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"It feels like I have a camera in my eye": New methods for literacies research in maker-oriented classrooms

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This paper focuses on new data collection methods made possible through first person-perspective or point-of-view (POV) recording technology and how these tools can provide important insights into students' digital making and learning processes. Observation is a powerful tool, but researchers and educators are limited in what they can observe during a given moment and their inferences about student learning are made through the lens of an "outsider". Audiovisual recording can supplement classroom observations to provide a more complete picture of students' learning, but we contend that commonly-used methods are insufficient to capture the dynamic, social processes and literacies at play in a maker-oriented classroom. Through analyses of students' learning during a digital tutorial-making task, we examine the affordances of and considerations for using POV "spyglasses" in digital literacies research. Spyglasses look and feel like regular glasses that one would wear to improve their vision, augmented with an integrated video camera and recording functionality. Our findings indicate that using tools that allow data to be collected from the student perspective gives access to important, alternate narratives about what students' final products might show or represent about their digital skills and competencies. We also explore the important technical, ethical and data management considerations associated with using spyglasses as a data collection tool. As physical and digital making practices become more prominent in education and classroom-based research, this study highlights the importance of research tools capable of capturing the nuance and process of learning through making. Future research could explore the gap between researcher interpretation of collected data when it is not "read" alongside, or compared against, documentation from the "insider" perspective.

KEYWORDS

qualitative research methods, point-of-view recording, data collection, assessment, student perspective, spyglasses, maker education

1. Introduction

Digital networks and technologies are now ubiquitous in society. For example, no matter where we go, the smartphone, which has been described as "… our other limb" (Huffington Post, 2017), is always there. Mobile devices are in our pockets and, increasingly, attached to our bodies. Wearable technologies such as smart watches, fitness trackers and wearable cameras blur the boundaries between our bodies and the networks into which they connect us. The vast datasets of moment-to-moment movements, biometrics and perspectives captured by these devices reflect who we are as humans in ways and at scales never seen before.

Wearables have implications for teaching and learning, as well as for educational research. In education, observations of student learning are always limited by teachers' own senses, and by their "outsider" orientation and perspectives. Even while observing a child's behaviors, questions, and attentional gaze very closely, inferences about what a child is learning in these moments are always an imperfect construction, based on what can be seen, or heard, or felt by the teacher. To capture students' own perspectives, teachers and researchers may ask students to think aloud while they work at an activity, or to reflect on their process in a written journal or in a person-to-person interview. These ways of accessing students' own understandings of what they were doing, or why they did something can be limited by the learner's own metacognitive awareness or by their reading, writing and oral communication skills. These evaluative techniques, in combination with summative assessment of students' work, arrive at a partial representation of their learning; however, so much learning occurs in the process of classroom activity, which is often ill-represented in rubrics and checklists (Papert and Harel, 1991; Bell, 2010). In makerspaces or classrooms oriented around maker pedagogies, the limitations of traditional assessment strategies become even clearer (Hughes, 2022; Murai et al., 2022), advancing a need for techniques to accurately capture students' learning and making in process.

Audiovisual recording can provide a contextualized record of students' approach to making and learning, including their gaze and focus of attention, conversations with table partners, gestures, and movement patterns (Jewitt, 2012), which teachers and researchers may not have the opportunity to observe while engaged with other students. Capturing video has been part of the researcher's toolbox for quite some time and has been used by educators for the purposes of professional reflection (Hamel and Viau-Guay, 2019), feedback and assessment for physical education, dance, and other motor skills (Banville and Polifko, 2009; O'Loughlin et al., 2013), and creating multimodal student assignments (Kearney and Schuck, 2006; Baepler and Reynolds, 2014). However, considering the use of video recording for capturing students' learning – particularly in maker classrooms – we recognize several limitations in the technologies currently under use. User-operated devices (e.g., camcorders and iPads) necessitate making decisions about when and what to record, as well as being in place and ready to record when these moments occur (Goldman, 2007; Lemke, 2009; Jewitt, 2012). Stationary recording devices (e.g., overhead cameras and camcorders on tripods) can be limited in their perspective, capturing only a narrow field of view (Heath et al., 2010; Luff and Heath, 2012), and may miss valuable discussions of learning due to room noise or hushed student volume. Body-or head-mounted cameras, like the GoPro, overcome many of these challenges, allowing for continuous recording from a perspective that approximates the wearer's and better isolation of local conversations and exchanges between students (Kindt, 2011; Kinsley et al., 2016; Vannini and Stewart, 2017). However, issues with audibility (Polkinghorne, 2019), comfort (Kindt, 2011), and affordability (Kindt, 2011; Vannini and Stewart, 2017) may reduce their usefulness in the classroom. At the time of writing, commercially available GoPro models range from $400-$600 which – while an affordable option for action filmography (Vannini and Stewart, 2017) – may pose a budgetary challenge for educators and researchers. In-the-moment learning data collected with wearable technologies such as "spyglasses" – or as Jaldemark et al. (2019) call them, Point of View (POV) glasses – may offer a method for circumventing the challenges of the aforementioned technologies, as well as the cognitive and linguistic demands that think aloud and reflection might place on learners while opening new access for teachers to what learning looks like and includes, *for students* (e.g., Hagerman and Cotnam-Kappel, 2019). Indeed, Jaldemark et al. (2019) suggest that using wearable technologies may "…result in developing new research methods in order to understand and visualise the child's perspective, and using wearable technologies could certainly be one of these areas" (p. 1292).

In this paper, we explore the methodological implications of the use of POV glasses with students in a split-grade junior classroom at a school located in a lower-income, urban community in Ontario, Canada. Through analyzes of students' learning during a digital tutorial-making task, we discuss the affordances of POV glasses for digital literacies research, including in-the-moment access to the students' challenges, accomplishments and efforts in their making and learning processes (both individually and in collaboration with others) and the value of students' perspective for assessing their learning outcomes. The use of POV glasses, however, also includes a host of methodological considerations – including data management strategies, privacy and ethics concerns, and hardware considerations – which we outline in detail, as well.

The specific research questions driving our study include: (i) What complexities are captured as children engage in phases of a multimodal digital-physical maker project through first-person gaze "spyglasses"? and (ii) What are the methodological considerations for use of first-person gaze "spyglasses" in maker-oriented classrooms?

