Raspberry Pi

ACM SIGCSE Special Projects Report

Developing criteria for K-12 learning resources in computer science that challenge stereotypes and promote diversity

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Project Summary

The overarching aim of the project was to develop guidelines for computing teachers and resource developers which were informed by research into culturally relevant pedagogy and culturally responsive teaching, with a specific focus on the English educational context. These guidelines could then be used as a basis for broadening participation in computing and addressing the needs of diverse learners in K-12.

We set up a working group of researchers and teachers from our community to consult on the guidelines.This included two academics working in primary and secondary computing education respectively, and two invited academics from the United States (US) and Canada bringing international experience. Seven teachers were recruited to the study through an open call on local teacher networks and social media.

The working group developed the guidelines over the course of three months. The work involved two meetings and an ongoing process of discussion and collaboration before, between and after these meetings, as we gradually iterated the guidelines from an initial set of draft criteria into the final product.

As part of the project, we asked teachers in the working group to consult with their learners to understand their perspectives on computing and how schools can engage more diverse groups of students in post-compulsory computing education. We have also used the guidelines to support professional development and plan to expand this further to help more computing teachers to understand and use culturally responsive approaches in their teaching.

1. Background and Rationale

Cultural relevance and responsiveness in education are the focus of several key theoretical frameworks that have emerged in the US since the 1990s. Culturally Relevant Pedagogy [1], Culturally Responsive Teaching [2], and Culturally-Sustaining Pedagogy [3] all focus on the importance of allowing students from a range of backgrounds to express their cultures and identities through learning activities that are meaningful to them and that allow them to excel academically.
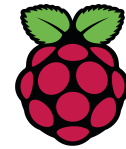
Scott and colleagues have developed Culturally Responsive Computing (CRC) to translate the tenets of these approaches into a computing-specific theory [4,5]. CRC posits that technological and digital innovation is possible for all students and is in fact enhanced when students have opportunities to reflect on their own identities and cultures. Providing a learning context that supports this reflection encourages students to understand the current biases in technological development and to use technology in innovative ways to address issues that are meaningful to them and their communities [5].

While the computing education community in the US has begun to focus efforts on developing culturally relevant, responsive and sustaining curricula for computing, the curriculum in England has not been derived from these principles. In this context, we aimed to develop guidelines for computing teachers in England that introduced culturally relevant and responsive theory and practice and to provide practical examples from curricula in England and the US that they could use in their own teaching.
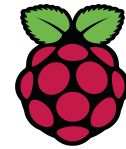
2. Activities

Working group meetings and discussions

Two meetings were convened for all working group members. Prior to the first meeting, all participants were given reading material and resources to inform the initial discussions. The first meeting focused on the initial development of 'criteria' that would support teachers in evaluating learning materials to ensure that lessons took account of culturally-relevant pedagogy. Through a series of whiteboard activities, small and whole group activities, it became clear that the focus we had initially set was too narrow, and the teachers in the group felt that a more broader perspective on curriculum and pedagogy was needed, beyond our focus on learning materials.

Between the two meetings, the authors revised the criteria to develop a broader set of guidelines, drawing in the perspectives presented by the teachers. These were iterated and circulated again for comment, and then iterated again. In the second meeting, participants collectively revised the third version of the guidelines and also considered learner engagement, professional development opportunities, and the ways in which we could understand and develop our notions of 'culture'. All input was captured and represented in a fourth version of the guidelines. After the second meeting, these were again re-circulated and the final version developed.

Learner engagement

To complement the development of the guidelines, the intent was to carry out a small pilot study to investigate the perspectives of learners. One of the teachers in our working group engaged with 18 students as part of this pilot study. Two groups of nine students, one group between 13 and 14 years and the other between 16 and 17 years, participated in an activity requiring them to individually answer three questions:

(1) Is computing relevant to you/to everyone?
(2) When you were in grade [younger than now], what kind of activities would have inspired you or put you off computing?
(3) What can teachers/schools do to ensure a diverse group of students take up computing at school or computing-related careers?

The main four themes emerging from the learners' comments related to (i) engaging students from a young age (ii) the importance of games and fun activities in computing lessons (iii) engagement with meaningful projects and contact with industry (iv) the importance of diversity in computing, including gender balance. Ten students made comments that related to the age in which computing was introduced:

> *"I believe introducing computing to people at a young age will make them to develop a liking to computing." (student, older group)*

Many students (12) talked about fun activities and enjoyment of computing with seven out of 18 mentioning the impact that games, either outside lessons (video games) or inside lessons (creating games) has had on their interest in computing. Students reflected that there were some aspects of computing that were hard or boring, with 'coding' and 'theory' being explicitly mentioned. A number of students (eight students, primarily from the older group) mentioned the importance of the real world, role models, and careers in computing, specifically relating to how teachers could engage more students by talking about careers or inviting professionals in to talk to students:

> *"Making the curriculum more personal to students might encourage some interest in the subject. There also needs to be more effort put into workshops, trips and maybe getting computing professionals to talk to the students. These are the different ways, I think, could get students of all ethnic backgrounds to collectively share a hobby in technology." (student, older group)"*

Supporting teacher professional development

Throughout the project, we have also been involved in some professional development opportunities for teachers. First, teachers were invited to participate in the working group to learn about culturally responsive computing and to contribute to discussions based on their own experiences and school contexts. Their input to the guidelines was invaluable and ensured that teacher voice was central to the project.

