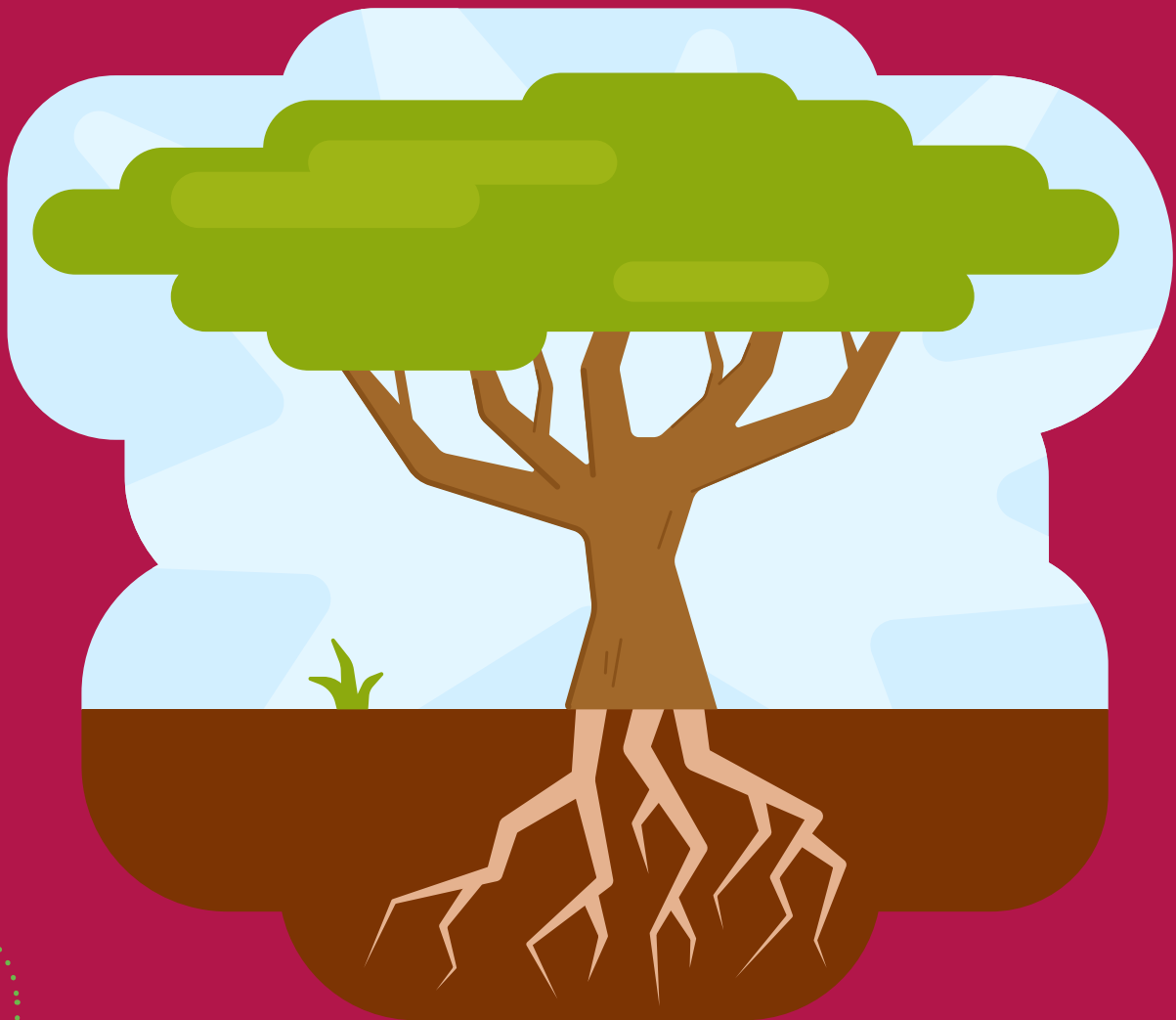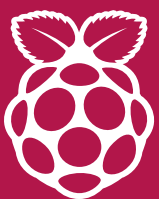# Culturally relevant and responsive computing in the classroom: A guide for curriculum design and teaching

Raspberry Pi

Executive summary

Computing can give young people skills for life. It is a subject that can help learners to participate in and shape a rapidly changing world. However, learning materials often reflect the historic stereotype that computing is a subject and career for White men. This includes how topics are presented, as well as the language and media assets chosen to introduce them. Learning materials that present this view of computing may prevent a diverse group of young people from engaging with them or identifying with the subject.

