Engaging primary (K-5) computing teachers in culturally relevant pedagogy through professional development

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ABSTRACT

Countries are increasingly introducing Computer Science (CS) as a mandatory subject, but access does not ensure that all students are included and can succeed. Culturally Relevant Pedagogy (CRP) is a theoretical framework that aims to make learning more equitable. It encourages the incorporation of learners' cultures and experiences and emphasises the development of learners' critical consciousness to equip them to address societal inequities.

Research in the UK has started to localise CRP theory and practice in CS classrooms and has highlighted the need to overcome bias in lesson resources. To address this, we have conducted a pilot study with 13 primary teachers, co-creating culturally adapted CS resources for their classrooms. This paper describes the first step of the resource adaptation study, a teacher professional development (PD) workshop, and reports on how attendance affected participants' confidence, attitudes, and perceptions of CRP for CS. We also introduce a knowledge appropriation model to reflect on teachers' experiences of learning about and implementing CRP in their computing lessons.

After the PD, participants reported statistically significant improvements in their confidence in adapting computing resources to be culturally relevant for themselves and others. Qualitative responses identified important first steps in knowledge appropriation in terms of raised awareness and increased understanding of CRP in CS. The PD resources presented can be reviewed and built upon by other researchers to investigate whether CRP can be introduced to teachers in other contexts and outcomes compared to our findings.

CCS CONCEPTS

• **Social and professional topics → K-12 education**; **Race and ethnicity**.

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computing education, K-12, culturally relevant pedagogy, teachers

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1 INTRODUCTION

In England, there is a mandatory National Curriculum for 5 to 16-year-old children to have computing lessons, although formal computer science examinations are optional beyond the age of 14 [13, 14]. Despite these opportunities, there is an underrepresentation of many groups working in IT, studying computer science (CS) at university, and taking school computing qualifications. For example, a 2021 review of diversity in the UK IT workplace reported that only 19% of IT specialists were females [1]. Similarly, in higher education settings, 2020 UK data shows the ratio of undergraduate females studying CS to males as 1:4.5 [40]. In schools in England, there are fewer females and Black and minority ethnic students taking formal computing qualifications [23, 24].

Schools in England have a statutory requirement to promote diversity, equity and inclusion among pupils [31]. They also teach a set of conceptualised 'British Values', including aspects of democracy, the rule of law, respect and tolerance, and individual liberty [15]. These arebased on the idea of multicultural education, which seeks to celebrate diversity and create positive interactions across differences to promote social harmony [21]. However, a recent survey of 2000 UK teaching staff found only one in three thought that the diversity of pupils and the world around them was reflected in education and 80% said Black, Asian, and minority ethnic groups were not well represented in schools[1].

Work to address barriers experienced by diverse learners in the UK seeks to reform and rebuild the education system so that it supports all students and teachers. Central to this reform is the idea of decolonising the curriculum, which was instigated in higher

[1] https://www.pearson.com/uk/educators/schools/issues/diversity-and-inclusion/diversity-and-inclusion-in-schools-report.html

education [2, 8, 42] and is an emerging theme for school education, including in history [28], science [17] and computing [16]. Despite issues raised to counter decolonisation efforts such as tokenism [29], decolonisation seeks to recognise, interrupt and dismantle existing biases within the education system, thus developing learners' critical consciousness towards social and educational inequity [21].

Culturally Relevant Pedagogy (CRP) is a theoretical framework that emphasises the importance of incorporating learners' cultures and experiences into the curriculum, developing learners' critical consciousness, and providing opportunities for learners to address issues that are personally meaningful [25]. CRP proponents take the position that the education system is not culture-neutral (e.g. [44]) and that learners may underachieve or be marginalised in educational settings due to systemic biases.

To start to address these biases, we undertook a pilot study to investigate how freely-available computing resources could be adapted within a CRP framework. To our knowledge, this is the first study of its kind in England. This paper describes the first stage of the study, which was a one-day in-person workshop with 13 primary school teachers and 5 researchers. Changes made to the computing resources that came about during and after the workshop will be analysed and reported separately; this paper focuses on teacher responses to the workshop, a form of professional development on CRP.

