School Inclusion Through Remote Presence, Virtual Spaces and Digital Artefacts, for Students with Chronic Health Conditions

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Abstract: Students with chronic health conditions often miss significant amounts of school, impacting their learning and social wellbeing. This paper sought to develop a greater understanding of how digital tools mediate remote learning for four students with chronic health conditions, through a qualitative multiple case study of two secondary schools in Australia. Cultural Historical Activity Theory (CHAT) and Postphenomenology provided a theoretical framework to guide interview data collection and analysis. A model of digital tool identities including digital artefacts, virtual spaces and remote presence, is proposed to support teachers of students with chronic health conditions who are intermittently learning remotely.

Introduction

In Australia, it is estimated that 1.6% of the student population are absent from a significant amount of school due to injury or illness (Australian Research Alliance for Children and Youth, 2015). Some children with chronic health conditions (CHCs) are missing months or even years of school, and are not exposed to the same opportunities for education or social connection as their peers. Digital technologies can provide opportunities for inclusion of students at their regular schools when they are not able to physically attend. However, as the uptake of digital technologies in schools has been accelerated by technological innovations and the global pandemic, it is important for educators and policy-makers to understand how the technologies are being used and their impact on teaching and learning. In particular, awareness is required of the implications for continuous, and inclusive, equitable and quality education, part of the United Nations Sustainable Development Goal 4 (United Nations, 2015) as committed to by Australia.

This paper describes a qualitative, multiple case study of two secondary schools in Australia, involving four student participants with CHCs who were using digital technologies to continue learning with their regular schools. Data were collected through student and parent interviews. This was part of a broader study which also involved students who were remote learning due to the COVID-19 pandemic. Cultural Historical Activity Theory (CHAT) (Cole & Engeström, 1993) and Postphenomenology (Ihde, 2008) provided the theoretical framework for the study to guide data collection and analysis. Findings have led to a proposed model of digital tool identities. This model could support teachers, students and parents in understanding ways to support the learning of students with CHCs when they are unable to attend school.

Theoretical framework

CHAT was used to frame this research study and guide data collection and analysis. It was chosen for this study because it provides a manageable framework to support research into real-world, complex, learning environments (Yamagata-Lynch, 2010). Key concepts in CHAT include activity as the unit of analysis (Leont'ev, 1978) and mediated action (Vygotsky, 1978). In this study the activity being analysed was intermittent remote learning, and the focus was on how digital tools mediated this form of learning. Contradictions and tensions (Cole & Engeström, 1993) and expansive learning (Engeström, 2001) within the activity were also important as part of the broader context, however the focus of this paper is on the technological mediation.

The expanded mediational triangle of Cole and Engeström (1993) can be used to illustrate the activity of intermittent remote learning (Fig.1). The subjects are the students with CHCs and their parents. The tools in focus are the digital technologies in use. The object in focus is continuous and inclusive, equitable and quality education, in line with the United Nations Sustainable Development Goal 4 (United Nations, 2015). Rules and norms, community and division of labor are part of the broader context and beyond the scope of this paper.

