

Impact Evaluation: Teach Computing Science Handbook

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28 February 2020

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INTRODUCTION

Background

Teach Computing Science Handbook: A Guide for Primary and Early Years Practitioners was developed to help teachers implement the new computing science strands of the Scottish Curriculum for Excellence. Its authors were Kate Farrell, Professor Judy Robertson (University of Edinburgh), Professor Quintin Cutts (University of Glasgow) and Professor Richard Connor (University of Stirling); who drew upon multiple sources, their own experiences as CS educators and deep understanding of computing science as a field. Importantly, the handbook was developed to align with the Curriculum (which they had also helped to develop) – while at the same time breaking down the teaching objectives into accessible, pedagogically informed steps. The handbook was printed, with distribution to primary schools, and also made available online in the spring of 2017. (<http://teachcs.scot/2017/05/17/a-guide-for-primary-and-early-years-practitioners/>)

Objective of the evaluation

'The purpose of the evaluation is to gather evidence of the impact (if any) that (a) the Teach CS handbook has had on the confidence and competence (particularly understanding of CS concepts) of primary teachers who have engaged with it while teaching the new computing science strands of the Technologies section of the Curriculum for Excellence and (b) gather views from teachers about how the change in curriculum has impacted their learners.' (e.g. via vignettes).

Approach/Methods

The core approach was to seek views and experiences from individuals who could provide a 'window' into possible impacts of the handbook (and related activities, such as workshops offered by the team). This was done through eight semi-structured interviews (template attached) over the telephone. Interview appointments were scheduled following emailed invitations explaining the purpose and nature of the interviews, as well as their anonymity in this report's discussion of general points. Half of the interviewees are teachers; half have a bigger picture or 'overview' perspective (e.g. from a Local Authority).

'Impact vignettes' were written based on the interviews; these were checked for accuracy by the interviewees and amended with any suggested edits. The seven approved vignettes from five interviewees (two interviewees also provided pupil vignettes) are included as a separate section within this report. Some of the key points described in the vignettes are deliberately also captured briefly below, within discussions regarding each of the evaluation's core questions. (Each vignette tends to provide input on more than one question.)

In addition, observational analysis was conducted at a related activity: a 'Coding and Cake' workshop held at the University of Edinburgh for teachers on a Saturday, 1 February 2020. A brief 'focus group' activity at the end was conducted to gather input from the seven teachers and two pupils attending. For purposes of this evaluation, interviewees were also encouraged to talk about experiences with both the handbook and 'related activities'.

As is frequently the case with impact evaluations, selection of interviewees was purposive – seeking out individuals who had in fact engaged with the handbook and who were willing to reflect upon their experiences in an interview. Thus this impact evaluation does not purport to cover scale of impacts but rather to dig deep into and illustrate the sorts of impacts the handbook has generated within, or been seen by, specific knowledgeable individuals.

FINDINGS

Impact of the Teach CS Handbook on teachers' confidence

Without a doubt, use of the Teach CS Handbook has increased the confidence of those teachers using it.

One primary teacher responded to the question of any impact on confidence by combining confidence with a change in teaching practice: 'Definitely, just to realise that I suppose it helped me, being quite computer literate, I wanted to make sure what I was teaching was the right thing. ... Now I can see that what I had thought was nursery level, they really need a good grounding in it first to make other things easier. *If I hadn't been directed to the handbook, I wouldn't have changed my teaching. It made me see it in a different light.*

Another primary teacher gains confidence from the way that the handbook illuminates how to enact the progression desired by the Curriculum: 'Yes (*I gained confidence*) because you think "I could do that yes, that is the right thing I should be doing"; it matches with the breakdown of progression that they've given you. At the beginning of the document, they've broken it down, probably 'aspects of learning'. It breaks down progression really clearly, more than the Curriculum, to show you how things progress. It definitely fleshes out the Curriculum.' This teacher went on to observe that she thinks it gives confidence to colleagues that the progression she developed (for which drew heavily from the handbook) are written up in the handbook.

Another primary teacher agreed that the handbook has an impact on her confidence as she teaches her students: Yes. *It gives you activities, ... shows you what learning looks like, has a glossary, you can really break it down for people. It has technology and the Experiences, Outcomes, Benchmarks' – as in the Curriculum for Excellence. It helps me see what I should look for in pupils' work.'*

An interviewee with an overview perspective believes that '*the handbook gives teachers confidence. With the Curriculum for Excellence, especially at primary level, they are expected to know all this stuff. They do have Es and Os to follow, but if they are not in computers, they will not necessarily have the confidence to know they are on the right path to achieving the outcomes.*' The handbook is useful because '*It allows the teachers to know they are doing the right thing; it points them in the right directions and the concepts are quite good, like computational thinking and the idea that you don't need a computer to do it. You can use computational thinking in English, maths, other areas, not just computer science. It is order and structure. ... The activities are quite good; they can look at the resources and the content as well.*' This interviewee is so positive about the handbook that he commented: '*We need to be promoting this to the pupils, empower the kids to do it themselves. It's not secret! Not only teachers should have access to it.'*

Another interviewee commented forcefully on the issue of confidence: '*If we keep telling primary teachers they aren't confident, they'll start believing it. We need to say what is wrong with our resources that they are not confident or don't understand it. We need to create materials so they do. The handbook makes a step towards that.*'

Impact of the Teach CS Handbook on teachers' competence and understanding of CS concepts

The Teach CS Handbook has had an impact on teachers' understanding of CS concepts and in their competence when it comes to conveying those concepts to pupils.

