

Running head: EXPLORING YOUNG CHILDREN'S IDEAS ABOUT WEARABLE TECHNOLOGY

Exploring Young Children's Ideas about Wearable Technology:

A Case Study

by

Bridgette Atkins

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Abstract

This case study, which forms a part of the *Kids, Creative Storyworlds and Wearables* project, explores children's perspectives on wearable technology through their stories and other creative ideas inspired by wearable technology. Five children between the ages of four and seven were each given a smartwatch and were interviewed three times over the span of four weeks. Using a multi-method approach, inspired by the Mosaic approach to ethnography (Clark & Moss, 2011; Clark, 2005) and social semiotics (Kress and van Leeuwen, 2006; Kress, 1997), children were invited to share their ideas in a variety of ways (face-to-face discussion, oral storytelling, written text, drawings). This research viewed children as meaning-makers and sign-makers. Results supported and extended elements of Papert's constructionist learning theory and Sutton Smith's "play as a viability variable" theory (2008) and provided novel insights relevant to formal education practices. Empowerment is a key theme that emerged from this case study.

*Keywords: wearable technology, child-computer interaction, Mosaic approach to ethnography, constructionism, empowerment*

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## Introduction

### Overview

This qualitative research study involves young children's creative ideas and opinions regarding wearable technology and sits within the context of the *Kids, Creative Storyworlds and Wearables* project. The project is a collaboration between individuals in a lab focused on digital culture and media within a Faculty of Social Science and Humanities and members of the Faculty of Education at the University of Ontario Institute of Technology. *Kids, Creative Storyworlds and Wearables* seeks to explore children's perspectives on wearable technology largely through their oral storytelling, pictures and written text and is informed by Clark and Moss' Mosaic approach to ethnography (Clark & Moss, 2011; Clark, 2005) as well as Kress and van Leeuwen's (2006) work on social semiotics. This thesis contributes to our understanding of how children incorporate wearable technology in their lives. Amongst several novel ideas, it identified the role of empowerment in connection with children's experiences with wearable technology (and other novel technologies), including learning with this type technology.

Wearing technology on the body is not a new practice. The wristwatch, for example, became a common way to monitor time after it was used in World War I, though its history dates back to the 1600s (Martin, 2002; Guler, Gannon, & Sichhio, 2016). Wearable technology, sometimes more generally referred to as *wearables*, can encompass a wide range of devices. As far back as the Qing Dynasty in the 17<sup>th</sup> century, rings that included technology that could help to perform calculations are believed to have been used by traders (Guler, Gannon, & Sicchio, 2016). Billingham and Starner (1999) refer to "wearable computers" as "anything from small, wrist-mounted systems to bulky backpack computers" (p. 57). Although, as exemplified by the smart rings

believed to have been worn in 17<sup>th</sup> century China, they could encompass even more discrete forms of technology. Since the 1970's, various iterations of the smartwatch have appeared on the market (Guler, Gannon, & Sicchio, 2016) and have been situated within the realm of the Internet of Things (IoT) (Deepthi & Anil, 2016), which describes a network of physical objects which can be controlled or accessed over the Internet. Closely related to wearable technology, the terms *computational textiles*, *smart-textiles*, *electronic textiles*, or *e-textiles* are sometimes used synonymously and refer to the combination of computers, electronics and fabric, often sewn using a type of conductive thread and sometimes equipped with sensors (Buechley, Eisenberg, Catchen, & Crockett, 2008; Kafai et al., 2014; Qiu, Buechley, Baafi, & Dubow, 2013; Page, 2015). Though some e-textiles are worn on the body, Buechley (2006) argues that e-textiles represent a distinct field and can include things that are not worn on the body – smart quilts, for example.

Wearables continue to evolve in the imaginations of technologists, academics, writers and filmmakers and – to varying degrees – have made their way into mainstream culture. Regardless of their rate of adoption, acceptance or perceived value, wearables inspire thought regarding humans' relationships with technology, themselves and others. Pedersen (2013a) explored a variety of ways in which “reality shifting” is currently possible or could be made possible through the use of a number of wearable technologies that are either ready or close to being ready for use by the general public. Examples range from portable music players, to dresses displaying the wearer's Twitter feed, to lenses worn on the eye that augment reality or implantable technologies that are being imagined and tested by biohackers. Furthermore, wearables may also serve as communication devices. Pedersen explained, “Wearable computers, computers that you strap to the body and ‘wear,’ emerge as a new medium of communication” (2005, p. 1). She went on to explore their capacity as a communication phenomenon, rather than only a technological one. Acknowledging that

wearables and reality-shifting interfaces are predicted to be culturally transformative, Pedersen makes the argument that they need to be designed under values such as human-centricity. She stated in the article geared to engineers titled "Ready to Wear (or Not)":

As we design digital devices to augment our physical existence, how are we altering the way people conceptualize so many other aspects of humanity such as creativity, analytical reasoning, nostalgia, imagination, and privacy? When mainstream media celebrate technology such as Google Glass and so many other new wearable devices, we need to take a much closer look at how they frame us, our culture, our society. (Pedersen, 2013b, p. 1).

Wright and Keith (2014) stated that "the ultimate goal of wearable technologies is to incorporate functional portable computer and electronics seamlessly into people's daily lives" (p. 205) and pointed to the emergence of wearable technologies in a range of contexts including health care, fitness, education, gaming, music, etcetera.

Wearables intended to promote a deeper connection between plants and humans have also been conceptualized (Flanagan, 2015). The goal of wearable technologies to integrate "seamlessly" into humans' everyday lives is not embraced by all, however. In the Cranny-Francis (2008) article on the changing metaphors used for wearable technologies over time, contrary viewpoints, which highlighted the differences between the human body and wearable technologies, were also acknowledged. As one example, the relationship between a musician and their instrument was likened to an individual and their interactions with wearable technology (Shroeder & Rebelo, 2007, as cited in Cranny-Francis, 2008).

Regardless of whether wearables are perceived as being seamlessly integrated or highly visible, they have become engrained in the personal routines of a portion of the population with devices such as fitness- or health-trackers and smartwatches, as part of the *Quantified Self* movement (Gilmore, 2016; Jethani, 2015). Furthermore, sales of

wearable technology and smart-textiles are expected to grow in the next several years (Page, 2015). Wearable technologies – including e-textiles, smartwatches, wrist phones, and programmable bracelets – for young children are already appearing in stores, classrooms and summer camps. It is possible that wearable technology will become a normal part of our “technological ecosystem,” as Lee, Drake, and Williamson (2015, p. 46) described it. The growing market for technologies created for children is one reason Read and Markopoulos (2013) warned that there is currently a pressing need to study, not only the design of technologies for children and the interactions between children and technology, but also the associated research methodologies.

From a broad perspective, this research embodies elements of transformative, and social constructivist philosophical worldviews (Creswell, 2013). This study sought to give a voice to young children, who are often overlooked in research of this kind, and was primarily focused on the meaning that is constructed by these children with regard to newer forms of technology that have become a part of their lives.

In their introduction to *Reading Images: The Grammar of Visual Design*, Kress and van Leeuwen (2006) stated:

Like adults, children are engaged in the construction of metaphors. Unlike adults, they are, on the one hand, less constricted by culture and its already-existing and usually invisible metaphors, but on the other hand, usually in a position of less power, so that their metaphors are less likely to carry the day. (p. 8)

This viewpoint – in part – captures why the participant age group (ages four to seven years old) was selected and why it was deemed important to provide young children with an empowered and active role in this research. This fits well with the Mosaic approach, which Clark and Moss call a “framework for listening,” in particular to young children whose voices are often neglected in decision-making and research related to their lives (2011, p. 4).

Exploring wearable technologies through the perspective of a young child, without the specific goal of informing design, is perhaps more novel than the emergence of wearable technology itself. In this case study, children between the ages of four and seven were each provided a VTech® Kidizoom® Smartwatch and were interviewed independently three times each over the span of one month. Rather than focus on usability or technological design, this research concerns itself with what children think about this type of technology, what meaning they derive from it or cast upon it, along with the creative ideas and personal narratives it may inspire for them.

Children's ideas about other technologies have been explored to varying degrees in previous studies. Sherry Turkle, a researcher out of the Massachusetts Institute of Technology (MIT), for example, is interested in the ways people think about, and talk about computers, and likewise, how their thinking is influenced by interactions with computers (Turkle, 2005). In a manner that is similar to the approach taken in the *Kids, Creative Storyworlds and Wearables* project, Turkle wrote the following in her introduction to the twentieth anniversary edition of her book, *The Second Self: Computers and the Human Spirit*:

As it happens, experiences with computers become reference points for thinking and talking about other things. Computers provoke debate about education, society, politics, and most central to the theme of this book, about human nature. In this, the computer is a "metaphysical machine." Children too are provoked... irrespective of the future of machine intelligence, computers are affecting how today's children think, influencing how they construct such concepts as animate and inanimate, conscious and not conscious. (2005, p. 21)

Over thirty years prior to the current case study, Turkle observed a children's playgroup at a beach, in order to listen to their conversations about various electronic

games. Reflecting on the children's complex conversations about the technology, which inspired philosophical questions about life in general, she wrote:

Millions of parents have bought computer toys hoping they will encourage their children to practice spelling, arithmetic, and hand eye coordination. But in the hands of the children they do something as well: they become the occasion for theorizing, for fantasizing, for thinking through metaphysically charged questions to which childhood searches for a response. (Turkle, 2005, p. 34).

As another example, Ricki Goldman is an ethnographic researcher who has explored how children's learning experiences have been influenced by digital media. Taking an interest in varying points of view – referring to them as “points of viewing” (Goldman, 1998, p. 19) – Goldman gave children from two public schools the opportunity to video record their own perspectives, in addition to providing rich descriptions of her own observations. In her book *Points of Viewing Children's Thinking*, she stated:

I have composed and presented these portraits of children because I sense a crisis looming in front of us, a crisis of technological illiteracy that I believe we can overcome as a society if we simply listen carefully to the stories that young people tell us about their understanding. Although we introduce innovative programs in an attempt to reach students, we do little to find out *how they view their own thinking*. (Goldman-Segall, 1998, p. 169).

The above passage speaks to the relevance of this type of research to educators and others who are involved in the lives of children. As young children are provided new forms of technology, which may now include wearable technology, it is important to explore what it means to children in the context of their learning and other day-to-day experiences.

Much of the previous research relating to children's wearable technology focuses on issues regarding usability of the technology itself, design, how "do-it-yourself" forms of wearable technology may be used for educational purposes, as well as safety, and tracking or monitoring applications.

With a few exceptions, the majority of existing literature involving technology used by young children does not place the child in the role of the expert or "meaning-maker." Influenced by the Mosaic approach to ethnography, this research regards young children as meaning-makers and experts of their own experiences (Clark & Moss, 2011). Aspects of Papert's constructionist learning theory and Sutton Smith's play theory are also used to explore the creative, empowering, and educational possibilities for wearable technology as suggested by the children who participated in this study.

The research outlined in this thesis represents a subset of the larger *Kids, Creative Storyworlds and Wearables* project, and will be referred to as the *case study* going forward. Although this case study was influenced by the theoretical framework, and research questions which guided the larger project, it took a slightly different direction than the larger project. For example, two additional research questions, named in the second chapter, narrowed the focus of this case study.

### **Research Goal**

The overarching goal of this research is to gain insight into children's ideas about wearable technology in a manner that places the child participants in an active and empowered role and acknowledges the meaning that is articulated by their creative representations such as drawings, written text and oral storytelling. Specifically, this research seeks to learn about:

- What children think about wearable technology;
- What meaning they derive from it or cast upon it;

- What creative ideas are inspired by interaction with wearable technology, as represented in their personal narratives (stories, pictures and written text);
- How wearable technology may empower children in their day-to-day lives; and
- How children's perspectives on wearable technology may inform formal education practices.

### **Theoretical Model**

Elements of the Mosaic approach to ethnography, social semiotics, constructionist learning theory, and play theory form the theoretical model for this research. See Appendix A for a visual representation of the theoretical model and related themes.

**The Mosaic approach to ethnography.** The Mosaic approach to ethnography was developed as a means of involving children in the review of services for them (Clark & Moss, 2011). It takes its roots in the practice of participatory appraisal which “empowers poor communities to have a ‘voice’ in changes within their own communities” in addition to the practice of “pedagogical documentation” used in Reggio Emilia preschools (Clark & Moss, 2011, p. 1; Clark, 2005). The approach has been developed for use with young children – commonly children in pre-school age groups – and views young children as “experts in their own lives;” “skilful communicators;” “rights holders;” and “meaning-makers” (Clark & Moss, 2005, p. 5). The framework regards children and adults as “co-constructors” of knowledge and aims to consider a range of perspectives (Clark & Moss, 2011). It is important to acknowledge that the current case study focuses primarily on children's perspectives, though it involves a dialogue between child participants and adult researchers.

Clark and Moss describe the Mosaic approach using the following list of characteristics (2011, p. 7):

- *multi-method*: recognizes the different “voices” or languages of children

- *participatory*: treats children as experts and agents in their own lives
- *reflexive*: includes children, practitioners and parents in reflecting on meanings; addresses the question of interpretation
- *adaptable*: can be applied in a variety of early childhood institutions
- *focused on children's lived experiences*: can be used for a variety of purposes including looking at lives lived rather than only at knowledge gained or care received
- *embedded into practice*: a framework for listening which has the potential to be both used as an evaluative tool and to become embedded into early years practice

The current case study did not include any evaluative components and was not situated within institutional settings for young children. However, the Mosaic framework as a whole is relevant to this research as it provides a human-centric, in this case child-centric, approach to exploring issues related to technology and places young children in active, empowered roles. For example, a fundamental question at the core of the Mosaic approach is “What does it mean to be you in this place now in this present moment, in the past and in the future?” (Clark, 2005, p. 17) – a question that is highly relevant to the human-centric nature of the *Kids, Creative, Storyworlds and Wearables* project.

Listening is a critical component of the Mosaic approach. Citing Rinaldi (2005), whose work on pedagogical listening is foundational to the pedagogical documentation practices used in the Reggio Emilia preschools mentioned above, Clark (2005) acknowledges three types of listening:

- Internal listening – This involves how children listen in order to understand their experiences in the world. Reflection is a component of this form of listening as is the question of what it means to be one's self in a particular place is relevant to this form of listening.
- Multiple listening – This involves listening to a range of voices to ensure that certain voices are not neglected. For example, this could mean listening to the perspectives of a number of children, parents, practitioners, caregivers, researchers and others involved in a particular setting.
- Visible listening – This places an emphasis on different forms of documentation that can be used to convey information and help visualize the learning process. Examples provided by Clark include book-making, map-making, note-taking and photography.

Opportunities for internal listening and visible listening were included in this case study. Seeking to learn what children believe it is to be who they are – past, present and future – as they make sense of their relationships with technology, is a core part of the *Kids, Creative Storyworlds and Wearables* project. Moreover, exploring those ideas through visual representations created by children (photos, written stories and illustrations) was a goal of the current case study. However, examples of multiple listening were not applied in the case study, as the child's perspective was the primary focus of this research.

Clark and Moss (2011) identified three stages for their framework: Stage 1, wherein children and adults collect documentation (this could be through picture-taking, for example); Stage 2, wherein there is a shared dialogue; and Stage 3, which involves deciding what should remain the same and what should change. Since this case study did not involve evaluation, Stage 3 was not relevant to this case study. The

Mosaic approach and how it was (and was not) applied in this case study will be discussed further in the Method section.

**Social semiotics.** The work of Gunther Kress and Theo van Leeuwen (2006) provided a guiding framework for the *Kids, Creative Storyworlds and Wearables* project as a whole. In their book *Reading Images: The Grammar of Visual Design*, Kress and van Leeuwen (2006) described the intention for their work to serve as a “descriptive framework that can be used as a tool for visual analysis” (p. 14). Kress and van Leeuwen give considerable attention to the role of images in communication and view children, just as much as adults, as “active sign-makers” (2006, p. 153). They believe that all sign-makers have specific meanings which they wish to communicate and do so using whatever means they have available to them and deem to be most fitting (Kress and van Leeuwen, 2006). To explain this, they commonly use the example of a three-year old child’s drawing of a car, which consists of a number of circles (Kress, 1997; Kress & van Leeuwen, 2006). They explained that wheels were considered by the child to be key characteristics of a car, which were represented by the child as circles. Moreover, it was noted that circles were likely selected to represent the car, not only because of how they appear, but also due to the physical motion that would be used to draw them (similar to that of moving wheels on a car). The child’s commentary while drawing the picture was used to help understand the meaning conveyed in it.

Kress and van Leeuwen commented on the differing values placed on illustrations and written text for and by children in school. For example, they argued that, as children get older, they are less encouraged to produce illustrations versus written text in school, as evidenced by the formats of many assessments, which favour written communication (Kress and van Leeuwen, 2006). This is despite the observation that more illustrations are being used to teach older children than was previously the case. Similarly, Kress and van Leeuwen commented on the growing roles of images in texts children interact with outside of the classroom.

Kress, in particular, took a closer look at children's use of visual communication and language as they relate to education. He argued that, by the time children reach school ages, they are "competent and practised makers of signs in many semiotic modes" (Kress, 1997, p. 10). In *Before Writing: Rethinking the Paths to Literacy*, Kress (1997) explained that examples of children engaging in meaning-making are often dismissed as play rather than note-worthy aspects of communication, likely due to adults' focus on language and literacy over other forms of communication. Kress (1997) also wrote about the concept of "transformative action" as it relates to children's sign-making and design. He suggested that there is intentionality behind children's design choices – this could include the design of a paper cut-out, a drawing, a cardboard pirate ship, and so forth – and that children are constantly changing the meanings of objects which have been given to them (Kress, 1997). For example, he stated:

In the games which children play it is easy to see that all objects, all toys, no matter how seemingly predetermined and limited in their assumed mode of use, are immediately integrated into patterns in which they might never have been imagined by their makers. (p. 37)

The essence of the above passage, that children are constantly "re-making" the objects that have been given to them for other specific purposes in ways in which adults never thought possible, is at the core of this research, and also connects well with the constructionist learning theory described below.