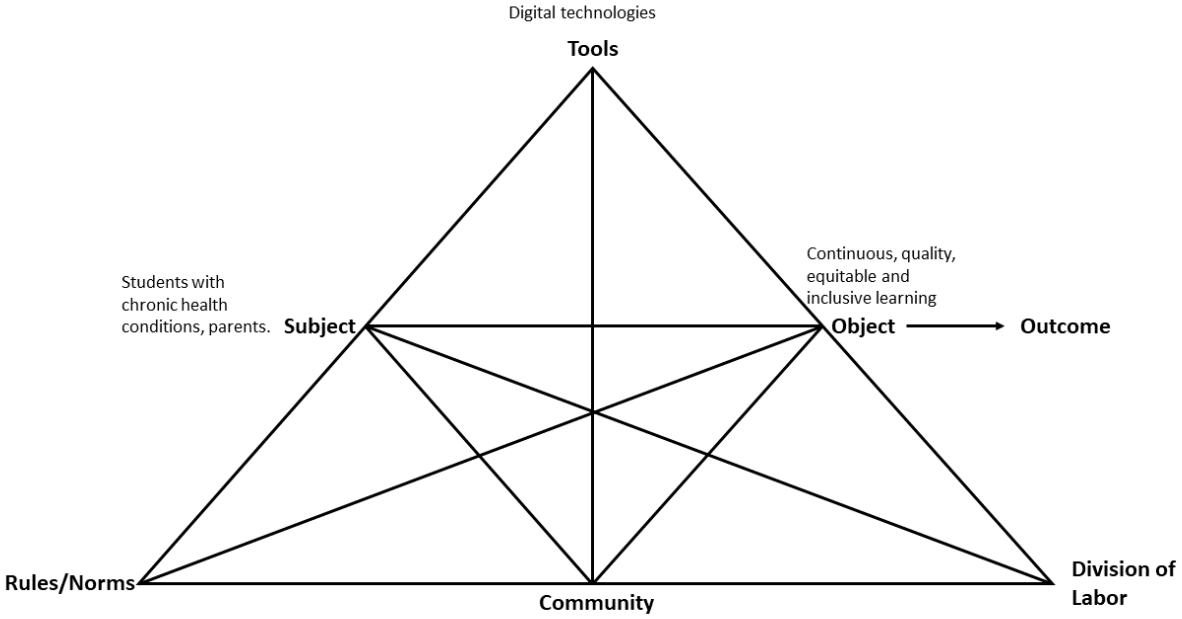

Figure 1: Intermittent Remote Learning Illustrated on Expanded Mediational Triangle

To further break down the concept of technological mediation, Postphenomenology was used to complement CHAT and provide greater insights into the use of digital technologies. Postphenomenology is a philosophy of technology which states that neither the subject nor object of a technologically mediated experience are pre-given, but are mutually constituted (Verbeek, 2005). This mutual constitution also means that technologies have no essence, but become what they are through human use and culture. As Ihde (1990, p. 70) explains, "A technological object, whatever else it is, *becomes* what it 'is' through its uses". This notion that digital tools have different identities in different contexts is referred to as *multistability* (Ihde, 1990). Examples of multistability include a compact disc which is no longer used as a source of music, but instead as a bird deterrent in the garden, or a laptop which over the course of a day may be used as a writing tool, a video conferencing tool, or even a paperweight.

This paper explores the identities that digital tools acquire in the context of intermittent remote learning for students with CHCs. It also explores the impact of these identities on the students and learning activity. These impacts can be understood through Postphenomenology's concept that technologies translate human actions through invitation and inhibition (Verbeek, 2005); and the concept that human technology relations are characterised by transformation

of human experience, which simultaneously amplifies one aspect while reducing another aspect of experience (Ihde, 1990).

Literature review

Studies of the use of digital technologies to support students with chronic health conditions (CHCs) to connect to their schools in the past decade have revealed a generally positive impact on learning and social wellbeing. They include some studies of ambient, or background, technologies which were found to increase a sense of belonging and connection between the hospitalised child and classroom (Hopkins et al., 2014; Vetere et al., 2012). For example, Vetere et al. (2012) studied four cases of hospitalised children, each with a colour-changing glowing orb, with colours controlled by the child, placed in the child's usual classroom during their absence. Colour changes prompted the students to imagine what their classmate was doing or feeling and to want to communicate further. The hospitalised child liked the idea that their classmates were reminded about them and it reduced their sense of isolation or disconnection from their peers.

Studies have also been conducted into Mobile Robotic Telepresence (MRT) systems to support students during school absences (Newhart et al., 2016; Soares et al., 2017). The robot takes the child's place in the classroom and can be controlled remotely by the child on a device from hospital or home, allowing the child to interact with their teacher and peers via video conference. Newhart et al. (2016, p. 10) refer to this as "virtual inclusion" in their qualitative study of five students with CHCs using telepresence robots to attend school virtually in the United States. They found that student engagement increased and children were also able to join in social aspects of school like the school choir or eating lunch, but this did not compensate entirely for not being at school as they still expressed a desire to go back.

Studies have also been conducted into virtual learning environments to enhance school connection (Klunder et al., 2022; Zhu & Van Winkel, 2015). For example, the Bednet learning tool used in Belgium (Zhu & Van Winkel, 2015), with a two-way synchronous audio and video connection between a child and their classroom. This includes document exchange and a class agenda. Surveys and follow up interviews found that this system benefitted educational continuity and social connections for children with CHCs. The benefits perceived by the children and their parents, included keeping up with schoolwork, and the ability to participate in group work rather than being assigned alternative tasks. The daily contact with their class reduced their feelings of social isolation and stress about reintegration in school. Klunder et al. (2022) conducted a study into teacher perspectives on using video conferencing to connect students with CHCs to their regular classrooms. They described this as a "hybrid virtual classroom" (Klunder et al., 2022, p. 493), with teachers reporting that they found it useful for continuity of education and social connection for the student with their peers, and to ease transition back to school.