Learning materials and teaching approaches should promote equity and ensure that learners can see themselves represented through computing. In the United States, a number of initiatives have developed **culturally relevant pedagogy** and **culturally responsive teaching**. We believe that this approach would also greatly benefit computing curricula in the UK.

In 2021, researchers at the Raspberry Pi Foundation were awarded a SIGCSE Special Project Grant for a project called 'Developing criteria for K-12 learning resources in computer science that challenge stereotypes and promote diversity'. As part of this project, a working group of international computing education experts and UK computing teachers was set up to develop guidelines for creating culturally relevant computing resources. This document is the result of the working group's discussions. It is designed to be interpreted and adapted by teachers in relation to their own context.

We outline some key elements of a culturally relevant and responsive teaching approach and provide guidelines on how to incorporate them into computing curricula. The guidance also encourages teachers to evaluate existing resources and offers advice on how to adapt lessons to support their own students, along with examples of best practice.

Introduction

What do we mean by 'culture'?

The term 'culture' can be interpreted in many ways, but is often used interchangeably with race or ethnicity. While a person's ethnic background can contribute to their culture, a person's cultural identity can be based on a number of influences. These include their age, their gender, where they live, their family income, and their religious beliefs. These elements all affect a person's knowledge, beliefs, language, and understanding of the world. Ignoring these factors, and attempting to be culturally neutral in education, can create barriers to young people's participation in the education system[1].

In subjects like computer science, these barriers can contribute to the underrepresentation of certain groups in formal qualifications. In England in 2017, Black students made up only 4.2% of GCSE computer science students and 3.3% at A level, despite accounting for more than 5% of the population[2]. Female students in the same cohort represented only 20% of GCSE computer science students and 10% at A level. When considering multiple interacting characteristics, Kemp and colleagues identified that learners from lower-income families were less likely to study GCSE computer science than their more affluent peers, although this pattern was reversed for White girls[3].

Understanding your own communities is key to the delivery of meaningful resources for your learners. Some areas of the UK are more ethnically diverse than others. For example, in London's population, 45% of people identify as White British, 13% as Black, and 18.5% as Asian. In the more rural South West of England, 92% of people identify as White British, 1% as Black, and 2% as Asian[4]. Some areas of the UK are more affluent than others; in these areas, learners are more likely to be exposed to computing outside of school, for example at a technology hub.

> In England in 2017, **Black students** made up only **4.2%** of GCSE computer science students

It is also vital to recognise the significance of youth culture on your learners' identities. There will be opportunities in school to reflect aspects of youth culture, including social media, games, music, films, or TV programmes. But it is also important to address social issues of particular significance to this generation, such as climate change or social justice for marginalised groups. Some teachers may be worried that because youth culture changes so quickly, they cannot keep up to date. This perspective offers an ideal opportunity to allow learners to be the experts, and to show them that you value their understanding of the world. It will also make the learning experience more relevant and meaningful for your learners.
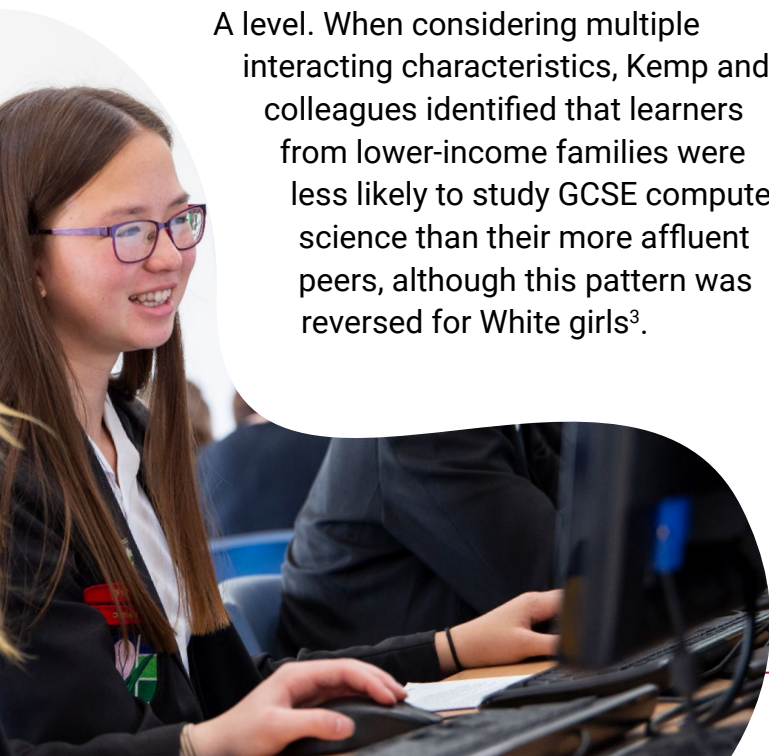
Box #1
Reflection

