The Influence of Digital Technologies on the Relationship Between Mathematics and Culture

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Abstract

Digital technologies are now an accepted part of many people's everyday life, but there is little research which considers how they affect culture(s), especially non-Western culture(s), and mathematics when integrated into mathematics education. Rather digital technologies tend to be considered benign additions to a teacher's repertoire of teaching resources. In this overview of the articles in this special issue, the supposedly benign benefits of technology are problematised by considering how digital technologies replace, amplify or transform aspects of mathematics and/or culture, which may then reduce or dampened the visibility of other aspects. The findings show that in this small data set research focuses on digital technologies either replacing physical cultural artefacts with digital ones or transforming cultural understandings in new ways. Similarly, this study shows that research focuses on how digital technologies either replace existing ways of presenting mathematics or transform the mathematics being presented. The implications for mathematics education research is that what is valued in particular is the transformative aspect of digital technologies.

Keywords: mathematics education, culture, mathematics, digital technologies, Indigenous

Introduction

In this article, we use the articles in this special issue to discuss the potential roles that digital technologies can have in mediating the relationship between culture and mathematics, to develop our understandings about what is valued in mathematics education research. We are inspired to do this by Valero and Knijnik (2015) who used a Foucaultian notion of governmentality to both consider the political in mathematics education research, specifically to do with the use of ICT in mathematics learning, and as a consequence "how mathematics education fabricates the desired child in contemporary societies" (p. 34). However, rather than focusing on the individual level of the "desired child" as a product of mathematics education research, we consider how a focus on digital technologies in mathematics education research contributes to expectations about culture and mathematics. Therefore, our focus is not on identifying the "desired culture" or the "desired mathematics" but rather the "desired relationship between them" which is reproduced and produced through this research.

In previous research on digital technologies and mathematics education, there has been limited discussion about culture. Therefore, it is important to problematise the various ways

that current research conceives this relationship in the hope that it opens up discussions about (un)desirable effects of such research. However, like Valero and Knijnik (2015), we focus on the ideas in the articles, rather than evaluate the authors as the originators of these ideas but ones who make use of existing discourses to frame their research. It is these discourses which situate the relationship between mathematics and culture in regard to what the research highlights when discussing the use of digital apps in mathematics education. To identify conceptions of this relationship, we use Pea's (1987) idea of cultural amplifiers and Hughes' (2005) ideas of replacement, amplification and transformation.

Cultural and/or Mathematical Replacement, Amplification or Transformation through Digital Technologies

Digital technologies are often considered benign (Selwyn, 2016). If they are discussed in mathematics education, it is their benefits to learning and whether these are achieved which are in focus (Drijvers, 2015). Yet, as Selwyn (2016) stated, "digital technologies are ideological in their nature and effect" (p. 1007). If these ideologies remain unrecognised or unproblematised, then the mathematics learning will be affected because of the impact that these ideologies will have on the mathematics or the cultures in which the learning takes place. For example, AlTarawneh, AlKhoshrman, Nabeel, Humayoun, and Hassanat, (2017) identified some problems of digital apps that were designed to be used by children in developing countries. Although not about mathematics, they described how they involved the children, their parents and teachers into the design of an app which reinforced the traditional values of the south Jordan region where they worked with low socio-economic families. This was considered to be more respectful use of technology for that community than the adoption of apps produced in developed countries. Yet although the role of culture becomes evident in this example, one wonders about the impact of this approach on mathematics if that had been the aim of the app. What kind of mathematics learning opportunities would be made available if

children, parents and teachers were involved in the design and their focus was on making the app culturally relevant?

In a seminal article in 1987, Pea discussed how cognitive technologies, such writing as well as more recent digital technologies, could be considered as cultural amplifiers in that they could push cognitive growth. In his article, Pea discussed how the mediation done by technologies is both informed by culture while also leading to cultural change, "by shaping nature and how our interactions with it are mediated, we change ourselves" (p. 93). Over time, educators change how they interpret the ways digital technologies can be used and reconsider definitions of what can be done with them, which then results in what is done with digital technologies being changed. Understandings about how these changes occur also contribute to the wider possibilities for future changes to be identified. In this way, digital technologies could be considered as amplifying aspects of mathematics, thus changing what can come to be seen as mathematics. Yet in the same way that a focus on culture might have an impact on the mathematics learning opportunities within digital apps, a focus on the mathematics could also have an impact on the mathematics learning opportunities made available if the cultural aspects, connected to expectations about how children learn, are not considered or respected.