1.1. Theoretical framework

As this study was oriented around a maker task, our research is rooted in design thinking (Kafai and Peppler, 2011; Gobble, 2014), knowledge creation (Engeström, 1999; Hughes and Morrison, 2018; Hughes et al., 2019), and constructionism (Papert and Harel, 1991; Kafai and Resnick, 1996; Kafai, 2006). The concept of design is central to makerspace learning, with its emphasis on promoting transferable skills and global competencies such as creativity, critical thinking, collaboration, and communication. The students in this study were tasked with solving an authentic, real-world problem and provided with open-ended ways to design and develop a solution (Kafai and Peppler, 2011). Through design-based learning, students engage in iterative processes of creation, testing, and refinement (Gobble, 2014; Smith et al., 2015) that may or may not be visible in their resultant products. Moreover, design activities encourage collaboration through the sharing of ideas as well as giving and receiving feedback (Carroll et al., 2010). The social activity that students engage in during a making session contributes to their knowledge creation and meaning making. Knowledge creation is mediated by the various tools students use, which can be both conceptual (signs, language), as well as material (Vygotsky, 1978). The results can be concrete – physical, digital and/or tangible artifacts – or conceptual (Wartofsky, 1979; Hughes et al., 2019). This perspective aligns with a constructionist approach (Papert, 1993), which suggests that knowledge is actively constructed through hands-on experiences and reflection on the learning that occurs throughout the process. As students work toward the construction of an artifact – whether physical or digital – they are leveraging and challenging their understanding of numerous concepts (Papert and Harel, 1991; Sheridan et al., 2014). For example, the construction of a model home may draw upon mathematics (for measuring dimensions), science (for creating electrical systems), visual arts (for designing interior spaces), social studies (for examining the environmental impact of different types of housing), and so on. Their final product becomes a tangible representation of the culmination of their learning, but those vital processes may be missed (Hughes, 2022). To extend this, we also draw on Vygotsky's (1978) theory of socio-constructivism to focus on how students' conceptual understandings of digital literacies might be developed through their engagement with others (e.g., table partners) throughout the making process. Maker classrooms are vibrant, bustling spaces supported by meaningful, student-driven inquiry. To gain a more comprehensive understanding of the learning that occurs in these dynamic contexts, researchers and educators need methods that move with students and capture learning in process (Hagerman et al., 2022; Hughes et al., 2022).

1.2. Literacies research in makerspaces

Research on student learning in makerspaces, which are characterized as democratic, inquiry-based and student-centered learning environments (Hughes, 2017; Hughes et al., 2020) often attempts to focus data collection on the student making *processes* and *experiences.* This is because an emphasis on "process over product" is among philosophical underpinnings of maker-centered learning (e.g., Halverson and Sheridan, 2014). Consequently, this shift in emphasis has necessitated a reconsideration of the kinds of data collection methods used in maker education research. In our work with teachers across Ontario, we have encouraged different approaches to the assessment of maker activities, focusing to a large degree on pedagogical documentation, which is the ongoing collection and triangulation of various learning artifacts, including notes, slides, images, video and text to make student learning visible (Gandini and Kaminsky, 2004; Hughes and Morrison, 2018). Pedagogical documentation also offered us a way to collect research data. However, the situated, embodied and collaborative experiences that are so much a part of the student making process are difficult to capture. Observing a student from the beginning of a maker session through to the end may afford a researcher a different, in-depth and contextualized understanding of all the various literacies and practices recruited by the student – from the conceptualization stage of a project through to the research process and finally the making process (otherwise known as the design process). In this context, the researcher might get a first-hand account of what the student shared with others, how they moved through the space, engaged with the physical or digital making tools and so on. Making draws upon a variety of literacies practices and involves more than just the cognitive domain (Blikstein et al., 2017; Hagerman, 2017; Marsh et al., 2018). In the absence of the full picture of what transpired during a making session it may be difficult to accurately assess developments in students' competencies and literacies skills. For example, making is inherently a collaborative process (it is socially situated) and rich conversations and knowledge-sharing between makers often occurs in the making process (Hagerman et al., 2022). However, these are not always reflected in student journals, caught on tape or obvious in final products.

Mason and Davies (2009) explain that new research methods have arisen from ever-changing advancements of digital technologies. To better understand the maker learning process as it relates to literacies development and to mirror the kind of democratized learning that occurs in the maker classroom, our research team chose to use spyglasses as an innovative data collection tool in our study on maker learning. These glasses, hereafter referred to as "spyglasses" (though they were not used covertly) are embedded with a mini-camcorder with audio and video recording functionality. The spyglasses offered continuous footage, taken from the perspective of the student. And, as maker pedagogies shift the traditional power dynamics of the classroom (moving power away from the centralized knowledge hub of the teacher and emphasizing the distributed knowledge, expertise and agency of the students) so did the spyglasses shift the power into the hands of the students in terms of what was recorded.

There are sound reasons that we decided to use and advocate for the use of continuous recording *via* spyglasses as a legitimate methodological innovation. These reasons need to be explored early in this paper in order to respond to Travers' (2009) discussion of the mislabelling of many new methods as innovative. He argues that when some of these methods are critically unpacked, they no longer can be viewed as truly new, but rather old methods repackaged. For example, Travers (2009) states

> …it is hard to see how new technologies add much that is really new to qualitative research since, after learning the new technology, one still has to engage with familiar issues and problems…they flatter us into thinking that, because the methods are new or innovative, no further thought about methodological issues or how one analyzes the data is required. (p. 172)

Our study, however, is intentional in its examination of the nuanced methodological implications of this "new" technology for generating new perspectives, and by extension, understandings of phenomena that are otherwise unreachable by outside observers. We position our use of spyglasses according Xenitidou and Gilbert's (2009) definition of technological innovation: "Technological innovation refers to advances in technology (usually in the form of software and/or internet-related) that either constitutes a method in itself or pushes the boundaries of a methodology in contributing to or amending previous research practice" (p. 11). In our case, we believe we are pushing the boundaries of video data collection and analysis with the spyglasses as they change the how, what and by whom of data collection. For example, the content from the spyglasses is continuous and it is entirely from the perspective of the student which changes who has control of the recording and also what is seen and heard by the researcher. The video content also requires new ways of organizing collected data and other considerations (including ethical) explored in more detail below. In the literature review in the next section, we situate the use of video as a qualitative research tool, outline some of the affordances and constraints of using video in research and finally, discuss spyglasses as an innovative data collection tool as they relate to video.

2. Literature review

> "Consider what happens when a research participant…takes us into the space of her own story. If we want to participate as fully as possible with her telling, then we adjust our assumptions and listen differently." (Haig-Brown, 2003, p. 429)

Perhaps with participant-perspective video we, as researchers and teachers, may "listen differently" to the making and learning stories of our participants and students.

2.1. Video as a qualitative research tool

2.1.1. Positioning video as a research tool

Over a decade ago, Knoblauch et al. (2006) asserted that video is a highly effective tool for data collection and that it is being used more and more in various areas of social science research. Over the years, researchers have developed different ways of using video as a research tool – from the static camera "arranged in different positions … to capture sequences that best showed each critical event" (Eliasson et al., 2016, p. 1660) to ceiling cameras (Luff and Heath, 2012), walking-with-video (Pink, 2007, 2012, 2015) and participant perspective video – done using hand-held devices (Rose and Cardinal, 2018; Hughes et al., 2019) or devices attached to one's person (Estapa and Amador, 2016; Gollihue, 2019; Jaldemark et al., 2019). Participant perspective video recording has become more prevalent with the rise in popularity of new mobile technologies, like the GoPro Inc (n.d.) and other wearable cameras.