Take some time to think about your own identity. Consider the following questions:

- ► **How much does your ethnicity and/or religious beliefs influence your cultural identity?**

- ► **Has this changed since you were at school?**

- ► **When you were growing up, did you feel like you were part of your local community?**

- ► **Did you feel different from your peers or did you feel like you fit in?**

- ► **What are your interests outside of work?**

- ► **Do you belong to any groups or clubs that contribute to your sense of identity?**

- ► **Do your music preferences reflect a particular era or group of people?**

- ► **How have these preferences influenced your identity?**

All of these aspects of your lived experience can affect your feelings of belonging to different groups. It is important to remember that your learners' identities are equally multifaceted and that you cannot make assumptions about them based on one characteristic.

Culturally relevant pedagogy and culturally responsive teaching

Culturally relevant pedagogy[5] is a framework for teaching that emphasises the importance of incorporating and valuing all learners' knowledge, ways of learning, and heritage. It promotes the development of learners' critical consciousness of the world and encourages them to ask questions about ethics, power, privilege, and social justice. Culturally relevant pedagogy emphasises opportunities to address issues that are important to learners and their communities.
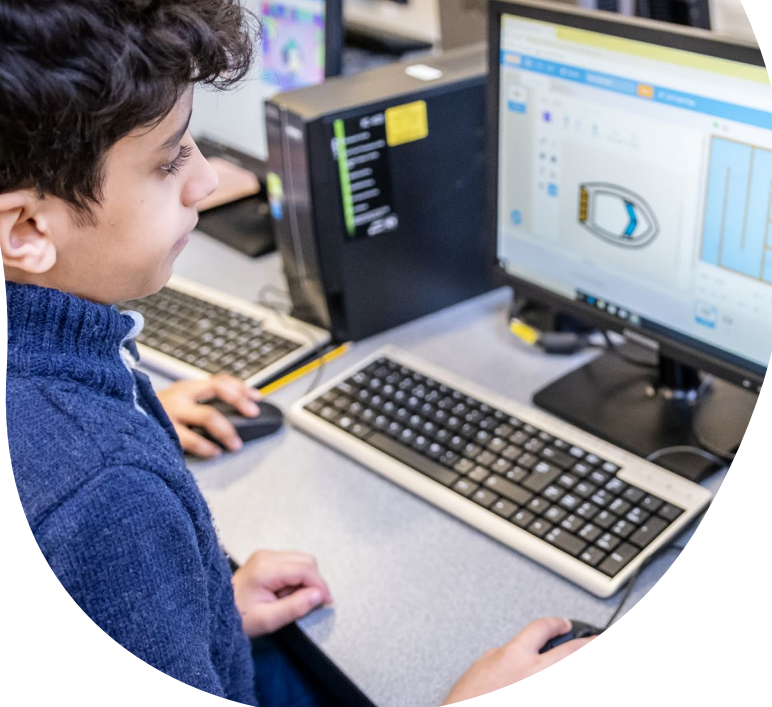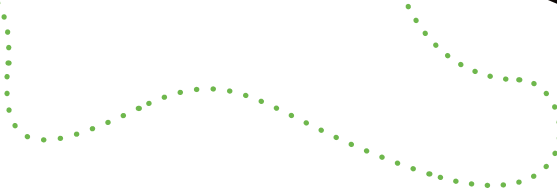
Culturally responsive teaching[6] builds on the framework above to identify a range of teaching practices that can be implemented in the classroom. These include:

▶ Drawing on learners' cultural knowledge and experiences to inform the curriculum

▶ Providing opportunities for learners to choose personally meaningful projects and to express their own cultural identities

▶ Exploring issues of social justice and bias

The key elements of the two approaches are covered in Box 2. This YouTube video also has a short introduction to culturally relevant pedagogy. You can request schemes of work that draw on culturally relevant pedagogy for K-12 students in the United States through the Exploring Computer Science and Scratch Encore curricula. These websites have lots of ideas and resources for lessons, which include creating cornrow curves for hair braids and an internet scavenger hunt.