Amplification through digital technologies is often contrasted with replacement and transformation, based on the work of Hughes (2005) who identified how literacy teachers used digital technologies after professional development. In mathematics education, Trigueros, Lozano, and Sandoval (2014) used these classifications of replacement, amplification and transformation, to consider how teachers used digital technologies across a set of lessons. In their research, the focus was on the teachers' professional practices and whether the technology merely replaced but did not change existing practices (replacement), or if the affordances of the technology allowed for practices to be done more effectively and efficiently (amplification) or if the technology led to changes in the professional practices

(transformation). As such, this research only considered established mathematics education practices and the parameters of what could be replaced, amplified or transformed did not include wider cultural considerations.

In this overview article, we re-envision these ideas about replacement, amplification and transformation to consider the impact on aspects of mathematics or aspects of culture from the integration of digital technologies into mathematics education. We then use these considerations to discuss the impact of digital technologies on the kind of relationship between mathematics and culture that is valued in mathematics education research. Before, doing that we give a brief overview of first culture and then mathematics and how they are described in the individual papers, before considering how and if digital technologies lead to replacement, amplification or transformation of these aspects.

Culture

Across the six articles, the cultures which are in focus are very different, from digital culture, to classroom culture, to Indigenous and other communities' cultures. Yet these definitions do fit into Geertz' definition that "culture is best seen not as complexes of concrete behaviour patterns - customs, usages, traditions, habit clusters - as has, by and large, been the case up till now, but as a set of control mechanisms - plans, recipes, rules, instructions (what computer engineers call 'programs') - for the governing of behaviour" (1975, p. 44). However, culture is not static and it can be changed as a result of interacting with digital technologies that are based on different cultural expectations. As was the case in AlTarawneh et al. (2017) when artefacts such as digital technologies present ways of behaving which are different to what is expected, there are possibilities that these digital technologies end up influencing and change the wider culture. If that were to happen, then would be a form of cultural transformation.

We, thus, discuss how culture is considered in each of the articles and what kind of impact using digital technologies in mathematics education may have on: whether aspects of culture are replaced or reproduced through the use of this new medium; or whether aspects of culture are amplified through the use of digital technologies; or whether the cultural aspects are transformed.

Western schooling has often been noted as being a situation, where particularly Indigenous cultures are transformed, although generally not in a good way. However, a more positive view is that of "borderlands":

> Gee's (1996) concept of borderlands describes the space where two cultures or linguistic styles meet by co-evolving into a practice that is not strictly either and becomes a new creation [confluence]. This is theoretically important. Classrooms have the potential for being these "third-spaces"; not necessarily those of the dominant culture, nor in a one-to-one correspondence with the local Indigenous or ethnic minority culture. These third spaces have the potential to become productive uncharted zones between school and local cultural knowledge and norms. From a critical pedagogical perspective, this third space has the potential for changing historically situated authority structures (cited in Lipka, Sharp, Adams, & Sharp, 2007, p.97).

Nevertheless, many Indigenous cultures resist attempts to transform their cultural practices into those of the coloniser through education. The idea of a borderland is not viewed as productive if it results in assimilation. In one of the articles in this special issue, amplification of aspects of Indigenous culture are highlighted as a way of responding to threats from transformation to Western expectations about ways of behaving.

The Lunney Borden et al. (2020) article links culture to a specific Indigenous community, "all resources reflect local cultures and contexts and are rooted in a Mi'kmaw learning perspective" (p. 33). To reflect this perspective of culture, the digital app, developed as part of the project, presents "tasks that were rooted not only in a Mi'kmaw cultural contexts but also in ways of knowing being, and doing that are inherent in the Mi'kmaw language" (p.

33). This approach was adopted in direct opposition to previous education efforts which had tried to eradicate aspects of Mi'kmaw culture. Citing Bouvier et al. (2016, p. 22), Lunney Borden et al. (2020) shared that learning for Mi'kmaw students "has been overshadowed with assimilative and punitive practices intending to destroy their languages, their cultures, and the holistic relationships that have been integral to their knowledge traditions" (p. 22). In contrast, "Both the holistic nature of the app and that way it is centred on Mi'kmaw knowledge systems, allow this to be a truly culturally enabling resource" (p. 35). It seems that in this research the intention was to amplify cultural aspects by utilising traditional expectations about learning within the design of the digital apps. Although the design could be considered replacement in that learning from another person is replaced by learning from an app, the discussion of the design principles suggest that the point was not just to utilize traditional expectations about learning but to use the possibilities within the digital medium to emphasis these ways of behaving/interacting as important. As stated by Trumbull et al. (2002) "When the important cultural values of Indigenous students are not reflected in what they see of mathematics and science, the students may conclude that they must ignore some of their own values to participate in those domains" (p. 8). By amplifying the cultural aspects, the intention was to ensure that the students also valued aspects of Mi'kmaw culture that had previously been deliberately downplayed in the development of mathematical understadings.

