

Supporting early childhood STEM education during the pandemic (and afterwards): Examining
parents' and early childhood educators' perceptions of digital resources

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Abstract

This thesis addresses the need for more accessible, high-quality early childhood STEM resources for early childhood educators, caregivers, and parents of young children to use during and after the COVID-19 pandemic. As the primary researcher, I assisted a team of educators and researchers with creating STEM learning experiences which are freely available on Pinterest and our website (www.STEMintheEarlyYears.com). To ensure the team is producing high-quality resources, I explored users' perceptions of our resources' pedagogical quality, technical/design quality, and user satisfaction with a questionnaire that I created which included closed-and open-ended questions. Statistical analyses results suggested that respondents (who used our resources) perceived our resources to have good pedagogical and technical/design quality and were satisfied. However, respondents perceived our resources' pedagogical quality to be significantly better than the technical/design quality. Furthermore, respondents' perceptions about the pedagogical and technical/design quality influenced their satisfaction with our resources; with technical/design quality having a stronger influence on their satisfaction. The reflexive thematic analysis results also indicated that respondents perceived our resources to be of good pedagogical and technical/design quality and were satisfied; however, I captured respondents' recommendations on how the resources' quality may improve within the generated themes. The STEM in the Early Years' team will use the results to reflect on our resources' successes and will consider modifying the resources according to the areas that respondents suggested needed improvement.

Keywords: Early Childhood Resources, Online Resources, Pinterest, STEM in Early Childhood.

List of Acronyms

ECE: Early Childhood Educator

STEM: Science, Technology, Engineering, and Math

LE: Learning Experience

Chapter 1: Introduction

In Chapter 1 of my thesis, I begin by discussing why there is a need for affordable high-quality early childhood STEM resources for caregivers to use during and after the COVID-19 pandemic. I then outline the goal, objectives, and research question of my thesis. I conclude Chapter 1 with a description of my conceptual framework for my thesis.

The COVID-19 virus caused many governing systems across Canada to close early childhood programs and schools. Confronted with the closures, educators resorted to online teaching using digital platforms such as Zoom and Google Classroom. Although online teaching may have been a feasible solution for educators who teach older students, early childhood educators (ECEs) may have found it challenging because young learners require more guidance during intentional hands-on activities (Inan & Inan, 2015; Kermani & Aldemir, 2015; Moomaw, 2013). Since online learning was not an optimal solution for continuing early childhood education during the pandemic, ECEs were tasked with providing parents free or affordable learning resources that contain guided hands-on activities to do with their children to help them stay engaged in their learning process and continue growing.

Educators, parents, and policymakers around the world have recognized the importance of science, technology, engineering, and math (STEM) in early childhood, and are seeking to find ways to offer young children high-quality STEM experiences (Ata-Akturk & Demircan, 2020; Dubosarsky et al., 2018; Hapgood et al., 2020; Haden et al., 2014; Simoncini & Lasen, 2018). Including disciplines in early childhood can contribute to academic achievement in the formal school years (e.g., math, science, reading achievement, as well as enhanced problem-solving skills) (Duncan et al., 2007; Morgan et al., 2016; Kermani & Aldemir, 2015). Attitudes towards STEM develop in early childhood, therefore offering young children STEM experiences can foster enjoyment and interest towards the disciplines in particular and learning in general (Malone et al., 2018; Denton & West, 2002; Simoncini & Lasen, 2018). However, many young children are often not offered high-quality STEM experiences (Brenneman et al., 2018; Banilower et al., 2013; Tu, 2006), and unfortunately, many of the hands-on learning resources available at no cost in the area of STEM are unsystematically presented and of low quality. These free online STEM resources may suggest interesting learning experiences; however, they often fail to explicate the areas of STEM. Research suggests that ECEs can benefit from more high-quality resources in STEM (McClure, 2017; Peterson et al., 2019).

Early childhood educators need affordable, high-quality early childhood STEM to use during and after the pandemic; parents and caregivers can also benefit from no-cost high-quality STEM resources. Early childhood educators are currently in need of high-quality STEM

resources as many early childhood programs and schools have reopened across Canada. However, ECEs may continue to recommend affordable STEM resources to families because some parents/caregivers are hesitant to send their young children back to school (Centers for Disease Control and Prevention, 2020; Neustaeter, 2020). Early childhood educators will still need STEMs resources after the pandemic because research conducted prior to the pandemic suggested that ECEs can benefit from more high-quality resources in STEM (McClure, 2017; Peterson et al., 2019).

Parents who do not have access to high-quality early childcare and other caregivers can also benefit from having access to high-quality, no-cost STEM resources to use during and after the pandemic, as they guide children's learning at home. Also, parents and other caregivers who want to engage their young children in STEM can benefit from high-quality, accessible STEM resources. Thus, it is imperative that high-quality and affordable early childhood STEM resources are produced for ECEs, caregivers, and parents to use during and after the pandemic.