Lastly, a key aspect of Kress and van Leeuwen's (2006) work on social semiotics is that visual language is not considered to be universal but instead closely connected to culture. As such, exploring signs created by children (through a variety of communication modes and media) serves to learn more about the specific culture(s) in which those children are members.

**Constructionism.** Seymour Papert, one of the developers of the LEGO/Logo programming system and a founder of the Media Lab at MIT, is a key theorist behind constructionism (Papert, 1980a; Papert, 1993; Resnick & Silverman, 2005). Papert explains that it can be challenging to define constructionism, as the essence of it is that “everything be understood by being constructed” (Papert & Harel, 1991, p. 2). Constructionism involves the belief that people learn best when they are able to design and create things that are of meaning to them (Resnick & Silverman, 2005). It also involves a public representation of what the individual has learned (Papert, 1993; Alimisis & Kynigos, 2009). Along with this, are the beliefs that individuals can choose different paths in their learning and represent what they have learned in different ways (Kafai & Resnick, 2012). In an article which addresses Papert’s contribution to the field of Child-Computer Interaction (CCI), Read and Markopoulos comment on how constructionism places children in the roles of authors and creators of educational content and other content, suggesting that it is “still as radical today as it was in the sixties when one considers educational systems worldwide” (2013, p. 2).

Papert was a colleague of developmental cognitive theorist, Jean Piaget, and there are commonalities between their similarly named theories, constructionism and constructivism. Papert states: “*Constructivism* is the idea that knowledge is something that you build in your head. *Constructionism* reminds us that the best way to do that is to build something tangible – something outside your head – that is also personally meaningful” (1990, p. 14). As such, the act of building is a key component of constructionism, as are rebuilding or “reconstructing” (Kafai & Resnick, 2012). Closely related to this is the importance of design in the learning process. Kafai and Resnick (2012) explain that theories of design and theories of learning have both come to “focus on the construction of meaning” and that constructionist learning theory is less focused on the actual final product of a design project as it is with the process and the concept of “learning through design” (p. 18). In a similar regard, although this case study is not

concerned with children's ideas about wearable technology with the intention of informing design, children's ideas regarding design become of interest as they help convey the meaning children ascribe to the technology.

Constructionist practices, which are learner-centered, are contrasted with instructionist practices, which are more instructor- or teacher-centered. Constructionism rejects the notion that the solution to improving learning is to improve teaching (Papert, 1993). Rather, Papert (1993) suggested that it involves more learning with less teaching. Likewise, Constructionism does not adhere to a "technocentric" view of learning (Papert, 1990; Papert, 1987). This fits well with Pedersen's call for human-centricity in the design of wearables. In an article addressing applications of software design to serve as a learning environment, Harel and Papert argued that it is not a computer that produces better learning, but that children can "do 'good' learning with computers" (1990, p. 2). Constructionism's emphasis on doing and creating suggests a certain intentionality behind phrasing that explanation in such a manner.

Papert commonly referred to the aptly named construction kits, discussed in more detail in later chapters, and other computer applications as "microworlds." In "Microworlds: Transforming Education," Papert described the Logo turtle microworld to illustrate the ways in which microworlds may transform learning. As it speaks to the nature of constructionism, a passage from that description is included as follows:

This is a microworld in the sense that it's a little world, a little slice of reality... The microworld is created and designed as a safe place for exploring. You can try all sorts of things. You will never get in trouble. You will never feel "stupid." It will never say a rude thing to you; it will never embarrass you; it will never fall to pieces or bite you or give you a low grade. You are totally safe in this little world. And yet while being safe, it is also designed to be discovery-rich in the sense that

little nuggets of knowledge have been scattered around in it for you to find.  
(Papert, 1987, p. 86).

This approach to learning, which values safety, experimentation, exploration, and curiosity, lends itself well to the spirit of the *Kids, Creative, Storyworlds and Wearables* project as a whole. Without an awareness of the connection to constructionism, at least initially, the researchers involved in this project sought out to embody and invite such qualities, so children would feel comfortable sharing their perspectives.

**Play theory.** Brian Sutton Smith's work is situated around the same time as that of Papert and Piaget, and is relevant to the current case study. One of the research questions that guided this case study was inspired by a keynote address by Dr. Jane McGonigal, author and game designer, at the Higher Education Quality Council of Ontario (HEQCO) Transitions conference in 2016 in which the work of Sutton Smith was mentioned. McGonigal refers to gamers as "super-empowered, hopeful individuals" (2010). Although games are only one element of the device used for the study, the idea behind McGonigal's uplifting argument – coupled with Sutton Smith's play theory – inspired thought regarding how this type of technology may empower young children.

In 2008, Sutton Smith reflected on his life-long work on play, which includes three main theories: play as a viability variable, as culturally relative play forms, and as a co-evolutionary multiplex of functions. Of these theories in particular, "play as a viability variable," described below, is the most relevant to the nature of this case study.

***Sutton Smith's "play as a viability variable."*** "Play as a viability variable" presumes that play allows one to overcome the hardships or monotony of life (Sutton Smith, 2008). Examples of this type of play explored by Sutton Smith are the controversial, often shocking, stories, rhymes, and jokes composed and/or recited by children. Interested in children's folklore, and the commonly off-side nature of it,

Sutton Smith and his students collected over 150 “jokes” from public schools in the 1960s, categorizing them by the following terms: “Cruel Jokes, Bloody Marys, Hate Jokes, Ivy League Jokes, Sadist Jokes, Gruesomes, Sick Jokes, Meanie Jokes and the Comedy of Horrors” (Sutton Smith, 2008, p. 90). Though Sutton Smith’s theories apply to children’s as well as adult’s play, he proposed that examples from children’s folklore can serve as forms of rebellion, allowing children to triumph in their lives that are largely organized by adults. As this case study invited young children to share their own personal narratives, and ideas inspired by their experiences with wearable technology, this notion is of interest, particularly as it relates to the theme of empowerment.

To summarize, elements of the Mosaic approach to ethnography, Kress and van Leeuwen’s work on social semiotics, constructionism and Sutton Smith’s “play as a viability variable” theory form the theoretical model for this case study. The remaining chapters in this case study are as follows: (2) Literature Review; (3) Method; (4) Results; (5) Discussion, and (6) Conclusions.

## Literature Review

### Overview

Much of the literature that is included in this review represents adults' perspectives on children's wearable technology. This is due to a lack of literature focused on children's perspectives in this area of research, or intended to learn more about children's perspectives on wearable technology without the specific goal of informing design. Likewise, some of the research that is included in this review applies to technology in a broader sense, where it is relevant to the goals of this research. It is also important to note that there is a body of literature on wearables for healthcare (including children's healthcare) that is not included in much depth in this review, as it is beyond the scope of this case study.

The following literature review focuses on themes that are of relevance to the current case study – namely, children's narratives and creative ideas involving wearable technology; imagining the future of wearable technology; children's wearable technology and formal education practices; and how wearable technology might empower children in their day-to-day lives.

### Children's Narratives Involving Wearable Technology

In her article concerning the potentials for digital narratives for children, Madej (2003) drew on the work of the psychologist, Polkinghorne, stating that: "Narrative is central to human experience, and a key way that experience is made meaningful" (p. 1). In the same article, Madej outlined a timeline of children's narratives from the middle ages to the year 2000 – from oral, to print, to digital media. Although this work provides validation of the importance of narrative as it relates to meaning-making, it was focused primarily on the perspective that narrative constructs meaning *for* children. Whereas, the current case study seeks to explore how *children* construct meaning(s) represented

in their own narratives. Madej (2003) provided an example of how some interactive, digital stories of the 1990's began to offer children options in terms of the direction a story can take – the National Geographic Society's online story, *The Underground Railway*, served as an example. Citing examples of websites from the late 1990's, Madej added that "one of the most promising developments in interactive narrative is the opportunity for children to write and post their own stories on host websites" (2003, p. 12). Ways in which wearable technology in particular can provide children with these kinds of narrative experiences are not included in the article.

Jones, Williams, and Fleuriot (2003) argued that wearables may offer more opportunities for self-authorship than other existing forms of technology. Despite this, there are not many examples in the literature of children's narratives about and/or enabled by wearable technology. The Today's Stories project proposed the use of head-mounted cameras that would document young children's daily experiences from multiple children's perspectives and sense notable events, in order to allow for reflection (Panayi et al., 1999). Although this appeared to be a promising example of children's narratives enabled by wearable technology, evidence of this project coming to conclusion has not been found.

Resnick and Silverman (2005) described construction kits (which often include some form of wearable technology) as "expressive" in nature. At least one study on e-textile workshops addressed young peoples' creative narratives (Ngai, Chan, Leong, & Ng, 2013). Although Ngai et al. (2013) were primarily interested in design, a component of their research explored an e-textile workshop focused on creative arts and self-expression for young adolescents between the ages of thirteen to sixteen. The adolescents in the workshop wrote and performed plays that involved the e-textiles they worked with over five days. The following narrative was written and performed by one of the groups at the workshop:

A boy goes into the forest [*walking*] and is listening to mp3s [*speaker plays a song*]. He doesn't notice a tree in front of him and walks into it [*walks towards a desk in front of him, which is detected by the ultrasonic sensor*], and he's badly hurt [*the ultrasonic sensor triggers the turning on of a series of red LEDs*] and falls down [*pantomimes falling down...*]. An ambulance arrives [*speaker plays a series of notes resembling the siren of an ambulance*], the boy is sent to hospital [*walks a few steps*]. However, it is too late; he sees the bright lights of heaven [*all the white LEDs on the jacket turn on*], and God received him into heaven [*flings open arms*]. (Ngai et al., 2013, p. 20).

Although Sutton Smith began his work studying play in the 1940's, the above narrative serves as an example of how his "play as a viability variable" theory unfolds in the information age, in this case, inspired by interactions with wearable technology. Returning to the nature of the study overall, however, evidence of the same type of workshop being facilitated for young children, such as those as young as the participants in this case study, was not included.

### **Imagining the Future of Wearable Technology**

This case study deliberately placed children in the role of exploring ideas about their own futures by asking them to tell stories about themselves. Previous literature exists on imagination and technology, including wearables (e.g., Cranny-Francis, 2008; Flanagan, 2015; Sharples, 2000; Jones, Williams, & Fleuriot, 2003; Razak, Salleh, & Azmi, 2013).

Unpacking the changing metaphors used for the relationships between humans and wearables, for example, Cranny-Francis (2008) drew on philosopher Michele Le Doeuff's definition of the imagination proposing that it can be "enabling," allowing us to realize new experiences and capabilities as well as uncover assumptions related to these experiences and capabilities. Furthermore, Flanagan (2015) argued that "our ability to

imagine the future enables us to design the future" (p. 628). Research concerned with what children imagine technology (including wearables) will be like in the future often does so with design-related intentions (e.g., Sharples, 2000; Jones, Williams, & Fleuriot, 2003; Razak, Salleh, & Azmi, 2013). "Informant design," for example, is a term that comes up a number of times in the literature (e.g., Xu, Mazzone, & MacFarlane, 2005; Sharples, 2000). Following a paradigm similar to that described by the Mosaic approach, Scaife, Rogers, Aldrich, and Davies (1997) consider both children (as "Native informants") and adults, such as teachers, as informants in the design process. Furthermore, informant design involves uncovering what is not known about children's experiences rather than seeking to affirm what researchers thought was known (Scaife et al., 1997). In that sense, the theory behind informant design is related to the approach taken in this case study.

Sharples (2000) reported on a case study regarding their proposed HandLeR technology. Informant design sessions and questionnaires involved children ages seven to twelve years old. The children were asked to draw their imagined computers of the future. Sharples (2000) found that children wanted future computers to be able talk and have intelligence and personality. A "man in the machine" was a theme in the children's drawings (Sharples, 2000, p. 187).

The "Mobile Bristol" project in the United Kingdom, which – as one of its objectives – sought to explore how wearables could be used to help children more freely roam their urban neighbourhoods, addressed children's ideas about a particular form of wearable technology, which involved the use of "soundscapes" (Jones, Williams, & Fleuriot, 2003). As part of the "A New Sense of Place?" initiative within the larger "Mobile Bristol" project, focus groups were held with the children in order to "explore what the children thought about the potential of such technologies, especially with regard to their use in the outdoor environment" (Williams, Jones, & Fleuriot, 2003, p. 115). Unlike the current study, children's ideas were explored in order to inform the

design of a specific wearable technology. Children in the study suggested possibilities for broadening the boundaries in which children could play, by using technology to display where they are on a digital map (Williams, Jones, & Fleuriot, 2003).

Razak, Salleh, and Azmi (2013) utilized drawing and interview methods to facilitate a brainstorm session with children ages eleven and twelve, in order to learn more about their perspectives on technology. The children were placed in the role of designers and invited to illustrate technologies that would be good for their own purposes. Two of the drawings that emerged from this brainstorm session were of wearable technologies and one of the main characteristics of technology for children that came out of the research was that it should be wearable. Other elements the children added to their drawings included touch screens, social media compatibility, cameras, access to music and movies, and anytime/anywhere access. This particular study was similar in nature to that of the current case study, though it did not involve children as young as four to seven years old. Moreover, Razak, Salleh, and Azmi's (2013) research had design objectives.

### **Children's Wearables and Formal Education Practices**

This section briefly addresses research that more broadly explored children's ideas about technology in educational contexts (as it offers insight regarding the rationale and methodology used for the current case study), before moving to research related to wearable technology in formal education contexts.

Rennie and Jarvis (1995) looked at children's drawings and writing about technology to learn more about the extent to which they use illustrations to express their understanding of technology in ways that others could understand, arguing that "it is important that teachers explore children's understanding of technology and take the findings into account when planning their teaching activities" (p. 240). Some of the children who participated in the study were interviewed, in order to determine if their

drawings and/or writing indicated their actual level of understanding. It was reported that interviews with children uncovered deeper meanings, which were not always clear from the children's drawings. Furthermore, these findings suggest that multi-method approaches are useful when seeking to learn more about children's ideas about technology. Although this was a large study (over 1000 participants) involving children's illustrations of technology in formal educational settings, it is important to note that children under the age of seven were not included as the researchers believed their understanding of technology was "likely to be limited," symbolic in nature and not easy to interpret (Rennie & Jarvis, 1995, p. 242). Additionally, wearable technology was also not a form of technology addressed in the article, perhaps due to the time in which the study took place.

Baytak, Tarman, and Ayas (2011) conducted a study of a similar size of the current case study, exploring a small group of fifth and sixth grade boys' perceptions of technology as it relates to learning. Children in the study were interviewed at school and at home. Some of the themes that came up were a greater sense of authority in classrooms that had access to technology, limited ideas regarding advantages of using technology in the classroom (searching for information on the Internet being a key advantage) and fears over computers breaking and losing content they had saved. Although the study was similar in some regards to the current case study, it did not acknowledge children's perspectives on wearable technology in particular, nor did it explore in detail children's creative representations (illustrations or written stories, as examples) which may also articulate their perspectives. The sample did not include perspectives from younger children and only included perspectives of male children, as mentioned above.

Evidence of how children's ideas about wearable technology in particular could inform formal education practices is not prevalent in the literature to date. The use of construction kits for wearable technologies (including e-textiles) in formal education

settings, however, does address this topic to some extent (e.g., Katterfeldt, Dittert, & Schelhowe, 2009; Mikhak, Martin, Resnick, Berg, & Silverman, 1999; Ngai et al., 2013). In this context, construction kits are defined as “systems that engage kids in designing and creating things, sometimes on the screen, sometimes in the physical world, sometimes both” (Resnick & Silverman, 2005, p. 117).

Lau, Ngai, Chan, and Cheung (2009) wanted to know if I\*Wear programming/e-textile workshops for young people (ages eleven to sixteen) would inspire the participants, and stimulate their imaginations in order to promote creativity, amongst other related objectives. Results indicated that all students found the workshop content interesting, and more than half would pursue science subjects after their participation in the workshop. Students in the workshops created highly creative final projects including interactive sports clothes, a smiley face shirt that would change colour when patted, and clothing with lights that changed based on the speed of the person wearing it. Although the goals of the study were related to those of the current case study, it did not consider perspectives of younger children.

The modular i\*CATch e-textile construction kit was explored in classroom settings from the kindergarten to graduate levels of education (Ngai et al., 2013). Ngai et al. (2013) acknowledged the importance of opportunities for learners who would be using this type of technology to express creativity. Their study, however, focused primarily on design and functionality and explored reasons why wearable computing kits had been less popular in educational contexts than robotic construction kits and how that might be changed. The authors suggested that children and adults see popular robotic kits as toys but to teachers they are “teaching equipment masquerading as toys” (Ngai et al., 2013, pp. 4-5). Whereas the current case study set out to speak to children directly to learn more about their perspectives, a limitation of Ngai et al.’s (2013) research was that they did not hold focus groups with the younger children (ages ten to twelve) who were involved due to their perceived lack of maturity.

### **Other Applications of Wearable Technology for Learning**

There are more examples of adults considering how wearable technology could inform formal education practices than there are of research focused on children's perspectives. The examples that follow include other applications for wearables for learning in a range of levels of education and for varying purposes. The end of this section provides examples of wearables used in higher education and for lifelong learning as a way of addressing possibilities for the future of wearable technology for learning.