2 BACKGROUND AND LITERATURE

The lack of diversity amongst CS students and, later, employees has led to a range of initiatives to broaden participation and attract groups of individuals who may be underrepresented in the field [39]. However, Yadav and Heath and Shah and Yadav argue that providing access to computing does not address the underlying issues that prevent some groups from engaging with computer science, which are systemic biases within education, in the labour market, and in technology itself [39, 43]. They propose that CS should be taught through a critical, community-focused and justice-oriented lens, allowing students to understand and address biases and promote a more equitable workforce.

These principles are reflected in the recent Culturally-Responsive Sustaining CS Education Framework [22], which is drawn from the broader theoretical frameworks of Culturally Relevant Pedagogy [25], Culturally Responsive Teaching [18] and Culturally Sustaining Pedagogy [32], and on the CS-specific theory of Culturally Responsive Computing [37, 38]. Recent literature reviews highlight that such a culturally relevant approach to CS education is becoming increasingly popular in the US [26, 30]. However, teachers' conceptualisations of CRP vary depending on each teacher's individual context and experiences [11]. Professional development (PD) activities are therefore an important tool to help teachers develop a strong foundational understanding of CRP theory [9, 36] and translate that theory into practice [5]. PD activities also guide teachers in moving from surface-level changes, such as selecting culturally diverse images, to a set of values that are embedded in all teaching and learning [3]. In the US, Goode et al. reported that teachers were more able to challenge the color-blind discourse [20] that was often observed when they were first introduced to CRP in CS. Codding et al. found that teachers went on to include a wide range of culturally responsive practices in their lessons after discursive PD on CRP in CS. In order for teachers to deliver an equity-focused and culturally relevant computing curriculum, it is therefore vital to provide PD in both computing and CRP.

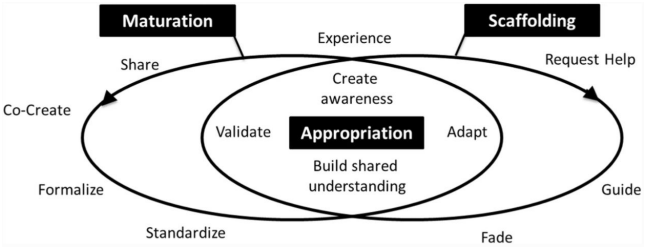

Figure 1: Ley et al.'s Knowledge Appropriation Model [27, p.107]

Recent work has aimed to localise CRP theory and practice in CS education to a UK context, producing guidelines with and for computing teachers [33]. Building on this work, Waite et al. operationalised these guidelines into ten Areas of Opportunity (AOs) to be used by teachers to review their current practice and potentially design or adapt their computing curriculum to be more culturally relevant and responsive (Table 1) [41].

To investigate whether the AOs could be used in a PD activity with primary teachers, we conducted a pilot study comprising a one-day in-person workshop using these AOs as a framework to support teachers to explore computing schemes of work through a culturally relevant lens. Teachers took on the role of re-designers [12] working collaboratively with the researchers to discuss and suggest potential adaptations to be made. In some instances, teachers also took the role of co-designer [12] by designing new resource components with researchers. This process of adaptation and extension aimed to improve teachers' understanding of CRP and their confidence in adapting computing resources for their own contexts, and create a sense of co-ownership toward the materials [12].

For the purposes of this paper, we focus on teachers' reported changes in confidence and attitudes towards CRP, and in their perceptions of the barriers and benefits of CRP in computing through a pre- and post-workshop survey. Specifically, we aimed to address the following research question: RQ1 *''What effect do collaborative professional development activities have on teachers' confidence, attitudes and perceptions of CRP in primary computing lessons?"*

Simply offering PD to teachers does not guarantee practical adoption. Ley et al. [27] have proposed a model of knowledge appropriation (Figure 1), which identifies phases through which a practitioner must pass before new knowledge is fully taken in and embedded in their practice. These phases include creating awareness of new knowledge, scaffolding, and gradual maturation of new or adapted practices, resulting in formalised and standardised changes [27]. This model has been used successfully to work collaboratively with teachers to co-design and introduce tools in educational settings [35], and we apply it here to reflect on the contribution of the PD workshop to teachers' knowledge appropriation regarding CRP in CS. This forms the basis of our second research question: RQ2 *"To what extent do teachers start to appropriate knowledge through*