In Allen and Trinick's (2020) article also based in an Indigenous context and presents a similar story of revitalising culture that was under threat from an education system that was assimilationist in nature, as in the Lunney Borden (2020) article. In the article, culture is related to Māori cultural identity, "there is little doubt that the conservation of cultural identity and retention of traditional knowledge are key issues for Māori, especially in a world that is on a path of globalisation and cultural homogenisation, at a speed and rate of acceleration scarcely conceivable a few decades ago—let alone by our Māori ancestors" (p. 4). The article highlights

the difficulties faced by schools, which use the Māori language for instruction, known as Māori-medium schools, to incorporate digital technologies, including mathematics education, into their teaching. These issues include the financing of the technologies, as well as a lack of resources in the Māori language.

A fall-back position of using digital materials designed for English-medium schools was problematised because of the impact that it could have on Māori culture. Through the use of resources designed for English-medium schooling, Māori culture becomes transformed into the culture of the colonisers. This kind of transformation has a long history in New Zealand. Citing Smith (1999), Allen and Trinick (2020) state, "Initially, arithmetic and European forms of schooling were introduced to Māori communities to inculcate the Māori population into European beliefs, attitudes, and practices, with the intent to "civilise" the Māori population" (p. 4). In Allen and Trinick's (2020, p. 11) article, it is highlighted that there is a need to value the cultural knowledge expressed in artefacts as this knowledge can be lost when the focus is on mathematical idea. For example, kōwhaiwhai patterns (frieze patterns) "express important cultural values such as unity, genealogy, and family interconnectedness" (Witehira, 2013 cited in Allen & Trinick, 2020, p. 10) and cannot be simply seen as representations of mathematical concepts of translation, rotation, and reflection. The patterns represent tribal values, genealogy and the ancestral world (Adsett, Graham & McGregor, 1992 cited in Allen & Trinick, 2020, p. 10). In considering how the impact of Covid19 could be researched in Māori-medium schools, Allen and Trinick's (2020) article shows how digital technologies can transform cultural aspects, through the incorporation of new language and themes which represent present, not just traditional, concerns. This kind of transformation is more in alignment with Gee's borderlands concept in that it utilises the dynamic nature of culture to move forward in a manner that is no longer assimilationist.

In Johnson and Corey's (2020) article, culture is defined in a similar way in that it is connected to the attributes of a particular group. The article relates culture to ethnomathematics, through "a group's cultural identity, i.e., race, language, vocabulary, values, beliefs, norms, physical traits, and symbols" (p. 51). The main argument in the article was that students use mobile devices, such as smart phones in their everyday life, and so these also need to be considered part of their cultural background, as well as familiar, traditional objects, such as henna designs, prayer beads, and bamboo baskets. Yet the use of apps was criticised by some of the parents of the preservice teachers who considered apps to be entertainment and not part of school culture. In regard to how the technology utilised the cultural understandings in the traditional artefacts was to replace engaging with them physically, to providing opportunities for them to be reproduced virtually, as a form of replacement. This can also be related to Gee's (1996) concept of borderlands in that it merges two perspectives, traditional artefacts with virtual possibilities, into something different to what could be considered from using one or other of them.

In contrast, in the article by Christiansen and Meaney (2020), culture is not connected to a specific group but to an institution, the Norwegian early childhood institution (known as kindergarten) and its traditions, which are visible in the curriculum document, the Framework Plan (Ministry of Education and Research, 2017). The Norwegian kindergarten tradition is considered to be part of the social policy pedagogy approach where the emphasis is on children learning through play, based on children's own interests. The article considers how digital apps could focuses on preparing children for school, that would lead to changes in other kindergarten traditions and aspects of culture, thus changing the control mechanisms for the governing of behaviour (Geertz, 1975). The potential for the digital apps to transform, but not in a good way, the culture is highlighted in the article.