Goal, Objectives, and Questions of Thesis

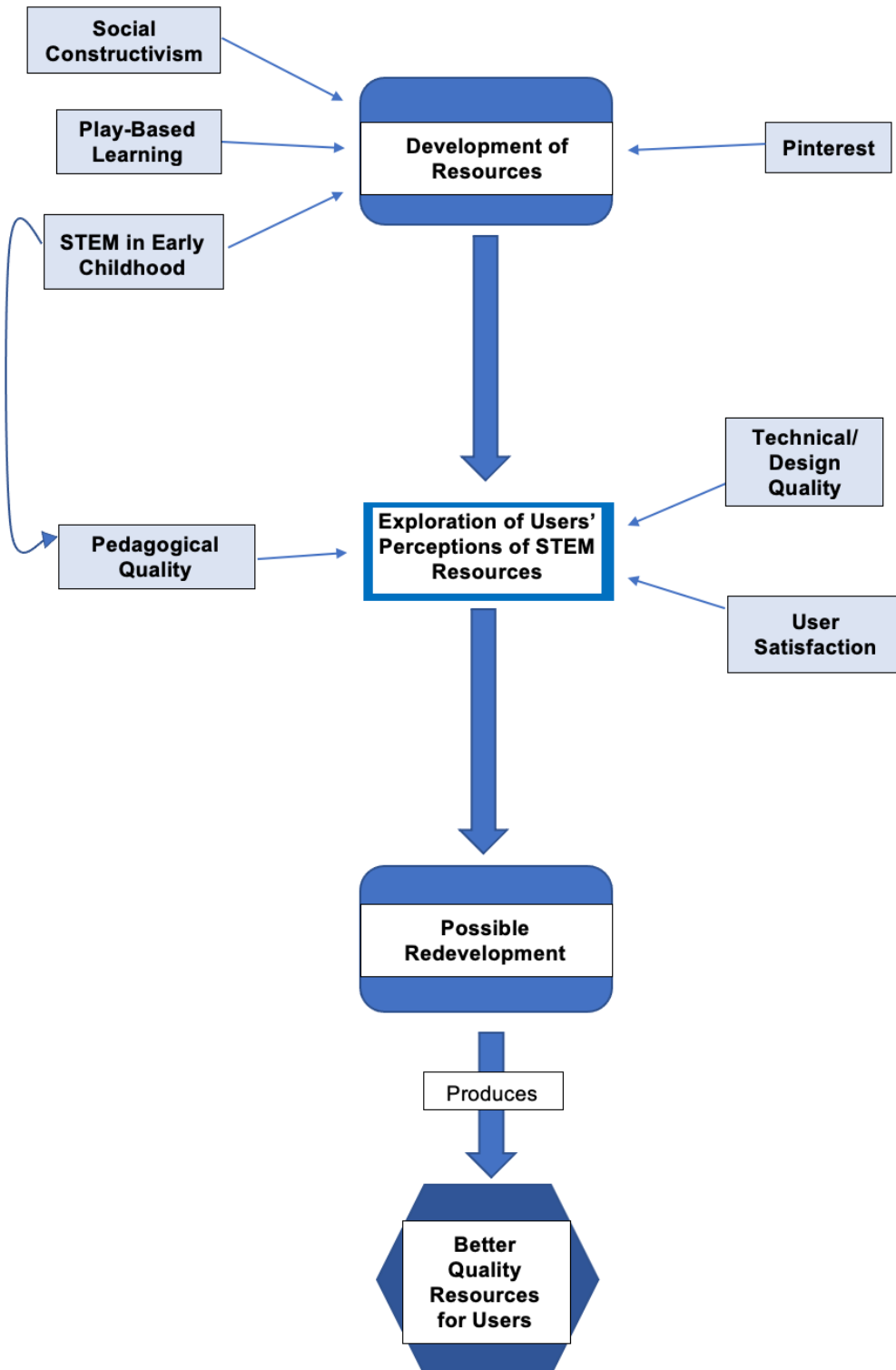
The overall goal for my thesis project was to create high-quality, freely available, and widely accessible STEM resources that can be used by ECEs as well as by caregivers and parents of young children, during and after the COVID-19 pandemic and to explore users' perceptions of those resources. I worked with Dr. Tippett's STEM in the Early Years team to collaboratively plan developmentally appropriate, play-based STEM learning experiences that are available on Pinterest and housed on an easily searchable website along with supplementary information. The team consisted of Dr. Tippett, Ms. Roxana Yanez Gonzalez (a doctoral candidate under Dr. Tippett's supervision), Dr. Milford (a professor at the University of Victoria), and me. (See Appendix A for more information about the team's expertise). I obtained an understanding of users' (ECEs, parents, and other caregivers) perceptions of our resources by creating and administering a questionnaire, then analyzing participants' responses. The results from my thesis provided insights into our resources' successes, as well as the areas that could be improved for our users. The team may modify our resources according to my results. The specific objectives of my thesis project were to:

- **Create** free, high-quality, and evidence-based online STEM learning resources for ECEs, caregivers, and parents of young children (ages 1.5 to 5 years).
- **Explore** ECEs', caregivers', and parents' perceptions of our resources to understand our resources' successes and the areas that may need to be improved.

The main research question that I explored was: What are users' perceptions of the early childhood STEM resources created by the STEM in the Early Years team?