Jewitt (2012) explains that, as a research tool, "Video can provide a fine-grained record of an event detailing gaze, expression, body posture, gesture, and so on" (p. 6). Unlike a written description of an event, video "…is a multimodal record in which talk is kept in context and all modes are recorded sequentially" (p. 6). In classroom-based research, where social learning and interaction is important, video enables the researcher to situate or contextualize a moment (or moments) of learning.

2.1.2. Considerations of video as a research tool

While the use of video in research comes with many affordances, Jewitt (2012) warns of the "fractured representations" of an event that may result when using video due to "[t]he time (gigabit) limits of video recording…" (p. 5). In order to manage the time and filesize of these videos, researchers often limit their recording to short clips of notable events or conversations rather than engage in continuous recording of a research session (Jewitt, 2012). These snippets (as opposed to the entire event) may be isolated for micro-analysis, which may not be reflective of the entire event (Lemke, 2009). In addition to the time limitations of using video-recording as a data collection tool, there is also the limitation of field of view (Heath et al., 2010). For example, a tripod-mounted camera positioned in the corner of a room will only be able to capture a certain portion of the room from that one perspective (Luff and Heath, 2012). These limited perspectives not only restrict our ability to observe the whole of a research event, they also reflect (consciously or not) the researcher's preferred field of view; as Goldman (2007) asks, "Are these rich media artifacts a new way of understanding not only those we study, but also ourselves as researchers as the camera is pointed in a certain direction taping what the camera-person wants to display about these learning cultures?" (p. 5). To capture a more holistic view, researchers such as Pink (2007, 2012, 2015), Shivers-McNair (2017), and Gollihue (2019) have explored the use of walking with video techniques and mobile video recording tools, like the GoPro. The researchers have found that these techniques capture participant perspectives and their embodied and sensory experiences as they go about their work.

Video also poses other issues related to validity. For example, there is the question of whether or not video, as a data collection tool, is really capturing reality. Jewitt (2012) explains that when video is seen (by researchers) as wholly representative of the event being recorded, this can be problematic. With the knowledge of being recorded, participants' may alter their natural actions and interactions (Goldman, 2007). Though, Heath et al. (2010) have expressed that after a brief period of time the "…the camera is "made at home". It rarely receives notice or attention and there is little empirical evidence that it has transformed the ways in which participants accomplish actions" (p. 49). In turning away from this line of thinking altogether, Jewitt (2012) and Goldman (2007) both discuss alternative paradigms in which video is used. Goldman (2007) suggests that we need "to accept the performative actions we demonstrate whenever we are being observed" (p. 5). Jewitt (2012) suggests video could be used "…as a reflexive tool in the research process" (p. 10). She explains that "[f]rom this perspective, whether (and how) the camera is "made at home" or brought into the interaction is not understood in terms of "good data" or "bad data" but rather they become points of investigation" (p. 10). These arguments suggest that no matter the intended use, video data collection practices must be acknowledged for their potential influence(s) and situated by the researcher in relation to analytical affordances and limitations.

2.2. Innovative video research methods

2.2.1. Walking with video

Walking with video is a method that is popular in documentary filmmaking. Sensory ethnographer Pink (2011) explains that now, "people have started to use walking methods using video as part of social research method" (n.p.). It has become increasingly common in academic research with the rise of more mobile and wearable devices like the GoPro (Shivers-McNair, 2017; Gollihue, 2019) and spyglasses (Estapa and Amador, 2016; Jaldemark et al., 2019) which allow for researcher point of view and participant point of view (depending on how the cameras are used, by whom and for what purposes). For example, in her work on meaning-making in the makerspace, Shivers-McNair (2017) developed a technique she refers to as the "3D interviewing with digital video" approach (n.p.). In this approach, the researcher wears a GoPro that is primarily head mounted, but sometimes worn on the chest or held in the hand. She explains that the benefit is that the camera can "move with my head when I nod…, lean in to look closely at a machine…, or look down at my field notebook to take notes…" (n.p.). The technique helps the researcher attend to and record the embodied and sensory experiences related to the wearer's attention and making activity in the moment (Shivers-McNair, 2017). Similarly, in her research, Gollihue (2019) uses first person video ethnographic methods and explores "…the ways making is an embodied and relational process that is present in the practices of people living outside the margins of academic and corporate Maker movements" (p. 21). More specifically, her research focuses on agricultural production as a form of making and as a result expands the definition of "making" and what it means to be a maker. To document the agricultural making practices of her participant, both Gollihue and her participant engaged in continuous filming for the purposes of data collection. Importantly, the participant wore a GoPro to capture her making processes. This enabled the participant to tell her story of the making processes and to later engage in critical reflection. Gollihue (2019) discusses how "…bodies are integral to understanding expertise within a making environment" (p. 31). And, as a result, using cameras that better capture this embodied experience is key. The first person video ethnographic methods Gollihue uses borrows elements from Shivers-McNair's (2017) 3D interviewing approach, such as capturing and considering movement through the x, y, and z axes, videovoice which puts documenting one's community or experiences in the hands of the participant (Catalani et al., 2012), and sensory ethnography which prioritizes walking with participants as they go about their lives, chores, activities and/or making and video recording it all in an attempt to capture important sensory elements (Pink, 2007, 2012). Gollihue (2019) explains how "…listening to the stories of our bodies in a moment of making is important to understanding how people see themselves as makers, how they identify as makers" (p. 31). Unlike written or verbal accounts of making, the multimodality afforded by video captures the entire embodied making experience.

In these studies, the GoPro captures a unique perspective often absent from video-based research: a first-person account of the wearer's gaze, attention, and activity that can redefine what we, the researchers, observe from an external position (Kindt, 2011; Chalfen, 2014; Kinsley et al., 2016). Participant-perspective video not only lends credibility to our assertions about social phenomena, it also enables those who take part in our research to maintain control over what is collected as data, and to more accurately be regarded as participants, versus subjects, of research (Kinsley et al., 2016). However, use of the GoPro in social sciences research has revealed a number of logistical challenges that create space for alternative methods. First, positioning the device for both comfort and accuracy of perspective can be difficult. The GoPro can be worn on the head or upper torso, affixed to proprietary harnesses. A head-mounted device is preferable for capturing participants' perspectives, but the weight of the camera and design of the straps can impact its comfort over longer recording sessions (Kindt, 2011; Lee et al., 2017), particularly for younger children. Wearing on the chest may provide better comfort and stability but lacks the ability to capture participants' gaze and may result in unusable footage if the lens is blocked by furniture occupied by the participant (Kinsley et al., 2016). Even when worn on the head, calibrating the GoPro's optimal recording angle may require the researcher to view live footage while adjusting the device. Another consideration is the burden of cost; while the quality afforded by the GoPro makes it an affordable option for action videographers and other hobbyists (Vannini and Stewart, 2017), the number of devices needed to capture multiple perspectives may be challenging to justify for researchers and educators. Finally, the quality of the GoPro's audio recording may be inadequate for literacies research in the classroom. Gaining insight into participants' learning and making processes *via* their perspective includes the conversations they have with peers, teachers, and themselves amidst the crosstalk of a classroom. Both Kindt (2011) and Polkinghorne (2019) remarked that they experienced auditory challenges that would necessitate the use of an external microphone in future iterations.