Table 1: The ten Areas of Opportunity (AOs) for reviewing, creating and adapting computing lessons [41]

#	AOs	Description
1	Learners	Find out about learners in order to reveal opportunities to adapt our teaching
2	Teachers	Find out about ourselves as practitioners to reflect on one's cultural lens
3	Content	Review what is taught in terms of the content; add in extra culturally relevant content (e.g., about social justice/ethics, data bias accessibility, user aspects etc.)
4	Context	Review contexts and examples used – to make teaching relevant, meaningful, to contextualise and make connections
5	Accessibility	Make the content accessible and relevant for all learners
6	Activity	Provide opportunities for learners to participate in open-ended, inquiry led, or problem-solving activities
7	Collaboration	Develop student oriented learning through collaboration and structured group discussion
8	Student Agency	Develop student oriented learning through student choice
9	Materials	Review the learning environment (including learning materials) – to increase accessibility, a sense of belonging and promote respect
10	Policy	Review related policies, process and training in your school and department

collaborative professional development activities on CRP in primary computing lessons?"

3 METHODS

The focus of the current paper is a one-day PD workshop conducted in person with 13 primary school teachers in November 2022. Ethical approval was obtained to conduct the workshop and to collect and analyse quantitative and qualitative data through pre- and post-workshop surveys, which are reported here. The research was conducted in line with the guidelines set out by the British Educational Research Association (BERA) [4].

3.1 Participants

Convenience sampling was used to create a pool of teachers interested in the research, recruiting through blogs and social media. Teachers were eligible to participate if they taught computing to Year 4 and/or Year 5, had access to computers or laptops in the Spring Term, could attend a face-to-face workshop at the beginning of the project in the Autumn Term, had consent from their Headteacher to participate. Selecting Year 4 and/or Year 5 teachers related to the resources chosen for adaptation. (Section 3.2.1). Initially, 15 teachers from 13 schools were sampled, but 2 teachers were excluded for not fulfilling all the requirements of the study. The final sample consisted of 10 females (77%) and 3 males (23%), aged as follows: 1 participant between 18-24, 4 between 25-34, 4 between 35-44, and 2 between 45-54. Participants reported their ethnicity as follows: 9 White, 2 Asian or Asian British, 1 Other ethnic group (Arab). Five participants were specialist primary computing teachers, while the remaining 8 were class teachers of whom 6 were the computing lead or coordinator for their school. The 12 schools in which the participants taught were in mainly urban settings, with 1 rural school. Five were based in London, 4 in the South East, 2 in the East of England and 1 in the North West of England.

3.2 Materials and Procedure

3.2.1 The workshop. The one-day workshop was designed so that participants could attend in person to learn more about CRP and the research project, as well as begin the co-construction process for the adapted resources. Participants' travel and accommodation costs were reimbursed and schools were able to claim for the costs of supply cover while the teacher was attending the workshop.

Before the workshop, participants were asked to complete tasks to help them begin to think about some key aspects of CRP: a pre-workshop survey (Section 3.2.2), a guided reflection on their own cultural identity, and an activity reflecting on and writing their own definitions of the word 'culture'. The latter two activities were not used for data collection purposes but formed the basis of a group discussion to come to a shared understanding of the terms 'culture' and 'cultural identity', which are central to CRP. All surveys, template reflection booklets and other workshop materials are available on the project website [34].

The first 90 minutes of the workshop focused on group discussions concerning culture and identity, and the introduction of CRP. Teachers shared information on their own practice and school contexts. An important part of this session was providing space for participants to speak about their own experiences, and to address potentially sensitive or difficult topics so that they felt more confident to express their views and work in a group (e.g. [19, 20]). At the end of the session, participants were encouraged to write reflections on what they learned, their feelings, and plans for their own practice.