Conceptual Framework

The conceptual framework in Figure 1 shows how the seven main concepts of *social constructivism, play-based learning, STEM in early childhood, Pinterest, pedagogical quality, technical/design quality, and user satisfaction* influence the process of developing the team's online STEM in the Early Years resources and my exploration of users' perceptions of our resources. The initial creation of the team's resources was informed by the literature on social constructivism, play-based learning, STEM in early childhood, and Pinterest. The literature that explores users' perceptions of digital educational resources influenced the constructs that I explored with my questionnaire, which were our resources' pedagogical quality, technology/design quality, and user satisfaction. Additionally, the literature that explores users' perceptions of digital educational resources, the three constructs, and STEM in early childhood influenced the questions I asked. The results from my exploration of users' perceptions of our resources' pedagogical quality, technology/design quality, and user satisfaction, will be used to reflect on our resources' successes and may be used to redevelop our resources to be of better quality for our users.

Figure 1*Flowchart of Conceptual Framework*

Chapter 2: Literature Review

In Chapter 2, I provide an overview of the literature on the seven aspects in my conceptual framework that guided the development of the team's STEM resources and my exploration of users' perceptions: social constructivism, play-based learning, STEM in early childhood, Pinterest, and perceptions of digital educational resources in the areas of pedagogical quality, technical/design quality, and user satisfaction. I begin the literature review by discussing two learning theories that influence Canada's provincial Kindergarten curriculums and early learning frameworks (ELFs): social constructivism and play-based learning (Shalima, 2017). In the next section of the literature review, I discuss the literature on STEM in early childhood. Afterward, I discuss Pinterest as an educational platform. In the final section, I present research that explores perceptions of digital educational resources and the literature on the three constructs that I explored: pedagogical quality, technical/digital quality, and user satisfaction.

Prominent Theoretical Perspectives in Canada's Early Childhood Education

The first aspect of my literature review is on two theoretical perspectives that influence the field of early childhood education in Canada today: social constructivism and play-based learning. I begin this section by discussing social constructivism; specifically, Vygotsky's sociocultural theory's influence on social constructivism. Afterward, I discuss the importance of play-based learning and reputable early childhood figures' views on play in early childhood. At the end of each section, I present how the theoretical perspective influenced the development of the team's resources.

Social Constructivism

Social constructivism is a theory of learning that Vygotsky developed and continues to impact early childhood education today (Amineh & Asl, 2015; Churcher et al., 2014; Dietze, 2006; Edwards, 2004; Woolfolk et al., 2019; Wood & Bennett, 1998; Vygotsky, 1978). Vygotsky believed that "young children are curious explorers who are actively involved in their learning and discovering new principles" and that knowledge is socially constructed within a cultural context (Shaffer et al., 2019, p. 252). Vygotsky argued that children's cognition develops through social mediation, in that children are better able to construct their knowledge when they collaborate with a knowledgeable other who can "provide feedback to help new ways of thinking about the world" (Hesterman, 2018, p. 142). The team developed the early childhood STEM resources using a social constructivist perspective because the STEM learning experiences are structured in a way that ECEs, caregivers, and parents are able to guide children to notice and

explore STEM during play. Thus, ECEs, caregivers, and parents who use our resources take on the role of the more knowledgeable other.

Play-Based Learning

Many theorists, researchers, and educators continue to suggest the importance of play in early childhood (Smith, 2013; The Canadian Association for Young Children, 2016; Vygotsky, 1978). Vygotsky believed that play was the leading source of development in the preschool years; specifically, children's social, emotional, and cognitive development (Wood & Bennett, 1998; Vygotsky, 1978). Piaget saw children's play as a way to "practice and consolidate skills and information [and] make sense of their world" (Mayfield, 2001, p. 264). Inspired by Vygotsky and Piaget's work, Malaguzzi, an influential figure in Canada's early childhood programs and the founder of Reggio Emilia, believed play was a vehicle for expressing learning (Malaguzzi, 1993). Similarly, the team believes that play is essential to children's development; thus, our resources were created from children's interests expressed during open-ended play and designed for children to purposefully explore STEM during play.

STEM in Early Childhood

The second aspect of my literature review is STEM in early childhood education. I begin this section by sharing and defending my perspective of STEM. I discuss the importance of STEM in early childhood education. Afterward, I outline the areas of STEM that have been suggested to be developmentally appropriate for young children. Then I discuss the important role that adults have in supporting young children with STEM learning experiences, and present reasons for why there is a need for more early childhood STEM resources.

The acronym STEM can be used to refer to educational activities that include one of the individual disciplines, to activities where all four disciplines are fully integrated, or even to the disciplines themselves (National Academy of Engineering and National Research Council, 2014). Following other early childhood researchers (e.g., Moomaw, 2013), my perspective is that a learning experience can be considered a STEM learning experience if aspects of any two of the four disciplines are intentionally incorporated and emphasized. However, the team's resources aim to incorporate all four STEM disciplines.

Research indicates the importance of the individual STEM disciplines for young children (Campbell et al., 2018; Clements & Sarama, 2016; Lee et al., 2016; Moomaw, 2013). For example, when science is purposefully incorporated into early childhood learning experiences, it can impact children's later enjoyment of, and interest in, the subject (MacDonald et al., 2019). Children can develop self-efficacy in science learning when they engage in science activities in their early years (Moomaw, 2013; Patrick et al., 2009). Literature suggests that incorporating

technology can allow children to become aware of the tools they can use to aid in their inquiries as they explore their world (Early Childhood STEM Working Group, 2017). Furthermore, incorporating engineering in early childhood education can elicit children's curiosity (Bagiati & Evangelou, 2020) and foster enjoyment in exploring the world around them (National Science Teachers Association, 2014). Research suggests that mathematical skill development at an early age is associated with later academic achievement (Hunting et al., 2012; Lee et al., 2016; McGarvey, 2013; Ontario Ministry of Education, 2011; Watts et al., 2017). Although literature outlines the importance of including the individual disciplines in early childhood, researchers have yet to explore the benefits of including integrated STEM in the early years. However, since the four disciplines are very interconnected at the early childhood level, the benefits of the individual disciplines may be applicable to the benefits of integrated STEM in early childhood.