An interviewee with an overview perspective has observed that, with the use of the handbook, '*Once primary teachers get a chance to understand the thinking behind it, suddenly the penny drops with them.*' This interviewee thinks very highly indeed of the handbook and the team that created it: '*I commend them for the work they've done. It was an incredible bit of work.*'

A primary teacher has felt an impact on ability to teach CS through the fact that the handbook, while aligned with the Curriculum, provides a more operational focus: *'Yes, because it focuses you in. The Curriculum is really wide (You can change years you teach ... (this) gives you a really generic thing about how to teach.) The Curriculum is really wide but this focuses you in – 'why not take this route', then you know the children are making progress toward this outcome, whereas sometimes the Outcome is a bit wide (leaving one feeling) 'I could go quite a lot of places with that' - and the handbook is dictated by the Curriculum.'* She refers back to the document for herself or to help others with CS concepts; *'the document continues to be really important'*.

A primary teacher who probably already had good understanding of CS concepts nonetheless responded positively to this question by saying *'Yes ... The handbook has shown me different activities and ways to teach it and look at different resources ... which has enhanced what I'm doing.'*

Another teacher with good personal understanding of the concepts also felt that her ability to teach was enhanced by the handbook: *'There is a section under Organisers that says "this is what learning looks like"; it gives ideas for what to take forward; it has a glossary. It helps me to explain in simpler terms what these things are to kids - helping pupils understand the concepts; helping me explain it to them in a way they understand it.'*

A teacher stepping back and thinking of primary teachers in general praised the help the handbook provides them:

'Basically the organisers (of the handbook) give very detailed information about what the Curriculum means. If it wasn't there, I think most people would find it very very difficult to comprehend the content. They would find it very difficult for their own understanding. The Teach CS resource certainly would give you a wee bit more confidence in what you are talking about, concepts, benchmarks, what you want as outcomes and therefore what people are achieving in the classroom. A neat bit of work! ... So, for example, if a teacher is unsure about what something is, say, as a computational thinking skill, it exemplifies it for them. Computational thinking skill was new for us all several years ago. They can get a good grasp and from that start to think what would the learning look like in the classroom. ... The way they will have to plan it is that they have to link to Experiences Outcomes and Benchmarks, the main drivers of what goes on in the classroom. ... Certainly in the book they use Experiences Outcomes and Benchmarks as the framework for exemplifying. You can actually scroll through and it is nicely colour coded. It simplifies looking for things.'

Impact on teachers' practices (behaviours, activities, planning)

The Teach CS Handbook has had an influence on the teaching practices of individuals and also on planning processes for colleagues as well as for themselves, thus having a 'ripple effect' onward to other teachers.

For example, a primary teacher refers to it regularly in shaping her teaching practices: *'I use it to select my activities when I'm teaching computing science. That is what I go to; it is my go-to thing, when I think "what should I be teaching".'*

Another primary teacher uses the handbook for her class and for a group of pupils: *'I use it as a planning tool for my P5 class and for planned activities with a digital leaders group P5-7'. This is aided by the convenience of the handbook's layout as well as its content. 'Going through the booklet at a specific level, it is very quick to search by outcomes at the bottom, I can look to teach processes and level, and find (things) quickly and look for different ideas under what learning looks like. And (there is a) section at the back on resources and activities which gives you links which are really helpful. ... Resources at the back of the handbook are all free and readily accessible.'*

One primary teacher who had assumed responsibility for planning documents on digital learning and literacy for all primary years commented '*I did find the document very very helpful*'.

At a different level, a Council is emulating for different subjects the handbook's approach of concepts, progression pathways and activities ('*Senior management like the way it is set up*') – a somewhat unexpected wider impact on education.

Impacts of the changed curriculum

Gradual change, timeframe

When asked about any general sense of how the change in curriculum is affecting learners, interviewees did not necessarily see a distinct black and white change. For example, one primary teacher reflected:

'It is hard for me to say. Definitely, teachers know they have to teach computing science, whereas before when it was time for ICT, it was very much "how do we use this piece of software or hardware". But teachers are so busy and our bread and butter is language and maths, but whether it has gotten round, I don't know. When the Scottish curriculum was published, we all got a green folder – people are probably still using that. And it is not as fleshed out (as the handbook). And it has been updated, but as it is not very common for a curriculum to be updated; people are not necessarily aware that it has been updated. ... It has changed because the pedagogy around what children need to know in the area of technology has changed. At the time, there was also emphasis on food and on design, so outcomes. So the technology section had been "how to use computers" and it needs to be more on "how does technology impact on our life; what do we need to know".'

Like many other interviewees, another teacher noted an inevitable time lag: '*I think the Curriculum change will take a good few years to get embedded. Teacher education may need to get more on the ball with it, too. Teachers a few years ago didn't know the subject.*' When asked if the handbook might be helpful at this inflection point of teacher training, the teacher responded '*If they had any sense, they would point to this document to help them (teachers in training). It has Experiences, Outcomes and Benchmarks and how that links to the classroom. ... I would like to think the teacher colleges would be using (the handbook).*' Despite having '*noticed a big sea change in the subject over last few years (and emphasis on the content and resources out there); it will take at least seven years before the first early years students come into the secondary sector. It will take time before it gets embedded.*' This teacher does see some early positive signs: '*Over the next 5, 10, 15 years, hopefully we'll see kids coming into secondary school with much better skills – computational thinking skills, logic skills and so on – that will be essential for being good with computers, thinking algorithmically as well. You are starting to find that kids are a bit more inquisitive in the classroom. They are a wee bit more understanding of how the thing works and have a wee bit more programming, coding skills.*'

A primary teacher who tried to offer CPD in coding to her colleagues gave a specific example of a time lag (with forward movement) by noting that '*First, no one showed up – saying things like "I don't know how to code; it doesn't make sense to me; the younger ones will do it". But then, when the CPD was made mandatory, "all of the teachers enjoyed it and saw the benefits of coding. We are making slow progress"*'.