**Cross-curricular applications with physical activity.** Lee, Drake, and Williamson (2015) sought to answer the question: "What might technology-supported teaching and learning activities look like when classrooms have access to wearable devices?" (p. 46). In their efforts to answer this question, they reported on a cross-curricular application of wearable fitness trackers to teach about science and math, making use of students' physical activity data, in kindergarten to grade twelve (K-12) contexts. The term "Quantified Recess" was used to describe an activity wherein fifth grade students were placed on teams and used data collected during recess periods on Fitbit® pedometers to calculate team scores (Lee & Drake, 2013b as cited in Lee, Drake, & Williamson, 2015). Similarly, wearable "Thinking Tags" have been combined with a physically active game to teach children in kindergarten about concepts related to dental hygiene (Andrews, MacKinnon, & Yoon, 2002).

**RFID technology and classroom settings.** Radio Frequency Identification (RFID) technology has also been combined with wearable technology for certain education-related applications. Larabi Marie-Sainte et al. (2016) identified ways wearable/RFID technology could be used to keep a classroom environment running smoothly. Enabling efficient communication with technology support technicians who are otherwise outside of the classroom was one example provided. Following a different approach,

SoundTag (Ueko and Hirose, 2008) and Tagaboo (Konkel, Leung, Ullmer, & Hu, 2004) serve as examples of wearables combined with RFID technology designed to promote physical activity and collaboration amongst young children.

**Wearables in higher education.** De Freitas and Levene (2003) proposed a number of applications for wearables in higher education settings including the IBM Linux smartwatch for scheduling, location details and messaging; the Xybernaut mobile assistant to assist students who are differently abled and offered word processing, calculation and multimedia capabilities; iButtons for registration purposes; and the MIThril vest to provide reminders. In contrast, literature on ways in which smartwatches can be used to facilitate academic dishonesty in higher education settings has also emerged, posing questions about whether they should be banned in classrooms (e.g., Migicovsky, Durumeric, Ringenberg, & Halderman, 2014; Lipson & Karthikeyan, 2016).

**Beyond post-secondary education.** Educational applications for wearables beyond the primary, secondary and post-secondary levels of education are also identified in the literature. The WristEyesystem, for example, which can assess individuals learning to use computers and display their data in real-time to a teacher has been used with elderly individuals in classroom settings but may present opportunities for a range of age groups (Chen, Li, Chang, Tang, & Li, 2016). Furthermore, the HandLeR software, which would interface with a handheld or wearable device, mentioned in previous sections of this review, was proposed as a tool to promote lifelong learning (Sharples, 2000).

Sharples (2000) suggested that wearables could be a new genre of educational technology. A key gap in this area of research as a whole, however, as provided in the examples cited above, is the lack of attention placed on children's versus adults' ideas

regarding the use of wearable technology in classroom contexts or for education in general.

### **How Wearables Might Empower Children in Their Day-to-Day Lives**

Literature on do-it-yourself (DIY) wearables and GPS-enabled wearables address a few ways in which wearables may empower children in their day-to-day lives. In order to highlight differences between techno-centric and human-centric applications of the same type of technology, examples of applications for wearable technology to monitor or evaluate – rather than empower – children are also addressed at the end of this section.

**'Do-it-yourself' wearables and empowerment.** Empowering children is a recent theme that arises often in the literature. The do-it-yourself (DIY) trend is aligned with the Maker movement that has made its way into primary and secondary levels of education (Smith & Smith, 2016; Thompson, 2014). The wearable/e-textile construction kits described in the previous sections are examples of the DIY trend in practice.

Research on construction kits is often influenced by Papert's Constructionist learning theory, which holds "empowerment" as a key pillar (Katterfeldt, Dittert and Schelhowe, 2009). Though DIY wearables, including e-textile construction kits, might not yet be a part of the day-to-day lives of most young children, a number of construction kits have been developed for children, which are available commercially and used in school environments (Blikstein, 2013). Increasing their accessibility, e-textile construction kits can appeal to children, and adults, who may not otherwise believe they are inclined to STEM-related activities (Buechley, 2006; Katterfeldt, Dittert and Schelhowe, 2009).

Inspiring creativity is another theme relevant to empowerment and children's wearable technology. Mikhak et al. (1999) describe a project entitled "Beyond Black

Boxes” which was intended to provide children with materials (Cricket programmable blocks, as one example) to create their own instruments to explore issues that are of interest to them. In the same article, the authors explain:

We think of Cricket-like computational objects as an addition to the existing and growing collection of handheld and wearable devices that not only expand the range of possibilities, but also more importantly empower our children to open up the systems that surround them and take intellectual ownership of them. (Mikhak et al., 1999, p. 39)

Focusing on the theme of design, the authors also conclude that design decisions regarding children’s technology commonly rest with adults and argue that children should be given control over how their technological devices work (Mikhak et al., 1999).

Similarly, the EduWear project in Europe held as one of its learning objectives to “empower young people through working with this new, but familiar technology to build their own (futuristic) prototypes, and thus participate actively in information society” using e-textile construction kits (Katterfeldt, Dittert, & Schelhowe, 2009, p. 9). Katterfeldt, Dittert and Schelhowe (2009) noted the importance of “empowerment” as opposed to “teaching” from a constructionist standpoint and that empowerment was thus an intention of the EduWear workshops. Another fundamental component of the EduWear project was to discover some of the “personally meaningful” affordances of e-textiles for young people. The results indicated that this type of workshop did provide opportunities for young people to design personally meaningful e-textiles based on their own areas of interest and/or problems they faced in their day-to-day lives. Examples included an interactive sports t-shirt, a “thief-proof” bag, and a shirt that massages its wearer’s shoulders (Katterfeldt, Dittert, & Schelhowe, 2009). The participants’ rationales for designing the e-textiles they chose to make were addressed. For example, the group of adolescents who created a massage shirt explained that it might be

something to wear after a long day of work or school, in order to relax. Lee, Drake, and Williamson (2015) also commented on the “personally meaningful” potentials of wearables for young people, discussing applications for children to collect data as part of their daily classroom activities.

**Mobile technology/GPS-based wearables and empowerment.** Some of the literature on applications of mobile and location-tracking (GPS-enabled) wearables argues that it can be empowering or enabling for children. The “A New Sense of Place?” initiative, part of the “Mobile Bristol” project mentioned in the earlier part of this literature review, for example, held as one of its objectives to develop wearable technology to help children more freely explore their urban neighbourhoods (Jones, Williams, & Fleuriot, 2003). The authors pointed to the relevance of this type of research amidst societal fears regarding a) the diminishing amount of child-friendly outdoor spaces and b) children exploring their potentially “dangerous” urban neighbourhoods without their caregivers knowing exactly where they are, in addition to the increasingly complicated relationship(s) between children and technology. Ueoka and Hirose (2008) also cited concerns over the decreasing amounts of space for children to play outdoors, coupled with the belief that children today prefer play inside with their technological gadgets. Jones, Williams, and Fleuriot (2003) suggested that wearables represent a technology that has the potential to challenge recent concerns about childhood.

Moreover, the “A New Sense of Place?” initiative sought to directly involve children (ages eleven and twelve) in the design of wearable technologies for children (Williams, Jones, & Fleuriot, 2003). The authors noted that they observed a confidence in the children who participated in focus groups – an observation which was attributed to the children’s experience of being at the lab and getting to use cutting edge technologies (Williams, Jones, & Fleuriot, 2003, p. 115). An awareness of parents’ concerns for their safety, and the desire to be able to explore their neighbourhoods

were expressed in some of the children's comments. These concerns were associated with limitations on the children's level of freedom to go out and play (Williams, Jones, & Fleuriot, 2003, p. 116). As such, this exemplifies the theme of children seeking ways to feel more empowered in their own lives emerging from conversations about wearable technology.

Pain et al.'s (2005) work took into account the viewpoints of young people (ages ten to sixteen) regarding the use of mobile phones and their relationship to safety and urban geographies. Findings included that the ability to coordinate meetings with friends was of utmost importance to many of the participants, some expressed an awareness of their parents' concerns about their safety and mobile phones helped them to feel safer while in public spaces (Pain et al., 2005). Although the mobile phones in the study were not wearables, the intention to capture young people's perspectives was similar to that of this case study. The current case study provides insight into younger children's perspectives on more current technology.

**Wearables to monitor and evaluate children.** In contrast to the above examples highlighting how wearables may be used to empower children, a number of other studies involving kids' wearables for safety – studies on safety vests, for example – focused on the perspectives and concerns of the parent or caregiver, rather than those of the child (e.g. Jutila, Rivas, Karhula, & Pantsar-Syväniemi, 2014; Takata, Ma, & Apduhan, 2006).

Duval, Fujisawa, and Hasizume (2007) suggested that a range of children's needs, including those pertaining to safety, physiology, belonging and esteem, ought to be considered when designing wearables for children. One of the areas for further research suggested by Duval, Fujisawa, and Hasizume (2007) concerned how wearables may be used to evaluate a child's development. Learning more about what children

think of these technologies or the authors' suggested considerations, however, were not included in the recommendations for addressing these needs.

Rehg et al. (2013) proposed the use of wearables with what they have termed the *Rapid-ABC* protocol, in order to assist in the diagnosis of certain developmental disorders. Similarly, Mehmood and Lee (2017) proposed to use of an electroencephalography (EEG) headset connected to a "computer aided education system" (CAES) in order to detect and report specific emotions (examples: happiness and sadness) in young students with disabilities (p. 1). In both of these studies, wearables were used to measure children's emotional states or behaviour, without an indication of whether they gained the children's insight into what they thought about such applications of the technology.

### **Limitations and Gaps in Previous Research**

Although there is a growing body of literature on children's wearables, a lack of research centered on children's ideas regarding wearable technologies – the meaning they ascribe to it, personal narratives associated with it and potentials it may inspire for them – is a notable gap in the literature on children's wearables. Existing literature which has focused on children's perspectives on technology (e.g., Razak, Salleh, & Azmi, 2013; Rennie & Jarvis, 1995; Baytak, Tarman, & Ayas, 2011; Sharples, 2000) or their creative representations relating to wearable technology in particular (e.g., Lau, Ngai, Chan, & Cheung, 2009; Ngai et al., 2013) did not include the perspectives of young children under the age of seven.

Moreover, existing research that highlights the empowering or creative affordances of wearable technology most commonly involves construction kits in particular (e.g., Katterfeldt, Dittert, & Schelhowe, 2009; Mikhak et al., 1999; Ngai et al., 2013). Other kinds of wearable technology are either being developed or are already on

the market for young children, including the smartwatch used for this research, and the other two devices that were considered for inclusion in the study.

Therefore, this case study is intended to contribute to the body of research on wearable technology by lending more in terms of young children's perspectives using a new wearable toy, in a manner that honours their abilities to communicate what this type of technology means (or does not mean) in the context of their day-to-day lives.

### **Research Questions**

The research questions that guided the *Kids, Creative Storyworlds and Wearables* project as a whole are as follows:

1. What do children imagine wearables will be like in the future?
2. How do children narrate or illustrate the stories they tell themselves (and about themselves) and their friends/siblings in the 'wearable turn' that they live in?
3. What do children think about wearable technology and the potentials it might inspire?

Additional questions, which narrow the focus of this particular case study, are as follows:

4. How might wearables empower children in their day-to-day lives?
5. How might children's ideas about wearable technology inform formal education practices?

## Method

### Overview

Although the Mosaic approach served as a framework that would allow the researchers to explore the research questions in a manner that provided children with an empowered role, there were certain elements of the framework that were not adhered to due to the scope of the study, and the timeline involved. In particular, parents' and practitioners' perspectives were not specifically addressed in this case study. In rare cases, parents did join in the dialogue between children and the researchers, though parents' viewpoints were not intended to be included in this research. Furthermore, with regard to being embedded into practice, the framework was not used in an evaluative manner nor did it involve early years practice. However, the procedure and findings could be of interest to individuals who are involved in evaluation within early years' environments.

Methods used in this research were semi-structured independent interviews with each child, observation and analysis of children's drawings and verbal and written narratives. As stated in the Theoretical Model, Clark and Moss (2011) identified three stages for their framework: Stage 1, wherein children and adults collect documentation (this could be through picture-taking, for example); Stage 2, wherein there is a shared dialogue; and Stage 3, which involves deciding what should remain the same and what should change. Since this research did not involve evaluation, Stage 3 was not relevant to this case study. Stages 1 and 2, however, occurred in a non-linear manner. For example, children could bring documentation in the form of photos, videos and audio they recorded on their wearable devices or pictures and text they had recorded in their sketchpads or created during interviews. Then, the children and adult researchers would discuss what the children had shared, where possible.

The wearable device that was used in this study was the VTech® Kidizoom® Smartwatch (see Figure 1). The Kidizoom® features a touch screen, which allows children to toggle between the time in digital and analogue formats, a number of pre-loaded games, a camera to record video and take still shots, a voice recorder, a stopwatch and limited picture editing tools. The device is available in a range of colours and is marketed to girls and boys ages four to seven years. This version of the device is not Wi-Fi enabled but can be connected to a computer via a USB cable in order to download additional games. The device is not GPS-enabled and does not have mobile communication capabilities. It is important to note that children did not receive instruction from the researcher on how to use the device, as this was not a study about usability and the researchers were interested in learning about how the children learned to use it.



**Figure 1 - The VTech® Kidizoom® (Kidizoom Smartwatch – Blue, 2017)**

## **Participants**

Five children between the ages of four and seven years old participated in the case study. Though the home address of each participant was not requested, the town in which research posters were displayed and the university summer camps which the families on the email list were involved were both located in a large municipal region that had a population of 656, 862 in 2016 (Statistics Canada, 2017). In 2010, the average family income in the region was \$106, 590 (Durham Region Planning and

Economic Development Department, 2015, p. 42) and in 2011, over 80% of the region's population over the age of 15 had a certificate, diploma or degree (p. 39).

Recruiting within the university in which this study took place was likely to generate a good amount of interest. However, that could have increased the likelihood of obtaining a sample of children who already had preconceived ideas about what this type of technology is or means, with parents who work in a STEM-focused institution. For that reason, recruiting within the university itself was not the primary means to obtain participants. It is important to note, however, that there are staff at the university who send their children to the university's summer camps and are on the email list. To this researcher's knowledge, however, none of the parents of the children who participated in this case study were employed at the university at the time of study.

In an attempt to obtain a gender-balanced study, while also acknowledging that the study would be limited to an odd number of participants due to the number of wearable devices available, families of boys and girls who responded to the recruitment messages were contacted in the general order in which their email response was received. There were a number of cases in which two children from the same family were interested in participating. Due to the small size of the study and the likelihood that siblings would be significantly influenced by one another in their ideas about the technology that would be presented, it was decided not to include more than one child from a particular family in this study. There is still the possibility that children who participated in the study were influenced to some extent by their siblings who did not participate in the study. However, this exclusionary criterion was selected with the intention of focusing on each individual participant's perspectives on this type of technology as much as possible.

To protect the anonymity of the children who participated in the study, pseudonyms were used. As one way of providing these young participants with an

empowered role in this research, each child who was selected to participate was given the option to choose their own pseudonym. The primary researcher explained this in a manner that was intended to be clear to young children, stating for example, “We won’t use your real name when we write about what we talk about together. Is there a special name that you would like us to call you?” Two of the five participants indicated a name that they wanted to be used to refer to them; the three remaining participants were each randomly assigned a pseudonym after the first interview. Table 1, on the following page, lists the pseudonyms, ages and gender breakdown of the children who participated in this case study.

**Table 1 – Pseudonyms, Ages and Gender Breakdown of Participants**

Pseudonym	Age	Gender*
Sarah	4	Female
Cayden	6	Male
Charlie	6	Male
Skye	7	Female
Timothy	7	Male
<i>*Children and parents were not asked about gender identification in particular</i>		

**Sarah.** Though she was the youngest participant in this case study, Sarah demonstrated the ability to listen attentively to the questions even when presented with a distracting wearable device part way through the first interview. She named colouring, and playing with LEGO® (to build houses and other places), sometimes with her brother, as some of her favourite things to do. She also shared that she likes playing with her dolls, writing stories in her notebook and expressed an interest in hair styling.

She had experience using an iPad to play games and watch videos and to do math. Sarah often chose to colour during each of her interviews. She was quiet, and had a shyness about her though she was willing to talk and shared a number of creative illustrations and written text that represented her ideas about the technology used in the study.

**Cayden.** Building vending machines with LEGO® with his older brother, creating rocket ships out of cardboard boxes, writing and illustrating stories on a computer, playing with plastic people characters at home, playing with a dollhouse at school, and riding his bike were activities Cayden enjoyed. One of his favourite hobbies, expressed early in the interview process and which carried through as a theme in each his three interviews, was creating and editing videos shared on his older brother's YouTube® channel. By the age of six, he already had experience using a chest-mounted GoPro camera to record action videos and shared that he enjoyed watching videos of people – including a popular YouTube® personality known as 'Stampy' – playing computer games such as Minecraft. Cayden was forthcoming in sharing creative ideas for inventions during each of his three interviews.

**Charlie.** Charlie was also a soft-spoken participant in the study. Going bicycle riding and playing at the park with his friends or usually his sister were two of his favourite pass-times. When asked what his favourite toys were he mentioned his toy cars and talked about his special "*water colour changer*" cars. He also added that he liked to play with remote control cars. He expressed that he liked using computers and that he usually played car games. He had a tablet, which he used to watch shows on YouTube® and could find the shows that he liked on his own. He added that he liked to download games on a tablet. His inclination for technology stood out to the researchers as early as his first interview, and he was inquisitive about the capabilities of the smartwatch used for the study. He shared an interest in computer games, and downloading games and spoke about his big sister.