2.2.2. Spyglasses as an innovative data collection tool

While Pegrum (2016) does not specifically discuss wearables as a tool for data collection tool or meta-cognitive reflection, he does discuss how truly mobile technologies and learning experiences have the potential to support situated, embodied, collaborative and constructivist learning. In their study on the use of wearable tech as a tool to better understand how people learn, Jaldemark et al. (2019) indicates that "Spy glasses have the obvious advantage of closely following the wearer, which is very helpful since people tend to move around during excursions and lab work" (p. 1301). Essentially, the spyglasses enabled the researchers in this study to follow a sequential series of events that began with capturing teacher instruction and then watching and listening to student interpretation and response. Similarly, the study by Sund (2016) on effective evaluation of students' science skills made use of the mobile, wearable spyglasses technology for data collection. In Sund's (2016) study, the use of spyglasses was important as "Gathering data in a confined space is complicated, especially when people are constantly moving around and the room is full of equipment" (p. 2221). The use of spyglasses and other wearable technologies can enable educators to assess students' scientific processes in addition to their submitted work, creating a holistic picture of students' learning. Moreover, Sund (2016) found that the novelty of wearing spyglasses for data collection was short-lived, given their similarity to the safety glasses ordinarily worn by students in a science lab. Finally, Sund (2016) explains that with regard to spyglasses, "Another advantage is that data can be collected with a number of cameras simultaneously, which makes it possible to "cross-reference" key situations in practical work and make sound recordings of all the people involved in the specific situation" (p. 2221). Worn by all members of a student group, for example, spyglasses enable researchers and educators to gain a fuller, richer picture of what occurred in a research space from multiple perspectives and vantage points where bodies and materials are in constant motion. This is echoed by Jaldemark et al. (2019) as they explain that

> Compared to camera recording, it was possible not only to pick out more details (audio and video) but in some instances, the spy-glass recordings actually gave completely different angles on what was taking place. For instance, in one lab work situation, one participant (not wearing spy glasses himself) was moving constantly among the other students, talking and laughing, from the video camera recordings appearing to act mostly as disturbance and not taking the teaching situation seriously. However, from the spy-glass recordings it became clear that he was at the same time leading his lab group and communicating (scientifically) with other groups. (p. 1297)

More accurately than a static camera or an observer's monitoring of a bustling research environment, the spyglasses can capture dynamic, embodied learning from an insider perspective.

In the aforementioned studies, the spyglasses are used primarily with students. However, in Estapa and Amador's (2016) study the spyglasses are used to record preservice teachers' in-the-moment noticing of significant events in the classroom as they relate to mathematics teaching and learning, with the intention of enhancing participants' reflective practice. This is done to later "…allow analysis of their [the pre-service teachers'] marked in-the-moment noticings within the classroom, which…provides insight that otherwise would have been unknown without the use of the technology" (p. 303). To denote a noticed event, the preservice teachers flag their hand in front of the spyglasses. During post-interviews when reviewing the content, Estapa and Amador (2016) noted that "the pre-service teachers never indicated they could not remember why a moment was marked when shown the video. Rather, through the technology, participants recalled the marked moment and re-entered that moment" (p. 303). In this way, as with the wearable tech from Gollihue's (2019) and

Shivers-McNair's (2017) studies, the participants can revisit, reflect upon and "extend their understanding" (p. 303) of events and interactions from their unique perspectives. What is captured is driven entirely by the participants (their interests, movements, noticings) centralizing the research participants' lived experiences, interests and agendas, and not the researchers'.

Compared against participant perspective recording using head mounted GoPros, researchers have found that glasses with embedded cameras are more comfortable to wear (Paro et al., 2015; Lee et al., 2017). This added comfort may prevent premature removal of the recording devices, ultimately capturing more data and a more complete picture of participants' experiences.

3. Methodology

3.1. Research design

In this study, we provide analysis related to one aspect of our methodology – the use of spyglasses worn by participants to collect data. The data come from activities conducted at one of two research sites during the second year of a four-year inquiry focused on children's literacy practices while making. The larger study uses a Design-Based Research methodology (DBR) (McKenney and Reeves, 2019) to investigate the impact of maker pedagogies on literacies teaching and learning for marginalized students. But for the purposes of this paper, we focus on the affordances and constraints of using spyglasses as an innovative tool in the collection of data pertaining to one of the "maker" activities the students engaged in at the beginning of the project. This activity involved students making "how to" guides, or tutorials, using Google Slides. Sharing is an integral part of the maker movement (Halverson and Sheridan, 2014), so this activity served three purposes: engaging students in authentic processes of collaborative knowledge construction; participating in a digital making project that showcased students' digital literacies use and development; and aligning with provincial curriculum standards around procedural writing, which enabled the teacher to devote multiple class periods to completing the project.

3.2. Setting

Center Ville (all names are pseudonyms) is a public elementary school located in an urban center in Southern Ontario. The school serves 366 children from Junior Kindergarten through Grade 8, 48.9% of whom come from lower-income households (Ontario Ministry of Education, 2018). Academically, Center Ville's provincial mathematics and literacies test scores have been among the lowest 6% of Ontario's elementary schools (Cowley and Eames, 2020), but their curricular programming and extracurricular opportunities emphasize innovation, equity, and student wellness. Over 5 years ago, Center Ville began to develop its makerspace program, partly through the support of a longstanding research partnership with the study authors from Ontario Tech University. Recent building renovations enabled the construction of an Innovation Lab, upgrading Center Ville's makerspace from a small room adjacent to the school library to a space that can accommodate maker projects with several classes simultaneously. The school routinely participates in regional technological skills competitions and supplements their curricula with STEAM programs and workshops hosted by community partners. Their commitment to student success and innovation has been echoed in previous projects, where both teachers and administrators expressed the importance of these programs and partnerships to their school culture (see Hughes et al., 2018, 2021, 2022; Hughes, 2022). To date, challenges posed by teacher turnover and the unpredictability of the COVID-19 pandemic have slowed the proliferation of a maker culture throughout Center Ville, but their teacher-librarian continues to support individual teachers in developing comfort and capacity in making with their students (Hughes et al., 2022).