An interviewee bemoaning lack of progress noted, with some frustration, that the computing science strands may not be fully embedded into the Curriculum system: '*there doesn't seem to be any heed paid to digital literacy and computing science by Inspectors, you don't even see it mentioned very much in reports. So if Scottish jobs will require digital input, computing science or digital literacy – problem-solving, computer literacy, complex work – why aren't they looking at that more? If schools know inspectors will only give it a cursory glance or not at all, they won't do it, what's the point.*' This interviewee went on to say, forcefully: '*Many of us will do computing science and not become computer scientists, but*

problem-solving, critical thinking and collaboration are the key skills pupils will need. And computing science provides that and the kids are missing out.'

Another interviewee referred to 'the slow burn in using technology', with a challenge existing in teachers' confidence: *'A lot of our more mature teachers aren't confident in using computers, when you talk about computing science, they think about computers, but the resource is about computational thinking, not computers.'*

Another interviewee also saw changes from the Curriculum as acting very slowly, in terms of affecting teachers (and thus students): *'There is a long way to go. The overwhelming feeling from teachers is they don't feel they have the understanding or resources to be teaching computing science. And I think that is true for digital skills. ... There is a lot of work to be done at teaching college level on this to have impact on general teaching. And showcasing and highlighting good teaching practices. ... In Scotland there are not enough computing science teachers at secondary level, but those that are are frustrated because there is low uptake. It is seen as too hard, since students are not getting enough at primary. It is too big a leap in understanding from never getting it at all to trying to do it at qualification level'. This interviewee framed the overall contextual challenge: 'It is getting more apparent, the skills gap and how fast everything is moving in the digital domain and (yet) education is not changing that fast. The gap gets wider, people are putting in inflection efforts but it takes a long time to change the course of a big ship so we keep plugging away.'*

The Curriculum and the Handbook

Interviewees sometimes reflected on what was effectively a mix of the handbook and the changed Curriculum it brought to life. For example: *The children say 'yes!!' when my computer icon goes up for a session; they know they will be doing something fun and exciting. The activities the handbook suggests are very interactive and colourful and engaging for the pupils.'*

One interviewee injected a fairly positive view of the Curriculum change, particularly when/if the robust handbook is used to facilitate it: *'The change in curriculum has been transformational in terms of Es and Os. Five years ago, no child was experiencing a computing science education. Fast-forward to now, most schools around P4-5 are experiencing some form of computing science education that is linked to the Es and Os that underpin the document itself'. This interviewee provided a thoughtful summary of the close interrelationship between the handbook and the Curriculum and what the handbook offers teachers. 'Until the Es and Os were created, computing science really didn't feature in the Curriculum. So the document they created (Teach CS Handbook) is inextricably linked with that; it is a translation of the original work. ... So although Es and Os are giving schoolteachers an understanding of what every child should understand in the curriculum, the document takes that and makes it much more manageable for teachers in schools. It relies on the Es and Os created by exactly the same authors. ... This is very different from other curriculums. Many are very content led. This was future proofed. The strength of concepts behind it could be applied if one was doing very complex applications of computing science like in medicine or as simple as Scratch. That is what the document offers, with Es and Os - that I am not sure everyone understands. Scratch - is about what is happening behind computational thinking and principles behind computer science content; the next level - how a machine would use these things; the final level - how you would build a machine, creating programmes. The beauty of the document is that it has these three levels in this structure. I am not sure everyone understands (appreciates) this. ... Another document produced recently goes straight to building ... and another document is very much about resources - "here's a resource to do this, here's another to do that". Teachers find that helpful, but it is not actually teaching the underlying principles behind it - which the Teach CS handbook absolutely does.'*

Other dimensions

Related activities

Those who have attended the workshops tend to be very positive. One primary teacher referred to it as '*fabulous, a supercourse*', just suggesting that one workshop be dedicated to early years.

Another primary teacher commended the complementarity of the handbook and related workshops: *The sessions have been really good. The booklet is great but it's not until you have time to sit down and work through the suggested activities that you can really get it. Having Kate there so you can challenge yourself and have the support there. Kate is really good at breaking it down and explaining and giving you different options. That's reassuring if you have a problem – or even if you are doing something right. The handbook and workshops go together. Even the first workshop on Unplugged which I had found particularly difficult to teach ... then Kate told me about the booklet.'*

An overview interviewee underscored that the impact of the workshop would reach through teachers taking the session onward to the pupils themselves: '*People who get the benefit of Kate's classes – will definitely benefit the children in the classroom.'*

One aspect of this evaluation was observation of the Coding and Cake workshop, run by Kate Farrell at the University of Edinburgh on 1 February, 2020. Seven primary teachers, one with two students, and three with a child each, as well as a parent and child, attended. Objectives for the day included: an introduction to how to use the Scratch environment; learn about CS outcomes in the Scottish Curriculum; do some code building in Scratch to make games; find out sources of support; activities and 'have fun'. Kate Farrell set a lively, cheerful friendly tone – matter of fact and reassuring. As well as technical questions specific to the task, she answered some teachers' questions about how to set it up in their classroom context, for instance how their pupils could keep working on their own files. Adults and accompanying children interacted, with advice going in both directions, often. Especially as time went on, there was peer-peer help among teachers. The tone became quite cheerful, sometimes a bit of a buzz as they talked to each other about what they were doing. At the very end, Kate put up a slide with more resources. She showed them the Teach CS Handbook (several teachers were disappointed that physical copies were no longer available). She provided a recap of what they had done and learned today and showed them a list of other potential sessions. Overall, there was a very positive atmosphere in the room, even though some of the teachers were evidently somewhat 'unsure' about coding.