The rest of the workshop was focused on the more practical task of examining the units of work and working in groups to consider how the lessons could be adapted within the framework of CRP. A pair of six-week units of work were selected to be adapted with the teachers from an existing large-scale national curriculum resource[2]. The selection was based on the following criteria:

(1) lessons would usually be taught in the term that the study would be taking place (i.e. Term 3 or 4)
(2) lessons did not require any special additional hardware or specialist software
(3) lessons did not include programming as this may require more experienced teachers and would add a further dimension of complexity to the study
(4) during a walkthrough of potential resources, the research team noted that artwork elements could be adapted to a variety of contexts

[2] https://teachcomputing.org/curriculum

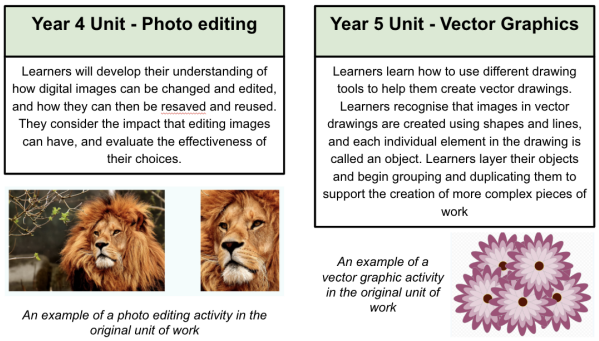

Figure 2: A summary of the two units of work that were selected to be adapted

Based on these criteria, a Year 4 unit on photo editing and a Year 5 unit about vector graphics were chosen for the study. A summary of the content is shown in Figure 2.

The research team introduced the two units of work to be adapted, along with the ten Areas of Opportunity (AOs) (Table 1) to be used to prompt potential adaptations to the resources. Participants worked on one of the two units and were grouped based on the year groups they regularly taught. They formed four workshop groups: two Year 4 groups and two Year 5 groups, each with a researcher to support the discussions, take notes where necessary, and to answer questions as they arose. For each AO in turn, the groups examined the lesson plans and associated resources for their unit and identified where they could adapt activities. Suggestions were recorded in booklets provided for this purpose, and each group presented the main ideas and adaptations for their unit of work to the other participants. At the end of the workshop, participants were given another chance to write in their reflective diary about the day and were asked to complete the post-workshop survey.

3.2.2 The pre- and post-workshop surveys. The pre- and post- workshop surveys consisted of closed and open-ended questions to investigate participants' experience, knowledge and perceptions of CRP and their own practice before and after attending the workshop.

Two closed questions asked about participants' confidence in designing computing resources for themselves (Question 1) and others (Question 2), and two about adapting computing resources to be culturally relevant for themselves (Question 3) and others (Question 4) (Table 2). Answers were scored on a 5-point Likert scale (1 = Not at all confident, 2 = A little confident, 3 = Quite confident, 4 = Very confident, 5 = Extremely confident), with an additional option of "I don't do this". Eight statements about attitudes towards CRP in computing lessons were presented (Table 3) based on a scale adapted from Goode et al. [19], and responses from a 5-point Likert scale could be selected (1 = Strongly disagree, 2 = Slightly disagree, 3 = Neither agree nor disagree, 4 = Slightly agree, 5 = Strongly agree). Questions on confidence and attitudes were repeated across surveys and were analysed using non-parametric within-subjects statistical tests to assess change over the course of the workshop. For the Likert scale questions, due to the small sample size and non-normal distribution of the data, non-parametric Wilcoxon signed-rank tests were applied to compare pre- and post-workshop responses to the confidence and attitudes questions. Bonferroni corrections were applied in each case to account for multiple comparisons (p=.0125 and p=.006 for confidence and attitudes comparisons, respectively).

Two open-ended questions were asked in the post-workshop survey on teachers' changes in views as a result of the workshop on the benefits and barriers to using CRP in computing lessons. Two researchers met to discuss responses and categorise the comments collaboratively by analysing their latent meaning using an interpretivist approach [7]. From these categories, a set of emerging themes were agreed.