In recognition of student's use of multiple technologies, Maor and Mitchem (2018) take a broader approach into the use of mobile technologies (i.e. handheld devices such as tablets and smartphones) by hospitalised adolescents. This qualitative study was conducted through interviews with 18 hospitalised students aged 12 to 18, 29 hospital teachers and four parents. They found that these technologies allowed students to keep up with their school work, and engage with their peers. For example, students were able to connect to their class wiki for collaborative work or communicate with friends using social media to ask questions or share information about school work. Maor and Mitchem (2018) also found that students made choices of how to present themselves, for example through audio or video recordings and the hospital teachers were able to adapt the use of technology to the student's emotional or physical condition.

The studies conducted have demonstrated that digital technologies can have a positive impact for students connecting to their schools in both learning and social wellbeing, and they can also ease transition back to school after absence. However, most are focused on individual technologies, many of which are designed specifically for students with CHCs. This study begins to address the gap in understanding how teachers and students utilise a range of digital tools to support remote learning, including those technologies already in use in schools by all students.

Methodology

A qualitative case study design was used for the research. The cases were two schools: Banksia College and Acacia College. Purposeful sampling was used to select participants with CHCs who were learning remotely (Tab.1), and data were collected through semi structured interviews with the students and their parents. The students

participating in the study included Lachlan, a Year 12 student from Queensland, and three siblings from New South Wales, Olivia in Year 12, Jack in Year 11 and Charlotte in Year 7. All of the students had CHCs which impacted their school attendance.

Table 1. Participants

Participant Pseudonym	Year Level	School Pseudonym	Chronic Health Condition	On Site School Attendance
Lachlan	12	Banksia College	Myalgic encephalomyelitis/chronic fatigue syndrome (ME/CFS).	Part-time, 2 double lessons per week.
Olivia	12	Acacia College	Ehlers-Danlos Syndrome, Autonomic Dysfunction, Dysmotility, Pseudo Obstruction, Chronic Fatigue, Migraines.	Intermittent, with short medium and long absences.
Jack	11	Acacia College	Ehlers-Danlos Syndrome, Autonomic Dysfunction, Dysmotility, Pseudo Obstruction, Chronic Fatigue.	Intermittent, with short medium and long absences.
Charlotte	7	Acacia College	Ehlers-Danlos Syndrome, Autonomic Dysfunction, Dysmotility, Pseudo Obstruction, Chronic Fatigue, Migraines, Growth Failure.	Part-time, 4 half days per week.

The interviews were analysed using reflexive thematic analysis as described by Braun and Clarke (2022). These themes were then reviewed through the lenses of CHAT and Postphenomenology. Measures were taken, such as continued reflexivity, to ensure trustworthiness and ethical conduct.

Findings

Interview data from the students revealed that the schools and teachers were supporting the students' remote learning through various digital tools (Tab.2).

Table 2. Digital Tools

Digital Tool	Functionality	Activities
Canvas	Learning Management System (LMS).	Access uploaded course content and teacher announcements. Message teachers.
Edrolo	Learning platform with science video content and assessments.	Self-paced science lessons, watching videos, completing multiple choice questions and receiving automated feedback.
Microsoft Teams	Team collaboration software.	Access uploaded course content, communicate with teachers.
Stile	Learning platform with interactive science lessons and learning analytics.	Self-paced interactive science lessons, receiving written teacher feedback.
Swivl	Robotic device tracking teacher to support video conferencing or recording of lessons.	Participate in classroom lessons through video conferencing (one to many connection).
Telepresence Robot	Remotely controlled, mobile robotic device for video conferencing.	Participate in classroom lessons through video conferencing (one to many connection).
Zoom	Videoconferencing	Participate in online lessons through video conferencing (many to many connection).

The multistable nature of the digital tools meant that their identities were fluid, as they were used and experienced differently in different contexts. These identities were categorised into three types: digital artefacts, virtual spaces and remote presence (Fig.2).

Digital artefacts includes digitised learning resources such as documents and recorded videos which can be generated through programs including Microsoft PowerPoint and camera applications; virtual spaces are where school communities can join together in online spaces which can be generated through digital tools such as Microsoft Teams and Zoom; and remote presence occurs when a student has a digital representation in the school community which can be generated through digital tools such as telepresence robots. These three digital tool identities are not clearly

delineated and can be used in conjunction with one another, for example digital artefacts are often shared in virtual spaces or through remote presence, and students may generate a remote presence in the school community through a virtual space or digital artefact.