3.3. Participants

Although 39 students opted into the research study (with parental permission) from Center Ville, this paper focuses on the making practices of two students who were purposefully selected because of the rich and representative interactions and engagements they recorded using the POV glasses. We present data from two male students from a Grade 5/6 split classroom. The students were between 10 and 11 years old, and described broadly by their teacher as "need[ing] more emotional regulation" but "more independent" and "motivat[ed]" while engaged in maker activities.

On the first day of the project (after consent forms were signed and the study's purpose was explained to the students), the research assistant (RA) facilitated a discussion centering on what the students thought it meant to be a maker. This led to the idea of sharing as an important aspect of making. The teacher and RA then facilitated a discussion on tutorials – what they are, when the students have used them previously, important elements included in tutorials (during this time, the teacher made links to procedural writing work students had already done in class). The RA distributed the "how to guide" activity instructions and rubrics. She then explained the activity included choosing a task the students knew how to do well and creating a tutorial that could teach someone else to do that thing. Students were directed by the teacher and RA that their tutorial should be broken down into clear, concise steps (more than just "a couple"). Google Slides or Microsoft Powerpoint were suggested as tools, although some students asked to use Word / Docs. Students were instructed that the task was individual but they could share ideas and ask questions of their peers. It was not mandated, but the teacher and RA both suggested that students take time to plan out their tutorials using the back side of the rubric/activity sheet.

Before students got started, they were re-introduced to the spyglasses (some had used them in the study the previous year). The purpose of the spyglasses was explained and the students were asked to be volunteers to help us collect data (we were unable to cross-reference the volunteers with the consent forms at time, so we later discarded any videos where the students did not provide consent). The students were initially given two consecutive class periods (approx. 1 h and 20 min) to plan and complete their multimodal tutorials; very few completed their guides in this time frame. As a result, they were given additional time around other class periods to work on them. During these additional time periods, the RA was not present. The RA left a USB thumb drive with each teacher to have students save their tutorials as they were completed, which was then returned to the RA to retrieve the finished products.

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3.4. Data collection and analysis

The digital student products (i.e., the "how to" guides the students created using Google Slides) were initially collected using a central shared folder on the class Google Drives; copies of these files were then created and shared with the RA *via* a USB thumb drive. Student interactions and the students' digital creation processes were collected using the spyglasses (more of this below). Researcher field notes were also collected.

3.4.1. The spyglasses

There are a number of different wearable technology glasses on the market. Some glasses enable a user to view data on their lenses and others act simply as recording devices. In this study, we used the Toughsty GL1100 multifunctional eyewear which resembled conventional thick-rimmed seeing glasses with clear plastic lenses so as not to obstruct the vision of the wearer (see Figure 1). Each pair has a small microphone and camera embedded into the frame of the glasses adjacent to the left lens. The temples (or "arms") of the spyglasses are comparatively thicker than those of conventional glasses in order to accommodate the operational buttons, microSD card, wiring, and other electronic components. The spyglasses used in this study are a two-button model; one button turns the camera on and off and allows the user to capture photographs of their work, while the other controls longer-form video recording. An LED located on the inside left arm of the glasses indicates the state of operation: solid blue when the camera is on but not recording, flashing blue and then off when the camera is recording, and solid red when the camera is plugged in and charging. The exact model of spyglasses used in this study are no longer available, but comparable models retail for between $50 and $80 per pair. During recording, the spyglasses capture video in 10 min increments until (a) recording is stopped manually, (b) the memory card becomes full, or (c) the battery is depleted. An 8GB microSD card was included with the spyglasses, however the 1 to 1.5 h battery duration meant that the spyglasses' battery typically depleted before the memory card became full, despite the camera's 1080p recording resolution. Video files were transferred from the spyglasses to password-protected external harddrives *via* the researchers' computer through use of the microUSB-to-USB cable included with the device, although a microSD card adapter could also be used. Recordings for each session ranged between 2.5GB and 5GB per student; as students became more familiar with the spyglasses' controls, some opted to stop recording when they no longer wished to wear the spyglasses, while others accidentally disabled the recording while adjusting the glasses on their face, passing them to friends to wear, or placing them on the table when they needed to step out of the classroom.

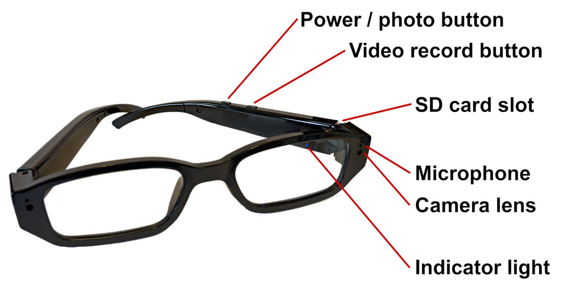

FIGURE 1
Example of the spyglasses used by students in the study.

As students began to design their multimodal tutorials, the RA activated and distributed the spyglasses to students who had provided consent to participate in the study. In addition to the discussion about respecting privacy that had been facilitated with the entire class, students were reminded that they could remove the spyglasses or stop recording at any time they wished. By disseminating the spyglasses early in the project, we hoped to capture the valuable design processes, cycles of inquiry, and social interactions that form the basis of maker learning (Hagerman et al., 2022; Hughes, 2022) and, in this context, could highlight students' use and development of digital literacies.

3.4.2. Data analysis

The final version of the students' digital "how to" guides were the first pieces of data analyzed as we wanted to record our initial impressions of the student end-products before referring to the video recordings of the students' process work for context and an insider perspective. It was important for us to understand the extent of the interpretive gap between what might be reflected in student end-products and the learning and development of skills that might occur during the process work. For this initial investigation of the digital artifacts, we drew on visual and content analysis. To create our analysis categories (outlined below) we borrowed from the principles of design outlined in the Ontario Visual Arts curriculum and what we knew of procedural writing from the Ontario Language Arts curriculum. We then assessed the final products using the following categories: (1) Layout design (balance of image and text and placement of image and text in relation to one another and to the negative space on each slide), (2) Color-theme (appropriate and complimentary colors related to the topic), (3) Appropriate amount of instructional description (i.e., all essential information present, but not too much as to overwhelm and/or confuse a reader), and (4) Information presented in a logical, step-by-step manner so that a reader is taken from the beginning step to the desired outcome. While we recognize that the content of students' learning – and thus, the capacity of spyglasses to capture it – extends beyond formal curriculum expectations, we aligned our analysis of students' tutorials with their teacher's evaluative criteria in order to work from a uniform baseline. We noted how well the students adhered to these in their final products before reviewing the video documentation of their process work.