4 RESULTS

4.1 Confidence and attitudes data

Confidence question data are presented in Table 2. Before the workshop, 31% (n=4) of the 13 teachers reported being very confident or extremely confident in adapting resources to make them culturally relevant for their own use, rising to 62% (n=8) after the workshop; this was a statistically significant increase in confidence (Mdn_{pre}=2, Mdn_{post}=4; z=-2.88, p=.004, r=.1). Similarly, teachers' confidence to adapt resources to be more culturally relevant for others to use also significantly increased (Mdn_{pre}=2, Mdn_{post}=4; z=-2.64, p=.008, r=.1); only one teacher was at least very confident to do this before the workshop, but this rose to five teachers after the workshop.

Participants reported quite high levels of pre-workshop confidence in designing general computing resources for themselves, with 54% (n=7) being at least very confident to do this; although this rose to 77% (n=10) after the workshop, this was not a statistically significant increase. Participants' reported confidence in designing general computing resources for others was somewhat lower, with only 23% (n=3) being very confident or extremely confident to do this; although this rose to 54% (n=7) after the workshop, this was not a statistically significant increase in scores.

Participants were asked to rate their agreement with eight statements related to CRP that were adapted from prior work by Goode et al. [19]. The data are presented in Table 3 with the items producing the largest changes in scores presented first. No teacher reported they disagreed with any of the statements before or after the workshop. After the workshop,more teachers reported strong agreement with the statements for all but one item (item 6) than in the pre-workshop survey. For example, with respect to statement 1 about the importance of self-reflection, 38% of teachers strongly agreed with this before the workshop, but this rose to 92% afterward (Table 3). Despite noticeable increases in strong agreement for statements 1,2, 3, 7 and 8, there were no statistically significant changes detected once analyses were corrected for multiple comparisons.

4.2 Perceptions of CRP

Ten participants answered the open-ended question on how their perceptions of the benefits of CRP had changed as a result of the workshop (average response length = 26 words), and nine answered the related question on barriers (average response length = 22 words). From these answers, four emerging themes arose: teachers' increased understanding of CRP, benefits to learners, reflections on translating learning to own practice and the role of peer discussion.

4.2.1 Teachers' increased understanding of CRP. Teachers were able to articulate ways in which they better understood CRP. For

Table 2: Teachers' reported confidence to design or adapt computing resources to be culturally relevant before (pre) and after (post) the workshop. The pre and post % and number (n) of respondents for each scale is shown and is ordered by the change in confidence p-value from a Wilcoxon-signed rank test (*Significant change at p=.0125 (corrected), effect size 0.1 (small))

Ques-tion	For computing resources what is your confidence to	Pre %(n) Not at all	A little	Quite	Very	Extremely	Post %(n) Not at all	A little	Quite	Very	Extremely	Exact p	Change
3	adapt for CRP for yourself	8% (1)	46% (6)	15% (2)	23% (3)	8% (1)	0% (0)	0% (0)	38% (5)	31% (4)	31% (4)	**.004***	↑ 10 ↓ 0 = 3
4	adapt for CRP for others	23% (3)	31% (4)	38% (5)	0% (0)	8% (1)	0% (0)	15% (2)	46% (6)	15% (2)	23% (3)	**.008***	↑ 8 ↓ 0 = 5
2	design in general for others	8% (1)	38% (5)	31% (4)	15% (2)	8% (1)	0% (0)	8% (1)	38% (5)	31% (4)	23% (3)	.018	↑ 8 ↓ 1 = 4
1	design in general for yourself	0% (0)	23% (3)	23% (3)	23% (3)	31% (4)	0% (0)	0% (0)	23% (3)	31% (4)	46% (6)	.084	↑ 6 ↓ 2 = 5

Table 3: Teachers' reported attitudes towards culturally relevant pedagogy in computing statements before (pre) and after (post) the workshop, ordered by the change in attitude p-value from a Wilcoxon-signed ranks test

