the benefits they have compared to desktop computers. One primary school teacher said that because her students used Scratch and Kodu on desktop computers, she didn't see the need to use Raspberry Pis for on-screen programming. She also didn't think that her students had reached the skill level required to use Raspberry Pis for any more advanced projects the computers might be used for.

Another educator mentioned that although he understood the merits of using Raspberry Pis for physical computing and robotics, his students could write Python code on a computer other than a Raspberry Pi. He felt that using our computers would add complexity to his work without enough benefits.

Recommendation:

- Review how we clearly communicate the unique benefits of using Raspberry Pi computers to schools

Curriculum needs

A few teachers mentioned that because of the AQA's focus on on-screen programming as well as the focus on theory in GCSE Computer Science, it was difficult to justify using Raspberry Pis. This echoes previous feedback from teachers about the need for more resources and guides aimed specifically at teachers in the form of lesson plans.

Recommendation:

- Explicitly link our resources to national curricula through tagging

Funding

Another reason for not adopting Raspberry Pis was the cost of purchasing classrooms' worth of equipment, as money is very limited in schools. Some schools had secured funding in innovative ways. Others said that if the product was presented in a more obviously education-focused kit, including accessories for projects and lessons, it might make securing funding from their school budgets more feasible.

Recommendation:

- Share examples of how teachers are securing funding, and encourage other teachers to take such an entrepreneurial approach
- Produce an education kit with accessories and add-ons needed for a specific set of projects

Lack of skills or confidence

A few educators we interviewed said that their biggest challenge was having to first build their skills, and to then also train colleagues they worked with, before they could consider Raspberry Pi–focused applications in the curriculum. One teacher said she also needed to consider how to build the skills of parents at her school to help reinforce what children learn in class. Another teacher explained that the school's technician was unable to give advice on using Raspberry Pis since he did not believe in their usefulness. Therefore, the school did not use the Pis.

Most of the teachers who had not attended our Picademy educator training were not aware of its existence. One teacher mentioned he would have loved having a local option to receive face-to-face support as well as answers to his questions about setting up and using Raspberry Pis at his school.

Key takeaway:

- Picademy addresses the need for face-to-face training of teachers who are not using Raspberry Pi computers

Limited time in lessons

A teacher mentioned that although he enjoys using Raspberry Pis personally, using them in schools would require plugging in monitor cables, and he also said electronics is a challenge in a 50-minute lesson. He felt that by the time the students set the Pis up, the lesson would be over and they would need to put them away. Therefore, he preferred products that allowed him to open resources for students and get them started straight away.

Recommendation:

- Address the troubleshooting issues raised above

  Through channels such as our website, Hello World magazine, post-Picademy resources, and the Raspberry Pi Learn newsletter, share more positive and realistic stories of how educators are successfully using Raspberry Pis in their lessons

Time for physical computing projects

The time needed to teach physical computing was another barrier teachers described, stating that by the time students started working on projects, the lesson was almost over. The need for having shorter lesson plans was therefore emphasised.

Recommendation:

- Create a range of resources that can be completed within a one-hour lesson

Conclusion

In this study, we explored the use of Raspberry Pi computers in 21 UK schools of different types, including some schools that had acquired our computers but not used them. We gained some key insights, and recommended actions to improve our support for schools. At the time of writing, some of these recommendations are already being addressed.

Usage and perceptions of the Raspberry Pi in schools

Although a few schools we visited had whole class sets of Raspberry Pis and accessories for use in lessons, most had just a small set. The limited numbers meant most teachers could not use these computers with an entire class of students at the same time, and so they tended to stick to running activities with small groups or in informal, optional clubs. Where the Pis had not been adopted, this was because teachers either did not see the value of physical computing, were not familiar with how it can support their curriculum, or thought that the benefits were not worth the additional setup time and purchase of equipment.

In the schools we visited, Raspberry Pi computers were mostly used in informal contexts for physical computing projects with electronics and other hardware: a wide variety of simple projects and exercises such as lighting LEDs and creating traffic lights using the GPIO pins and Python. Our computers were also used for specialist software perceived to only be available on Raspbian, such as Minecraft Pi and Sonic Pi. Sometimes students used Raspberry Pis for more open-ended projects, but many teachers found it hard to find time for such activities within their lessons. We did not see Raspberry Pis being used as general-purpose computers, but instead only as specialist resources for teaching Computing. Schools tended to disconnect their existing desktop PCs to use Raspberry Pi computers with the monitors and accessories. A few schools had dedicated mobile screens, or had Raspberry Pis permanently set up with their own monitors.

Schools mainly used the Raspberry Pi computer for extracurricular activities. At some schools, these informal sessions were a first step for teachers to develop their skills and gain some experience with a view to embedding Raspberry Pis in their formal lessons. Other schools appeared to view the sessions themselves as the best way to use Raspberry Pis. Some teachers were using our computers in their lessons, but they may be limited in these applications by lack of funding for equipment and lack of time to develop projects.

Teachers reported that Raspberry Pi computers were often thought of as a subject-specific resource for Computing and thus set apart from more standard desktop PCs,

which are usually seen as part of the school infrastructure. This view of Raspberry Pi computers had implications for how they were funded, managed, and how technical issues were supported.