The video recordings of the student interactions were then reviewed by the research team. The researchers compared notable differences in terms of the digital literacies skills development revealed in the videos versus reflected in the students' final products. Following this, the interactions were documented by one of the researchers using a hybrid model of narrative description and the verbatim recording of rich or noteworthy conversations between students. The spyglasses afforded us the ability to look carefully at students' digital making process, including movements of their cursor on screen to indicate reading or design decisions, head movements that suggested areas of focus either on screen or in the room, instances of watching and learning from peers, etc., The conversations that were flagged for verbatim recording included those that directly referenced or were related to digital literacies, highlighting the important role of social interaction in students' knowledge development during their digital making (Vygotsky, 1978; Hagerman et al., 2022). Also recorded verbatim were any revealing think-alouds the students may have engaged in that communicated their learning about, and/or performance of, their digital literacies skills.

The transcripts of the students' interactions were then analyzed using thematic coding. The researchers first reflected on the patterns that emerged in the transcripts and then went back through the transcripts to code them for the following: (1) Instances of reflection and revision, (2) Instances of keyboard shortcut commands, (3) Instances of basic computer navigation (including file uploads), (4) Instances of search-term optimization, (5) Instances of knowledge-sharing and collaboration, and (6) Instances of trouble-shooting and problem-solving. These were then condensed into two main themes: digital literacies practices/development and collaboration. Through analyzes of students' digital maker work on their multimodal tutorials, both with and without the added perspective provided by the spyglasses, we were able to construct rich cases of students' literacies learning in the maker classroom. While fragmented versions of these cases could be pieced together from traditional recording methods, the spyglasses afforded continuous recording of students' engagement in design processes, artifact creation, and social knowledge construction that provided a very different interpretation of their digital literacies use and development than their artifacts alone.

Researcher field notes were also reviewed and thematically coded to reveal methodological considerations related to the use of the spyglasses.

4. Findings and discussion

The specific research questions driving our study include: (i) What complexities are captured as children engage in phases of a multimodal digital-physical maker project through first-person gaze "spyglasses"? and (ii) What are the methodological considerations for use of first-person gaze "spyglasses" in maker-oriented classrooms?

4.1. Insights afforded by first-person gaze "spyglasses"

Examining the data captured by the spyglasses, we were interested in examining the complexities that become apparent when a child's gaze and perspective become the orientation for the data. These included:

- Interpersonal complexities (e.g., peer-to-peer interactions)
- Sensory complexities (i.e., we gain access to the visual, auditory and tactile sensory environments as experienced by the children)
- Learning complexities (i.e., we gain access to the digital skills of focus and practice that are often hidden behind the laptop screen, or only partially visible in the end products we receive and analyze for evidence of learning; we also gain access to the ways that children have to work to maintain focus in a dynamic maker environment)

The spyglasses provided rich insight into the students' complex making processes. The recordings allowed the researchers to observe some of the students' digital literacies skills at the start of their making processes and also how these literacies skills developed as they navigated the learning activity and engaged in collaborative learning. The spyglasses allowed the researchers to see beyond the final products the students made in their diagnostic activity – many of which, at first glance, did not appear as though much time or thought had been invested or skill applied in their creation. Furthermore, the first-person perspective and continuous recording afforded by the spyglasses revealed more complete insights into students' making and learning processes compared with other audiovisual data collection techniques. Stationary recording devices such as camcorders and iPads placed on students' desks are effective for capturing social cues such as body posture and facial expressions, as well as projected conversations between groups of students, but from a limited (often third-person) viewpoint (Heath et al., 2010; Jewitt, 2012). If mounted behind the student, we approach their perspective but lack valuable understanding of the ways in which their shifting gaze can indicate areas of focus, confusion, or distraction. Handheld devices, operated either by the student or the researcher, offer focused recording of notable events and exchanges but require the operator to not only decide what counts as "notable," but also to be in a position to record which may not reflect their authentic, in-the-moment learning activities from being captured. In our study, it was only in having access to the student vantage point that the rich thinking, communication and learning processes were revealed and this painted an entirely different picture of how the students spent their time and what they learned in the process.

Moreover, reflecting on classroom maker activity through students' eyes offers valuable perspective for both educators and researchers. Given the active, inquiry-based, and embodied nature of making, students' resultant artifacts rarely tell the whole story. Spyglasses can capture the nuance and process of students' making, highlighting the ways that interacting with others (Vygotsky, 1978), engaging in iterative design cycles (Kafai and Peppler, 2011; Gobble, 2014), and creating tangible or digital products (Papert, 1993; Kafai and Resnick, 1996) facilitated the construction of students' knowledge. As such, spyglasses have the potential to complement teachers' existing assessment strategies as an unobtrusive and relatively inexpensive way to engage in pedagogical documentation and supplement students' submitted work.

We organize the findings around the major theme we saw emerge most prolifically from the data: the practice of students' digital literacies skills through in-the-moment discovery and peer-collaboration. We also outline our discoveries around the various methodological considerations that we experienced, as researchers, when choosing to use POV glasses for classroom-based research. We then discuss the implications of these findings.

4.1.1. The practice of digital literacies through in-the-moment discovery and peer collaboration

To exemplify the insights into students' making and learning practices captured by the spyglasses, we present the case of Larry and Donald (pseudonyms), who sat near each other as they worked on the Google Slides tutorial activity.

Larry's video is interesting because it captures the rich digital-literacies-focused conversation between him and his seat partner, Donald. If one were only to look at his and Donald's diagnostic end products one would conclude that they were struggling with the development of their digital literacies skills. For example, Larry's end product does not appear as though it took a lot of time to compose, nor does it look like much thought was invested (see Figure 2 below):

The final product is rife with spelling and grammar errors and there is little in the way of multimedia or detailed description. As a result, one might assume that this final product was rushed and/or that the student was not engaged in on-task learning. However, when listening to the video recording from Larry's spyglasses, the two boys can be heard and seen exploring various functions related to Google Slides, Chrome, the Desktop Manager on the computer and importantly, a variety of keyboard shortcuts – one marker of digital fluency. Below is a narrated excerpt from the spyglasses transcript that provides a snapshot of some of the in-the-moment discovery and sharing surrounding keyboard shortcuts:

> Donald: "It's Ctrl M to make a new slide."
>
> Larry repeats, "Ctrl…"
>
> Donald: "Do Ctrl + I–- it's to inspect."
>
> [Larry then appears to get distracted by some options in the top right corner of the Google slides]
>
> Larry: "Oooh what's this?" [Larry starts tapping the screen which makes the presentation full screen and makes a finder tab appear. The tab displays options for uploading files to the Google Slides]
>
> Larry: "Oh, boy look at that! I can post my video on here." [referring to the picture and video options that appear in his Finder window of files that could be uploaded to his Google Slides presentation]
>
> Donald: "That's not a video, those are pictures."
>
> Larry: "This is a video." [Larry points to one of them].
>
> [The two boys keep working on their slides]
>
> Donald: "Ctrl + D is to make a slide too."
>
> [Some time passes]
>
> Donald: "Ctrl + A is to highlight all the slides."