Box #2

Key tenet	Culturally relevant pedagogy	Culturally responsive teaching
Student academic success	Teachers attend to learners' academic needs	Model high expectations for all learners
Cultural competence	Learners maintain cultural integrity as well as academic excellence Learners' culture is used as a vehicle for learning	Draw on learners' culture to shape curriculum and instruction Promote respect for learner differences Communicate in linguistically and culturally responsive ways Reflect on one's cultural lens Collaborate with families and the local community
Critical consciousness	Learners develop a broader sociopolitical consciousness that allows them to critique cultural norms and values that produce and maintain social inequities	Recognise and redress bias in the system Bring real-world issues into the classroom

Adapted from Hanover Research[7].

The rest of this document offers guidance to help you develop culturally relevant and responsive pedagogy:

▶ Through your curriculum

▶ In your teaching approaches

▶ In the learning materials you use or develop

Some examples from the [Teach Computing Curriculum](#) in England are also provided. Wider issues around school support, professional development, and policy are discussed in the section 'Beyond the computing classroom' on page 15.

Box #3
Glossary

Term	Definition
Culture	A person's knowledge, beliefs, and understanding of the world. It is affected by multiple personal characteristics, as well as social and economic factors.
Culturally relevant pedagogy	A framework for teaching that emphasises the importance of incorporating and valuing all learners' knowledge, ways of learning, and heritage. Promotes critical consciousness in teachers and learners.
Culturally responsive teaching	A range of teaching practices that draw on learners' personal experiences and cultural identities to make learning more relevant to them. Supports the development of critical consciousness in teachers and learners.
Intersectionality	The recognition that each person is made up of many identities in relation to gender, ethnicity, social/economic background, etc. People may be marginalised on the basis of one or more of these identities, and the effects of identifying with more than one characteristic may be multiplicative rather than additive.
Social justice	The extent to which all members of society have a fair and equal chance to participate in all aspects of social life, develop to their full potential, contribute to society, and be treated as equals.
Equity	The extent to which different groups in society have access to particular activities or resources. To ensure that opportunities for access and participation are equal across different groups.

Preparing and delivering culturally relevant and responsive computing resources

Learning materials

Teaching approaches

Curriculum

There are a number of things to consider to make sure that your computing resources are culturally relevant and responsive. The tree analogy illustrates that some considerations are more obvious than others. For example, applying this approach to the pictures or cultural examples used in learning materials may be more obvious than linking cultural responsiveness to how you teach and to the curriculum. Scrutinising these elements reveals that they can unintentionally be biased towards the dominant culture, even when trying to be culturally neutral.

As a teacher, keep these considerations in mind when you plan your lessons. While planning, you might think about the curriculum, followed by the teaching approaches, and then the actual learning materials you use. A culturally relevant and responsive approach involves the same process.

The guidelines below offer suggestions to help you use this culturally responsive approach in your own teaching. The suggestions are not intended to be a checklist of actions, but can be used as a starting point to reflect on your own computing teaching. You may not be able to address each issue in every lesson. However, taking them into account across topics will help to diversify your curriculum, promote understanding and interrogation of cultural bias in computing, and engage more young people from a range of backgrounds in computing.

Curriculum

While planning culturally responsive units of work, it is vital to embed computing in its wider context. You should make connections to other parts of your learners' lives and to what they are learning in other subjects. The teaching materials you use should also consider the diverse experiences and community backgrounds of learners, and how they can be used to give examples of computing concepts.

Contextualise

▶ How are computing topics discussed in relation to their social/historical/political context? For example, can you link the topic to pioneers of computing who have contributed to its development, or to current social justice issues?

▶ How can you relate the content of the lesson to youth or popular culture to make it more meaningful to your learners?

▶ Are there any social/cultural ideas in arts, stories, music, etc. that could be expressed computationally?

▶ How can you cover ethical issues in computing topics to promote curiosity in your learners?

▶ To what extent are there any specific issues in your local community that you could use to give real-world context to classroom computing concepts?

▶ How could you provide opportunities for learners to understand that the skills they are learning will prepare them for a range of different careers?

▶ How have you thought about your own learners and their perspectives on computing topics? For example, you could provide a range of cultural perspectives.