Culturally relevant pedagogy in computing statements	Pre %(n) Neutral	Slightly agree	Strongly agree	Post %(n) Slightly agree	Strongly agree	Exact p	Change
1. An important part of being a computing teacher is examining one's own attitudes and beliefs about class, race, gender, disabilities, and sexual orientation.	15% (2)	46% (6)	38% (5)	8% (1)	92% (12)	.014	↑7 ↓ 0 =6
3.Part of the responsibility of the computing teacher is to challenge teaching practices that maintain societal inequities.	8% (1)	38% (5)	54% (7)	0% (0)	100% (13)	.020	↑6 ↓ 0 =7
7. It is important to allow student choice when designing computing activities.	23% (4)	46% (6)	31% (4)	31% (4)	69% (9)	.046	↑6 ↓ 1 =6
2. Issues related to racism, sexism, and other inequities should be openly discussed in computing classrooms.	8% (1)	54% (7)	38% (5)	23% (3)	77% (10)	.058	↑6 ↓ 1 =6
8. Part of the responsibility of computing teachers is to make sure school policies and processes include opportunities for culturally relevant pedagogy.	0%(0)	38% (5)	62% (8)	15% (2)	85% (11)	.180	↑4 ↓ 1 =8
5. Connecting my students' prior knowledge with computing concepts will lead to deeper learning.	0%(0)	8% (1)	92%(12)	15% (2)	85% (11)	.317	↑0 ↓ 1 =12
6. Incorporating a variety of teaching methods in computing will help my students be successful.	0%(0)	0%(0)	100% (13)	8% (1)	92% (12)	.317	↑0 ↓ 1 =12
4.Good computing teaching incorporates diverse cultures and experiences into classroom lessons and discussions.	0%(0)	15% (2)	85% (11)	8% (1)	92% (12)	.564	↑2 ↓ 1 =10

example, one teacher stated that they *"feel more confident at understanding what it actually means to me"* (Teacher 203) and another explained that *"I believe it can be really beneficial and can be appropriate in all different schools"* (Teacher 302).

4.2.2 Benefits to learners. Teachers identified a number of ways that they thought using culturally relevant resources would benefit their learners. One teacher suggested that CRP could help make resources more accessible for learners by pre-teaching technical vocabulary and linked this to engagement and achievement. *"The workshop has developed my understanding of how culturally adapted resources can support pupil progress and engagement. It has also highlighted how contextual appropriateness of resources can help children to access resources"* (Teacher 204). Another teacher adapted an activity so that learners could create images that represented themselves and explained the importance of allowing learners to *"...demonstrate their cultural interests and backgrounds - allowing them to control and produce an output which matches their own idea of identity - in the many forms that may take"* (Teacher 101).

4.2.3 Reflections on translating learning to own practice. Some teachers expressed enthusiasm about applying their CRP learning to their practice. One teacher said *"I can't wait to take some of the work back and apply it to other areas and subjects I teach"* (Teacher 303). Another teacher recognised that *"there are clearly creative options for building opportunities of this kind within computing"* (Teacher 101). However, another teacher expressed caution about the work needed to overcome barriers to implementing CRP and said that *"we can target the barriers but will perhaps need to do some research ahead of time to get a starting point"* (Teacher 203).

4.2.4 The role of peer discussion. Some teachers highlighted the importance that peer discussion had on developing their understanding of CRP. For example, one teacher said *"based on discussions with other participants, I have come to understand more about how barriers can differ depending on school contexts"* (Teacher 204). Another teacher echoed this saying that *"the dedicated time and value-added from peer discourse helped make this authentic and not just token activities to check a box"* (Teacher 303).

5 DISCUSSION

The first research question in this study aimed to better understand how collaborative professional development (PD) activities affected teachers' confidence, attitudes and perceptions of culturally relevant pedagogy (CRP) in primary computing lessons. Prior

studies have noted the important role that PD plays in developing teachers' understanding of CRP and applying to their own practice [5, 9, 36]. Our study shows a statistically significant increase in teachers' confidence to adapt resources to be culturally relevant for themselves and others after the workshop. As Brown et al. [5] found in STEM subjects, these results suggest that PD activities in CRP give teachers the theoretical and practical tools that they need to apply the principles in their classrooms [6]. The materials used in the workshop, including the slides, survey instruments and booklets are available at [34]. Further research could examine the relationship between practical adaptation activities and teacher confidence levels in greater depth.