Here, Larry and Donald can be seen exploring the features of Google Slides and the computer, in general, especially as these relate to keyboard shortcuts. Getting to view the students' creation processes contextualizes how the boys spent their time and how much exploration and collaboration were involved in their digital literacies development and in their product creation. Given their alignment with students' eyes, the spyglasses more accurately capture areas of visual focus as well as minute gestures that can illustrate students' discovery, learning, and making processes than traditional recording methods or other wearable cameras. For example, after Larry is informed how to access to his web browser's "Inspect" dialog, his

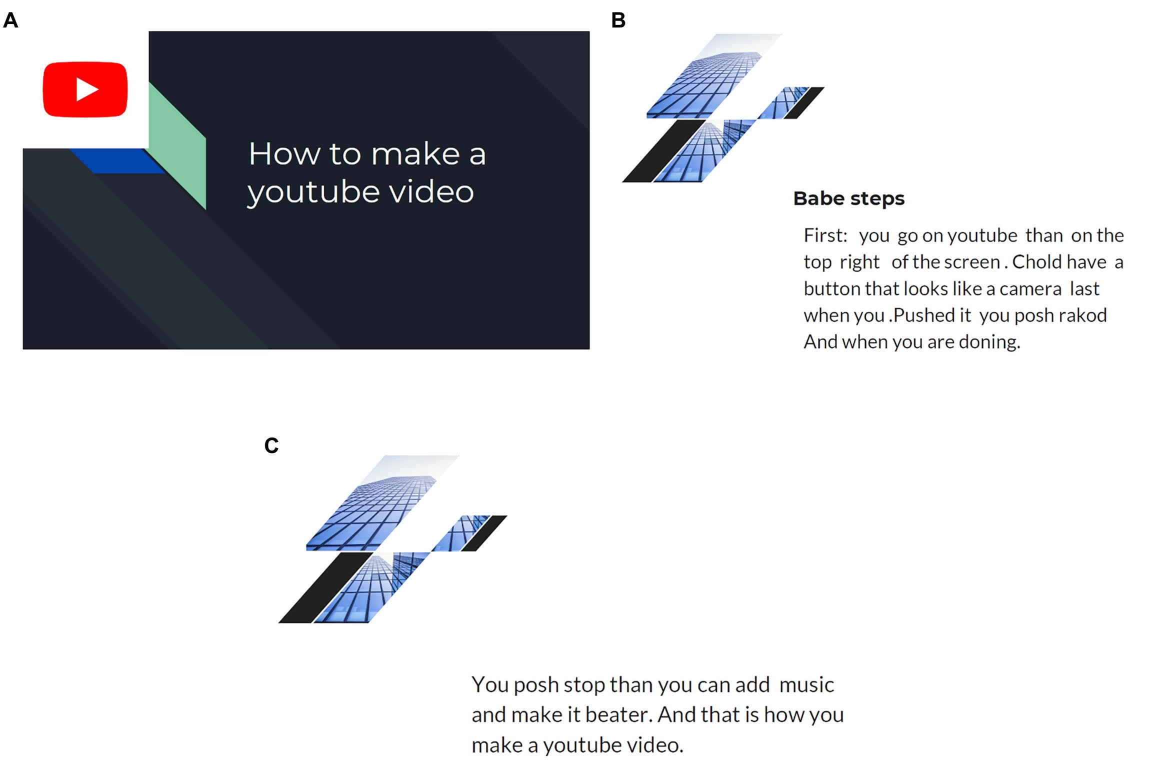

FIGURE 2
(A-C) Larry's Google Slides walk-through on "How to Make a YouTube video."

shifting gaze and small movements of his cursor indicate that he is actively reading the revealed source code. While his comprehension of the code is understandably limited, he comes to realize that he can change (or in his words, "hack") the version of the page he sees on his screen. The spyglass videos provided important insight into what kinds of 'aha' moments the boys experienced and how much they learned about the features of Google Slides, in general. Below is another narrated excerpt from one of the spyglass clips that supports this:

> Donald: "How do you make slides? Google Slides?"
>
> Larry: "You type it. It's so easy" [points to the Google Chrome search bar]. "Oh! You already have it. That's Google Slides." [points to the Google Slides icon realizing the icon is displayed on the search page]

Through this interaction (helping Donald), Larry learns something new himself about how to access and open a new deck of Google Slides. In this case, Larry realizes there is a shortcut (a Google Slides icon) at the top of the Chrome browser.

Another "aha" moment Larry experiences is when he discovers that he has access to files in the Google Drive that he created in previous years.

> Larry: "Oh! Look how much I made! Our team name is Pixelators. I remember that! The Pixelators! Remember?"
>
> Donald: "Well you posted it."
>
> Larry: "Oh! I opened it Feb. 15th." [reading the file history]
>
> [Larry continues to search through old presentations he's made that he has not seen since he made them]

The surprise and fascination are notable as Larry quickly becomes absorbed looking at the metadata available (i.e., when he last accessed this content). Again, the spyglasses capture the subtle head movements that accompany Larry's shifting gaze illustrating that he is, in fact, actively engaging with the file's metadata as opposed to other methods of recording that may capture students' screens without the nuance of their engagement or may not capture it at all. It appears that Larry was not aware that his previous work in Google Slides was housed in a central location within his personal account in the Google Drive. Basic navigation and organization of files in the cloud is an important digital skill to master. From this example, it is clear that Larry is building an awareness of where his files are saved, how to access them and how to read the metadata attached to them (which can provide important information, depending on the context of the file retrieval).

Larry then shares some other interesting insights he has come across in his exploration of Google with Donald.

> Larry: "Do not push Ctrl N…I dare you to push it."
>
> [Donald pushes Ctrl + N]
>
> Larry: "Boom! It just restarts your whole thing." [the command opens a new browser tab]

Larry's intrigue with his newfound control over the laptop through keyboard shortcuts is palpable. His discoveries (some accidental) encourage him to continue in his exploration and sharing of newfound knowledge with Donald. Soon after, Larry is also heard explaining to Donald what he's discovered about the alignment features in the text boxes of the Google Slides he has open (i.e., left, middle, right align).

> Larry: "Watch, apparently this is the middle."
>
> Donald: "No it's not."
>
> Larry: "Watch…And then when I add the "middle", it goes to the middle."

Larry exemplifies, through demonstration, his point to Donald about this command.

The spyglasses also reveal unique insights into the social construction of students' digital literacies. While existing methods of audiovisual recording can effectively capture students' conversations (provided low levels of room noise and crosstalk), movement between peer groups for discussion, collaboration, and sharing, and inspiration obtained from glancing at nearby students' work, the spyglasses can illuminate the active choices that are made as a result of these interactions. For example, after both students had finished creating a basic title slide, Larry glances at Donald's computer and sees that he has added the Roblox logo to visually enhance his tutorial on signing into the game Roblox. Larry quickly looks back to his own computer, saying "wait, I want the YouTube sign," and begins the process of adding the YouTube logo to his tutorial. Looking only at Larry's final product, we would see the choice he made to include visual elements – such as logos – to his tutorial, and a stationary recording device might capture his sideways glance prior to his decision to do so. However, through Larry's gaze captured by the spyglasses, we recognize that this design decision was inspired by his observation and evaluation of a peer's creative choice.