Scholars, as reflected in government curricula and ELFs, continue to suggest developmentally appropriate areas of STEM that young children can explore during play. Developmentally appropriate content areas of science that young learners can explore are physical science (e.g., characteristics of objects), earth science (e.g., examination of earth materials), and life science (e.g., growth cycles of plants and animals) (Barbre, 2017; Dejonckheere et al., 2016; Massachusetts Department of Elementary School Education, 2016; Moomaw, 2013; Olcer, 2017; Pennsylvania Department of Education and Department of Human Services, 2016). Young children can learn about technology when learning experiences encourage the use of simple tools (e.g., handheld magnifiers) and/or complex tools (e.g., cameras) to enhance play and exploration in the disciplines (Hartle, 2020; Moomaw, 2013). During play, young children can learn about engineering (e.g., exploring what engineers do and the types of engineering) (Bagiati & Evangelou, 2020, p. 55; English, 2018). Also, children can begin to explore important engineering practices, such as engaging in the Fundamental Design Process (thinking/problem solving, searching, creating or building/improving, testing, and consulting) (Bagiati & Evangelou, 2020, p. 55; English, 2018). Lastly, appropriate math content areas young children can engage with are number operations (e.g., counting), algebra (e.g., patterns), geometry (e.g., naming of shapes), measurement (e.g., measurement comparisons), and/or data analysis (e.g., explaining probability/predictions and gathering information) (Moomaw, 2013; Oppermann et al., 2016; Ontario Ministry of Education, 2016). These perspectives on STEM in early childhood and the developmentally appropriate areas of the disciplines are outlined in our resources.

The involvement of adults – educators, family members, or other caregivers – who are capable and rich in experience are of particular importance in supporting young children's

STEM learning experiences (Ontario Ministry of Education, 2014, Sheehan et al., 2018; Sikder & Fleeer, 2018; Simoncini & Lasen, 2018). Adults can support STEM in early childhood by offering developmentally appropriate hands-on play-based learning experiences that capitalize on children's innate interests and allow for inquiry and exploration in the STEM disciplines (Campbell et al., 2018; National Science Teachers Association, 2014; Simoncini & Lasen, 2018). Adults can also take advantage of the many opportunities that the preschool and home settings have for STEM exploration when they create and/or offer STEM learning experiences (Gomes & Fleeer, 2017; Sarama & Clements, 2009; Sikder & Fleeer, 2015).

Although the literature outlines the importance of incorporating STEM in early childhood and suggests developmentally appropriate areas of STEM that young children can explore, many young children are not offered high-quality STEM experiences (Banilower et al., 2013; Brenneman et al., 2018; Tu, 2006). Early childhood educators report a lack of confidence in their abilities to support STEM (Chen et al., 2014; Caspe et al., 2018; Greenfield et al., 2009; Gresham & Burleigh, 2019), feel unprepared to support young children's learning in STEM (Park et al., 2017), and are unsure how to incorporate STEM into their practice (Ata-Akturk & Demircan, 2020). Early childhood educators report a lack of STEM content knowledge (Bers et al., 2013; Brenneman et al. 2009; Greenfield et al. 2009; Park et al., 2017) and have expressed that they do not have the time to understand STEM and incorporate it into their practice (Bers & Portsmore, 2005; Park et al., 2017). These reports can be attributed to training programs not adequately preparing ECEs to support learning in STEM disciplines (Brenneman et al., 2018; Bers & Portsmore, 2005; Buysse et al., 2005; Perry et al., 2007). Early childhood educators are also given an insufficient amount of administrative support required to provide high-quality STEM experiences (Bers & Portsmore, 2005; Park et al., 2017). More professional development and/or high-quality early childhood resources, such as the resources developed by the team, could help ECEs support young children's learning in STEM (Brenneman et al., 2018; McClure et al., 2017; Peterson et al., 2019).

Literature suggests that parents may also experience anxiety towards supporting their children's STEM learning; particularly, in the areas of math and science (McClure et al., 2017; Kaya & Lundeen, 2010; Latterell, 2008; Whyte & Anthony, 2012). However, parents believe that STEM is an important aspect of early childhood education and want to know how to include more STEM activities during interactions with their children (Tippett & Milford, 2017). Thus, parents and other caregivers may also benefit from professional development and/or high-quality early childhood STEM resources, akin to the resources that the team developed.

Our STEM resources were developed to help ECEs, parents, and other caregivers support children's STEM learning. The resources offer ways in which ECEs, parents, and other caregivers can engage young children with STEM with our range of play-based learning experiences. The resources show how adults may guide children's attention to notice STEM during play to help build ECEs', parents', and other caregivers' confidence and preparedness in facilitating STEM. Our resources contain a definition of STEM and indicate the developmentally appropriate areas of STEM each learning experience links to help build ECEs, parents, and other caregivers' content knowledge. Furthermore, we have designed the resources to be inexpensive as our STEM learning experiences use household or low-cost items, and can be accessed on a no cost platform, Pinterest.