In a very brief focus group seeking possible impacts of the workshop, teachers were asked to write down 1-3 changes (with saying 'none' acceptable) that they felt the workshop's experience had brought about, for them. They were told they could write anything, which could be 'personal, like confidence; or technical like understanding – generally or about specific concepts; or practical – like being ready to try a new way of delivering something or running an activity'.

Changes brought about by the 1 February 2020 Workshop

Teacher A: 1) confidence in developing more complex games in Scratch (moving obstacles which I had never coded before); 2) confidence in discussing the processes within Scratch with my pupils; 3) different ideas to build on existing knowledge – we've been creating maze games in school so very helpful!

Additional comments: Teaching coding has allowed children to become creators of digital content rather than just consumers! Scratch has been a very useful tool for teaching mathematical concepts without children realising they are doing maths.

Teacher B: 1) ability to motivate children in the classroom to create their own games; 2) also the ability to problem solve using technology – but applying skills that have already been learned in maths; 3) introducing more fun into classroom teaching and hence motivating learners; 4) Using transferable skills. Anecdote: My bright girl in P7 told me she loved this!

Teacher C: 1) new knowledge to take back to school; 2) confidence to do activities myself and use with pupils; 3) patience – knowing activities/fixing errors won't take a long time.

Teacher D: 1) More confidence differentiating lessons; 2) Creating class accounts; 3) confidence in my own abilities and to take more risks.

Teacher E: 1) increased confidence in own skills + knowledge; 2) practical resources to take back into class; 3) enthusiasm > classroom + talking to colleagues.

Teacher F: 1) more confidence to try out with my class; 2) understanding how scratch works; 3) knowing how to set up for a class.

Teacher G: 1) improved my confidence in using simple coding and (2) given me a foundation for teaching this; 3) provided me with further resources that I can explore and share with colleagues.

Impact on confidence was cited by all but one teacher. Knowledge of how to actually do activities with pupils had clearly been improved. Fun and enthusiasm were cited. There is likely to be a 'ripple effect' in the schools of teachers attending, as two mentioned specifically that they would be sharing with their colleagues.

Pupil Replies

Pupils were asked what they enjoyed the most and were encouraged to either write or draw their answers. Replies were enthusiastic. **Pupil a:** The best bit about today was making the games! Variables, points, lives. **Pupil b:** Maze game. **Pupil c:** Messing around. Trying weird stuff out. **Pupil d:** Today I enjoyed doing the maze. (nice picture of computer with detailed maze). **Pupil e:** Coding. **Pupil f:** I have enjoyed making cool scratch games. Some of these things I did not know who (how) to do. It has been a lovely time here. Thx so much!!! Let's game! (Illustrated letters: SCATCH IMAGE CREATE, with a picture of a smiling computer.)

Introduction of interviewees/focus group participants to the handbook

Interviewees were asked how they themselves had come across the Teach CS handbook or related activities. One teacher had it recommended to her by a visiting inspector. Another teacher had learned about it, even helped to test it, during a course for primary teachers at the University of Edinburgh several years ago. Another found out about it during a workshop run by the team; similarly, someone else received a pdf document and a link to the teach cs website at a day-long course about computing science in the primary setting given by Farrell and Robertson. There had clearly been no one systematic delivery process bringing the handbook to all of them.

Promoting impacts through increasing breadth of usage

Most interviewees and focus group participants believe that awareness of the Teach CS handbook is not as high as it could – or should – be. While others' comments are captured below, the following narrative (approved by the interviewee) captures this line of thought, while at the same time suggesting possible steps to take to enhance the impact of the (admired) handbook.

Potential for enhancement of impact

One interviewee with experiences and perspectives on multiple levels is 'an advocate for the book' but offered suggestions for how the potential impact of the handbook could be enhanced. The fairly comprehensive set from this one interview captured the sense of suggestions made by many others.

First, the handbook is seen as being of excellent quality – although its usage is not correspondingly widespread.

I am a fan of the content of the document. I think it is complete for what the Scottish Government wants in Es and Os, but sadly I think it is not being used. ... It is a very useful document. I think it is perfect, all the information a teacher needs to know, although some improvements could be made.

It is 'worthy' of wider usage, albeit with improvements such as those suggested below:

Improve online accessibility and searchability - *Make it really usable, make it a web page or blog that is easily searchable, updatable. Having it as a pdf makes someone store it and have to search for what they want to extract. Make it online so it is easy to use and a teacher can click on it straight away – the opportunity for greater use is there. I can understand there could be funding implications but if it were presented in online format, as well as a pdf, it would be of far greater use. For example, in order to link to Paul Curzon's work in London, they would have to go to the book (pdf), but if it were on a website, teachers could go to computational thinking, click on Paul's work and up would come examples that pupils could use straightaway.*

I do think Barefoot will get more traction because teachers can just click. The Teach CS Handbook is more advanced and would probably have more validity to teachers – if they could get access to it.

Update resources and links - *It is getting out of date with a couple of resource links not found.*

Simplify the language - *For an improvement, the language should be looked at and simplified. We have early years practitioners who need simpler language. ... So soften the language a bit and make it more appropriate to people who are not confident users of the technology and are not confident in wanting to use the technology.*

Especially with such improvements, the handbook is a high-quality resource, which teachers need:

I don't think schools, sadly they are not applying the technology in the way they are meant to be. There are a small number of schools where it is happening but in most it is not - pupils are sadly missing out. That can only be down to teachers missing confidence, so we need a document like this one where they can easily go in for examples. If it were structured slightly differently and it had a friendlier language for primary teachers, I think that it could be easily promoted and used.