Similarly, the multimodal pairing of students' gaze with their gestures and/or verbal expressions can elucidate their intentions during independent and collaborative work. Across the spyglass recordings of this maker task, we can hear Larry thinking aloud as he navigates the Google Slides interface and types the content of his tutorial. At one point, he says "I know how to add a background" which, given the context of his prior utterances, could be incorrectly classified as another example of self-talk. However, the spyglasses video shows his gaze shifting slightly upward, looking over the top of his computer screen in the direction of a peer who had asked a question of the research assistant. With this information, we can ascertain that Larry was offering peer support for the task, and gain a greater understanding of the ways in which students learn from one another as their digital literacies develop.

4.2. Considerations

While the POV spyglasses provided us with important insights into the students' learning processes, we noted a variety of considerations that were common at both research sites. These considerations can be grouped into two major themes – data considerations and hardware considerations.

4.2.1. Data considerations

As with any new technology, outlining usage guidelines was a must. Previous research on wearable cameras noted ethical concerns with inadvertently capturing the likeness and activity of individuals who had not consented to be recorded (Chalfen, 2014; Kinsley et al., 2016) – a concern that we shared. We found it was necessary to make students aware of appropriate use guidelines to avoid recording sensitive or inappropriate data. We advised students that they must remove their spyglasses and leave them on their tables before leaving the room to avoid recording students, teachers, and other members of the school community who were not involved in the research project, and to prevent capturing private details (such as out-of-class discussions, students going to the washroom, etc.,).

We also experienced a restriction of control in terms of what was actually recorded. For example, at times interesting conversations were recorded but when the child wearing the spyglasses moved away from that conversation, the capturing of it ended.

In terms of data organization, transcriptions and analysis, the sheer volume of data was, at times, overwhelming. In previous years of this study, a tripod-mounted camcorder produced between 2.5GB to 5GB of data per hour-long session; spyglasses produce the same amount of data *per participant*. For this reason, the traditional practices surrounding transcription of recorded video were adapted. In our case, we opted for narrative description coupled with verbatim transcription of noteworthy conversations. However, this is also an imperfect strategy as one might question what is lost if one researcher does not deem something "noteworthy" that another might have. Furthermore, as with any large volume of data, a robust organizational system was needed to facilitate within-and cross-case analysis (Chalfen, 2014). We developed a master spreadsheet in which all of our raw data were listed, described, and hyperlinked. Additionally, the spyglasses transcriptions were recorded per student rather than per 10 min video segment, reducing the number of active files per maker session by a factor of five. Despite the logistical challenges posed by the additional data, the continuous recording of individual students' perspectives created rich cases of digital literacies use and development that would have been missed through traditional video methods and artifact analyzes alone.

Time management considerations related to keeping devices charged, downloading and organizing the data, and storing it between planned days for data collection necessitated careful scheduling of research activities. This was particularly challenging when we wanted to capture several days of learning in sequence. The data had to be downloaded and immediately cleared from the glasses' internal storage in order to be ready for the next days' research.

Working in a classroom with young children, we also ran into the issue of students wanting to have the same pair of glasses every time. Although the students had been made aware that the glasses no longer contained their previous days' data, our referral to the glasses as "spyglasses" resulted in them framing themselves as spies, and appropriating our glasses' internal inventory labels (e.g., Spy 01, Spy 02, etc.,) as code names. So, labeling and keeping track of the glasses became important to maintain the narrative students had created – and enjoyed – for their use.

4.2.2. Hardware considerations

Students who wore corrective lenses were often unable to wear the spyglasses, given their close fit to the face. Using a model with a looser fit or, ideally, intended to accommodate glasses worn for vision improvement would have made for more inclusive video capturing.

The thicker arms (compared to regular glasses) caused some students discomfort in wearing them for longer periods of time; other students found it cumbersome/uncomfortable to have the glasses sitting on their face/seeing the frame out of their peripheral vision/etc.

Battery life was also an issue. On a full charge, the spyglasses could record for anywhere between an hour to an hour and a half and would take several hours to charge. For short, singular sessions, this was adequate, but planning to record multiple sessions per day required strategic thought as to (a) which students' perspective would be captured and (b) balancing the placement of spyglass-wearing students throughout the room to capture as much working conversation as possible.

5. Conclusion

POV glasses take us into the students' lived experience in a way that is unfiltered by our own researcher ideas, ways of seeing, knowing and making meaning. The access to the students' interactions is interpreted by us – but not at the moment of the experiences being gathered. This is a unique and important methodological insight. Furthermore, these data challenge us to recognize the complexities in the digital literacies learning and practices that the students try to use, fail to use, talk about using. No teacher or researcher can possibly gather all of that information from all students, so through use of the spyglasses we end up with data sets that include much more complete evidence of the challenges, the accomplishments, the efforts made and how children try to negotiate all of this independently and in collaboration.

Although there are many benefits to using POV glasses for research, there are also a plethora of considerations related to data collection and the hardware itself. These need to be adequately thought through before using POV glasses in research. Systems need to be in place that ensure researchers deal with important ethical issues, data storage and management issues, and hardware issues, like battery life and fit. These are particularly important for educators who may wish to employ POV glasses to supplement their classroom observations and assessments. To normalize their use, we recommend introducing the devices early in the school year and designating students as the glasses' caretakers, ensuring they are cleaned and charged for the next days' use. Moreover, while recording and transcribing first-person perspective videos for a larger number of students may be desirable for research, it may be more manageable for teachers to use them with a select group of students, rotating between assignments or curricular units as needed, and reviewing the videos for relevant learning outcomes rather than verbatim transcription of entire videos.

As classroom-based research continues to explore practices related to digital and physical making, having research tools that can more comprehensively capture the students' process work and learning will be important. Maker education is highly process-driven, and while students' submitted artifacts represent a part of their learning, without insight into students' design decisions, peer interactions, and making processes through their perspective, our judgments may be incomplete. Future research might continue to explore the gap between researcher interpretation of collected data when it is not "read" alongside, or compared against, documentation from the "insider" perspective. This research may help classroom-based researchers build more robust and trustworthy methodological practices.

Data availability statement

The datasets presented in this article are not readily available because of potentially identifiable information about youth participants. Requests to access the datasets should be directed to JH, janette.hughes@ontariotechu.ca.

Ethics statement

The studies involving human participants were reviewed and approved by Ontario Tech University Research Ethics Board. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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