Similar to the Johnson and Correy (2020) article, the article by Herheim and Johnsen-Høines (2020) discusses students' digital culture but extends this to aspects of classroom culture, in particular the productive learning culture in the mathematics classroom. The article makes use of Eriksen's (2001) definition of *current* perspective of culture but also shows how this also draws on the *historic* perspective of culture. The dynamic nature of cultural development has similarities with how Allen and Trinick (2020) described the needs of Māori-medium schools to build on the past but move into the future.

As was the case in the Christiansen and Meaney article, the Herheim and Johnsen-Høines (2020) article highlights how children work with digital tools at home in that their "initiative, interests, and intentions are driving forces, and common cultural denominators create conditions for these processes" (p. 94). Problem solving and communication become tools for developing their thinking. This is in contrast with how students work with digital tools in schools generally, presenting the possibility to discuss "cultural clashes". Understandings about cultural clashes have resonances with Gee's (1996) borderland culture in that possibilities are presented for blending school culture with home culture around the digital tools. However, the focus in the article remains mostly on how digital tools can transform a classroom culture which encourages students to engage in productive struggle. Thus, the aim is to consider how the school could be changed.

In the Ärlebäck and Frejd (2020) article, the technological culture in which simulations are used to replicate real-life problem solving are highlighted as important ones for students to gain access to. Consequently, they discuss ideas around socialisation and enculturation into this culture through education. "Education is one context in which students are being encultured into using new technology" (p. 111). They discuss conventional affordances of digital games as "the culturally manifested expectations of the environment of the individual as well as the ability of the individual to engage in cooperative social practices and to decode

explicit or implicit expectations, norms, and conventions" (p. 114). Reference to "culturally manifested expectations" has clear links to Geertz' (1975) definition of rules governing behaviour. In the research, examples of Herheim and Johnsen-Høines' (2020) cultural clashes were evident. The cultural knowledge gained from playing digital games at home meant that students struggled with interpreting the results of the app from the perspective of a real-world situation. The cultural norms of what might be expected in a mathematics classroom were suppressed and could be considered as being transformed so that from the students' perspective became more like those from game playing at home.

In summary, the six papers in this special issue show that mathematics education research emphasize different kinds of relationships between digital technologies and culture. One article considers issues to do with replacing of cultural experiences, by allowing school students to virtually replicate traditional artefacts (Johnson & Correy, 2020). Another article focuses on amplification of culture, by emphasising in the app Indigenous ways of viewing knowledge and relationships (Lunney Borden et al., 2020). The remaining four articles considered how digital technologies transformed some aspects of culture.

Mathematics

We will let the philosophers carry on the discussion of 'what is mathematics?' For our purposes, Hersh's (1997) humanist definition suffices, "mathematics must be understood as a human activity, a social phenomenon, part of human culture, historically evolved, and intelligible only in a social context" (p. xi). In some respects, mathematics can also be considered a culture in that it provides rules that govern behaviour. So here we consider mathematics to be a cultural artefact but with specific modes of behaviour connected to it. In this section, we discuss how the articles in this special issue describe how (school) mathematics is replaced, amplified or transformed through their inclusion in digital technologies.

In the Lunney Borden et al. (2020) article, the focus is on mathematical processes, "such as reasoning, problem solving, communicating, estimating, making connections, or visualizing" (p. 37). Spatial reasoning, viewed as important within Mi'kmaw culture, is also linked to later achievement in school mathematics and is seen as important aspect to highlight in the digital assessment tool. Lunney Borden et al. (2020) clearly indicate that the aim of developing the digital tool was to give teachers' insights into students' thinking and to show what they could do rather than from a deficit perspective on focusing on what they cannot do. In this way the mathematical ideas valued in Mi'kmaw culture are amplified and the emphasis on what is important in school mathematics is transformed.

Mathematics is considered broadly in the Allen and Trinick (2020) article, but the focus narrows to being about interpreting statistical data used in explanations of Covid19 on news services. As developers of classroom materials that could be used during the Covid19 lockdown, they designed "examples of how teachers could introduce the ideas of formulating a statistical question, planning an investigation, collecting and analysing data, and forming a conclusion regarding the COVID-19 pandemic at different levels of the curriculum" (p. 17). Although the context of the tasks was to benefit the Māori community's understanding around the impact of Covid19, the digital technologies replaced, rather than amplified or transformed the mathematics that was in use.

As had been the case with the definition of culture, in the Johnson and Correy (2020) article mathematics is defined in relationship to ethnomathematics, "Mathematics, in this context, refers to different aspects of thought and culture that could lead to different mathematical constructions, ideas, and explanations within concepts such counting, measurement, deduction and modelling" (p. 51). However, in the examples provided, it seemed that the digital technologies replaced other ways of presenting school mathematics such as measuring and geometry.