**Skye.** Skye enjoyed watching Monster High® shows on Netflix®, playing with dolls, collecting Shopkins® toys, and reading. The researchers who interviewed Skye observed that she seemed less willing to participate than the other children and was not forthcoming in her responses to the interview questions. She commonly responded with “*I don’t know,*” and her body language suggested that she was not often interested in engaging in conversations about wearable technology. She was assured that she did not need to answer any questions that she did not want to answer, and that it was her choice to continue to participate. She did not share many pictures or notes recorded in her sketchpad. Illustrations that she did create during interviews usually included bookcases, and her bedroom. Skye reported that her smartwatch was either stolen or lost at school prior to her third interview. For these reasons, the data from her interviews is not thoroughly addressed in this case study and her interviews were quite brief.

**Timothy.** Timothy shared that he liked to play with LEGO®, draw, and watch cartoons on television for fun. His favourite toys at home included a robot with wheels and flashing lights that can be controlled by an app and cars of different types. He shared that he liked using computers, and sometimes made his own videos on a computer, using different background scenes, and colours. He expressed nervousness over being interviewed and, during the first interview, of being able to see the sound waves on a program that was used to record audio during the session. His interviews tended to be quite brief, since he appeared to experience some anxiety. This was to ensure his comfort, and minimize his anxiety. He shared a number of creative ideas regarding this type of technology.

## **Context**

**Research context.** In some regards, this research falls within the area of Child-Computer Interaction (CCI), a subset of Human-Computer Interaction (HCI), which is

multi-disciplinary in nature, and takes its roots in work by constructionist learning theorist Seymour Papert (Read & Markopoulos, 2013). Storytelling – a key element of the *Kids, Creative Storyworlds and Wearables* project – has also been a long-standing element of CCI (Read and Markopoulos, 2013). Read and Bekker (2011) defined CCI in the following terms:

A study of the Activities, Behaviors, Concerns and Abilities of Children as they interact with computer technologies, often with the intervention of others (mainly adults) in situations that they partially (but generally do not fully) control and regulate. (p. 7).

Although it is true that the children did not have complete control over their participation in this study – a parent was required to find the advertisement for the study, schedule meetings, and drive to and from the lab – the research team sought to provide the children with a high degree of control over their involvement. Of the elements included in the definition above, this research is most concerned with children's concerns and, to some extent, their activities related to wearable technology. Children's "creative ideas" and "affordances" (which could perhaps be a part of "abilities") as related to or inspired by wearable technology would be even more apt with regard to the focus of this study.

When the Director of the lab in which the study took place initiated the *Kids, Creative Storyworlds and Wearables* project, a pre-market wearable device that would allow young children to program using pictorial coding language, called Linkitz, was the device that had been selected for use in the study. Linkitz is modular in design, and integrates with a software program that allows children to work with code to program their device. Incidentally, programmable technology for children was of significant interest to Papert as far back as the 1960's (Read & Markopoulos, 2013). Of considerable interest to the Director of the lab, and other members of the research

team, however, was that Linkitz was created to be appealing to girls. Although boys and girls appear in the marketing materials for Linkitz, the founder of the company expressed that she hoped to create something that would show girls in particular that coding could be fun, in order to nurture their interests in science and technology (Bogart, 2015). However, after many months of communications with founders of Linkitz, versions of the device that could be shared with children were not available in time to move forward with this research. Therefore, two other wearable devices for young children were considered for this case study, and, as such, there was a slight shift in the focus of the research. In particular, Science, Technology, Engineering and Mathematics (STEM)-related toys marketed to girls became less of a focus. Other devices that were considered included the Tinitell wrist-phone and the VTech® Kidizoom® Smartwatch. Due to its availability, the Kidizoom® Smartwatch was selected for this case study.

**Lab context.** Though the intention was to meet each of the children in their home or another child-friendly such as a local public library, this study took place within the lab, mainly on weekends during spring and summer months. During that time of the year, the university building in which the lab is located is quiet and only opened by request on weekends. Since this location is unique, and possibly quite different from other spaces familiar to the children in this study, it is important to describe.

The lab is located behind a common area on the main floor. The wall shared by the lab and the common space is glass, which displays mannequins modeling wearable tech gadgets on a stage platform below track lighting. A seating area next to an entertainment unit, which houses game consoles and futuristic-looking speakers, takes its place along one side of the room. Open workspaces, whiteboards, an interactive table, and glassed-in shelves showcasing wearable devices take up the rest of the space. One wall in the lab is lined with movie posters with elements of wearable or implantable

technology (see Appendix B). Figure 2 is a photo of a portion of the lab wherein the majority of interviews took place.



**Figure 2 - The seating area used for interviews in the lab**

The research team sought to create an inviting environment that would be comfortable for young children. Large chart paper, markers, and crayons were laid out for the children to use during each of their interviews. The children were invited to sit in either of two green chairs, kneel beside a coffee table to draw on large sheets of blank paper, walk around or choose another chair at a higher table for drawing. Parents were invited to sit within the lab during their child's interviews out of view of the video camera, and out of the way from the interviewing area. Aside from the researchers, and siblings who sat quietly with their parent, and out of the way of the camera during two of the fifteen interviews, no other people were present during the interviews.

## Data Collection Tools

Semi-structured interviews were the primary sources of data used for this research. Children's drawings, and notes, in addition to observations by the researchers also served as a form of data collection.

**Interview data.** An interview guide was used to provide the general structure for the interviews (see Appendix C). The guiding themes of each of the three interviews were as follows: Interview 1 – *Getting to know the children and introducing the wearable toy*; Interview 2 – *After some experience with the wearable*; and Interview 3 – *Reflection*. The interviews were intended to unfold in an organic manner, guided by the children's stories and interests.

**Participant drawings and notes.** Each child was provided with a sketchpad and crayons, which they could keep to illustrate their ideas about the smartwatch they were given or any other ideas they wanted to share with the researchers. They were invited to bring their sketchpad to each interview though the researchers would only take pictures of anything they shared within the book with permission from the child. The children were not provided with prompts or strict instructions regarding the use of the sketchpads and crayons. The intention was to encourage the children to share any drawings or written texts related to the study that they did not create during interviews. Additionally, blank paper, markers and crayons were available for them to use in the lab during each of the interviews.

**Observation.** During each interview, researchers recorded point-form, hand-written notes to capture some of the children's responses to interview questions and other observations related to the research questions. Furthermore, two of the researchers watched or listened to recordings of the interviews in order to observe any additional details that were not recorded in hand-written notes taken during interviews.

## Research Ethics

The university's Research Ethics Board (REB) provided approval for the *Kids, Creative Storyworlds and Wearables* project (see Appendix D). As one of the co-investigators in the project is a member of the Research Ethics Board, another member of the Board, who is external to the project, reviewed the application.

## Procedure

**Study recruitment.** Two methods of recruitment were used to generate interest in the study. With permission, print posters were placed on a community board of a public library in a town located near the university campus (see Appendix F). Additionally, an email was sent to families who consented to receive news from the Faculty of Education summer camps at the university (see Appendix G). Due to the timing of the email recruitment message (several days after the recruitment poster was displayed), and the response to the study, it is likely that most of the interest in the study was generated through the email invitation.

Parents of children who were short-listed to participate in the study were contacted via email to confirm their children's availability to participate during the weeks allotted for the study. Children who were available and still interested in participating were scheduled for three one-hour timeslots over the span of one month. Consent and assent agreements were emailed to parents when interviews were scheduled. It was decided that the interviews would take place in the lab, rather than the children's homes or other locations more familiar to them, for logistical reasons mentioned above. In particular, significantly more time would be required for members of the research team to travel to the various locations for each of the interviews for the children who participated and certain security issues could be raised in visiting children's homes.

When children and their parents arrived for their first interviews, details of the study, including the information in the consent and assent forms were explained. Children were provided the wearable device that was used for the study partway through their first interview and were assured that it was theirs to keep, unless they decided to withdraw from the study – at which point they would still receive a thank-you gift. .

**Interviews.** Two researchers interviewed each child at a time, for a total of three interviews each. An interview guide was used to provide structure (see Appendix C), though a number of the questions that were asked during the interviews emerged organically. The primary researcher for this case study interviewed each child using the guide provided. Although, if other researchers found any other questions were necessary, they were asked. Having at least two researchers present was beneficial for safety reasons and allowed one researcher to focus on either taking notes or asking questions at a given time and to ensure that most questions were covered.

Prior to each interview, the room was prepared with large sheets of blank paper laid out on a table, coloured markers and crayons, bottles of water and a space for parents to sit. Recording equipment was also set up, including a tripod with a video camera, a standalone microphone connected to a laptop with audio recording software. During the first interview, children were provided with a sketchpad and crayons that they could take home with them to draw pictures or write stories that they could share with the researchers during each of their interviews. Children had the option of keeping any of the artwork they created during the interviews and could keep their sketchpads. If they chose not to keep their artwork, it was locked in a cabinet within the lab. Otherwise, photographs were taken of the artwork, if permission was provided by the child who created it, in addition to parental consent.

The researchers were mindful of creating a comfortable environment for the children and, as such, were not as focused on recording detailed notes during each interview, in case it would make the children feel as though they were being evaluated. Furthermore, part of following the Mosaic approach is to respect participants' silence (Clark & Moss, 2011). As previously mentioned, children were not provided with any instructions to follow between interviews. However, in their first interview they were informed that they could use their sketchpads and crayons to record any ideas they wanted to share with us when they came back for subsequent interviews. Furthermore, at the start of each interview, the children were asked if they had any pictures or stories they wished to share. Depending on each child's observed level of interest in continuing the discussion, interviews ran from approximately 20 minutes to a maximum of 1 hour in length.

The children were thanked for their participation and were each mailed a t-shirt as a thank-you gift after their final interviews.

### **Consent**

In keeping with the goal of providing the young children in this study with an empowered and active role, the children were assured that they could communicate whether they wished to participate or to discontinue their participation in the study. Parents were provided a consent form to sign (see Appendix E-1), and children were also provided with an assent agreement which was written in terms that were more appropriate for children in the participant age group than those of the consent agreement (see Appendix E-2). This researcher read the assent agreement aloud to each child before their first interview started. The children were invited to print their initials and indicate whether they would like to participate or not by checking a "Yes" or "No" box before their first interview (see Appendix E-2). Each child was also reminded that, if they did not feel comfortable telling one of the researchers directly that they no

longer wished to participate, they could communicate that information to a parent. Furthermore, at the start and end of each interview, the children were asked if they wished to continue their participation.

Children were never required to share the images, audio recordings or videos they had recorded on their smartwatches and permission was requested to take photographs of any of the pictures and writing relevant to the study that were created by children during or between interviews.

### **Data Collection**

Each interview was audio and/or video recorded and researchers hand recorded observation notes in point form. Recordings and handwritten notes were saved and organized by this researcher. Notes were recorded using a general outline of the research questions, though – due to the semi-structured nature of the interviews – notes did not always correspond with the order of questions on the interview guide.

Photographs of some of the artwork and written work shared during the interviews were saved with the children's permission. If children chose not to keep some of the artwork created during the interviews, their art was saved and stored in a locked cabinet within the lab. Videos and pictures saved on the children's smartwatches were not downloaded or saved by the researchers.

All digital data (videos, audio recordings, and photographs) were saved to encrypted USB keys which were stored in the care of the research team.

### **Data Analysis**

Close reading of the children's texts (including drawings and written texts), along with audio and video recordings from interviews, was used as a method of analysis. Bizzocchi and Tanenbaum described *close reading* as "a detailed examination,

deconstruction, and analysis of media text,” and referred to it as “the quintessential humanist methodology” (2011, p. 1). It involves exploring and questioning the meaning behind specific words and other symbols. In this research, it provided a way to carefully “listen” to the children and explore the meaning behind the words, images and other symbols that they shared. In many regards, this was well-aligned to the Mosaic approach and aspects of Kress and van Leeuwen’s “Grammar of visual design,” which are concerned with exploring a range meanings. As imagination, play and story-telling were aspects of this research, much of the data collected was fictional, though seen as representing what the children believed to be important details to communicate.

This researcher began by reading the hand-written notes recorded by researchers through the interviews in order to compare observations and prepare point-form, summary notes organized by participant and interview number. This made it possible to create a general description of each participant and determine high-level themes that emerged in the interviews. Examples of high-level themes included creativity, empowerment, and learning.

Organizing the summary notes by child and interview number helped when selecting video or audio recordings to review, in order to further explore each theme. Photographs of the artwork that the children shared and provided permission to photograph were also analyzed, in order to further develop the list of themes and explore (through close reading) examples which illustrated each of those themes. This researcher’s interpretations of the data were discussed with two other researchers.

There are few key points to summarize before moving to the next chapter. First, the young age group that was included in this study was selected for reasons that have been well-articulated by Kress and van Leeuwen (2006). In essence, young children are less likely to be influenced by societal notions of what this type of technology is or means, and they typically have less power to disseminate their ideas. Furthermore, the

Mosaic approach to ethnography employed in this research is concerned with giving young children a voice and thus “listening” to young children (Clark and Moss, 2011). Both Kress and van Leeuwen (2006) and Clark and Moss (2011) see children as being competent to convey their own ideas. Additionally, it was anticipated that young children would have varying levels of comfort communicating verbally with adults who were not a part of their day-to-day lives. As such, a variety of methods, including semi-structured interviews, observation and analysis of the children’s drawings, as well as any verbal or written narratives, were used with the intention of allowing children to express their ideas through modes that were most comfortable for them. Allowing the children to communicate in ways that they preferred was also done with the intention of bringing forth more rich and meaningful data. Close reading was used as a way of analyzing the data that was collected through this case study.

## Results

### Overview

This section begins more generally with results regarding children's ideas about or inspired by the smartwatch, including creative ideas and narratives, then moves into how their ideas might inform formal education practices, and concludes with results concerning how wearables may empower children in their day-to-day lives.

### Children's Thoughts on Wearable Technology and the Potentials it Inspires

Partway through their first interview, each child was given a smartwatch to keep. Initial reactions to the smartwatch are described in this section, as they provide a sense of the children's immediate response to this type of technology, before they have had a chance to bring it home or to school where others may begin to influence their ideas about it. Following that, results regarding potentials the smartwatch inspired by the smartwatch as shared by the children.

**Initial reactions to the smartwatch.** All of the children quickly began to push buttons along the side and swipe the touchscreen on the top of the smartwatch within a few minutes of being given the device, suggesting an interest in seeing how it works or playing the games. Specific responses to the new smartwatch varied by child, however.

When the smartwatch was taken out of the box and presented to Sarah, she immediately gasped "*Woah! Can I keep it?*" When asked if it looked like a toy or anything different, she stated "*it looks like a toy to me*" and that it did not look like anything else that she had at home. A few minutes into trying out the watch, she was asked if there is anything in particular that she would like it to do, to which she promptly responded: "*Yeah... braid hairs,*" explaining, "*It would teach me.*" Nearing the end of her interview, she excitedly shared that she would be going on a cruise in the summer and

would bring the smartwatch with her and would probably use it while she was on the plane.

When Timothy was presented with his smartwatch, he very quietly studied it. His first question was *"How do you turn this thing on?"* but he quickly found the on/off switch on his own. He had not decided how he felt about wearing it, stating with a sigh *"still don't know."* When asked who or what he could pretend to be with the smartwatch, he responded *"my friends,"* explaining, *"...they have a Fitbit® but it goes around their neck and my teacher has, like a...something like this but it's something else."* He expressed that he was not sure what they did with their Fitbit® pedometers.

Charlie's reaction was one of curiosity and experimentation. Within seconds of being given the smartwatch, he wanted to know if it had a charger. He observed that it told the time and stated that, *"it looks like a toy,"* adding, *"I don't know what it does."* He was the first to find the camera feature and, getting up from his seat and moving closer to one of the researchers, he offered: *"this is where it takes the picture from,"* showing the camera lens. Getting back to his initial concern after a few minutes, he asked, *"how do you charge it?"* and began plugging in the cord provided in the box, observing that it did not have a typical wall charger attached. Following that, he asked, *"Now, how do you take the video?"* Further along into the session, he began pacing back and forth as a stopwatch app was open on his screen that included the figure of a person walking as numbers advanced along the screen. He approached his mother and noted quietly that it was not tracking his steps.

Seconds after Cayden was handed his smartwatch, he commented with a bit of a laugh: *"I think I already know how to do this."* Shortly after getting started with the smartwatch, he was asked what it reminded him of, to which he responded: *"like a mini iPad."* When asked what about it made him think of an iPad, he explained: *"Like games, and there's a camera and movie."* He decided that he would wait until he got home to

try it out and asked how to turn off the device. Like Timothy, Cayden found the power switch on his own.

Although Skye was the least forthcoming of the participants, her initial reactions to the smartwatch are important to note. Her first comment, upon having a few minutes to study the watch was *"I don't really like it."* She wanted to know if there were any games on the watch. When asked if there was anything she would want the smartwatch to be able to do, she replied *"Nope."*

**Imagining what a smartwatch could do.** In the second and third interviews, the children were asked if they wished the smartwatch could do anything that it could not do, or if they had an ideas in general regarding what they would like technology to be able to do, if they were to create it. Questions of this nature were asked in order to get a sense of what capabilities were seen as being important or desirable to the children, rather than to suggest any changes to the design of the smartwatch used in the study. By the first and second interviews, most of the children had shared ideas for enhancing the current wearable device or other creative inventions for technology in the future.