Pro-active promotion would enhance teachers' opportunities to take advantage of this resource: *(People) should have been out promoting it; it certainly does the job. ...*

If the handbook was on a website and people knew about it, certainly officers in local authorities would promote it. Education Scotland would have a responsibility to at least promote it to the national technology network they have, which would then go on to council officers. You just need one or two people in each authority (to promote it) – to go to teachers and let them know how easy it is to use.

Broader promotion would enhance the impact of the handbook: *The Teach CS handbook should be getting more traction across schools. If people don't know about it, they are not going to use it.*

Enhancing the impact will be important because the Teach CS handbook addresses a critical problem: *Many of us will do computing science and not become computer scientists, but problem-solving, critical thinking and collaboration are the key skills pupils will need. And computing science provides that and the kids are missing out.*

Not everyone agrees completely with all the points made by the above interviewee, naturally enough. For example, comments by several interviewees suggested that the tone of the handbook is actually about right for primary teachers: *'Particularly for colleagues who couldn't come to a course – who maybe didn't even know what computing science is - you could see it would be really clear; it breaks down what computing science is and gives them things to do. ...It is a document that is simple but not patronising. "Here is some information about what is happening". It gives you the right level of what you need to know.'* And, even a primary teacher who agreed that having linkable sections to click on might make it easier to navigate or search, nonetheless said *'But, honestly, the handbook is pretty accessible if you have it in a physical form.'*

Because interviewees and focus group participants tended to be so very positive about the utility of the handbook, they offered suggestions as to how more teachers might benefit, whether through greater awareness, better distribution and/or changes in online formatting.

In fact, one interviewee was so positive about the handbook (*'It is a fantastic resource and the way it is broken down is superb'*) that he transformed it (with the team's permission) into a web version to make it more accessible to teachers (*'I have done nothing other than to turn the resources into an electronic version and link them together'; so if you go to Experiences and Outcomes, you can go to the (related) concepts or the activities or progression pathways.'*). *'They can just tap into the piece they are looking for, rather than flip through the whole document.'* In one Local Authority, this web version of the handbook certainly seems to be useful; it receives a *'pretty steady 5 hits a week, tapping in and out'*, mostly from primary teachers. This interviewee would recommend that the Teach CS handbook team use a link to this or make a similar transformation so that the handbook could be accessible in this format to all (not just the domain of one council). At least one other interviewee, when told of this in general terms, thought this would be a very good step.

A primary teacher who finds the handbook very useful observed that: *'I hadn't heard of it until 3-4 years into my teaching career, as someone teaching coding all that time. So I think maybe it was sent out as a handbook, maybe it has been lost and maybe it needs reminding people that it is a really helpful tool. Maybe redistributing it. Making probationers aware or making teacher training aware. Mailing out to high school Subject Heads of Years/Subject Principal Teachers, primary science or STEM coordinators for a council; maybe use the platform of Edinburgh University and whoever published it to re-promote it.'* She offered these suggestions because *'It is still relevant. ... It would be useful to get it out to people.'* She recommended *'making people aware of it as it is a great planning tool'*. When asked what marketing messages might be used to promote it to primary teachers, she suggested: *'It helps reduce planning time. It is useful.'* *'There is a clear progression of concepts along with clear examples of what learning should look like at each level.'* *'It is a valuable planning tool.'* *'It shows you you don't actually need a computer to teach computational thinking.'*

A realistic interviewee pointed out that any promotion of the handbook would inevitably take place in a crowded world *'Everyone wants a piece, their view of how something should be delivered that teachers are accessing. ... It will be down to the writers to somehow promote, market and make sure it is (seen as the) best for teachers. They've got to win that space.'* This is true at the level of government, but also at school level: *'Schools get sent resources day in and day out; they are awash with them. It is how you promote and market it that makes the difference.'* There is a complementary role for 'word of mouth': *At the end of the day, teachers are great people and if there is a great resource, they will share it with others.... People who have used it (the handbook) can share with other teachers. It just takes that time.'* In a sense, pro-active promotion could be the last leg of the handbook's journey, the tipping point of effort: *'You (The Teach CS Handbook team) have invested so much time, and are so committed to what you are doing, for no apparent rewards. ... Promotion could make a difference.'*

Various suggestions for promotion were put forward by interviewees to increase the number of people who know about the handbook. Key events could be used; for example, one suggestion was to distribute copies of the handbook at Computer Science Lead Teacher events led by Education Scotland. Mailing an announcement about the handbook to Glow users was one suggestion; another was Google GSuite for Education. Other suggestions include: putting something in the Teachers Union Magazine, e.g. the Scottish Educational Journal; the GPCS 's Teaching Scotland – 'we all get it so an article in there reminding about the handbook would reach people'. Another possibility suggested was to send notices to Local Authorities, which could then post that within the news they send to their teachers.

Some Regional improvement collaborations (RICs) might have particular interest in computing science and might help to promote awareness of the handbook. One interviewee said *'The change needs to be driven at Local Authority level. The RICs would be a handy vehicle for developing change ... The handbook could work with RICs prioritising computing science.'* Another interviewee also saw RICS as an important channel: *'Regional improvement collaboratives – they need to be made familiar with it.... I would encourage use by regional collaboratives. ... We have 6-7 cross-council collaboratives; there needs to be a strategic rollout.'*

Even among the attendees at the workshop, only three of the seven had been aware of the Teach CS handbook before it was mentioned at the end of the session. Two had used it but four to five expected to use it in this school year. Teachers were asked to suggest ways in which awareness of the Teach CS Handbook could be spread more widely across Scotland's teachers. Suggestions included:

- Send copies to Head of Department, Business and Computing (and Perhaps Digital Literacy) in secondary schools
- Send copies to ICT Coordinators in primary schools
- Email head teachers
- Use social media, Twitter, Facebook
- Share news through GLOW
- Include it in university courses, teacher training.