Technical support was usually the responsibility of teachers, and we heard many reports of school technical staff being unfamiliar with or unwilling to use Linux or Raspberry Pis. The teachers we spoke to were relatively confident with technical support, but they did say that keeping software up to date could take a long time. This was partly the case because many schools used proxy servers or network filtering that prevented software updates on Raspberry Pis, and so updating them had to be done at the teachers' homes. Technical support related to students setting up Raspberry Pi computers was reported to take up some lesson time, but many teachers said that learning how to do troubleshooting was part of the purpose of using the devices.

Since conducting this research, we have continued to develop our beginners' resources for using Raspberry Pi, which now address teachers' requests for more guides on getting started with the computer. We have also been working on tools for managing sets of Raspberry Pis, and have launched the PiServer software. This tool allows teachers to manage fleets of Raspberry Pis across a network, and even to boot them without SD cards. Operating systems, updates, user accounts, and files can then be centrally managed across all Raspberry Pis. This makes the process of keeping multiple the computers up to date much more efficient, and also facilitates file management on machines that are used by multiple students.

Teachers' requests and suggestions

Regarding the product, teachers' main suggestion was to sell Raspberry Pis in kits specifically designed for schools, including key accessories and components linked to a particular set of projects. The challenge of updating software needs to be addressed, and teachers also suggested labels for GPIO pins, a power switch, and on-board storage for the operating system and software.

Most of the teachers we interviewed had made use of our educational resources and spoke highly of them. There were many requests to link them to national curricula and exam specs so that teachers would be able to select projects for their classes based on these. There is room for us to make teachers more aware of the resources that are available, and some teachers asked for resources to be created that already exist. Some suggested a public site to share lesson plans, and some primary school teachers asked for more resources specifically designed for pupils of the age they teach.

Teachers said that further integration of Raspberry Pis in schools could occur through a combination of explicit curriculum links in project resources, and selling the computers in education-focused kits.

Insights and recommended actions

We conducted this research to gain insights into the adoption of Raspberry Pi computers in UK schools that could be used to inform the future design and positioning of products from Raspberry Pi Trading Ltd, and the development of educator support and resources from the Raspberry Pi Foundation.

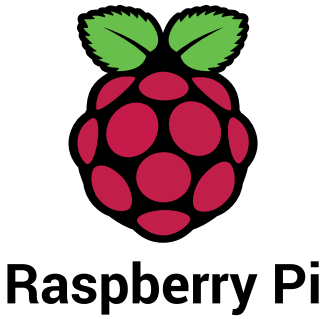
Key takeaways

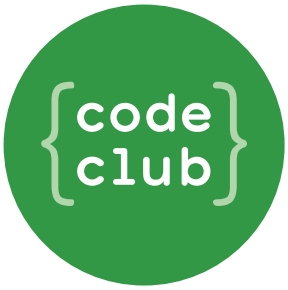
- Raspberry Pi computers were mostly being used in these schools for physical computing. Students were working on a wide variety of projects, but these tended to be fairly simple and reliant on instructions. So that more students can experience open-ended projects, teachers need examples of how such projects can be achieved within the constraints of lessons and clubs.
- Most schools we visited had less than a class set of Raspberry Pi computers (12 on average), and usually they set these up by replacing desktop computers. This meant that the Pis were usually used for informal learning. In order to be able to use Pis to support physical computing within formal lessons, schools would need the funding to purchase more of them.
- Management and tech support of Raspberry Pi computers was often the responsibility of teachers, not technicians. While experience of setup and troubleshooting was said to be beneficial for students, it does take up time in lessons that some teachers needed for other content.
- Teachers valued and used our learning resources, and they largely wanted more of the same, including more in the format of lesson plans.
- Picademy addresses the need for face-to-face training of teachers who are not using Raspberry Pi computers.

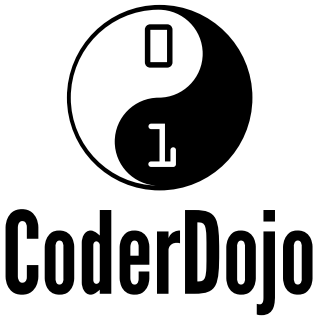
Recommendations

- Develop Raspbian software to make the process for using Raspbian with proxy servers as easy as possible
- Plan to influence providers of school network filtering to allow access to our software updates
- Provide more troubleshooting guides in a format that students can use to quickly set up Raspberry Pis

- Produce an education-focused kit with accessories and add-ons needed for a defined set of projects
- Position the Raspberry Pi as a replacement for general-purpose desktop computers in schools
- Improve how we communicate the unique benefits of using Raspberry Pi computers to schools
- Through channels such as Hello World magazine, post-Picademy resources, and the Raspberry Pi Learn newsletter, share examples of how teachers are securing funding, and encourage other teachers to take such an entrepreneurial approach
- Create a range of resources that can each be completed within a one-hour lesson
- Explicitly link our resources to national curricula through tagging
- Improve the discoverability of our resources for teachers
- Crowdsource resources and help teachers to share their own resources at scale
- Create more physical computing resources explicitly for primary school–age students
- Through channels such as our website, Hello World magazine, post-Picademy resources, and the Raspberry Pi Learn newsletter, share more positive and realistic stories of how educators are successfully using Raspberry Pis in their lessons
- Continue to develop resources for a wide range of contexts, including more help for educators to build professional networks







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