In his second interview, Charlie recommended that a button could be added to the smartwatch that, when pushed, could cause the straps to disappear so it could be held rather than worn on the wrist. The researchers observed that the smartwatch was large in comparison to the wrists of most of the children, and that some of the children would take it off their wrists in order to hold it in their hands while navigating it during the interviews.

In his second interview, Timothy wanted to show the researchers how he had attached a small stuffed animal, named "Baby Wolfie," to his smartwatch. Later in the interview, he confided that he sometimes pretended that his stuffed animals were playing with the smartwatch. Timothy also brought in labeled drawings of three games – a mining game, a racing and braking game, and a building game – which he believed

would be good additions to the smartwatch (see Figure 3). He was asked if he would be able to explain what he included in his drawing, stating politely *“Um... I can't explain it,”* before passing the drawing toward the researcher. He was asked if the ideas he drew were based on a game he has played and he replied, *“Uh yeah, but...just...you can look at the picture.”* He offered, *“And, I did a GPS so my mom and dad can know where I am,”* as indicated near the bottom of Figure 3.

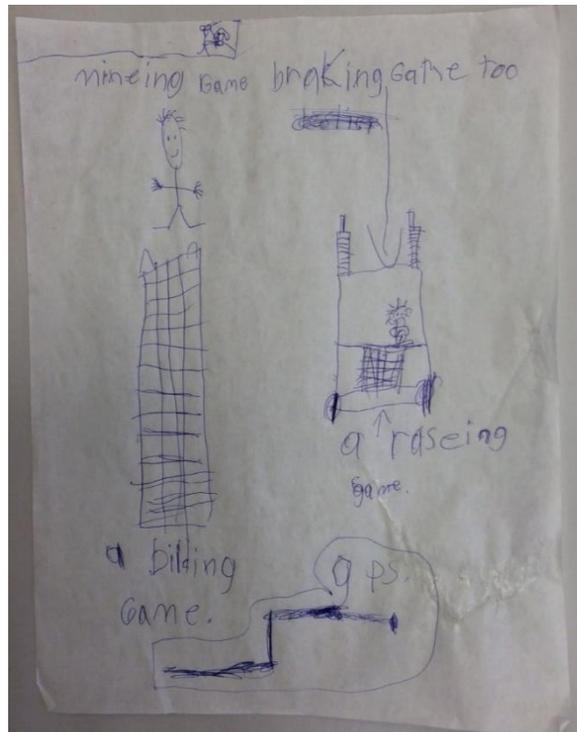


Figure 3 – New games for the smartwatch proposed by Timothy, 7

As Timothy was prompted a little more about the elements included in his drawing, he came around the table to stand next to the researcher and pointed out specific parts of his design, including a building game, and a component of the game that would require the player to take a picture of their self.

**Other potentials shared in discussions about wearable technology.** Some of the conversations with children regarding the smartwatch sparked discussion about other

creative ideas, some of which did not involve wearable technology but provide insight into what children find meaningful or would like to have in their lives.

During conversations about wearable technology, Cayden offered a number of ideas about technology. The following is one excerpt of a creative brainstorm during which he explored his idea about a bus of the future (see Figure 11):

*Cayden: I thought of some stuff that would be maybe in the future... A school bus that has like a swimming pool and, like, an arcade. And, a place you could sleep... A whole big bus that went down the road, it wouldn't be able to fit under bridges.*

Cayden added, *"At the top, you could just look off...the top there's a mini put course."* He Cayden illustrated a picture of his bus and added context to the story, explaining that he took a bus to school everyday. He was asked what made him think of this idea and his response was, *"Just because kids would love it and kids would just always like to go on the bus. Get rid of that old yellow school bus! Throw them away in the dumpster."* Adding more in terms of the personal relevance of his idea, Cayden also shared that he was often bullied by two kids on the bus on the way to school.

Upon presenting his finished drawing of his bus, Cayden got up and announced *"I would give that ... [drawing a checkmark]... I would not give it ... [drawing an 'x']*. *Know what – maybe even a... [drawing an A+]."* This suggested that he was pleased with what he had created and also felt entitled to add an evaluation of it.



**Figure 4 – Cayden’s bus of the future**

An additional creative idea of a future wearable that was shared by Cayden was one that could monitor a person’s health. He introduced his invention as follows: *“Like one of these [gesturing to smartwatch], has camera, pictures and all that but it also monitors your body to see how you’re feeling. It tells you if you have to go to the Doctor’s, or if you’re sick.”* He was asked what children might like about that the most, to which he responded, *“Probably if they’re not feeling well. They would just have to go to the Doctor. They would already know.”* Adding to this idea, he explained, *“If you just said ‘I’m not feeling well’, you didn’t wanna go to school and you were just joking, your mom says: ‘Well, let’s see about that!’”* When asked if he thought kids pretend that they are not feeling well, Cayden shook his head “no.” He was also asked what would happen if a child who was wearing it was not feeling well, to which he replied, *“It would just say ‘Doctor’ and then you just go to the Doctor.”* He explained that there would be one for children, and one for adults. Cayden provided rich details regarding this, and other inventions, which are explored in further detail in other sections.

### Children's Narratives Involving or Inspired by Wearable Technology

Illustrations, written text, and oral storytelling served as forms of narrative explored in this case study. Three of the five children interviewed – Charlie, Sarah, and Cayden – illustrated pictures of themselves wearing their smartwatches or cast themselves in stories involving wearable technology.

The illustrations that Charlie and Sarah shared included smiling faces, and took place in settings that would be common to young children in this part of the world (the park, their home and the schoolyard, as examples).

Charlie's drawings were unique from other drawings shared in the study, in that they sometimes included other children. The drawing in Figure 5 below was created on the same date as his first interview and, he explained, shows him sharing his smartwatch with a friend and again with his sister. In both cases, he is the figure wearing the smartwatch.

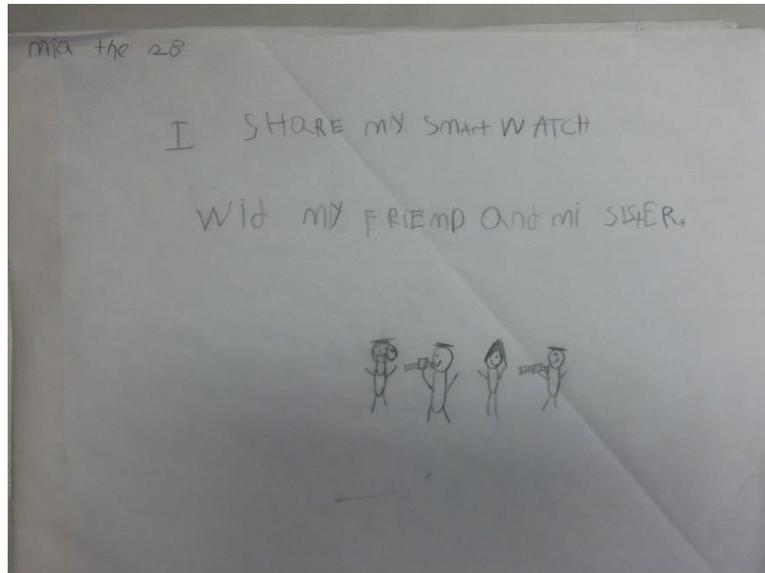
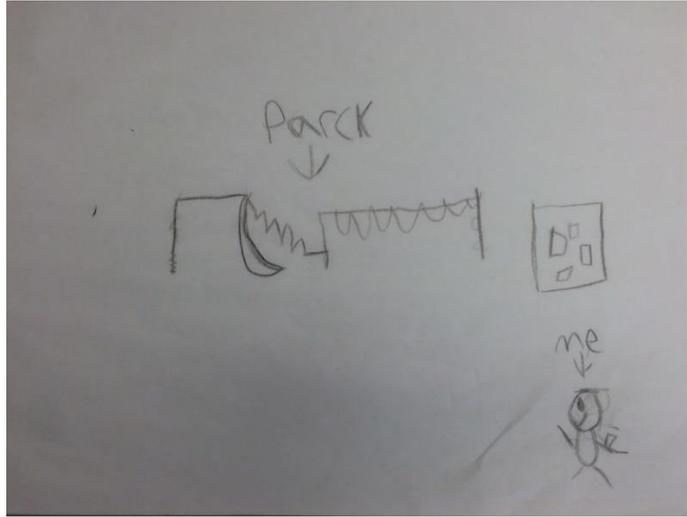


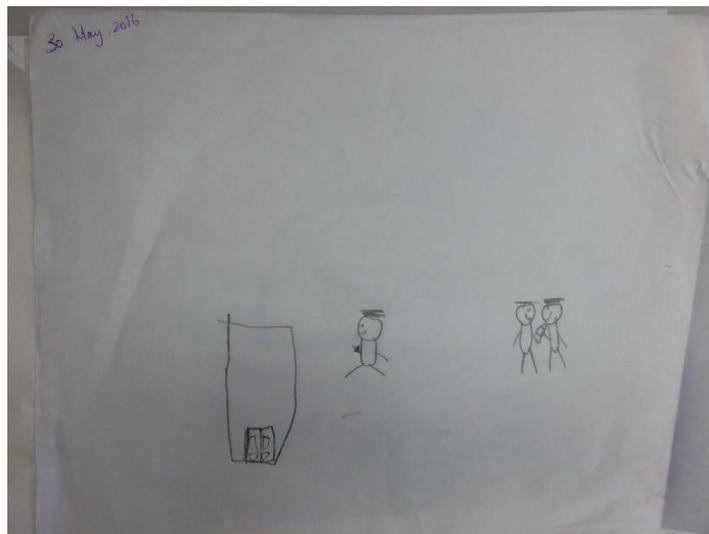
Figure 5 - Charlie sharing his smartwatch with his friend and sister.

Charlie revealed that he liked to pretend he was a spy with his friend at the park, viewing his surroundings through a green lens he found on the smartwatch (see Figure 6). The ability to change the colour of screen while using the camera was not mentioned by any of the other children.



**Figure 6 – Charlie, 6, at the park, wearing his smartwatch on his wrist.**

He also drew pictures of himself wearing the smartwatch outside of his school.



**Figure 7 - Outside the school, with the smartwatch**

Sarah drew a number of colourful pictures of herself with a smile on her face, wearing her smartwatch (see Figures 8, 9 and 11). Some of her pictures included hearts, and other heart-like shapes (Figures 9 and 10). At the start of her second interview, Sarah read aloud some of the written pieces that she created after her previous interview. She counted the number of hearts in one of her illustrations (Figure 10). When asked if she saw hearts on her smartwatch or drew them because she liked it, she confirmed, *"I drew it because I like it."* Her pictures captured the positive outlook and cheery demeanour that she embodied in each of her interviews.



**Figure 8 – Sarah, 4, drew herself smiling while wearing the smartwatch**

Sarah wrote uplifting messages about her positive feelings regarding the smartwatch and what it could do (see Figures 9 and 10).

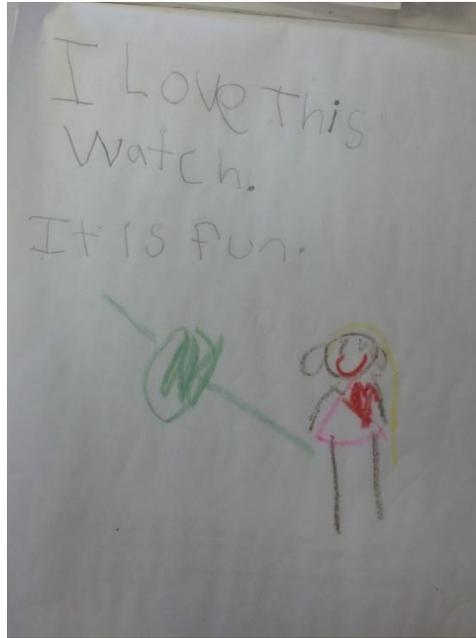


Figure 9 – 'I love this watch. It is fun.' (Sarah)

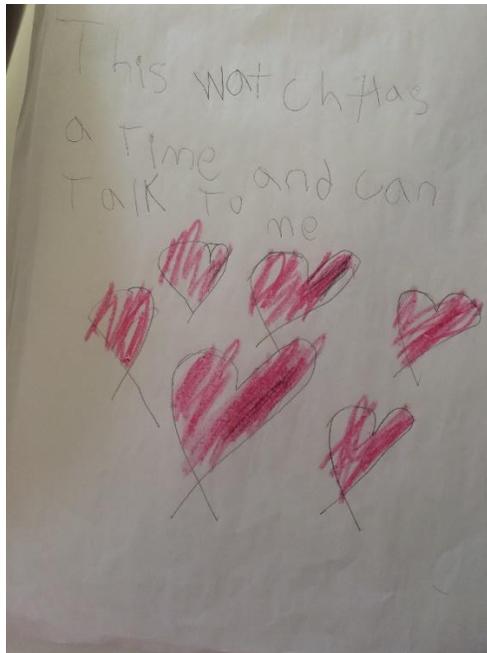


Figure 10 – 'This watch has a time and can talk to me.' (Sarah)

Similar to the narrative included in Ngai et al.'s (2013) article that shared examples of plays older children created as part of an e-textile workshop (see pages 16 and 17 above), Cayden told a story about a seemingly unfortunate incident with his smartwatch. When asked if anything funny happened when he was using his smartwatch, he initially shook his head "no," and then eventually shared the following anecdote: *"Except yesterday... I was videoing... I fell on my knees, hit the door [chuckles]... um, my head hit the door [chuckles], I wented down, hit a bean bag, my head bounced and I knocked over a game."* Sharing this story in a playful tone, he did not seem to be seeking pity, and appeared to be pleased to share a wacky tale.

In his final interview, Cayden also shared a creative story about an idea for an arcade. This theme of an arcade was of interest to Cayden and came up in a few discussions with him. The following is an excerpt of one of these discussions:

Researcher: *What are some of the things you want to do when you are big? Any fun things you think you'd like to try?*

Cayden: *Yeah. Like, I would buy a whole like... an apartment building, take out all the rooms and then put in a whole arcade with trampolines...vending machines.*

Researcher: *Cool. Any of the ones that you build [vending machines]? ... None of the LEGO ones?*

Cayden: *Well, yeah, maybe...except they would have to be huge.*

Researcher: *Who gets to go there with you when you're grown up, in that place?*

Cayden: *Well, there'll be a sign outside the driveway that says.... 'Arcade' and on the door it says 'Closed.'*

Researcher: *It's just for you?*

Cayden: [Nods his head 'yes']

Researcher: *You want it to be like a secret, private space for you?*

Cayden: [Nods his head 'yes']... *Unless Saturdays and Sundays I put an "Open" sign.*

Later on in that discussion, Cayden talked about a few other inventions including a game he would like to invent where the players using a wearable device would dance in order to get tickets. He explained that he would put this dance game in his arcade.

As conveyed in the above examples, children shared narratives involving or inspired by the smartwatch in a number of ways including pictures, written texts, and oral storytelling. Some children utilized certain modes more than others (for example, oral storytelling over writing), or regularly opted to share their ideas using multiple modes (drawing, writing, and oral storytelling, for example).

### **Empowerment and Wearable Technology for Children**

A sense of pride associated with being able to use the smartwatch, the ability to use a type of personal technology that is their own, as well as the ability to document events that are of significance to each particular child were some of the empowering aspects of this type of technology which emerged in the interviews.

**Pride.** A sense of pride related to the ability to use this technology was noted in several interviews. When asked, Cayden agreed that he was proud to show his friends that he had a smartwatch. During his first interview, Charlie frequently verbalized and then physically demonstrated what the smartwatch could do as he learned to use it. The example provided above of how he got up off his chair to show the camera lens and, on many occasions thereafter demonstrated the many things he could do with the watch suggested that he was proud of what he was able to do. In a similar regard, a

smile beamed across Sarah's face as she showed a video on her smartwatch of her talking about her brother in her kitchen. The audio was muffled on the video but she could be heard referring to her brother as a "funny boy" on a number of times in a giddy tone.

Moreover, the word "happy" was used by a few of the children to explain how they felt when they took pictures or recorded videos using the device or when they showed other people, often family members, how it worked. When Sarah played the video of herself talking about her brother, she grinned as she replied that it made her feel "*happy*" to make the videos. She revealed again that she felt "*happy*" (smiling down toward her watch) when she showed her dad how she used the smartwatch. Sarah shared in her final interview that, if big people used something like the smartwatch, she would show them how to use it. In a similar manner, Timothy quickly used the word "*happy*," with a smile on his face, to describe how it felt to show his dad how the smartwatch worked. Explaining why that made him feel happy, he said, "*Because I just really wanted to show him.*" Charlie said he felt "*Kind of happy*" when he showed kids at school how the smartwatch worked.

**Personal technology, ownership and privacy.** The related themes of 'personal' technology, ownership and privacy came up in several of the interviews. Despite some exceptions, letting siblings and friends use the smartwatch was not often something the children expressed that they wanted to do. For example, when Cayden learned that a girl at school had the same smartwatch at home, he shared that he was not glad that he was not the only one to have it.

Although Timothy mentioned at the end of his first interview that his friends had something similar, the Fitbit®, he stated that he did not think that he would show them his smartwatch. In his second interview, he shared that he did let one friend play with it but that it was more fun to play with it by himself. Displaying a similar back-and-

forth regarding whether he would like others to use his smartwatch, Charlie added a caveat when he mentioned he might play with his smartwatch with his friends, qualifying his statement with, *"my friends that are nice to me."*

Sarah expressed that she would show her brother her new smartwatch during the first interview, though when asked if she would share it with her brother, she stated that she would like to get one for him. In a later interview she explained that it was more fun to play with her smartwatch alone than with others and when asked what if other children had a toy like her smartwatch, she replied, *"I think they wouldn't know how to do it. Except me."* She offered that she would show the children how to use it, including how to play the games, however.