In the Christiansen and Meaney (2020) article, the definition of mathematics is based on the Norwegian Framework Plan' description of "Quantities, space and shapes, this learning area is based on Bishop's (1988) six universal mathematical activities (Reikerås, 2008)" (p. 71). However, in the two apps which were analysed, the mathematics which was in focus was comparison (bigger and smaller) in one app, with problem posing and solving connected to measuring and visuospatial reasoning was in focus in the other app. Although in the first app the digital technology seemed to replace physical comparison tasks, in the second app the digital technology amplified or even transformed the possibilities for seeing connections between problem posing and solving and measuring and visuospatial reasoning. This was because the app provided multiple possibilities for engagement which the children utilised based on their own interest.

As was the case with the articles by Allen and Trinick (2020) and by Johnson and Correy (2020), in the Herheim and Johnsen-Høines (2020) article, mathematics seems to be equated with school mathematics. However, a new requirement in the curriculum for Norway, as in many other countries, is the incorporation of programming into mathematics education. This requirement, linked to digital technologies, has necessitated consideration of how to include computational thinking into the classroom because "systematic steps to solve problems and find solutions, and programming is often required to execute these solutions" (Herheim & Johnsen-Høines, 2020, p. 96). In the data that was analysed, the students used an iterative approach to their programming to draw a pentagon on the screen. Initially the students were uncertain of what was a pentagon, but started to ask questions about interior angles, based on their understandings of squares and hexagons. In this way, the digital technology provided new ways to explore their geometric understandings. It could be said that programming transformed how they came to think about the mathematics.

In the Ärlebäck and Frejd (2020) article, a digital game based on modelling an exponential function, connected to a global pandemic, is described. The data, collected from upper secondary students, was analysed to identify "the mathematical characteristics of the graphs" that they used. The digital game was supposed to lead to the students developing their understandings of graphs. However, in most cases the students provided few reflections about the graphs and did not always provide all the information needed to make the graph interpretable by others. This suggests that their previous game playing rather transformed the students' understandings about what kind of mathematics should be provided. This is in alignment with, Stillman et al. (2020) who stated, "there is ample evidence that reasoning does not automatically transfer to make those skills available in other domains" (p. 1213). Given that a global pandemic has occurred and the importance of being able to interpret exponential graphs in everyday life has become a necessity for most people, one wonders if another set of cultural understandings would have come into play with producing graphs to represent what was seen in the game. Would the game amplify, rather than transform the contribution that mathematics can make to interpreting real-life situations?

In summarising the impact of digital technologies on mathematics, it would seem that the ways that the digital technologies either replaced or transformed the mathematics. The research community represented in this special issue, the focus is on how digital technologies either replace other technologies presenting existing views about (school and kindergarten) mathematics (Allen & Trinick (2020); Johnson & Correy (2020); and Christiansen & Meaney (2020)), or transforming those understandings, either through aligning with Indigenous mathematical understandings (Lunney Borden et al. (2020)), or by connecting to out-of-school game-playing cultures (Herheim & Johnsen (2020); and Ärlebäck & Frejd (2020)). In some of the articles, the transformation was situated as being problematic as the mathematics that is illustrated using digital technologies is not valued (Christiansen & Meaney (2020)) or dampens

the possibilities for learning (Ärlebäck & Frejd (2020)). As was the case with cultural transformations from using digital technologies, not always are they considered to be valuable.

Mathematics Education Research on the Use of Digital Technologies Mediating Culture and Mathematics

Mathematics education research focuses on the intersection between mathematical ideas and pedagogical practices in understanding how children and students engage with mathematical ideas. In this section, we consider what kind of relationship between mathematics and culture are highlighted in this set of articles as a way of conceptualising what is viewed as important in mathematics education. This is because views of children and views of teaching and learning are culturally based, as is mathematics itself. For example, almost a century ago, Schlauch (1928) stated:

> Any normal child is blessed with natural curiosity – that heritage of the evolutionary struggle during which not to comprehend the environment and its dangers meant death. Children take joy in mastering knowledge which they can see as has some relation to the phenomena of their lives. It is only the mass of abstract material in a dull curriculum, unpedagogically presented, that finally kills the desire to learn. (p. 28)