Box #4

Tip: Try to set computing within a wider context, such as climate change, conflict minerals, or the algorithm bias related to GCSE and A level results during the pandemic.

Examples from the Teach Computing Curriculum

Year 3 Computing systems and networks: The internet – Understand the issue of 'fake news'

Year 9 Data science – Use data to investigate problems in the local area

KS4 Impacts of technology – Identify different types of impact on a range of stakeholders

Make connections

▶ Can you make cross-curricular connections between computing and other subjects? You could use examples from history, geography, or English, or could conduct joint projects with these subjects.

▶ How could you use specific times in the school calendar (Black History Month, Ada Lovelace Day, EU Code Week, Internet Safety Day) to support your culturally responsive pedagogy?

▶ Are there opportunities to embed culturally responsive pedagogy within a whole-school approach to teaching?

▶ Can you show how computational thinking approaches have been used to solve problems? For example, could you

investigate culturally situated design tools (CSDTs) or e-textiles to teach computing?

▶ Are there opportunities to socially connect with others through computing? This could be through recreational pursuits, visits from experts, or off-site visits.

▶ How can learners make connections with local people or businesses to increase the personal relevance of computing projects?

▶ Can you identify any companies in your local area to help deliver professional computing experiences for your learners?

▶ Have you considered how to encourage parental or family involvement in your lessons to demonstrate different skills and types of knowledge?

▶ Are you able to offer opportunities to connect the computing curriculum to ethical and social justice issues or important news stories? For example, linking to data bias and the impact this can have on individuals from non-dominant cultures or backgrounds.

Teaching approaches

Once you have planned your curriculum, you need to consider the teaching strategies you will use to promote culturally relevant and responsive computing. You should consider the perspectives of your learners and support them to understand multiple perspectives and ways of working in computing. Providing room for discussion and the sharing of experiences will promote a positive and culturally responsive environment for learning.

Make the content accessible and relevant for all learners to help them to express their own cultures and identities

▶ Have you considered using a clear and repetitive structure that allows individuals with English as an additional language to access the content more easily?

▶ How are scaffolded learning opportunities used in lessons for all learners to achieve the same goal, irrespective of previous experience with computing?

▶ Will learners have the opportunity to identify issues or types of tasks that are personally meaningful to them or their culture/community?

▶ Can you use videos, news articles, or social media posts to bring global and local perspectives to your discussions?

▶ Have you considered industry perspectives and provided opportunities to hear from a variety of people working in industry or a variety of other careers?

Box #5

Tip: Show diverse role models working in tech and emphasise the range of careers that use computer science. Links with industry experts can also be set up with the help of organisations like Founders4Schools.

Examples from the Teach Computing Curriculum

Year 4 Audio editing – Produce a podcast on own choice of topic

Year 7 Programming essentials in Scratch (part 2) – Create a language translation quiz using questions and choice of language

Year 7 Using media – Pick a cause that is important to them and create a blog post

Provide opportunities for learners to participate in open-ended, inquiry-led, or problem-solving activities

▶ How have you encouraged learners to consider multiple perspectives when identifying a problem to be addressed through technology? You could talk to your learners about carrying out user research or actively thinking about the end user of the solution to the problem they are solving.

▶ How have you encouraged learners to consider multiple perspectives when solving a problem? This can be achieved by sharing their code or projects with the class to show alternative methods for achieving the same end point.

▶ How have you provided opportunities for learners to share their own knowledge, experiences, and technological and problem-solving skills? This may be during idea generation or when designing the end product of the task.

▶ Can you encourage learners to celebrate the mistakes they have made during tasks and reflect on what they have learned with others? You could offer a 'debugging' or 'problem-solving' session within a lesson or during a topic.

▶ Can you find opportunities for learners to engage in participatory data collection, so that they understand the challenges, decisions, and meaning associated with data?

Promote collaboration and structured group discussion

▶ Are there opportunities to discuss computing-related issues concerning ethics, equity, diversity and inclusion, and social justice? Are they embedded into the curriculum?