The concept of using passcodes came up in two discussions with the children. At the end of his first interview, Cayden stated that he would share his smartwatch. However, when his mother revealed to him during his second interview that his older brother had used his wearable device without him knowing, Cayden remarked, with an air of suspicion, *"I thought my battery went down!"* By the end of the interview, he shared that he had put a passcode on an iPad at home and would put one on his smartwatch, if he could. He explained that he already knew what his passcode would be and would keep it a secret, adding *"I want my room to...have a passcode on the outside 'cause I have all my gold medals and trophies in there."* Speaking to the purpose of a passcode, Cayden offered:

*A passcode's just so that, like, if kids, they use an iPad or something way too much, their mom and dad will put a passcode on it so they don't use it as much. They have to ask their mom or dad.*

In contrast to this, Timothy associated passcodes with technology used at school for literacy-related activities. When asked if the smartwatch is like the literacy games he

described are played on his classroom computer, he explained *"No... you would have to do a passcode."*

Discussions centered on YouTube® channels, subscriptions and getting due credit came up in conversations with Cayden. Cayden mentioned his older brother's YouTube® channel, which he sometimes referred to as *"our own channel."* Using a Go-Pro (a small, wearable-mounted camera), or recording within the game, Minecraft, he and his brother liked to make videos. In his second interview, he expressed an interest in getting his own channel, his own subscribers and "credit" for his work. He revealed that *"the YouTube channel,"* as he then called it, (his brother's channel) currently had close to twenty subscribers, stating *"Then we'll have this huge sign that says '20,' then we'll explode it."* He was asked if he would like to have subscribers for the videos he created on his smartwatch. The following is a portion of the conversation about video subscriptions and credit that stemmed from talk about the YouTube® channel's subscriptions.

Researcher: *Would you ever want to have subscribers on this, if you started to make movies on it?*

Cayden: *Yea, 'cause my iPad doesn't have CAMERA, which is a problem always.*

Researcher: *Would you be glad to have people who were watching it watching it? I mean, if you have subscribers, they watch what you make, right?*

Cayden: *Yea, my brother, he's the one who always gets all the credit, 'cause I'm never in any of his videos. I'm just helping out, getting wood and stuff... So, I'm never in it... But, my brother gets, like, a whole bunch of like 'scribers from people.*

Getting more into the topic of ownership, Cayden directed the conversation to how he would like his own iPad when asked about whether he hopes to have his own subscribers when he is bigger.

*Cayden: I kind of already have my own iPad [in a mischievous tone]... Like, my brother has his own, my dad has his own, my mom doesn't [laughing under his breath] have an iPad – she only has a phone. I don't want that. [Looks at his mom] GET AN IPAD.*

A brief dialogue between Cayden and his mother indicated that he had been using her iPad as if it were his own and either already added or wanted to add a passcode to it.

Related to the concept of passcodes, a certain amount of unease or distrust associated with sharing the smartwatch with other children at school came up in some of the interviews. Timothy explained that, when he brought it to school for a technology day, children at school started to play with it while it was on his wrist without his permission and that he was “*getting a bit freaked out.*” Similarly, though Charlie shared a story of playing a spy game in the park using the smartwatch with a friend, he also shared in the third interview that he did not tell other kids about it because they would want to use it. Cayden's desire to add a passcode may also relate to a distrust of others and wanting to keep his smartwatch private.

**Documentation of personally meaningful life events.** The types of videos and pictures recorded on the smartwatches, as well as the scenes depicted in some of the artwork shared by the children, suggest that the ability to document aspects of their day-to-day lives was of significance. Videos and pictures that the children shared commonly showcased family members and other aspects of a child's personal life.

Sarah's suggestion that she would bring her smartwatch on an upcoming family vacation, along with a video she shared of herself playfully telling a story about her

older brother serve as examples of her seeking to document things that were meaningful in her world. The location of some of her drawings that feature her wearing her smartwatch – her home – is also important to note as it represents a meaningful place in her world where she may have used the smartwatch (see Figure 11).



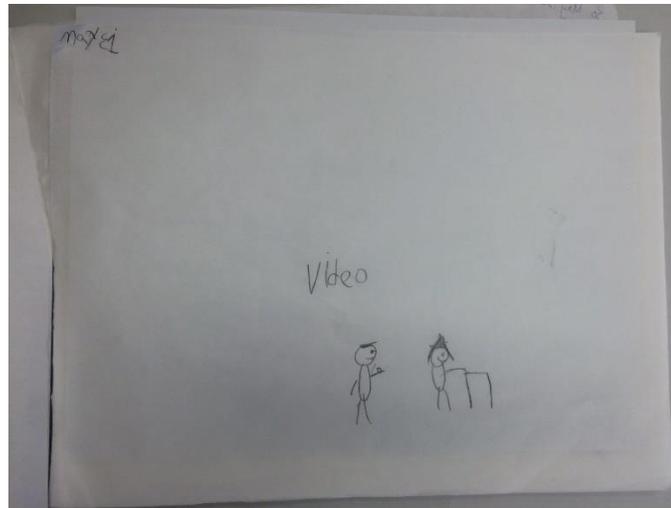
**Figure 11 – Sarah wearing the smartwatch in front of her house**

Timothy shared a number digital artifacts, which highlighted settings and events that were of meaning to him. Examples included a video recording of his car ride home that was taken after his first interview, pictures that he took at a local food festival, a 'selfie' of "Baby Wolfie," his stuffed animal, in addition to a few snapshots of his older sister and father.

Cayden's facial expressions indicated that he was glad to share a video recording of a figurine in his classroom. Furthermore, he expressed an interest in the Go-Pro-like, first-person perspective that the smartwatch provided. Take, for instance, his response to whether the smartwatch could give him powers of any kind:

Cayden: *No, but it kind of has Go Pro videos... Like, when I jump my monkey bars, it's still on me so people know that I'm actually jumping. And, if I want to do a backflip, like, pretend, I just go like* [gesturing with the smartwatch to demonstrate how he might simulate a backflip].

Charlie recorded a video of his sister playing the piano and also shared a picture that he drew of this (see Figure 12). He included the word "Video" above his own figure in the drawing. His and his sister's piano lessons came up in a few discussions, indicating that this was an important activity in his life.



**Figure 12 - Charlie recording a video of his sister playing the piano.**

Lastly, the children frequently commented on how they liked to scroll through the pictures and videos recorded on their smartwatches alone and only sometimes with other people. Sarah, for example, could not remember if she shared the video she enjoyed of herself talking about her brother. When asked if she shared it with her brother, she said *"Uhh, no,"* and took time to think before replying, *"Daddy, I think....I think."* Most often, the children explained that they liked to look through their pictures and videos on their own, suggesting that these artifacts were considered private and for their own enjoyment.

### **Children's Ideas about Wearable Technology Related to Formal Education**

There were mixed findings regarding the children's experiences and ideas about use of this type of technology in the classroom. This section follows in three areas: (a) children's experiences with bringing the smartwatch to school and (b) children's ideas regarding whether it would be useful in classroom contexts and (c) children's experiences with self-directed, informal learning using the smartwatch.

**Bringing the smartwatch to school.** Three of the five of the children shared that they brought their smartwatch for "technology days" at school or for use during recess. One child, Charlie, said that he was allowed to bring his smartwatch to school with him but none of the children shared that the wearable became a part of their regular day-to-day activities in the classroom. Additionally, none of the children's drawings or written texts involved using the wearable technology inside the classroom and examples of how they were able to use it for their learning within the classroom were not verbalized in the interviews. Although Charlie explained that he was allowed to bring his smartwatch to school and he drew a picture of himself with it at school, the picture shows him using it outside of the school (see Figure 7).

Cayden shared in his first interview that other technology, such as computers and iPads were already used in his kindergarten class. His smartwatch, however, was not a welcomed device in his class. He reported in the second interview that he brought the smartwatch with him on the first day of school after receiving it. He appeared to be proud to share a video recording he created in his classroom. One of the researchers commented on how that meant he was able to bring it to school and, with a smirk, Cayden replied: *"No, I got in trouble."* When asked if he would be OK with sharing the story of how that happened, he replied: *"OK, so, I video taped and then I took a picture of my teacher and then she got me in trouble."* He explained that his teacher did not ask what it was. A note was sent home to his mother to leave the device at home.

Two of the children commented on concerns about losing the device at school. Timothy mentioned during his second interview that he would not likely bring his smartwatch to school because it might get lost. Sarah explained that she was not allowed to bring her smartwatch to school and also expressed an awareness of the possibility that it could get lost if she brought it there. The following is part of a similar discussion on this topic between one of the researchers and Sarah.

Researcher: *What do you think you would do, if you brought it to school?*

Sarah: *I would play with it. Even...I'll just keep it in, like, in the sink, so it doesn't get lost.*

Researcher: *So it's something you wouldn't want to lose.*

Sarah: *'Cause I like it.*

Concerns over losing the smartwatch were similar to the fears regarding losing data on classroom computers expressed by children in Baytak, Tarman and Ayas' (2011) study. The researchers involved in this project were aware of the possibility that the devices used for this case study could be misplaced or stolen. In fact, as mentioned in an earlier chapter, Skye reported that her smartwatch was either lost or stolen at school sometime between her second and final interview.

**Children's thoughts regarding whether wearable technology would be useful at school.** Consistent with Baytak, Tarman and Ayas' (2011) findings regarding children's limited ideas regarding the advantages of using technology in the classroom, Charlie explained that he did not believe that his smartwatch could help him in class, though he thought teachers could use it to "*look up things*" and it could be used by people in high school for their work. Furthermore, Timothy shared in his second interview that he would be "*surprised*" and "*freaked out*" if something like his smartwatch was used in school, "*because if they brought it to school, then I would be crazy. I would be just*

*creeped out.*” He also felt that it would be distracting. When asked if his teacher would use something like the smartwatch, Timothy said *“No...because she already has a Fitbit.”* Pedometers, such as the Fitbit®, came up in discussions with three of the five children interviewed and may have served as a reference point for these children with regard to wearable technology.

**Digital literacy and development of creative skills.** Although there are challenges associated with allowing young children to utilize personal technology at school, a number of findings related to formal education – particularly in regard to the development of creative skills – were observed, though perhaps not explicitly acknowledged by the children. Digital storytelling, for example, stood out as an affordance of this type of personal technology. All of the children took pictures and recorded videos using their smartwatches and a few recorded audio. Kress and van Leeuwen (2006, p. 17) argue that the skill of creating “multimodal texts” is not facilitated in schools despite the relevance of these texts.

Children commented on or inquired about the recording capabilities of the smartwatch. As previously mentioned, Charlie’s first question about the smartwatch concerned how to create videos. Video editing was noted to be of interest to both Timothy and Cayden even prior to receiving their smartwatches. Cayden was interested in ways that he could polish the videos he had recorded, sharing *“... I don’t know how to make the movies yet. Like, I don’t know how to edit it and put all the clips together.”* This particular device did not seem to offer the sophisticated editing capabilities that Cayden had used with other devices or software. Furthermore, Sarah appeared to notice that the audio sounded was muffled in some of her recordings that she shared with the researchers.

Returning to the concept of multimodal texts and the use of images versus words in media intended for children versus adults, Cayden explained that the medical

monitoring device he imagined would be offered in different formats for children and adults.

*Cayden: There's two kinds. Like, one for kids, one for the adults. The kids have pictures and the adults have words, 'cause kids can't read! But I can. I'm Level H in home reading at school.*

*Researcher: Can you think about what kind of picture? Would it be a picture of a doctor or would it be a picture of you?*

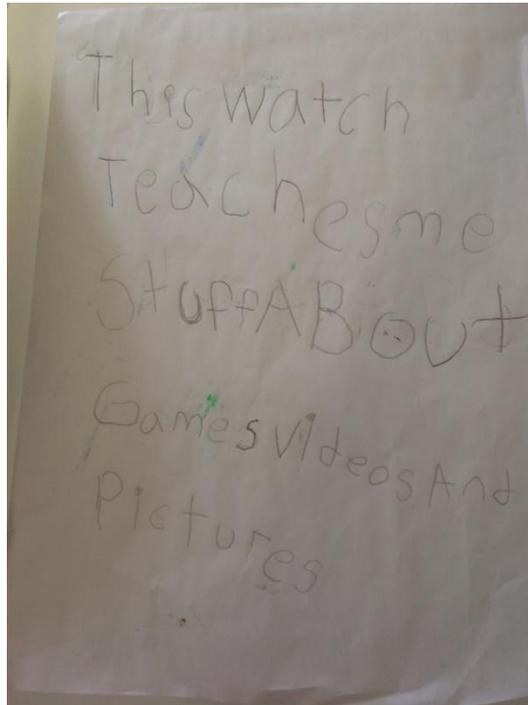
*Cayden: Like, it would be a picture of, like, a doctor... like a needle [giggled shyly]... Like it tells you what you need. Like, tells you need medicine or whatever, or, like, if you broke your leg [giggled].*

Evidence of how engagement with this type of technology, and discussions about those experiences, can also inspire an interest in game development or creative brainstorming is relevant to the development of creative skills. Other examples of children's creative ideas that have already been mentioned include:

- Timothy's drawings of games he would like to be able to use on his smartwatch (Figure 3);
- Sarah's idea regarding a wearable to teach how to braid hair;
- Charlie's idea to modify the smartwatch to make it easier for children to hold and use of the green coloured lens for imaginative-play;
- Cayden's 'bus of the future,' health monitoring device, and arcade.

**Self-directed, informal learning.** All children who were interviewed demonstrated that they could navigate the smartwatch to access various features, though none received direct instruction from the researchers. When asked how they learned to use the smartwatch, most described how they learned to use it with little or no help from others.

The youngest participants, Sarah, explained that she *“just tried new stuff”* and that it was easy. She mentioned that her older brother showed her how to use one of the games. In another discussion, she explained that she figured out how to use an iPad by herself. Sarah also included a written piece in her sketchpad about the watch teaching her (see Figure 13). This finding indicates that children as young as four years old can reflect on how technology aids in their learning.



**Figure 13 – 'This watch teaches me stuff about games videos and pictures' (Sarah)**

Furthermore, Cayden stated, *“Well, I just went on it, then I started to figure it out, then I saw a commercial.”* Similarly, Charlie and Timothy both explained that no one helped them learn to use the device, and that they showed family members how it works.

This chapter addressed findings related to three main areas. More generally, it began with findings related to what children thought about this type of technology and

any creative narratives it inspired, the chapter then moved into findings related to the theme of empowerment, and lastly, findings that may inform formal education practices. As a multi-method approach was employed, dialogue from interviews with the children, observations, drawings, and written texts created during, and between interviews were included. In the following chapter, these findings will be discussed in more detail.

## Discussion

### Overview

In this section, findings from the previous sections are combined to address the two overarching questions specific to this case study which are principally concerned with how wearables may empower children in their day-to-day lives and how children's ideas may inform formal education practices. Insights that emerged from the interviews related to the two main research questions support and extend aspects of Papert's constructionist learning theory and Sutton's Smith's "play as a viability variable" theory.

### Wearables Empowering Children in Their Day-to-Day Lives

It has been suggested that the wristwatch, and time-keeping in general, has served as a symbol of power (Hall, 2008). Being able to tell the time was one thing that the smartwatch allowed the children to do (see Figure 8, for example), though it did not seem to be the most significant or meaningful affordance of this type of technology from the children's perspectives. Themes that were more significant included the sense of pride and happiness associated with the use of the smartwatch; the creative affordances of the technology; as well as some of the "silly" stories that it inspired. Those key themes also serve to signify the empowering qualities of the technology and connect to other principles of Papert's constructionist learning theory and Sutton Smith's "play as a viability variable" theory discussed in the following subsections.

**Pride and happiness associated with using the smartwatch.** The sense of pride that was observed when children showed some of their digital artifacts and things they could do with the smartwatch to the researchers was a key finding that emerged from this case study that also relates to empowerment. Several of the children also

commented on positive feelings associated with showing what they could do with the smartwatch to family or friends, even despite commonly preferring not to share the smartwatch with others. Furthermore, the idea that children described themselves as being “happy” to use the device or to show others how they could use it suggests that engaging with this type of technology provides satisfaction and a certain amount of personal meaning to many, though not all, of the children. Skye did not exhibit the same positive response to the smartwatch or share creative ideas related to many of the themes that emerged from the other children’s interviewed, which is viewed by the researchers as an equally important finding. As with other forms of technology, it is important to acknowledge that not all children would enjoy using it or find it to be meaningful or useful.

**Creating content and empowerment.** Papert saw children as builders (Papert, 1980b) and believed that computers can empower children (1990). In terms of making and creating, the smartwatch offered opportunities for children to create their own multimedia content. All of the children recorded videos and took pictures on their smartwatches and a few played with the audio recording capabilities. Quite literally, the smartwatch allowed children to have their voices heard. Cayden wanted to learn how to make his video content more professional-looking and to gain subscribers and credit for his creations. Wanting to have subscribers and make his work polished content visible to others also supports the constructionist view that “creating” and “making public” are related to the personally meaningful potentials of learning with technology.

Discussions about the smartwatch also inspired the creation of pictures and written texts which signified children as story-tellers and “meaning-makers.” Even quiet children had detailed stories to share, which they articulated using the materials or modes that they preferred – drawings, written texts, spoken stories, or a mix of some or all of these. Cayden went to the extent of evaluating his own drawing that he created in his final interview – giving it a checkmark and an “A+” (see Figure 4).