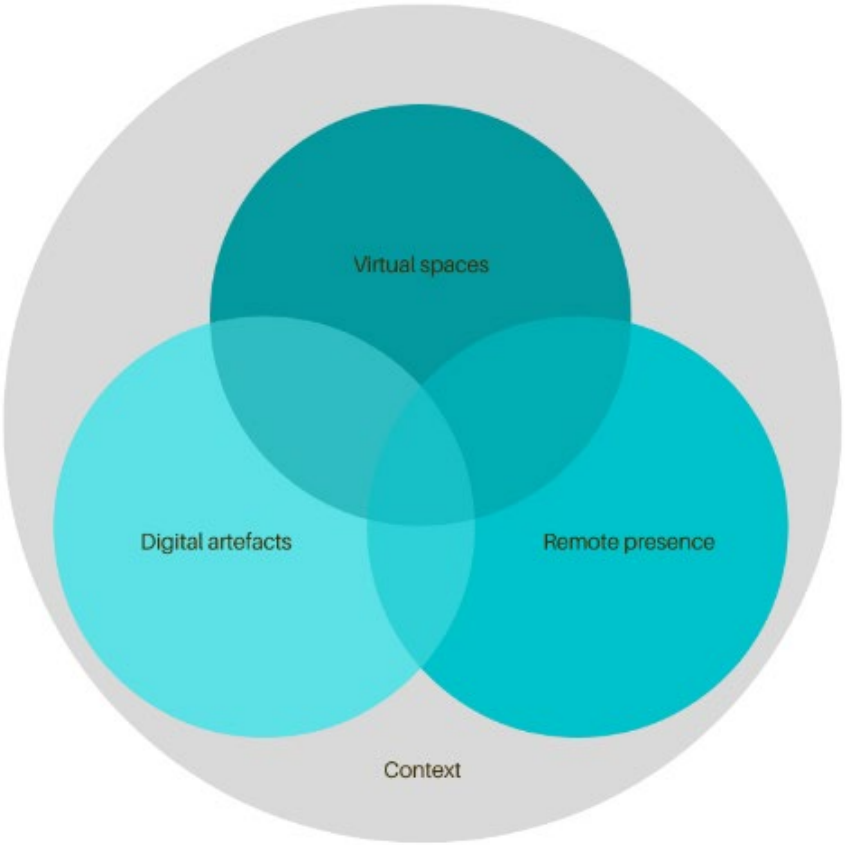

Figure 2. Digital Tool Identities in Remote Learning

Digital Artefacts

Olivia provides an example of a student being supported in their intermittent remote learning through digital artefacts, through her use of Edrolo. Edrolo is a learning platform targeted at Australian secondary school students, including products specifically for senior high school students working towards completion of their studies, like Olivia. It contains science video content, assessments and access to learning analytics for teachers. This learning platform was used by Olivia and her peers at Acacia College to engage in self-paced science lessons. Olivia found the amplified sensory experience of audio-visual content engaging, and she perceived it as a shared experience with her peers, who would be watching the same videos and answering the same questions as her. She explained, "It's really good because you can like easily see what they'll be going through". It was important to Olivia to feel that she was getting access to the same learning experience as her peers, even if she was in a different place and learning at a different time.

Independent remote learning was very important to Olivia as a student with a CHC, who was regularly unable to attend school. Edrolo invited practices including self-paced, asynchronous remote learning and student self-reflection through self-marking, supporting Olivia's ability to be an independent learner, working at her own pace at a time and place of her choice. This was very clear from the interview, with Olivia noting, "I do like Edrolo … because it has like multiple choice questions and stuff throughout the video to like, check your understanding and stuff". Asynchronous and self-paced learning were also helpful to her as she was often at appointments, or too unwell to learn

during absences at home or in hospital. These were supportive not only because of the current absence, but accumulated prior absences and resulting learning gaps.