▶ Have you considered a variety of structured formats for discussion, and how to set ground rules to make sure that they are culturally inclusive and allow multiple perspectives to be heard? You may wish to promote:

- Turn-taking
- Multiple roles (leading discussion, note taking)
- Listening to others' perspectives without dismissing their views

▶ How have you thought about using structured discussion for formative assessment? For example, to check understanding of concepts or identify misconceptions?
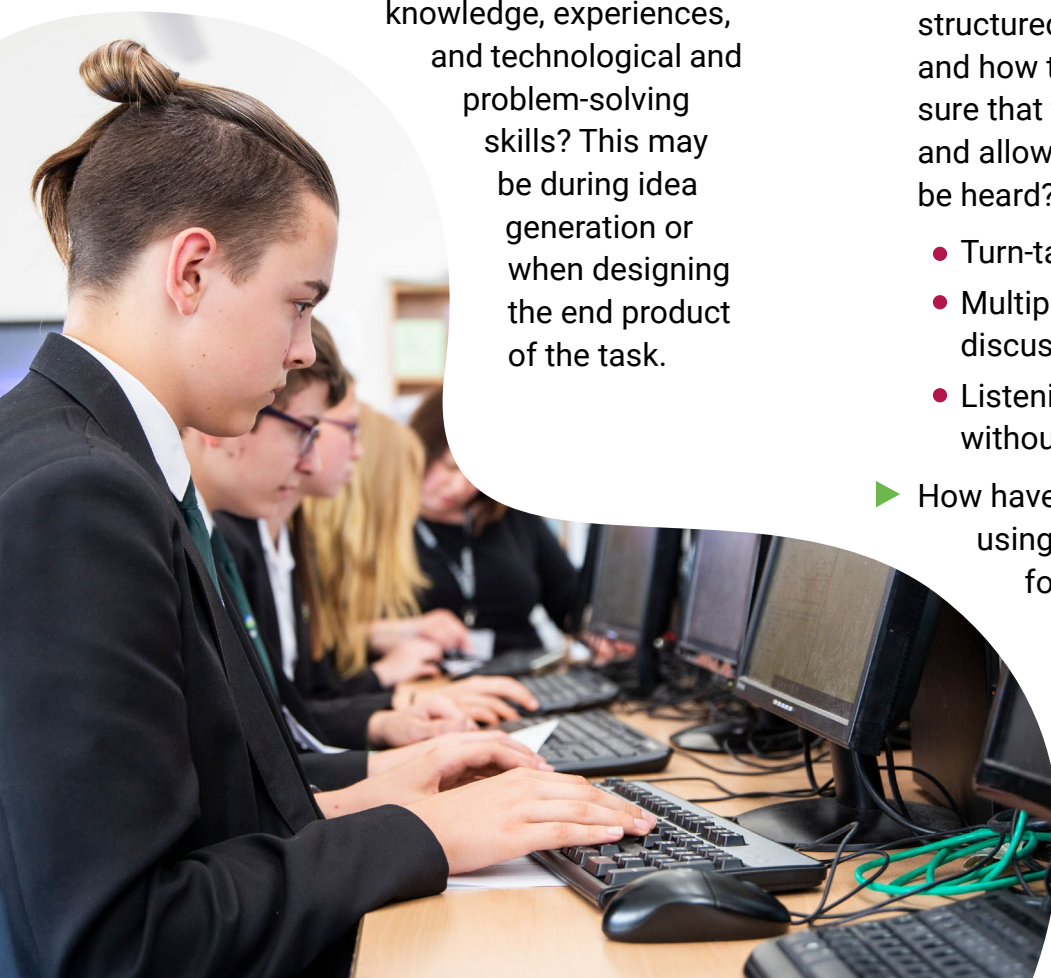
► How have you provided opportunities for collaboration that reflects industry practice? Examples of industry practice include Pair Programming and project teamwork.

Learning materials

When thinking about learning materials for teaching culturally relevant and responsive computing, it is important to be aware of the terminology and visual content that you use. As an educator, you can update resources to include diverse examples or remove inappropriate language or images, to make sure that all learners can access and feel represented in your lessons.

Accessibility

Language

► Is the language simple and easy to understand for those who speak English as an additional language?

► Is it possible to translate the instructions or media into other languages, or to use some key symbols that represent particular activities?

► Is the interpretation of the words you use dependent on a learner's culture?

► Have you made sure that any abbreviations, jargon, or technical terms can be understood by all learners?

Box #6

Tip: Consider a range of perspectives about technology use and development.

Examples from the Teach Computing Curriculum

Year 6 Creating media: Web page creation – Design a web page with consideration of the user journey and needs

Year 8 Mobile app development – Identify a problem to be solved with an app and consider different user needs

Images and video

► Do the videos or images have captions that could be translated into multiple languages, and are transcripts available for the videos?