Noting that *'sometimes something can come into a school but not get to the right desk'*, one primary teacher acknowledges that few colleagues are aware of the Teach CS handbook: *'I don't really think people know about it. Colleagues come in and you see blank faces. I've been on courses and been the only one who knows it'*. She commented *'People mention Barefoot Computing; I say "download this (the handbook); it will tell you about Barefoot and other things too"*. Ten people will say they have never heard of it.' She appreciates being able to tell people about its availability. *'It is great that it can be downloaded.'* To improve awareness, *'it needs to be campaigned, to get people telling others about it'* (as she does).

People who find the handbook useful are indeed happy to spread the word. As one teacher said, *'I try to encourage others to use it because it is a very good and useful book for people'*. This teacher (who shared the website teachcs.scot) felt that other teachers who were made aware of it *'were very appreciative that it is very well-structured'*. The teacher described showing the document to another teacher who was not too confident about how to fulfil the national standards set; that teacher said *'this is excellent; it will help me with how I plan lessons'*. Others noted the role of informal sharing across such 'early adopters'.

Thinking a bit longer-term, one teacher recommended going to the inflection point of teacher education establishments (as did some other interviewees): *'If you really want inroads, if every teacher gets a copy, it would have to have an impact. It's crucial; if you get the bedrock there, the scaffolding grows and grows, and becomes embedded.'*

Other suggestions

Suggesting that ideally face to face instruction would complement the handbook, yet there are natural constraints on time, one interviewee noted that, in the Teach CS workshops *'Kate is great!' and went on to suggest 'If there were some small video clips of them teaching, just to give people some understanding of why it is structured in the way it is, at the beginning, it would be helpful. Kate, Judy, Quintin are the ones with real understanding, who are engrained in this. There are so few of them that some way of making them sustainable would be helpful.'*

Another suggestion was that the handbook be complemented by a new addition: *Maybe it could create eight lessons for a teacher, build on Teach CS to develop a nice wee package for a teacher to work their way through, then the teacher could apply it. "Here's a wee group of lessons you could deliver that relates to this part of the curriculum for children in these ages." That takes time and investment and resources. People are not going to do that out of good will, it needs funding behind it.'*

VIGNETTES

A set of vignettes has been developed from interviews in order to capture impacts of the Teach CS handbook in some depth. All have been approved for accuracy by their sources. The Teach CS handbook has had multiple impacts, on a range of levels. While also encompassing examples of other impacts, the seven narratives captured below focus on:

- **Impact on a learner**
- **Impact on pupils: an ‘aha!’ moment**
- **Impact on a teacher and school**
- **Impact on teaching practices for diverse ages, by diverse teachers**
- **Impact: Helping teachers embed computing science**
- **Impact on a Council: Pro-active sharing**
- **Impact on primary through secondary progression.**

Impact on a learner

A teacher of a Primary 4 class reported using the handbook to deliver a Scratch exercise. When she did, a ‘terribly shy’ girl in her class ‘just got it’. *‘She was amazing and showed all the other kids how to do it. It gave her confidence and the other children asked her to help them’.*

Impact on pupils: an ‘aha!’ moment

A primary teacher provided an example of a sudden breakthrough in pupils’ thinking. *‘At the moment in numeracy, I am teaching coordinates and on Scratch I have the four coordinate planes. Today, for example, we did line drawings with coordinates and the kids realised they could animate it on a computer; they said “We’d never noticed x and y axes on Scratch before!” ... This is getting kids more excited about maths and doing it in a fun and engaging way without them knowing they are using maths!’* As the teacher observed, *‘teaching coding has allowed children to become creators of digital content rather than just consumers!’*

Impact on a teacher and school

One teacher has been using the handbook since helping to ‘test’ it in draft form during a course on Computational Thinking course for primary school teachers given by Professor Robertson in 2016-2017. It is a key part of her toolbox, affecting her planning and activities. She says, *‘I use it to select my activities when I’m teaching computer science. That is what I go to; it is my go-to thing, when I think “what should I be teaching?” Every year I’ve gone back to it and said, “alright, what can I do?”’*

Furthermore, through this teacher, the impact has spread into the primary school more generally. She uses it when colleagues ask her for advice. As the ICT Coordinator, she has used the handbook to help embed computer science teaching in a coherent way across the primary years. *‘I’ve tried to put together a progression and I did that heavily from my handbook. I look at the activities, I think “that would be best for P1”, for example.’* She believes that, in addition to the practical advice she can give, it gives colleagues confidence to know that this comes from the handbook source.

Impact on teaching practices for diverse ages, by diverse teachers

The Handbook is ‘reaching’ different students of different years and teachers of different experience levels. One teacher, who had prior experience with computing science, found that the Handbook helped her gear her teaching more appropriately, so that what she offered was age/stage appropriate. *“I suppose it helped me, being quite computer literate, I wanted to make sure what I was teaching was the right thing. ... Now I can see that what I had thought was nursery level, they really need a good grounding in it first to make other things easier. If I hadn’t been directed to the Handbook, I wouldn’t have changed my teaching. It made me see it in a different light.* Furthermore, the Handbook’s diversity of

offerings was helpful. *'The Handbook has shown me different activities and ways to teach it and look at different resources ... which has enhanced what I'm doing'*. She has also found that *'Other colleagues have enjoyed it when I directed them to it and didn't find it too hard to understand'*.