Previous research has demonstrated the effect of PD on teachers' attitudes towards CRP [19]. Our attitudinal data findings (Table 3) are consistent with Goode et al.'s results, which found six statistically significant increases in teachers' attitudes towards CRP after PD. Our data were drawn from a smaller sample and the results were not statistically significant; however, the four statements that showed the greatest change between surveys from our findings correspond to four of Goode et al.'s six statistically significant results, with the other two results being US-context specific, namely CS teacher qualifications and course enrollment. In both studies, PD caused teachers to feel more strongly about examining their own attitudes and beliefs, challenging teaching practices that maintain inequities, allowing for student choice when designing computing activities, and openly discussing issues relating to racism, sexism and other inequities. The lack of statistical significance in attitudes towards CRP reported in our findings is likely due to the very positive baseline attitudes reported in the pre-survey; this is perhaps unsurprising given the nature of the study and the fact that teachers volunteered to participate based on their own interest in the topic. Future research may be able to uncover greater variability in attitudes towards CRP and its role in computing using different recruitment methods, perhaps working with multiple teachers in the same school who have different roles and computing expertise.

The second research question examined the extent to which teachers appropriate knowledge of CRP through PD activities in primary computing lessons. Ley et al. [27] argues that knowledge appropriation begins with *creating awareness* of new ideas, solutions or experiences that could be applicable in a relevant situation. It is perhaps salient for researchers that this stage of knowledge appropriation begins at the point of study recruitment when participants begin to form ideas about the benefits of their research participation. In this particular study, further activities to create awareness and scaffold learning included the pre-work (Section 3.2.1) and the 90 minutes of group discussions and learning at the start of the workshop. These activities gave participants the opportunity to *share* their own experiences and working practices, and for those with more experience of CRP to support those with relatively less experience or understanding of the topic.

We noted that, once teachers were aware that CRP could be applied to primary computing lessons, they began to work in groups to *build a shared understanding* of how to apply this knowledge to a set of resources. Through negotiation and discussion, each group explored how their new knowledge could be transferred to *adapt* resources to be more culturally relevant, working together through a process of co-creation to develop ideas. Qualitative feedback (Section 4.2.4) suggests that teachers particularly valued this part of the PD for enabling ideas about authentic implementation of CRP in diverse school contexts. The teachers' qualitative comments (Section 4.2.3) indicated an emerging sense of how they could adapt their new knowledge for use in their own classrooms. Teachers also began to consider under what conditions the application of their new knowledge would be successful.

Considering how these outcomes relate to the Knowledge Appropriation Model [27], there was clearly evidence for the beginning of knowledge scaffolding and maturation processes amongst participants, supported by the researchers and their peers through workshop activities. Teachers appropriated knowledge about CRP in primary CS, but further adaptation and validation will be required in their own schools before they are able to formalise, and potentially standardise, a culturally relevant approach to all computing teaching and not just the project's adapted lessons.

5.1 Limitations

Using a survey meant we were unable to probe for meaning where the sentiment of answers was unclear; interviews or focus groups will be used in future research. The selection of non-programming units of work for the study context will naturally limit generalization. The small sample meant we could not conduct tests of internal consistency on the survey. Participant diversity was limited; the majority of participants were white females. With 23% identifying as male and 23% as an ethnicity other than white, the sample was more diverse than the national average of nursery/primary teachers (at 14.1% and 14.9%, respectively). Nevertheless, incorporating more diverse voices into research will be invaluable in understanding and incorporating different perspectives, experiences and beliefs.

6 CONCLUSION AND NEXT STEPS

The workshop here described is a useful first step in understanding the value of CRP professional development for computing teachers in England. It demonstrates that working collaboratively to co-design and adapt primary computing resources increases teachers' confidence to adapt resources for themselves and others so that they are culturally relevant. This pilot study has also made an important discovery that the outcomes from localising culturally relevant PD in England are aligned with outcomes from similar PD in the US. Further research is required to identify how this PD is applied in the classroom and its longer-term effects on teachers' practice and curriculum development in computing education. The AOs can also be explored with older learners, in other countries, and for curriculum review. Developing a more culturally responsive and relevant approach will be important in allowing a more diverse range of pupils to access, and excel in, computing as a subject.

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