► Is the interpretation of images or symbols dependent on a learner's culture? For example, the colour red has lots of meanings in the world, in Western culture it tends to mean 'stop', while it is considered lucky in Chinese cultures.

Examples

▶ Do the examples used in the learning materials draw on a range of cultural contexts?

▶ Do the learning materials provide multiple perspectives on any social/political/ethical issues presented, including people within different cultural groups? For example, are there opportunities to consider the impact of family income or region on how Black learners, or female learners, perceive local social injustice?

Box #7

Tip: Investigate pre-existing curricula that focus on culturally relevant and responsive pedagogy in the United States.

Exploring Computer Science curriculum – A curriculum for secondary school pupils incorporating the three strands of CS concepts, inquiry, and equity through every lesson.

CS CONCEPTS
INQUIRY
EQUITY

Scratch Encore curriculum – A curriculum for intermediate to advanced levels of programming in primary school or early secondary school. Learners can work through the same types of tasks and concepts through different cultural strands: multicultural, youth culture, and gaming.
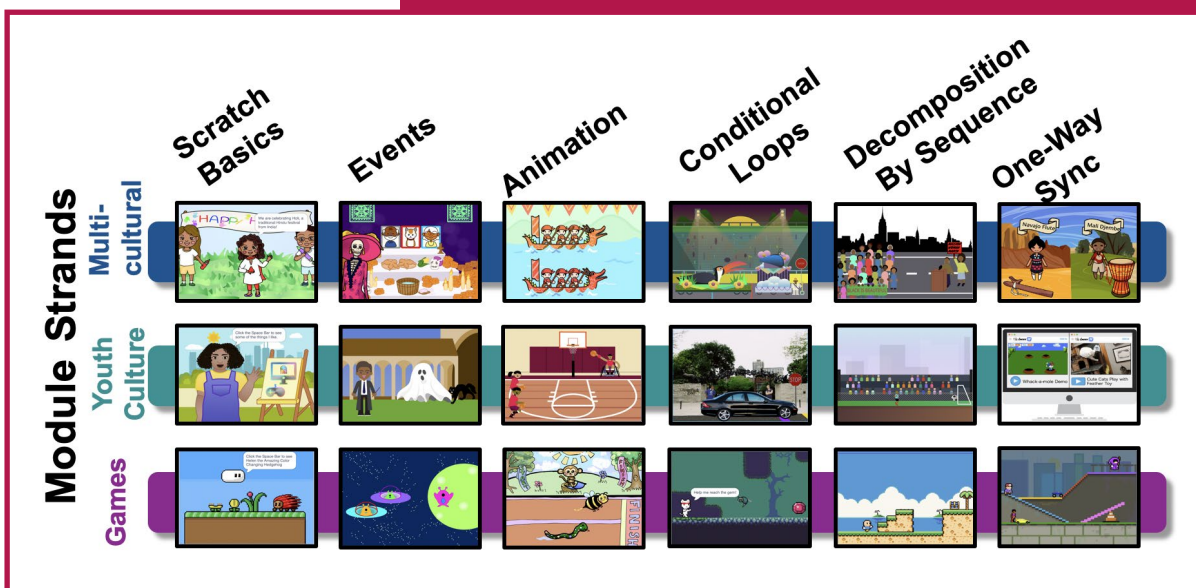
Module Strands

	Scratch Basics	Events	Animation	Conditional Loops	Decomposition By Sequence	One-Way Sync
Multicultural						
Youth Culture						
Games						

Figure reproduced with authors' permission[8].

Beyond the computing classroom

There may be factors that are not within teachers' control or exist beyond the classroom. These are not included as guidelines for teachers or resource developers, but they need to be acknowledged and understood.

Flexibility in the curriculum

The curriculum for computing may not be under a teacher's control. It may be a national or local authority curriculum, or a school may have adopted particular schemes of work for teachers to follow. This can create challenges for a teacher wishing to embed a culturally responsive approach in their teaching.

We hope that many of the guidelines can be implemented at the point of curriculum delivery; you could choose culturally relevant examples or case studies to illustrate a teaching point. If not, we hope that this document and the signposted resources provide a starting point for schools to review their computing curricula. You could engage learners, or a group of digital leaders, to suggest topics and activities that are representative of a range of cultural experiences. This type of approach is an excellent example of capturing the student voice and implementing their ideas, which can aid learner engagement.