Furthermore, this teacher used the Handbook in planning for her entire primary school. *'I have created planning documents right through from Primary 1 to Primary 7 with regard to digital learning and digital literacy, and taken on board some of the activities and documents there, and some others – and I created a set of plans. We are trialling them now, to see if they meet learners needs, do they fit with the school. Once I have trialled it, I will let the other two schools in our partnership see it, and if they like it, it would go to cluster level and then the local authority. We are following it (the programme of study) and just seeing have I got the right activities at the right stage, are they engaging enough for the learners, are they useful for staff of different ages.'*

This teacher reflected on the different ways in which the Handbook has been helpful to the teaching practices of different colleagues, as translated through the programme plan she has developed using the Handbook. For example, *'Some staff may not feel comfortable with computational thinking or analysing data. I tried to make it as easy as possible for any member of staff to follow so then they can deliver to the pupils. It is a scary thing if you are not used to it or don't understand the terminology. I find with the computing sciences, there are a lot of words that people wouldn't understand, so I have been trying to break it down and make it clear to staff what that really means. The Handbook definitely helped me do that. I really liked the way it was set out, broken into different sections - 'this is what you can teach and some activities you can do in each section'; that helped me enormously in planning the planning documents.'*

She also cited an example of the help the Handbook gave to a 'younger generation' teacher. *This year we have had a probationary teacher, very young and computer literate, who has never taught it to pupils before. She has found that the document we created - that was inspired by the Handbook - has allowed her to teach it. When she did her training, there hadn't been that much on it. She felt it was seen as a kind of given that they know how computing science works, but she did not know how to teach it to a child. The document allowed her to see "how I can teach or how I can cover a strand". So it definitely helps older generation teachers who are not confident and also new teachers on 'how do I actually teach it'.*

As an additional illustration of diversity of reach, *'there were lots of suggestions in the Handbook that would tie into other areas of the curriculum'*. This is helpful because *'with the Scottish Curriculum for Excellence we are really trying to create interdisciplinary learning'*.

The variety of practical, hands-on activities provided by the Handbook have been helpful in enthusing learners, at different ages and levels of confidence. *'The children say "Yes!!" when my computer icon goes up for a session; they know they will be doing something fun and exciting. The activities the Handbook suggests are very interactive and colourful and engaging for the pupils. ... The questions they come up with are more in-depth. ... We obviously have some very keen and able pupils – the Handbook also gave opportunities for the more confident pupils to be stretched as well.'*

Impact: Helping teachers embed computing science

A primary teacher, herself comfortable with computing science due to her background, nonetheless finds the Teach CS Handbook – and related activities – useful. She has been to four or five workshop sessions and is signed up for more, as they give her confidence in developing more complex games and in discussing processes (e.g. within Scratch) with her pupils, as well as giving her different ideas to build on existing knowledge. Although she had not heard of the handbook until it was introduced by Kate Farrell in the first session, she finds that the sessions and the handbook are complementary: *'The sessions have been*

really good. The booklet is great but it's not until you have time to sit down and work through the suggested activities that you can really get it. Having Kate there so you can challenge yourself and have the support there. Kate is really good at breaking it down and explaining and giving you different options. That's reassuring if you have a problem– or even if you are doing something right! The handbook and workshops go together. Even the first workshop on unplugged which I had at first found particularly difficult - then Kate told me about the booklet.'

She finds the handbook useful at several levels, as a planning tool for her own class and for planned activities with 'digital leader' pupils from three different year groups: *'It gives you activities, ... shows you what learning looks like, has a glossary, you can really break it down for people. It has technology and the Experiences, Outcomes, Benchmarks – as in the Curriculum for Excellence. It helps me see what I should look for in pupils' work. There is a section that says "this is what learning looks like"; it gives ideas for what to take forward, has a glossary and helps me to explain in simpler terms what these things are to kids. (That is) helping pupils understand the concepts, helping me explain it to them in a way they understand it.'*

Furthermore, she is making use of what she takes from the handbook as she reaches out to other teachers, to help them embed computing science in what they do. In charge of overhauling the topics planners in STEM at her school, she is currently in the process of developing bundles of E's and O's to go with different topics; she is looking at how to put computing science outcomes within social science or literacy planning, for instance. She will then spend planning time with each of the teachers, to look at how they could tie in computing science or digital topics. The handbook has been helpful to her in her work to date and *'hopefully there will be a ripple effect from my use of the handbook'* as she helps other teachers with planning topics. *'Often people think computing science is an additional thing to do; hopefully it will become just part of the curriculum as it is meant to be, rather than a standalone subject.'*

She is currently considering what more she might do with the handbook. *I just sent out an email to staff telling them to look at the handbook as it will make planning a lot easier. It might be another CPD session to do, to go through the handbook and help them see how they could use it in their planning.*

Even beyond her own school, she has started working with schools (including high schools) in her cluster, providing CPD and a coding club. She plans to let them all know about the handbook.

Impact on a Council: Pro-active sharing

A specialist in learning technologies for a Council attended a short course run by Robertson and Farrell, at which he was given the Handbook pdf. He was impressed by the quality: *'It is a fantastic resource and the way it is broken down is superb'. He wanted to share this with teachers in his local authority but did more than provide a link to the pdf: 'I came away with the resources and I thought it was great and it needs to be accessible to our teachers - so I turned it into a web resource and got it to them ... I made it a public-facing document so our practitioners (and the people who produced it) could link to it. I think it is much more accessible than a pdf. They can just tap into the piece they are looking for, rather than flip through the whole document ... I think if it had stayed a pdf document, it would have been lost.'* He also facilitated connections across sections: *'I have done nothing other than turn the resources into an electronic version and link them together, so if you go to experiences and outcomes, you can go to the (related) concepts or the activities or the progression pathways.'* <https://sites.google.com/ourcloud.buzz/computerscience>

He of course had gained the authors' permission and in turn provided them with the version he created, and a link which they could share with others beyond his Council's domain. Analytics from the Local Authority show an average of five hits a week and suggest that, in

addition to any downloading of the Handbook pdf they may have done, teachers are ‘tapping in and out’ as they need something from the online resource.