Pinterest as an Educational Platform

The third aspect of the literature review focuses on the social media platform Pinterest, which is used as an educational platform. I begin this section by defining Pinterest and outlining its key characteristics. Afterward, I discuss how educators and parents use Pinterest for educational purposes. Although Pinterest can be used as an educational platform, I present some problematic aspects that Pinterest users have reported, and I state the ways in which the team addressed the concerns during the creation of our resources.

Pinterest is an organized digital scrapbook that can act as a data management tool. Users create visual bookmarks called pins which can be organized into theme-based collection boards (Chapman et al., 2019; Hooks, 2015). Pins typically contain a visual representation of the content, a description, a link to an external website/blog, and hashtags to help other users find and curate the pin (Schroeder et al., 2019). There are more than 335 million Pinterest users worldwide (Clements, 2020; Franks & Krause, 2017; McLean, 2014; Statistica, 2018). Some of these users are educators and parents who view Pinterest as a valuable and trusted resource (Cleaver & Wood, 2018; Dwyer et al., 2019; Franks & Krause, 2017; Schroeder et al., 2019).

According to Cleaver and Wood (2018), there are hundreds of educational boards on Pinterest. Educators commonly consult Pinterest to find immediate inspiration for educational materials such as lesson plans, worksheets, and activities/projects (Chapman et al., 2019; Giebelhausen, 2015; Hooks, 2015; Schroeder et al., 2019). Educators also turn to Pinterest for teaching strategies and pedagogical approaches (Chapman et al., 2019). Educators may even prefer Pinterest to textbooks because they can find more up-to-date material (Hooks, 2015). Moreover, Pinterest has been recommended as a platform to increase parent involvement in their children's learning (Bickford, 2017; Franks & Krause, 2017). Parents can and do use Pinterest to search for educational resources (Bickford, 2017; Robuck, 2015). Pinterest contains

a plethora of widely followed pins and pages, that include activities for parents to do with their children. Therefore, the STEM in the Early Years team chose Pinterest as the initial platform for sharing our online STEM resources and is linked to a Host Website that contains more information about our resources.

Although there are many benefits of using Pinterest for finding and sharing educational material, there are some problematic aspects. Educators have expressed concerns over the quality of pins found on Pinterest and note that if a pin is perceived to have errors or be of low quality, they are less likely to use the material (Chapman et al., 2019). Educators have also reported frustration over the commercial and self-promotional nature of Pinterest because many pins link to paid resources on an external website (Carpenter & Harvey, 2019). To address these concerns, the team will ensure that our online STEM resources are of high quality, and free of cost. To ensure that we are producing a high-quality resource for parents, ECEs, and caregivers, I explored user perceptions of the resources for my thesis.

Perceptions of Digital Resources

The fourth aspect of the literature review is on exploring users' perceptions of digital educational resources. Despite an increase in the number of digital educational resources (El Mhouti et al., 2013; Koundinya et al., 2017; Leacock & Nisbet, 2007), the concept remains ambiguous. Currently, there is not a uniform definition for digital educational resources, and there are many terms that can be used to refer to these resources (e.g., digital learning resources, web-based professional development, web-based resources; Hadjerrouit, 2010; Libbrecht, 2015; Wang et al., 2019). The lack of a definition and the use of different terms may be a reason why literature suggests that exploring users' perception of digital educational resources remains a difficult task (El Mhouti et al., 2013). From overviewing the literature on exploring users' perceptions of digital resources within an educational context, regardless of the term used, it appears that digital educational resources can be defined as digital sources of information and support that educators, learners, and others can use (and re-use) to enrich their practice and/or grow their knowledge on a specific topic or subject.

Studies that adhere to the aforementioned definition of digital educational resources, commonly examine digital educational resources by exploring users' perceptions of them using a survey method. There appear to be three specific constructs that are important to explore when trying to gain an understanding of a user's perceptions of digital educational resources: pedagogical quality, technical/design quality, and user satisfaction. In the following subsections, I describe the three constructs and their indicators.

Pedagogical Quality

According to the literature, there are three important indicators of a resource's pedagogical quality which can be explored: information relevance, information reliability, and context-dependent quality. Users' perceptions of information relevance can include their thoughts on information usability and workability (El Mhouti et al., 2013; Faustmann et al., 2019; Hsu et al., 2009). Users' perceptions of information reliability can include their beliefs about the information being error-free and credible (El Mhouti et al., 2013; Faustmann et al., 2019; Hsu et al., 2009; Xie, 2008). In contrast to information relevance and reliability, there are no general areas of context-dependent quality to explore, because the areas are dependent on the subject or topic that the resource is developed to address (e.g., early childhood STEM education). Therefore, context-dependent quality can be measured by asking questions specifically related to the subject or topic of the resource. I explored users' perceptions of our resources' information relevance, information reliability, and context-dependent quality (regarding characteristics of early childhood STEM) to understand our resources' pedagogical quality.