Although stated as a universal view both of children and of teaching and learning, these perspectives are situated in a particular moment in time and in Western understandings more generally about individuals. For example, Lange and Meaney (2019) used activities in Danish children's magazines from the 1920s to describe that society's view of what a childhood should be. The visions of childhood included expectations about children being provided with only the barest of information about how to undertake task, which required them to engage in trial and error in order to produce an artefact. There are clear echoes of how the students in Herheim and Johnsen-Høines' (2020) article worked on producing a pentagon using the Scratch programming language, but at this point in time in this society this was considered as transforming typical mathematical classroom practices. These expectations about how children

should engage with mathematical ideas have a strong relationship to the Norwegian Framework Plan for kindergartens (Ministry of Education and Research, 2017) cited by Christiansen and Meaney (2020), where the components of quantity, space and shape when investigated in kindergarten are to "stimulate the children's sense of wonder, curiosity and motivation for problem-solving" (Ministry of Education and Research, 2017, p. 53).

However, these expectations about the connection between children's interests and likelihood to engage in mathematical ideas may not be representative of non-Western cultures, such as Māori. In this culture expectations about the learning of mathematics is closely linked to what the Māori community considered to be valuable for developing Māori identity, not about individual children's interests. To develop a Māori identity what is offered to students should be a blend of understandings about traditional cultural knowledge with understandings from living in the present. In the Allen and Trinick (2020) article, cultural symmetry is used to blend knowledge about mathematics and Māori culture so that activities provided to students have the possibility to support their valuing of the cultural artefacts or understanding, mathematical understandings and critical thinking. All of these aspects were considered important for providing students with the Māori identity needed for the world that they live in.

Thus, there is a need to problematise accepted relationships between mathematics and culture that are mediated by digital technologies, not just to consider what is happening in educational institutions but also to identify how mathematics education research is conceptualised. Digital technologies affect if and how cultural understandings about not just what is valuable mathematics but also about how it is expected to be taught or learnt. As is noted by many of the articles in this special issue, digital tools do not provide a benign benefit to mathematics teaching and learning. Several of the article problematise the kind of transformation that digital technologies produce on mathematics education when they mediate the relationship between culture and mathematics.

In Table 1, we summarise how digital technologies affect the mathematics and culture described in the set of articles in this special issue. This table forms a matrix that summarises how digital technologies replace, amplify or transform aspects of culture or aspects of mathematics in the set of articles.

Mathematics **Culture**	*Replacement*	*Amplification*	*Transformation*
Replacement	Johnson & Correy		
Amplification			Lunney Borden et al.
Transformation	Allen & Trinick; Christiansen & Meaney →	→	Ärlebäck & Frejd; Herheim & Johnsen-Høines →

Most of the research represented in this special issue documents how digital technologies transform either mathematics and/or culture. As noted earlier, transformation is in and of itself not considered a good thing but in some articles instead considered to lead to unforeseen consequences by those introducing the digital technologies, which could have long-term implications for mathematics and/or for culture. Yet, when considered the desirable relationship, following the finding of Valero and Knijnik (2015), transformation seems to be the one that mathematics education research values the most.

Replacement of existing ways of presenting mathematics was more common than the ways that culture was presented. The Johnson and Correy (2020) article was the only one which described digital technologies, in this case apps which were specially designed so that students could make connections between mathematics and traditional Emirati crafts. In the design and implementation of the apps into classrooms, there were several challenges to be overcome connected to existing understandings about the role of apps as well as what should happen in a classroom. So even though the apps themselves were not transformative, overcoming some of

the challenges could be considered as transformative of other aspects, outside our immediate focus in this article.

The article by Lunney Borden and colleagues (2020) is the only one in which digital technologies were considered to amplify aspects of digital cultures, in that ways of thinking were presented which amplified their high status and made them easily able to be identified by teachers. However, it would seem how digital technologies amplify aspects of mathematics and/or culture was not of interest in this set of articles about mathematics education research.

Conclusion

Digital technologies have been a focus of mathematics education research. However, research on their impact on aspects of culture and mathematics has been limited. In this special issue, six articles present empirical research that investigates how digital technologies affect mathematics education, using different understandings about culture. By reflecting on what is highlighted in these different articles it is the role of digital technologies in transforming aspects of mathematics and/or culture which are most often in focus. However, this set of articles indicates that transformation is problematised and not accepted necessarily as producing "good" outcomes. Taking into consideration, the connection to culture in particular supports the possibilities for investigating some of the ideologies that lie behind the digital technologies.

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