Since the guidelines have been published, members of our working group have also been using them as part of professional development sessions for Black History Month, and within formal teacher training courses. Our aim is to build on these early uses of the guidelines to develop a more robust and long-term professional development course that can support teachers to take a culturally responsive approach to teaching computing.
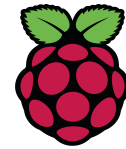
3. Outputs

All of the outputs of this project are shared on our [webpage](#), which we will continue to update with our future work and research in the area of culturally responsive teaching for K-12 computing.

The guidelines

The guidelines (Figure 1) include a section on definitions, followed by guidance under the three headings of Curriculum, Teaching Approaches, and Learning Materials (Figure 2). The guidance also includes a discussion about issues facing computing teachers beyond their actual classroom practice and a set of resources for further reading.

Figure 1: Extract from guidelines developed through the project

Figure 2: *Teaching and curriculum design at three levels: Curriculum (the roots), Teaching approaches (the branches), and Learning materials (the leaves).*
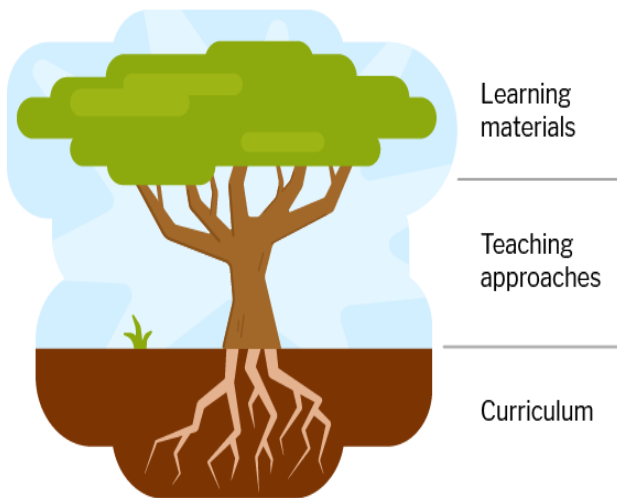
In terms of **learning materials**, the guidance focuses on inclusive representations of a range of cultures and ensuring the accessibility of the learning materials to ensure that all learners feel that computing is relevant to them.

Guidance on **teaching approaches** focuses on helping learners to express their own cultures and identities, providing opportunities for open-ended or inquiry-led activities, and promoting collaborative and structured group discussion.

The **curriculum** guidance includes the contexts in which computing concepts are taught, and how connections are made with issues that are meaningful to learners.

Academic publications

In the initial stages of the project, a Quick Scoping Review was conducted on the computing education literature, identifying 12 peer-reviewed papers that had evaluated the impact of culturally responsive approaches to teaching K-12 computing on learners. This review has been accepted for publication by the *International Journal of Computer Science Education in Schools.* An experience report related to the development of the guidelines has also been published in the *Raspberry Pi Foundation's Research Seminar Proceedings (Understanding Computing Education, vol. 2)*, as part of the series on diversity and inclusion in computing.

Other dissemination

Information about the project and the guidelines have also been shared through a number of different means in order to engage teachers and the wider public. Posts for the Raspberry Pi Foundation's blog have been shared through social media channels, and teacher-facing articles on culturally responsive teaching in computing have been written for Hello World magazine and the Big Book of Computing Pedagogy.

References

[1] Ladson-Billings, G. (1995). Toward a theory of culturally relevant pedagogy. *American Educational Research Journal*, *32*(3), 465-491. [2] Gay, G. (2000). *Culturally responsive teaching: Theory, research, and practice.* Teachers College Press. [3] Paris, D. (2012). Culturally sustaining pedagogy: A needed change in stance, terminology, and practice. *Educational Researcher*, *41*(3), 93-97. [4] Scott, K. A., & White, M. (2013). COMPUGIRLS' Standpoint: Culturally responsive computing and its effect on girls of color. *Urban Education, 48*, 657 – 681. [5] Scott, K. A., Sheridan, K. M., & Clark, K. (2015). Culturally responsive computing: A theory revisited. *Learning, Media and Technology, 40*, 412-436.