It is noteworthy however, to also consider how Olivia's visibility of and by her school community is reduced when working with a program like Edrolo, and how interaction with her school community is inhibited as it does not facilitate synchronous learning support from her teacher and peers. There are also limitations of a program such as Edrolo for learning science. Edrolo provides a positive, but partial solution to Olivia's learning needs as much of the science curriculum remains undigitised, as some aspects of learning science are challenging, or even undesirable to move into the digital realm. For example, Olivia is still unable to participate in many science practical experiments as she does not have access to the physical artefacts in the science lab. She explains, "most the time I'll …watch a video and use results from other kids". Olivia is effectively excluded from the experiential learning undertaken by her peers. Consequently, although Edrolo supports inclusion in terms of access and participation in aspects of learning it does not support her presence in the school community. Edrolo, through its digital artefacts, also works towards equity as Olivia gets some of the same learning opportunities as her peers. It supports continuity as Olivia can learn some of the curriculum remotely at her own pace and time. However, there remain quality issues due to all the aspects of learning that Olivia continues to be excluded from.

Virtual Spaces

Virtual spaces are digital environments where people can interact online with other people and digital resources. Examples include Zoom and Microsoft Teams which allow interaction through means including videoconferencing, messaging and document sharing. This interaction can be synchronous or asynchronous. The students in this study wanted to attend school and shared virtual spaces provide a means for them to meet online with their teachers and peers and access learning resources.

Charlotte's use of Zoom is an example of a student being supported in their intermittent remote learning through shared virtual spaces. Zoom is used primarily for videoconferencing and not designed specifically for schools, but was introduced to Charlotte's school in 2020, along with many other schools in Australia, to allow some educational continuity during COVID-19 restrictions, when the majority of students were not permitted to attend school face to face. Charlotte's participation in Zoom lessons, where she was able to see and hear all of her classmates and teachers amplified her feelings of inclusion. She explained, "Now that I know that everybody else is there, and that we can do Zoom where we can all see each other … that feels more including". Charlotte was in a virtual space synchronously with all of her peers for the first time, and perceived a level of equity with her peers. Zoom invited practices of synchronous student to student interaction and teacher to student interaction. Charlotte appreciated the opportunity to interact with her peers saying, "Homeroom is good because that is the class where we all just get to talk. So, when we're on Zoom, all like, all the girls, my homeroom, we all just get to talk really". This interaction supported her social wellbeing.

However, although virtual spaces may provide suitable environments for some school activities, there are those physical spaces in schools which cannot easily be digitised, such as the basketball court or theatre stage. Physical interaction is inhibited, limiting participation in certain sports or drama activities for example. Indeed, sedentary behaviour is invited by virtual spaces, as students sit in front of their devices so that they may see and be seen by or interact with others. There may also be quality issues arising from the change in pedagogy required to teach in virtual spaces, when teachers have little experience in this area. However, there is no doubt that virtual spaces allowed at least partial educational continuity and make progress towards equity and inclusion.

When Charlotte's school returned to face to face learning, Charlotte's mother Michelle persuaded the school to allow her to continue accessing lessons using Zoom as it had been a positive experience for her. However, this is where we see the multistability of technology as this could be considered remote presence rather than a virtual space, as Charlotte moved from a many to many connection when all the students were online using Zoom, to a hybrid model using Zoom as a means of having a presence in the physical classroom.

Remote Presence

Remote presence occurs when a digital device is used to feel or appear present in a remote location. Examples include the use of telepresence robots and other video conferencing technologies, which allow the user to be remotely present in a physical location synchronously with others who are physically present. Remote presence can support

students to participate in school activities when they cannot physically attend, and as such is the digital tool identity that is uniquely required by those absent students and not useful to the general student population.

Lachlan's use of a telepresence robot, is an example of a student being supported in their intermittent remote learning through remote presence. Lachlan was able to establish a physical presence in his classroom through a human-sized, manoeuvrable, telepresence robot, with video conferencing capabilities. He controlled the robot from his laptop device. Referring to the impact of the robot amplifying his presence in the classroom, Lachlan explained, "I think it's important that people know I'm there. It's easy to forget or just push you to the back of their mind." However, Lachlan was critically aware that the robot could also emphasise his difference in addition to his presence. Lisa, his mother explained, "his mood was very low in the lead up to him getting that robot and he was very apprehensive about it … he already appeared strange, weak, different". Lachlan experienced some reduced audio and visual acuity with the robot, for example he sometimes found it difficult to hear depending on the positioning of the robot in the room. He supplemented the use of the robot with digital artefacts downloaded from his school Learning Management System, so that he did not need to view them through the camera. However, some reduced sensory capacity was advantageous to him due to his CHC. He explains, "If I went to school I would only be able to do those 50 minute periods because there's a lot of stimulus like the smells and the sounds of the classroom, just like unexpected situations, but at home it's in like a controlled environment and it's a lot less straining on me, so I can do a lot more".