Technical/Design Quality

To gain an understanding of a resource's technical/design quality, there are two indicators that can be explored: platform design and browsing/navigation design. An understanding of users' perceptions of platform design can be achieved by inquiring about the quality of text (e.g., font style and size), media (e.g., clarity of pictures, graphics, illustrations, and videos; whether media communicates information to support user comprehension), and aesthetic appeal (e.g., colour scheme and appeal of specific resource aspects; El Mhouti, 2013; Hsu et al., 2009). Users' perceptions of browsing/navigation design of a resource can be understood by examining whether users believe resource functions are easy to use, the layout is organized, and there is reliability of internal pages (e.g., browsing back and forth; El Mhouti et al., 2013; Hsu et al., 2009; Xie, 2008). I explored users' perceptions of our resources' platform design and browsing/navigation design to understand our resources' technical/design quality.

User Satisfaction

An understanding of user satisfaction can be gained by exploring psychological antecedents of satisfaction and future behaviour with the resource. Literature suggests that there are two psychological antecedents of satisfaction: cognitive processes and affect (Caro & Gracia, 2007; Deng et al., 2010; Palaci et al., 2019). The two cognitive processes that can be explored are expectation fulfillment and need fulfillment (Burgess, 2016; Palaci et al., 2019). Expectation fulfillment can be explored by asking users if the performance of a product (overall or specific aspects of it) did not meet, met, or exceeded their expectations (Prentice et al.,

2018). According to the Expectation-Disconfirmation Theory, the more a product exceeds users' expectations, the more satisfied they are, and the more the product does not meet expectations, the more dissatisfied users are (Deng et al., 2010). Need fulfillment can be explored by asking the degree to which users think that a product has met or has not met their needs; when a product meets users' needs, it strengthens their satisfaction (Au et al., 2008; Cyert & March, 1963; Han & Hong, 2003; Oliver, 1995). Affect can be measured by exploring users' emotional responses (commonly after use) towards a resource overall or specific aspects of it (e.g., being pleased, and indicating a positive experience; Giese & Cote, 2000; Razeen Davids et al., 2014). The intensity of affect can indicate the degree of satisfaction (Giese & Cote, 2000). Intensity of affect can exist along a continuum from weak negative (e.g., displeased) to strong positive (e.g., very pleased; Giese & Cote, 2000). To explore satisfaction, many researchers also include specific questions that ask participants whether they intend to reuse the resource and recommend it to a friend (e.g., Delaney et al., 2012; Razeen Davids et al., 2014). I explored users' reports of their cognitive processes, affect, and future behaviour with our resources to understand users' satisfaction.

My Exploration of Users' Perceptions of the Team's Early Childhood STEM Resources.

To ensure that the team is producing high-quality STEM resources, I drew on the literature to explore users' (ECEs, caregivers, and parents who use our resources) perceptions of the team's STEM resources' pedagogical and technical/design quality, as well as user satisfaction. As previously mentioned, the main research question that I addressed in my thesis was: What are users' perceptions of the early childhood STEM resources created by the STEM in the Early Years team? Sub-questions were:

1. What are users' perceptions of the resources' pedagogical quality?
2. What are users' perceptions of the technical/design quality of the resources?
3. How satisfied are users with the resources?

Chapter 3: Methodology and Methods

In Chapter 3, I outline the methodology and methods that I used in my thesis. I begin with the methodology section, which includes a description of the worldview I adopted for my thesis, and the research design and data collection method I chose to explore users' perceptions. Next is the methods section, where I describe Phase 1 (the development of our STEM in the Early Years resources) and Phase 2 (the research component) of my thesis.

Methodology

I begin the methodology section of the chapter by describing pragmatism, because it was the worldview in which I situated my thesis research. I then describe survey research because it was the research design that I chose for my thesis. I conclude the methodology section with a description of questionnaires because it is the data collection method I used.

Worldview: Pragmatism

In social science and educational research, there are many different worldviews in which researchers situate their studies (Creswell & Plano Clark, 2011; Kaushik & Walsh, 2019). Each worldview has a unique philosophical way of thinking about the world and how it works, as well as a unique history of how the worldview began and developed (Kivunja and Kuyini, 2017; Creswell, 2014). Furthermore, each worldview consists of four philosophical components: ontology (assumptions about reality and truth), epistemology (assumptions about knowledge), methodology (assumptions about how knowledge of reality should be obtained and methods for inquiry), and axiology (assumptions about morals and values) (Lincoln et al. 2011; Morgan, 2014a; Kaushik & Walsh, 2019; Tashakkori & Teddlie, 1998). Researchers choose a worldview that aligns with their beliefs and use its philosophical assumptions to guide their investigations, actions, and interpretations (Guba, 1990; Guba & Lincoln, 1994; Weaver, 2018). Pragmatism is the worldview that I have chosen to guide my research.

Pragmatism began in America during the 1870s (Legg & Hookway, 2021; Weaver, 2018), and the preeminent scholars were Charles Sanders Pierce, William James, and John Dewey (Legg & Hookway, 2021). Since the 1870s, many scholars have used pragmatism's philosophical assumptions to guide their work.

A critique of pragmatism is that pragmatic researchers primarily focus on and report the worldview's practical aspect and neglect to describe the philosophical components of pragmatism (Morgan, 2014b). Thus, in the list below, I outline the core characteristics of pragmatism through the ontological, epistemological, methodological, and axiological beliefs. I drew from Cherryholmes (1992), Creswell (2014), Duram (2012), Feilzer (2010), Kivunja and

Kuyini (2017), Kaushik and Walkish (2019), Morgan (2007, 2014a, 2014b), and Weaver (2018) to create the list.