**“Silly” storytelling, creative play, and “play as a viability variable.”** Sutton Smith’s “play as a viability variable” theory explores children’s bold, sometimes gruesome, tales and views them as a way to “overcome the stuffy and bossy adult world they encounter” (Sutton Smith, 2008, p. 94). Cayden’s story about falling down, and hitting his head rather dramatically while videoing on his smartwatch; his comment about “exploding” a sign when his brother’s YouTube® channel gained twenty subscribers; and his suggestion that yellow school buses should be thrown out in the dumpster serve examples of how he used story to bring an element of excitement to the conversation. His idea for a future wearable that could monitor one’s health, and help children prove they were sick, is another creative idea that signifies his want to overcome some of the common hardships of being a kid. He was considering ways that wearables could be used to help children to advocate for themselves. Furthermore, his desire to be able to add a passcode to his smartwatch and his bedroom and to have his own iPad may be viewed as being related to the desire to maintain power or control over certain aspects of his life. He described a passcode as something parents use if children are using technology “way too much,” thus signifying a connection between control, passcodes and technology that he used in his day-to-day life. The view that he described at the top of his “bus of the future” also suggests a desire to be bigger, to have a more empowered perspective of the world. His plan to retrofit an apartment building to create his own private arcade when he is older served as an expression of what he would like to be able to do, if placed in the empowered role of an adult.

The playful story that Sarah told about her brother in a video on her smartwatch serves as another example of telling silly stories to make life as a child more interesting and less “stuffy.” The audio did not come through clearly but it was observed that she was giddy and teasing her brother in a friendly manner in the video. The smile on her face that remained as she played and replayed the video suggested that she was pleased with what she had created. Furthermore, Charlie’s imaginative use of the

smartwatch to pretend he was a spy also serves as a way in which he put himself in an empowered, all-seeing, role using the smartwatch.

### **Children's Ideas on Wearables Informing Formal Education Practices**

The *Kids, Creative Storyworlds and Wearables* project was not initiated with the intention of being an education study or to take place in children's educational settings. However, the informal, self-directed learning that was assumed to take place meant that it could produce findings related to formal education practices. Children's perceptions that these technologies are not for school and their experiences with informal, self-directed learning using the smartwatch can be of relevance to educators in formal education settings. Additionally, creative uses of the smartwatch including digital story-telling, and the documentation of personally meaningful events relate to formal education practices to varying degrees. As suggested by Rennie and Jarvis (1995), it is critical for teachers to learn about children's understanding of technology in order to consider this when preparing activities for their classes. As such, even if wearable technology does not become a regular classroom tool, it is important for educators to think about how children perceive or interact with current technology in their lives.

**Unlocking digital literacy.** A number of the children's comments, pictures and stories can be considered within the context of Constructionism and its key objective of empowering learners. Papert, influenced by his colleague, Piaget, saw children as builders of knowledge and epistemologists – thinking about how computers think and, in turn, about how they themselves think (Papert, 1980b). In *The Children's Machine: Rethinking School in the Age of the Computer* (1993), Papert stated of computers:

The Knowledge Machine offers children a transition between preschool learning and true literacy in a way that that is more personal, more negotiational, more gradual, and so less precarious than the abrupt transition we now ask children to

make as they move from learning through direct experience to using the printed word as a source of information (p. 12).

More than twenty years later, children in this study who engaged with wearable technology, amongst other technological devices that are a part of their day-to-day lives, provided examples of the personal nature of this technology, the ability to learn to use this technology in a self-directed manner, and engage in literacy-related activities (though sometimes not thinking it was the case). Although this technology did not provide the same kind of “microworld” that Papert described, the smartwatch did inspire questions from children about how it worked and what it could do. Charlie’s questions regarding the technology (e.g., How is it charged? How do you make movies with it? Can you download more games?), and Cayden’s interest in learning how to edit the videos he created exemplify the curiosity that it sparked amongst some of the children. Without instruction from the researchers, children found the answers to many of their questions on their own. In a direct manner, the youngest participant in the study, Sarah, wrote about what the smartwatch could teach her to do, revealing that she was thinking about her use of the smartwatch with respect to her own personal learning.

Timothy’s comment about literacy activities on computers in class requiring a passcode (and thus, distinguishing them from non-literacy-related activities that are available on the smartwatch), is also notable, particularly in regard to the related concepts of empowerment, learning by doing and the personally meaningful nature of constructionist learning. The literacy activities Timothy was familiar with at school were, from his perspective, associated with a passcode. Timothy’s belief that the things that he did using his smartwatch were not related to literacy, coupled with his belief that it would be strange to use his smartwatch at school were representative of the overall lack of creative ideas regarding how this type of technology could be used at school. Many creative examples of how their smartwatches could be enhanced, along

with other technological inventions and creative, digital artifacts produced with their smartwatches were shared by the children. Despite this, the children did not have many ideas regarding how it could be used in their daily activities at school.

Though there were findings pertaining to children's positive emotions associated with using the smartwatch (pride and happiness, as examples), and the theme of empowerment is generally a positive one, there are also key challenges associated with it that were addressed by the children. Cayden's story about getting in trouble for bringing his smartwatch to school, and Skye's experience of having her smartwatch stolen or lost at school call to attention difficult issues that can arise when using these technologies in children's day-to-day settings, including the classroom. The use of this particular type of technology in formal education settings, especially given its recording capabilities, would bring with it questions about how to help young children learn about appropriate use of this technology at a young age. The recording capabilities of this device, and others, would also call to attention important issues about privacy in the classroom. Furthermore, managing the distracting nature of any technology or tool in the classroom is another related concern. Timothy's comment that it would be distracting to him if it were to be used in school, signifies that even young children have an awareness of some of the inherent challenges associated with this and other forms of technology. Cayden switched off his new smartwatch partway through his first interview, suggesting that he realized it was a distraction, and also that he had a strategy for managing that distraction.

### **Discussion Summary**

This discussion began with a focus on findings regarding the empowering elements of this type of technology. The sense of pride associated with using the smartwatch and the children's use of the word "happy" to describe how it felt to show others how to use it was explored served as two points to illustrate these findings.

Furthermore, the affordances associated with making and creating content and having their voices heard with the smartwatch, even if they were observed to be shy, were discussed. The empowering aspects of the playful or “silly” stories shared by the children were also discussed in relation to Sutton Smith’s “play as a viability variable” theory, as they were seen as ways for children to add excitement to their lives or overcome some of the disempowering aspects of childhood.

The discussion then moved into findings regarding how this type of technology may inform formal education practices. Although the *Kids, Creative Storyworlds and Wearables* project was not initiated as an education study, it was assumed that that some level of informal, self-directed learning would take place, as formal instruction on how to use the smartwatch was not provided. Aspects of constructionism were discussed in relation to children’s use of the technology. For example, thinking with computers is an element of constructionist learning theory that was addressed. One of the youngest participants, Sarah, reflected on her own learning with the smartwatch (see Figure 13), and interactions with the smartwatch inspired questions amongst the children regarding how it worked, and what they could do with it. In most cases, the children were able to answer their own questions concerning various functions or limitations of the smartwatch.

In contrast, the children’s tendency to distinguish things they learned in school as being separate from what they learned to do with the smartwatch was also discussed. An example used to highlight this was Timothy’s suggestion that what he was doing on the smartwatch was different from the literacy activities that he did at school on a computer that required a passcode. Similarly, although children generated a number of creative ideas involving or inspired by the smartwatch, they did not have many ideas to share regarding how it could be used in school. Only one child shared that he could wear his smartwatch to school on a regular basis. Charlie’s suggestion that it could be used by older kids, or teachers, to look up information was an exception.

Moreover, some of the challenges this type of technology could present if it were used on a regular basis in school were discussed. Appropriate use of technology of this nature (which includes a camera, for example) was an issue that came up, as one of the children received a note from his teacher to leave his smartwatch at home. Managing the distractions that are inherent to this type of technology was discussed, as well as concerns over having it lost or stolen. One child reported that her smartwatch was lost or stolen at school.

### **Limitations and Future Research**

There are a number of limitations and related areas for further research to note. The small sample size is a key limitation of this study, which leaves opportunity for further research. With only five participants in the study, the results are not generalizable. Moreover, one of the participants lost or had their smartwatch stolen before the study ended, though she maintained her participation in all three interviews. As this was the first study of its kind for the lab (situated within a Social Science and Humanities Faculty), it was an intentionally small study. Furthermore, the cost associated with the wearable devices placed a limitation on the number of participants. It would be beneficial to explore these research questions with a larger group of children.

The second limitation concerns the location in which the interviews took place. Due to logistical reasons and time-constraints, it was decided to facilitate all interviews at one location, the lab used by the research team. Though this location was made as inviting as possible for the children, it was not an environment that was familiar to them. The researchers acknowledge that children may be more forthcoming and more willing to share their perspectives in an environment that is familiar to them. Further research that takes place in children's locations such as homes, childcare centres,

schools, local libraries or recreation centres could bring forth richer data that is more authentic to the children's day-to-day lives.

Another notable limitation concerns the diminishing novelty of the technology used. As the Linkitz® device that was going to be used for the study was not available at the start of the study, this research utilized a wearable device that had already been on the market for a while. It would be of interest to explore children's ideas of more novel or unfamiliar types of technology as they may be less conditioned to label them for certain purposes or have already been influenced by others in their lives (parents, teachers, siblings, care-givers, friends, as examples) regarding what these technologies mean or could mean in the future. Two of the children in this study, for example, shared that they noticed a friend or classmate had a similar toy and there were many references to popular pedometers as comparable devices.

With regard to the Mosaic approach, the data-gathering component with the children participants in this case study was not thoroughly addressed. It was explained to the children that the sketchpads and crayons that they were provided in the first interviews were theirs to keep, to draw pictures or write stories that they would like to share with the researchers the next time they met, but this could have been made clearer. Making the children more aware of their role as co-investigators in this study may have helped to achieve this. This, of course, would need to be articulated in a manner that could be understood by children between the ages of four and seven. Doing so may have brought forth more pictures and stories recorded by the children between interviews. At the same time, some children are not inclined to draw or write stories or may not find the topic so inspiring.

Observations from parents, teachers and other adults in the children's lives were not included in this study. The perspectives of parents and siblings are not widely studied within the discipline of CCI in general (Read & Markopoulos, 2013). Although

the researchers acknowledge that parents, other adults and even siblings could have many valuable insights to share about their children's behaviours and perspectives on the wearable technology that was provided, they decided to focus solely on the information provided by the child participants and did not plan to include this type of data in the study. This was intentional, due to the personal nature of wearable technology. A potential limitation that goes along with this is that the data collected was largely self-reported. The researchers intended to gain insight into children's experiences and ideas regarding this technology through their own perspectives, understanding the inherent limitations of self-reported data. Clark and Moss view children and adults as "co-constructors of meaning" (2011, p. 1), and an exploration of the similarities and differences between children and adults may be a worthwhile component of future research in this area that seeks to explore a range of perspectives. The response to study recruitment efforts, for example, revealed that there are a number of families with children close in age who would be interested in participating in research of this nature. This response suggests there may be an interest from families with several young children to participate in this kind of research.

Additionally, it would be of interest to meet with the children again at a later point in time. Meeting with the children beyond the month of this study was not a planned part of this research, though the Principal Investigator of this project identified an interest in interviewing the same children a few years later. Longitudinal research concerned with the evolving meaning children associate with this and other novel forms of technology could further the objectives of what Pedersen (2005) refers to as human-centric technology design and add depth to the literature on children's wearables.

Lastly, another area for further research involves exploring children's ideas about wearables that allow for greater opportunity for children to build and create. This relates to the concept of "black boxes" that has been addressed in research on construction kits and other programmable devices for children (e.g., Mikhak et al., 1999;

Resnick & Silverman, 2005). In this context, the term “black box” refers to the functional parts of technology that are made less visible/accessible to users. The Linkitz<sup>®</sup>, for example, was designed to be assembled by children in different ways and is said to offer children the ability to code using a pictorial coding language. Whereas, the smartwatch used for this study could be used to create pictures or videos and inspired creative ideas, but children could not program or alter the functionality of the technology to suit their needs or interests. In order to further explore key aspects of constructionism, which involve physically “constructing” and creating public representations of one’s learning, using a form of wearable technology that allowed for more manipulation and reconfiguration would be an interesting extension of the current research.

In summary, noted limitations of this case study related the small sample size (N=5), the location of the interviews (a university lab), the decreasing novelty of the device used, and a lack of emphasis on the role of the children as co-investigators, particularly with regard to data-gathering. Opportunities for future research related to this topic that have been identified by this case study include involving others in the research process (siblings, parents, care-givers, etcetera), facilitating longitudinal research of this nature, and exploring other forms of wearable technology that allow children more flexibility to program or manipulate the technology. The next and final chapter will address conclusions derived from this case study.

## Conclusions

Guided in part by the Mosaic approach to ethnography (Clark & Moss, 2011; Clark, 2005) and Kress and van Leeuwen's work on social semiotics (2006), this research sought to "listen" to the perspectives of five children between the ages of four and seven regarding the meaning they associate with wearable technology and other forms of technology. A children's smartwatch, the VTech® Kidizoom®, served as an object to inspire conversation and explore children's creative ideas about technology. Findings from this case study support and extend Papert's constructionist learning theory and Sutton Smith's "play as a viability variable" theory within the context of current advances in technology for children.

Two main research questions guided this case study:

- i.) How might wearables empower children in their day-to-day lives?
- ii.) How might children's ideas about wearable technology inform formal education practices?

Findings pertaining to other research questions which guided the larger *Kids, Creative Storyworlds and Wearables* project overall enriched findings that were related more directly to the two research questions mentioned above. For example, exploring what children thought about this technology in general, along with the narratives and other creative ideas it inspired, helped to answer how wearable technology may inform formal education practices and empower children in their day-to-day lives.

Empowerment is a major theme that came out of the interviews with children and is also a key tenet of Papert's learning theory, constructionism.

Findings related to how wearables may empower children in their day-to-day lives included a sense of pride associated with using the device; the ability to use recording features; a desire to maintain the device as their own personal technology; discussions on passcodes and privacy; and the telling of "silly" stories about using or

inspired by wearable technology. The “silly” stories and other imaginative ideas serve to exemplify how Sutton Smith’s “play as a viability variable” theory is relevant to children who engage with current technology, including wearables.

Although this study did not take place in children’s formal education settings or set out to be an education study in particular, observations of the children’s experiences with self-directed, informal learning involving the smartwatch, coupled with some of their reflections on how it may or may not fit into their classroom activities may be of relevance to educators. Findings related to how children’s ideas regarding wearables may inform formal education practices include: children’s experiences with informal, self-directed learning using the smartwatch; an awareness of children’s current perceptions that these technologies are not for school; and opportunities for digital story-telling, including children’s use of the wearable to document personally meaningful events.

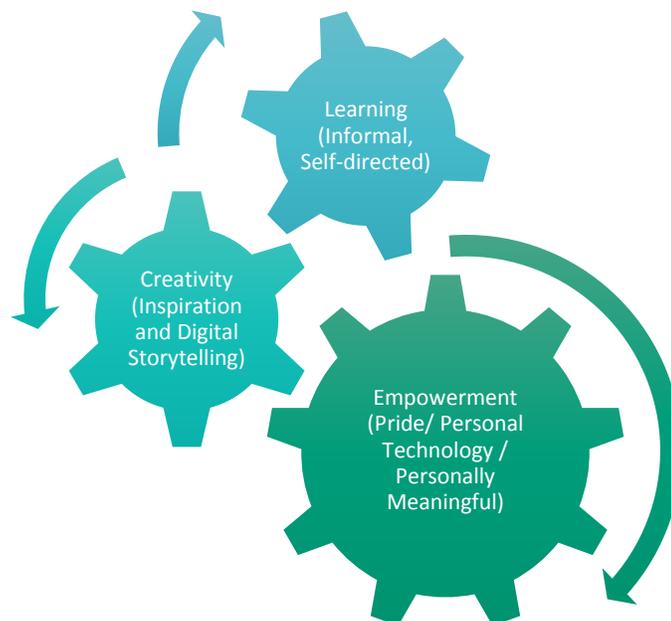


Figure 14 – Key themes from the smartwatch case study

Applying a multi-method approach in this research, inspired by the Mosaic approach to ethnography and supported by Kress and van Leeuwen's take on social semiotics, meant that ideas from young children, some of whom were shy or less inclined to verbalize their ideas, could be expressed in ways which were more comfortable to them. As examples, the drawings, written text and "silly" stories that were shared by the children provided rich details that could have been missed if the researchers relied solely on structured, traditional interviews. Three of the five participants brought in drawings and written text which helped to convey the meaning(s) they associated with the wearable technology (Figures 3-12). Children's artistic representations often served as springboards for discussion. As a primary example, Timothy, who often appeared to be nervous during interviews and provided brief verbal responses to many of the questions, brought in a detailed sketch of games he thought would be good additions to his smartwatch. He was more willing to talk once one of the researchers had his drawing in front of her. Moreover, the rich data shared by the children in this case study, including the youngest participants (who was just four years old) also exemplifies why it is worthwhile to engage in this type of research with young children.

Several limitations and areas for future research were identified in this case study. Noted limitations included the small sample size (N=5), the location of interviews, which was outside of the realm of a child's day-to-day activities, and that the data collection component was not as thoroughly explained to the children as it could have been. Furthermore, facilitating a longitudinal study of this nature was an idea proposed by the Principle Investigator for the *Kids, Creative Storyworlds and Wearables* project, which would add depth to this research. An identified area of further research which emerged from this case study concerns children's perspectives on wearables that can be manipulated and reconfigured in different ways, in order to delve deeper into

the constructionist principles of constructing, reconstructing and examining how technology works in personally meaningful ways.