Remote presence supported Lachlan's participation in school activities. For example, he found it particularly useful for group discussions in English, explaining, "with English it's more on a conceptual level and the group discussions really helped me learn what I need to". Lisa also explained the impact of the robot on class photo day, "He was always absent on the day that they took the class photos. So on the day, the class photo was being taken, Lachlan's robot, he logged in, and he was in the middle of the hall, and they made him, the robot, be in the class photo…It just it made him feel like people cared about him again". Remote presence not only contributed to Lachlan's learning but also to his social wellbeing through his sense of belonging and inclusion. Lachlan was also able to have his remote presence at school registered as school attendance. His prior attendance record was threatening his continuation at the school, as he needed a minimum number of days attendance in order to graduate.

Some activities were inhibited through the robot, for example practical activities such as group music. Lachlan explains the problems with synchronisation, "If they are all playing instruments, it goes through the computer. And the sound comes to me and I hear like half a second later. And then I play something. And then it ends up being like a whole second later". This time lag meant the solution for Lachlan was to work alone, he explained, "when I have to do like the practical stuff, I'll often just go off and do it on my own." This again is an example that some activities are very challenging to digitise, even when the physical resources are provided to the student at home. In this case, Lachlan was excluded from participating in the activity with peers. Lachlan also experienced limitations on his movement around the school as the robot could not travel over uneven surfaces, so his peers were assigned to carry the robot between classes.

The need for remote presence in the physical classroom became obsolete during pandemic restrictions when most students were learning from home, as they were all meeting in a virtual space. However, the introduction of Microsoft Teams at this time provided another means of participation for Lachlan which continued post restrictions. Lachlan became adept at selecting the technology that would best support him. He explained that he would use Microsoft Teams, "When I'm just feeling so tired, that I'm just going to lie down and listen to the lesson instead of like, contributing to the conversation." This was useful to Lachlan who had to carefully manage his energy levels through pacing, as this enabled him to move to a less interactive or asynchronous means of learning when necessary.

Remote presence helped Lachlan to ensure he was not forgotten by his teacher or peers at school. However, his technologically mediated presence both appears different to students at the school and is experienced differently and with limitations by Lachlan. Lachlan has however learnt to minimise those limitations by supplementing the robot with additional digital tools.

Discussion

The three digital tool identities identified in this paper of shared digital artefacts, shared virtual spaces and remote presence in the school community, have been shown to support students with CHCs with their intermittent remote learning, as students manage their learning despite not only their remoteness, but the limitations of their CHC. Digital artefacts primarily provide access to learning content, while virtual spaces provide an online community meeting point where the school community can interact and share, whether synchronously or asynchronously, and remote presence provides students with a means of visibility and synchronous participation at their physical school. The tool identities all have their limitations, some of which can be minimised by being used in conjunction with each

other, however significant learning activities remain in the non-digital sphere as they are either too challenging or undesirable as digital activities. For such activities, digital technologies do not provide a solution and therefore alternative solutions should be sought, such as participation during the intermittent periods at school.

The proposed model of digital tool identities (Fig.2) to support intermittent remote learning is helpful because it provides a means for teachers and students to consider the digital tools they have access to and are able to use, and consider how they may use them, with their context and needs in mind, to generate the digital tool identities in the model that have been shown to support students with intermittent remote learning. The model also helps clarify understanding of how digital tools mediate learning by considering identities instead of complex digital tools with a multitude of functions. This captures the dynamic or multistable nature of the tools. For example, it supports understanding of why a digital tool such as Zoom might meet greater resistance to its use in a school as the context changes and therefore its identity changes from a virtual space to remote presence, and also why a digital tool such as a telepresence robot with a relatively fixed identity of remote presence can become temporarily obsolete in a new education context of COVID restrictions. The main limitation of this model is that it has been developed from the experiences of only four students. The context around digital tool identities should also be considered in further detail, however that is outside the scope of this paper. However, these marginalised student voices are important and the rich data provides a holistic view of the students' digital ecosystems. For future research, this model can be applied, reviewed and possibly further developed in alternative contexts, perhaps beyond remote learning for students with CHCs.

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Acknowledgements

This research is supported by an Australian Government Research Training Program (RTP) Scholarship. Grateful thanks also to MissingSchool Inc. for their assistance to connect with research participants.