- **Ontology:** Multiple versions of reality exist and are accepted. There may be an objective environment independent from human perceptions/experience; however, individuals' understanding of the environment may be constrained by their experiences with it. Truth is what is considered useful over time and in the present time.
- **Epistemology:** Researchers determine how they come to know something. Many pragmatists believe that knowledge can be developed through inquiry, which is social, and the knowledge, or warranted assumptions, gained through inquiry are contextual and provisional.
- **Methodology:** Researchers can choose the most suitable research designs and methods to achieve the purposes of their inquiries.
- **Axiology:** Research is conducted to improve lives and experiences.

However, pragmatists are less concerned with ontological and epistemological assumptions, and primarily focus on methodology and axiology assumptions (Creswell & Plano Clark, 2011; Duram, 2012; Feilzer, 2010); the research design and methods that are most suitable to achieve the purpose of inquiry and how the inquiry will benefit human lives and experiences (Morgan, 2014a; Tashakkori & Teddlie, 1998).

Therefore, I focused on choosing a research design, a data collection method, and data analysis approaches that would best allow me to explore users' perceptions of our resources to understand our resources' successes and the areas that may be improved to better users' experiences. Furthermore, the team adopted a pragmatic view during the development of our resources, as we focused on creating practical (e.g., easy to use and freely accessible) high-quality early childhood STEM resources to benefit caregivers' and young children's lives. In the following section, I describe the survey design, the data collection method I used to explore users' perceptions of our resources.

Research Design: Survey Research

I chose a survey research design because it allowed me to explore users' perceptions of our resources within the set timeframe of my thesis. According to Creswell & Gutterman (2019), survey research is a popular methodology amongst researchers in the field of education. Researchers use survey research when they want to investigate the attitudes, opinions, beliefs, behaviours, or characteristics of a sample or population (Creswell & Gutterman, 2019).

The two basic types of survey research designs are cross-sectional and longitudinal (Brewer, 2009; Creswell & Gutterman, 2019). Researchers can use a cross-sectional survey design to explore beliefs, attitudes, opinions, characteristics, and/or practices at one point in time (Creswell & Gutterman, 2019; Hall, 2011; Lau, 2016). In contrast, researchers can use a longitudinal survey design to explore changes in beliefs, attitudes, opinions, characteristics, and/or practices over time. My thesis research follows a cross-sectional survey research design because the purpose of my inquiry was to explore users' perceptions of our STEM resources at one point in time.

Data Collection Method: Questionnaire

A questionnaire is an instrument used to collect survey data (Creswell & Gutterman, 2019). Questionnaires can include closed-ended and/or open-ended questions (Tanner, 2018; Lau, 2016). Respondents complete the questionnaire by providing answers of their choosing to the question and return the questionnaire to the researcher after completing it (Creswell & Gutterman, 2019).

A self-administered online questionnaire is a specific type of questionnaire instrument. Researchers who collect data with a self-administered online questionnaire often use software programs (e.g., SurveyMonkey) for designing, gathering, and analyzing data (Creswell & Gutterman, 2019). Respondents can access, complete, and return the self-administered online questionnaire using a smartphone, computer, tablet, or another device that provides access to the internet and at a time and place most convenient to them (Creswell & Gutterman, 2019).

Self-administered online questionnaires are becoming a popular method of data collection amongst researchers because there are many benefits of using the method (Chiang et al., 2015; Creswell & Gutterman, 2019). Researchers use self-administered online questionnaires when they want to take advantage of the vast number of internet users (Creswell & Gutterman, 2019; Fowler, 2012). Additionally, researchers use self-administered online questionnaires to collect data because the method allows them to gather extensive data quickly (Creswell & Gutterman, 2019; Fowler, 2012; Goodwin & Goodwin, 2013; Gay et al., 2009; De Leeuw & Toepoel, 2017). Lastly, researchers choose to collect data with a self-administered online questionnaire because the method is not costly (Berends, 2006; Creswell & Gutterman, 2019; Fowler, 2012; Horner, 2008). Although there are many benefits to collecting data with a questionnaire, there are some noteworthy challenges, including issues with validity, reliability, low response rate, respondent fatigue, sampling bias, nonresponse bias, and social desirability bias (Ben-Nun, 2008; Creswell & Gutterman, 2019; Fan & Yan, 2010).