Professional development

Professional development opportunities help embed culturally relevant and responsive teaching. Teachers may feel unprepared for discussions around culture and its relevance to computing, and would welcome support in this area. We believe that these opportunities should be widely available and that teachers need time out of class to attend such sessions. This requires support from senior management and prioritisation of the delivery of a culturally relevant and responsive curriculum across all subjects. Some online courses exist for educators that cover an equity-focused teaching approach, but none (to our knowledge) specifically relate to computing.

Advocacy for culturally relevant pedagogy

To promote equity in computing education, and to challenge the societal stereotypes of computing, we all need to be advocates for a broader computing perspective. This goes beyond including appropriate images and language, and beyond attention to visual stereotypes. Computing is an exciting and dynamic subject, and being skilled in it enables young people to ask questions about ethics, power, privilege, the distribution of resources, and the impact of computing on their communities and the world. In these guidelines, we have shown how we can use examples that focus on social justice and the issues that matter to the lives of young people. You could also challenge unhelpful views of computing when you encounter them and collaborate with other computing teachers to advocate for more culturally responsive teaching.

> Computing is an **exciting** and dynamic subject, and being skilled in it enables young people to ask questions about **ethics, power, privilege,** the distribution of resources, and the **impact of computing on their communities** and the world

Beyond computing, learners are required to study aspects of citizenship in some form in England, and equivalent topics in other areas of the UK and beyond. This offers an opportunity to engage learners in debates around the way their data is collected and used. Issues such as algorithmic bias, facial recognition, and digital identity are all pertinent to young people and demonstrate where computing and technology impact on society in potentially negative ways. Computing teachers have an important role in supporting these areas of the citizenship curriculum.

Further reading and resources

Books

Stuck in the Shallow End: Education, Race and Computing by Jane Margolis et al.

Culturally Responsive Teaching and the Brain: Promoting Authentic Engagement and Rigor Among Culturally and Linguistically Diverse Students by Zaretta Hammond

Algorithms of Oppression and *The Intersectional Internet* by Safiya Noble

Papers and reports around equity, diversity, and inclusion in computing education

Reflections of a Diversity, Equity, and Inclusion Working Group based on Data from a National CS Education Program (Ibe et al., 2018)

Cultivating Interest and Competencies in Computing (National Academies of Sciences, Engineering, and Medicine, 2021)

Rac(e)ing to computer science for all: how teachers talk and learn about equity in professional development (Goode et al., 2020)

Engaging equity pedagogies in CS learning environments (Madkins, Howard & Freed, 2020)

Culturally Situated Design Tools: Ethnocomputing from Field Site to Classroom (Eglash et al., 2006)

Ethnocomputing with Electronic Textiles: Culturally Responsive Open Design to Broaden Participation in Computing in American Indian Youth and Communities (Kafai et al., 2014)

Computing for all?: Examining critical biases in computational tools for learning (Litts et al., 2020)

Female performance and participation in computer science: a national picture (Kemp, Wong & Berry, 2019)

COMPUGIRLS' Standpoint: Culturally Responsive Computing and Its Effect on Girls of Color (Scott & White, 2013)

Computational communities: African-American cultural capital in computer science education (Lachney, 2017)

Guides for teachers

Research Brief and Discussion Guide on Culturally Responsive Curriculum (Hanover Research)

Guide to Inclusive Computer Science Education: how educators can encourage and engage all students in computer science (Microsoft and Microsoft Philanthropies TEALS in partnership with the National Center for Women & Information Technology)

Film and video

The danger of a single story, TED talk by Chimamanda Ngozi Adichie

The urgency of intersectionality, TEDWomen talk by Kimberlé Crenshaw

Building Code First: Girls – how we taught 10,000 women how to code, ACM-W UK Inspire 2020 talk by Amali de Alwis

Coded Bias, documentary directed by Shalini Kantayya, which investigates the bias in algorithms after MIT Media Lab researcher Joy Buolamwini uncovered flaws in facial recognition technology

Websites

Exploring Computer Science
Culturally Situated Design Tools

Professional development

Anti-racism journey for educators with students

Being an equitable educator (EdX course)

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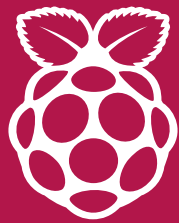
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