The Handbook is actually having an impact on the way the Council develops resources. *‘What we have done on the back of it (at the Council), we are trying with the other subjects to follow that same method of concepts, progression pathways and activities. Senior management like the way it is set up so when we develop resources for different subjects we do try to follow the same methods, the way they set the Handbook up. It has led to a change in the way we are producing resources.’*

Impact on primary through secondary progression

A secondary school teacher with extensive experience in teaching computing science has used the handbook to gain insight into what primary students (may) have been learning. This has allowed him to facilitate students’ progression from primary schools into his secondary school. *‘The handbook gives me a better understanding of what they should have been learning in primary and the technology they may have been learning with.’* When he used the handbook, he found it *‘very well-structured’*, saying *‘you can dip into it at any level; it gives you very good ideas as to lessons with links to resources. I actually learned a lot from that. Seeing how something looks at primary level and the way it links really neatly showing progression with benchmarks and outcomes in computing science’*. So, for example, he observed *‘Even though I am not a primary teacher, I quickly found a resource that helped me identify an outcome for the transition work with P6. And I’ll use it where pupils may be working at 2nd level within the secondary classroom’*.

The handbook represents a new resource helpful in planning progression. As he observed, *‘There is no doubt that if a primary teacher had said a few years ago “help support us”, I would have but I would have lacked understanding as to how they would need to structure their curriculum and fulfil national requirements. ... There was nothing as structured to go on with depth of content and exemplification of experiences and outcomes. The handbook helps me to plan progressive learning alongside the computing science benchmarks document. If teachers use it a primary level, I know the range of experiences and outcomes they will have covered, as well as the resources used and activities carried out.’*

Furthermore, as someone active in his Local Authority more widely, he interacts with many primary school teachers as they come to grips with computing science. He has already used the handbook to understand their situation and has recommended it to various primary school teachers. He intends to do even more of this over the next few months: *‘This year I am going to try and organise some trips out to the primary sector and I’ll certainly be using this document and maybe we can try to get a more structured transition. If I go out there, I can get a better judgement on how confident they are. I will certainly use this document to help support them and plan. It will help me if they need support. I can say to them “this will certainly give you the scaffolding, the start-up space as to where you need to go with your curriculum”.*’ In this way, the handbook is contributing directly to learning but also, in the bigger picture, to smoother transitions for learners as they move from primary to secondary school.

CONCLUSIONS

This evaluation took the form of a 'deep dive' into the views of a set of individuals who had interacted with the Teach CS Handbook and related activities. This made it possible to capture a range of impacts experienced or seen by these individuals. It is quite telling that so many impacts were generated even within this small set. This is suggestive of more numerous impacts being likely across the greater number of all who have interacted with the handbook (but who could not be contacted in this study). From the group studied, conclusions as to impacts are:

- The Teach CS Handbook was highly praised, for its clarity, structure, coverage, inclusion of underlying principles, and alignment with the Curriculum. It is seen as a high-quality, useful resource. As related activities, workshop sessions were very well-regarded, as well.
- Use of the handbook led to increased confidence among teachers – interviewees and, often, their colleagues.
- The handbook led to clearer understanding of key concepts and thus to an increase in teachers' competence when teaching pupils about those concepts – to the benefit of pupils.
- The handbook has had an impact on teaching practices of individuals and also, through various planning processes and documents, on practices of colleagues.

Views as to impacts of the changed Curriculum in general are less straightforward, with many seeing this as a long-term process just now getting underway. The thought was expressed more than once that widespread use of the Teach CS Handbook could facilitate the Curriculum change.

There is undeniably scope for even further impact, if more teachers are made aware of the Teach CS Handbook. Time and resources allowing, pro-active promotion would spread the word as to the availability of what is recognised as an outstanding resource.

APPENDIX

Semi-structured Interview Template

Background:

How did you come across the Teach CS handbook? Have you participated in related activities?

How have you used it/how are you planning to use it? What are your objectives?

I. **Impact of the Teach CS handbook on teachers' confidence & competence (while teaching the new CS strands of the Technologies section of the Curriculum for Excellence)**

Would you say that the Teach CS handbook has had any impact on your *confidence* as you teach your students?

If so, how? If not, why not?

Would you say that the Teach CS handbook has had any impact on *your ability or competence* to teach CS – particularly your understanding of CS concepts?

If so, how? If not, why not?

II. **Impact of the Teach CS handbook on teachers' behaviours & practices**

Do you have any examples of ways in which the Teach CS handbook has influenced (or is influencing, or is likely to influence) your teaching practices?

For example, has the Teach CS handbook had any effect on your teaching behaviours, activities, class planning?

III. **Impact of the changed curriculum on students**

What is your general sense of how the change in curriculum is affecting learners?

More specifically, can you think of any examples of how the change in curriculum has affected a learner? ('Anecdotal examples' can bring a narrative to life!)

IV. **Big Picture**

Do you have any sense of how widespread the use of the Teach CS handbook is across primary schools, as the curriculum changes?

Do you have any comments on the aims or objectives of the curriculum change and/or of the Teach CS handbook?

V. **Lessons learned/Recommendations**

Anything else?