Finally, although previous research has explored constructionist (i.e., empowering and creative) potentials of other types of wearable technology, including e-textile construction kits (e.g., Katterfeldt, Dittert, & Schelhowe, 2009; Ngai et al., 2013), this case study contributes novel insight regarding young children's ideas concerning a newer form wearable technology – the smartwatch – used within the context of their day-to-day lives. Furthermore, this case study has updated the Mosaic approach to ethnography and Sutton Smith's "play as a viability" theory by applying them within the realm of young children's relationships with a form of current digital technology. Responding to Pedersen's (2005) call for human-centric technological research, this case study provided young children with a platform to express their ideas about the meaning they associate with current and future technology made for them, using the modes that were most comfortable and meaningful to them.

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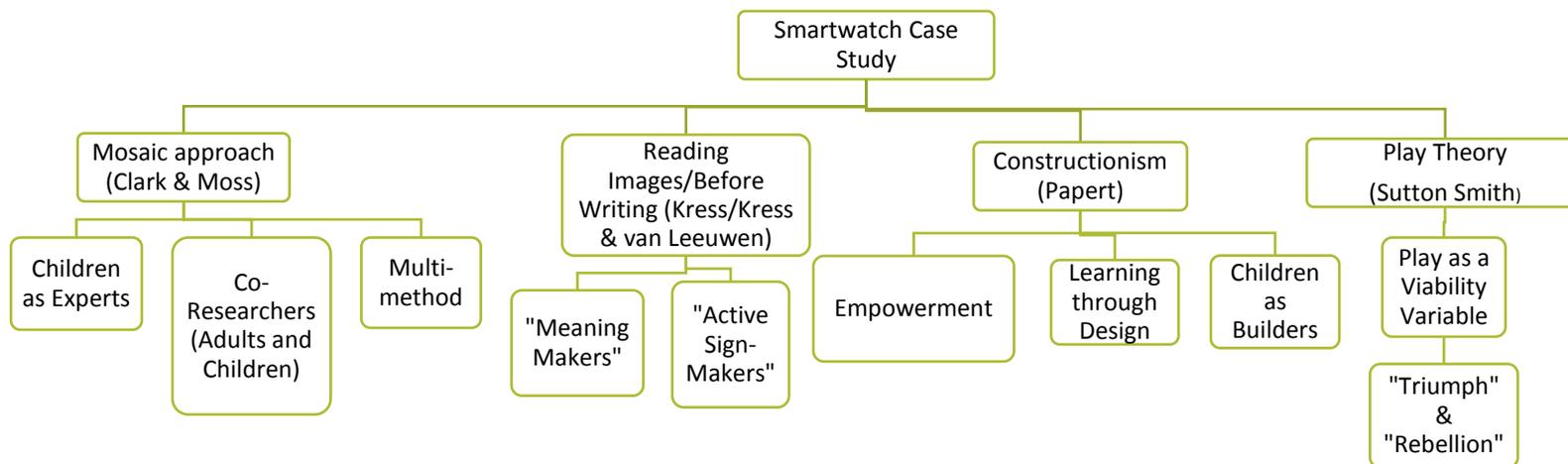
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### Appendix A – Graphic Organizer of Theoretical Model



## Appendix B – Wearables and Posters Displayed in the Lab



## Appendix C – Interview Guide

The following are intended to serve as general guides/ possible questions that might be used in each of the meetings with the children. The intention is to generate free-flowing conversations with the children about their ideas regarding this type of technology.

**Important:** All answers can be shared verbally or pictorially. Artistic supplies will be made available.

### **Meeting 1 – Getting to know the children and introducing the wearable**

#### **Prior to receiving the wearable device [Linkitz/Kidizoom/Tinitell?] (first half of meeting)**

1. What are some of your favourite things to do?
2. What are your favourite toys to play with at home?
3. What are machines going to be like in the future?
4. Can you imagine yourself wearing a certain kind of machine? Can you tell/draw a story about that? What would happen next?
5. If you would be able to wear a machine that gave you a super power, what would it be?
6. If you could have a super power, what would it be? How did you get it?
7. Do you know what technology is? [Canned answer if they say 'no': *Useful tools that can help us to do different things*]
8. Can you use your imagination to think of a person in a story who would use technology?
9. Do you like using computers? Tablets? Phones? [based on surroundings]

#### **Upon receiving wearable device [Linkitz/Kidizoom/Tinitell] (second half of meeting)**

10. What do you think this [Linkitz/Kidizoom/Tinitell] does?
11. What does this [Linkitz Kidizoom/Tinitell] remind you of?
12. Does this look like a toy to you or something different?
13. If you could give it a name, what would you call it?
14. Do you play with anything at home that is like this?
15. What do you think about wearing this?

16. What or who could you pretend to be with this [Linkitz Kidizoom/Tinitell]?
17. Can you tell me a story from your imagination about what you think this could do in the future?

### **Meeting 2 – After some experience with the wearable**

1. What are some of the things that this [Linkitz/Kidizoom/Tinitell] can do?
2. Can you show me something that it does?
3. How did you learn how to use it? Did other people help you learn how to do different things with it?
4. What do you like about it?
5. What don't you like about it?
6. Do you show other people how to play with it?
7. How do you feel when you show other people how to play with it?
8. Have you played with it [Linkitz/Kidizoom/Tinitell] with other kids (friends, siblings)?
9. Is it more fun to play with this [Linkitz/Kidizoom/Tinitell] alone or with other people?
10. Do you play with it [Linkitz/Kidizoom/Tinitell] every day? Some days? Or, not at all?
11. Do you use it with any other toys or things that you have at home?
12. Do you bring it outside with you?
13. Do you bring it with you to places other than your home?
14. Have you imagined or pretended that it can do anything special?
15. Do you ever pretend that it gives you any special powers?
16. Can you tell me a story or draw a picture about you and this [Linkitz/Kidizoom/Tinitell]?
17. How might you change it, if you could make your own toy?
18. Do you wish it could do something that it can't do?

### **Meeting 3 –Reflection**

1. Have you played with this toy since the last time we saw you?
2. Can it [the Linkitz/Kidizoom/Tinitell] do anything new that you didn't know it could do?
3. What if all children had toys like this? What do you think they would/could do?
4. What do/would you tell your friends or other children about it?
5. Do you think you would use/play with something like this at school/preschool/daycare? What could you do with it at school/preschool/daycare?

6. What do you think about technology or toys that you can wear?
7. Do you think it would be fun to wear a toy/gadget like this in a different way?
8. Can you imagine other toys or gadgets like this that we might see one day?  
What do you think they could do? Could you draw a picture of it/them?
9. Can you tell us/draw about something you would like to do when you are older?  
Would you use technology/gadgets/toys like this when you are older?
10. If you could make a toy or gadget, how would it look? What would it do? [Invite children to illustrate a picture]

## Appendix D – Research Ethics Approval Letter

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*Date:* November 03, 2015  
*To:* Isabel Pedersen  
*From:* Shirley Van Nuland, REB Chair  
*REB # & Title:* (15-021) Kids, Creative Storyworlds and Wearables  
*Decision:* APPROVED  
***Current Expiry:* November 01, 2016**

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Notwithstanding this approval, you are required to obtain/submit, to UOIT's Research Ethics Board, any relevant approvals/permissions required, prior to commencement of this project.

The University of Ontario, Institute of Technology Research Ethics Board (REB) has reviewed and approved the research proposal cited above. This application has been reviewed to ensure compliance with the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS2 (2014)) and the UOIT Research Ethics Policy and Procedures. You are required to adhere to the protocol as last reviewed and approved by the REB.

**Continuing Review Requirements** (forms can be found at: <http://research.uoit.ca/faculty/policies-procedures-forms.php>):

- **Renewal Request Form:** All approved projects are subject to an annual renewal process. Projects must be renewed or closed by the expiry date indicated above ("Current Expiry"). Projects not renewed within 30 days of the expiry date will be automatically suspended by the REB; projects not renewed within 60 days of the expiry date will be automatically closed by the REB. Once your file has been formally closed, a new submission will be required to open a new file.
- **Change Request Form:** Any changes or modifications (e.g. adding a Co-PI or a change in methodology) must be approved by the REB through the completion of a change request form before implemented.
- **Adverse or Unexpected Events Form:** Events must be reported to the REB within 72 hours after the event occurred with an indication of how these events affect (in the view of the Principal Investigator) the safety of the participants and the continuation of the protocol (i.e. un-anticipated or un-mitigated physical, social or psychological harm to a participant).
- **Research Project Completion Form:** This form must be completed when the research study is concluded.

Always quote your REB file number (15-021) on future correspondence. We wish you success with your study.

REB Acting Chair  
Dr. Wendy Stanyon  
[wendy.stanyon@uoit.ca](mailto:wendy.stanyon@uoit.ca)

Ethics and Compliance Officer  
[compliance@uoit.ca](mailto:compliance@uoit.ca)

*NOTE: If you are a student researcher, your supervisor has been copied on this message.*

## Appendix E – Consent Forms

### E-1 – Parental/Guardian Consent Form

May, 2016

Through this form I give consent for my child to participate in the research study entitled *Kids, Creative Storyworlds and Wearables*, which is being conducted by Dr. Isabel Pedersen, Faculty of Social Science and Humanities, UOIT, Isabel.Pedersen@uoit.ca, 905.721.8668 ext. 5874.

- I understand that this participation is entirely voluntary and there will be no negative consequences if my child does not participate.
- I understand that I can withdraw my consent (or my child can withdraw consent) from this study without consequence.
- I understand that if I (or my child) withdraw from this study I can have the results of the participation returned to me and removed from the records by Monday, July 11th, 2016 (before the research team analyzes the data and the results are published).
- I understand that if consent is withdrawn, I acknowledge that the wearable toy (Kidizoom) will need to be returned to the research team at that time, as the research team has access to a limited set of the toys and will need to continue the study. My child will still be provided with a 'thank you' gift if consent is withdrawn.

The following points have been explained to me (and my child):

1. **The purpose of the project is to** explore the stories children might tell themselves and others about this type of technology.
2. **The benefits that my child might experience from this study are:** the enjoyment of playing with a new toy, the satisfaction of learning to program the toy to do different things, and the opportunities to share stories involving themselves and/or the toy.
3. **The discomforts or stresses that might be faced during this research are:** possible frustration learning to use the toy; possible discomfort wearing the toy as a bracelet (I am aware that my child will never be forced to wear the toy as a bracelet if they do not wish to do so), and possible discomfort sharing their opinions of the toy or any other information with the research team. I have reviewed the accompanying safety information provided by the manufacturer of the Kidizoom to determine if this device is safe for my child and am responsible for my child's safe use of the device outside of the meetings with the researchers.
4. **The procedures are as follows:** my child will be provided a wearable toy and a notebook to record illustrations or written stories about the toy. Members of the research team will observe and record my child's initial reactions to the toy, how they begin to use it, and any questions or comments they might have about the toy. This initial meeting could take up to 60 minutes. Members of the research team will meet with my child and me on two additional occasions (a maximum of 1 hour at a time) to observe and discuss my child's use of the toy and stories they may tell about the toy. My child may be asked to answer questions about their use of the toy; share stories about themselves, the toy, and others who might use the toy; and draw pictures about their use of the device and/or their thoughts around the stories and possibilities the toy might inspire.

5. **The results of this participation are confidential:** observations, quotes, and artifacts (including photographs of artwork or printed stories created by my child for this research) may be included in published results. No identifying information will be included; pseudonyms will be used. Anonymity is not possible with video recordings. It is possible that video recordings will be shared at academic (non-commercial) events, though my child's name will not be shared and their face will not appear in any publicly shared videos or print publications. I am aware that I can contact the researchers to view any publications from this study.

6. **Data from this study may be used again:** I understand that the data collected from my child's participation in this study may be used again in future research. This may include video recordings, audio recordings and photographs. If this data will be used again in the future, the researchers will apply for Research Ethics Board approval, as was the case with this study, though my consent will not be requested again.

Signature(s) of Researcher(s):

Date:

\_\_\_\_\_  
\_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

**Statement of Consent:**

I understand the procedures described above. My questions have been answered to my satisfaction, and I agree to allow my child \_\_\_\_\_ [please print your child's name] to participate in this study. I have been provided a copy of this form.

**Please check the box that applies:**

- My child **may** be photographed
- My child **may not** be photographed (my child's face will not appear in print publications)
- My child **may** be tape recorded (audio)
- My child **may not** be tape recorded (audio)
- My child **may** be video recorded (anonymity is not possible with video recordings, though my child's face and name will not appear in videos that are shared publicly or in print publications)
- My child **may not** be video recorded
- My child's work (e.g., drawings, written stories) **may** be photographed
- My child's work (e.g., drawings, written stories) **may not** be photographed

Print Your Name: \_\_\_\_\_

EXPLORING YOUNG CHILDREN'S IDEAS ABOUT WEARABLE TECHNOLOGY

Signature of Parent/Guardian: \_\_\_\_\_ Date:

\_\_\_\_\_

Print Child's Name: \_\_\_\_\_

## E-2 - Assent Agreement –

### Kids, Creative Storyworlds and Wearables

May, 2016

We are doing a study about children and a toy called Kidizoom. A study helps us to learn different things about people.

**We are doing this study because we want to:** hear the stories children – like you – might tell about this toy and what you think this type of toy could be or do in the future.

**Good things that could happen in this study:** you might have fun playing with this toy, you might be happy to learn how to use the toy to do different things and you might have fun telling us stories and drawing pictures about the toy.

**Things that you might not like:** you might find it hard to learn to use the toy, you might not like wearing the toy as a bracelet, or you might feel shy to tell us stories. That is OK. You do not have to do anything that makes you feel unhappy or makes you uncomfortable in this study.

**The plan:** if you want to be a part of this, you will be given a wearable toy that you will get to play with. You will be given a notebook you can use to write or draw stories about the wearable toy. We will see how you like to use the toy and write down notes when we meet with you. If it's OK with you and your parents, we would like to record videos or take pictures when we meet. We will not share your name or let your face show up in any videos or pictures of you that we share with anyone else who isn't working on this study. We will meet three times. Sometimes we will ask you questions about the toy or ask you to draw pictures and tell us stories.

**If you do not want to be a part of this study:** you can always tell your parents or any of us, if you do not want to use the toy anymore or to talk to us about the toy. You can let us know, at any time, if you do not want to be a part of this. If you decide that you don't want to be part of the study, that's OK. You will still get a 'thank you' gift if you decide you do not want to be a part of the study, but the wearable toy will need to be given back to us since we only have a few of them.

Signature(s) of Researcher(s):

Date:

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**Statement of Assent**

I understand what it means to be a part of this study. I can also ask questions about this study and let my parents or the researchers know if I do not want to be a part of it at any time.

Do you want to be a part of this study?

YES

NO

Print your name or initials:

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Signature of Parent/Guardian: \_\_\_\_\_ Date: \_\_\_\_\_

Print Child's Name: \_\_\_\_\_

## Appendix F – Recruitment Poster



### LOOKING FOR PARTICIPANTS FOR KIDS' WEARABLE TECH STUDY

Do you know a child who would like to try a new wearable tech toy?

Dr. Isabel Pedersen, Canada Research Chair in Digital Life, Media, and Culture and Director of the Decimal Lab, is conducting an ethnographic study entitled *Kids, Creative Storyworlds and Wearables*.

Participants will receive a new wearable tech toy.

This study seeks to explore children's creative ideas regarding wearables and the potentials they may inspire, using a variety of methods including: drawing; story-telling; interviews (with parents present) and observation.

#### Study details:

**Participants:** Children ages 4-7

**When:** Beginning April 2016

**Time Commitment:** Three hours (three one-hour sessions)



Photo retrieved from <http://www.techlicious.com/blog/vtech-kidizo-om-sm-artwatch-for-kids/>

#### CONTACT INFO

Email:

Telephone:

This study has been approved by the UOIT Research Ethics Board. REB #15-021 assigned on November 3<sup>rd</sup>, 2015.

## Appendix G – Study Recruitment Email

**Subject:** Invitation to participate in study involving new kids' wearable tech toy

*This message is being sent on behalf of Dr. Isabel Pedersen, Canada Research Chair in Digital Life, Media, and Culture and Director of Decimal: Digital Culture and Media Lab, UOIT*

We would like to inform you of an opportunity for your child to participate in a study involving wearable technology.

Do you know a child between the ages of 4 and 7 who would be interested in trying a new wearable tech toy?

Dr. Isabel Pedersen, Canada Research Chair in Digital Life, Media and Culture and Director of the Lab at UOIT is facilitating a study to explore children's creative ideas regarding wearable technology and the potentials they may inspire. Children eligible to participate in this study will be provided with a new wearable tech toy which they will be able to keep.

This study is expected to begin in April 2016.

Information about the toy that will be used in the study is available at [https://www.vtechkids.ca/en/product/detail/15976/Kidizoom\\_Smartwatch\\_Blue](https://www.vtechkids.ca/en/product/detail/15976/Kidizoom_Smartwatch_Blue)

Please see the attached poster for more information.

This study has been approved by the UOIT Research Ethics Board – REB #15-021 assigned on November 3<sup>rd</sup>, 2015.

Contact [removed] or call [removed] to learn more about this study.

EXPLORING YOUNG CHILDREN'S IDEAS ABOUT WEARABLE TECHNOLOGY

Thank you!