Validity can be a challenge when collecting data with a questionnaire (Tanner, 2018). Validation entails providing evidence for the five sources of validity: content evidence, response process, consequences, internal structure, and relation to other variables (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 2014). However, according to Downing (2003), whether the evidence for each validity source is needed and the amount of evidence required for each source is dependent on the instrument's purpose and the desired interpretation of findings (e.g., high-stake questionnaires require evidence for all validity sources). I could not provide rigorous evidence for the internal structure and relation to other variables because my small sample size was not large enough to conduct the statistical analyses, and there are no established instruments similar to my questionnaire. However, providing evidence for internal structure and relation to other variables was not my primary concern because the questionnaire helped me understand users' perceptions regardless of the evidence for these two validity sources and reliability; I also did not intend to generalize my findings to the population of users, and my study was considered a low-stake exploratory study. Although I did not collect evidence for the two sources of validity, I established validity evidence for content, response process, and consequences. I collected content evidence by creating a table of specifications with expert assistance. I established response process evidence by receiving feedback on my questionnaire via individual debriefings and expert reviews. Regarding evidence for the validity source of consequences, the questionnaire allowed respondents to share their thoughts on the resources, which in turn, showed the STEM in the Early Years team the areas of our resources that could improve for their use

Reliability can be a second challenge when collecting data with a questionnaire and refers to the consistency and stability of scores on a measurement (Creswell & Gutterman, 2019; Tanner, 2018). Establishing the reliability of an instrument is important; however, establishing the reliability of a measure is more important for high-stake studies (i.e., studies where the interpretation of findings has great consequences) rather than low-stake studies (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 2014). Although I could not conduct the procedures to establish the reliability of my questionnaire (e.g., test-retest reliability and internal consistency reliability) due to the time constraints of my thesis and my low sample size, I followed Creswell and Gutterman's (2019) recommendations of ensuring that items were understandable and respondents felt comfortable (e.g., through ensuring that respondents knew their participation was voluntary and their honest feedback was appreciated) to avoid factors that could result in

unreliable data. Furthermore, establishing reliability was not a primary concern for my thesis because my study was considered low-stake and exploratory.

A low response rate is a third challenge of collecting data with a questionnaire, and respondent fatigue is a third challenge (Fraenkel & Wallen, 2009). A low response rate can cause a lack of in-depth insights into the perceptions of the population, nonresponse bias, low statistical power, and results not being generalizable (Brewer, 2009; Creswell & Gutterman, 2019; Pinsonneault & Kraemer, 1993). One reason for obtaining a low response rate is respondent fatigue, which is when respondents' motivation and attention drop, which, can result in respondents stopping the questionnaire before completing it and skipping questions (Ben-Nun, 2008). Respondent fatigue can also result in respondents not reading instructions; thus, respondent fatigue can cause acquiescence response bias and responses to lack quality (Ben-Nun, 2008). I minimized the risk of having a low response rate and respondent fatigue by receiving feedback on the questionnaire before recruiting respondents to avoid the potential respondent burden and technical problems (Ben-Nun, 2008; Fan & Yan, 2010; Vicente & Reis, 2010).

Sampling bias is a fourth challenge to collecting data with a questionnaire and occurs when the study's sample does not represent the target population, because some people are not given the opportunity to participate or have a lower chance of being able to participate (Bethlehem, 2010; Brewer, 2009; Goodwin & Goodwin, 2013). The results of a study cannot be generalizable when there is a biased sample (Goodwin & Goodwin, 2013). However, sampling bias was not a challenge for my study because all users of our resources were given an equal opportunity to participate, and I did not intend to generalize the results (Brewer, 2009; Bethlehem, 2010; Goodwin & Goodwin, 2013).

Nonresponse bias is a fifth challenge with using a questionnaire to collect data. This bias occurs when the respondents differ from individuals (representative of the target population) who did not complete the survey (Brick, 2017; Creswell & Gutterman, 2019; Vicente & Reis, 2010). I minimized the potential of nonresponse bias by assuring respondents that the information they provided would be kept confidential and attempted to optimize response rates (Brick, 2017; Merkle, 2008; Sax et al., 2003).

Social desirability bias is the sixth challenge to collecting data with a questionnaire. It is the tendency for respondents to provide answers that they perceive will make a good impression or be socially acceptable rather than what they truly believe (Holbrook, 2008; Holtgraves, 2004; Larson, 2019). Social desirability bias can produce results that do not accurately reflect respondents' true perceptions, beliefs, and opinions (Grimm, 2010; Larson,

2019). I avoided potential social desirability bias because my questionnaire was self-administered, online, anonymous, and confidential, and I indicated in the instructions that respondents' honest feedback was appreciated (Bethlehem & Biffignandi, 2011; Lindhjem & Navrud, 2011; Callegaro, 2008).

I chose to explore users' perceptions of our resources using a self-administered online questionnaire for the method's practical benefits. A questionnaire provided every user with an opportunity to share their thoughts on our resources. Furthermore, a questionnaire allowed me to gather a lot of data quickly and within the set timeframe of my thesis. Additionally, the method is not costly, and I could utilize the University of Ottawa's enterprise licence of SurveyMonkey to create and administer my questionnaire. Also, I began planning my research during the beginning of the COVID-19 pandemic; the unpredictable and uncontrollable nature of the pandemic led me to choose a questionnaire as the safest and most efficient method of data collection. Furthermore, I was able to minimize the potential limitations as outlined in the previous paragraphs.

My questionnaire included closed-ended and open-ended questions for practical reasons (Tanner, 2018). I included closed-ended questions to reduce respondent burden because my target population (users of our resources) were busy, especially during the pandemic. Furthermore, I aimed for my questionnaire to be completed in approximately 10 minutes, and closed-ended questions allowed for more data to be collected within that time frame because these questions are quick to answer (Ben-Nun, 2008; Connor Desai & Reimers, 2019). Closed-ended components also allowed me to understand trends and differences in respondents' perceptions (Creswell & Gutterman, 2019; Humble, 2020). I included open-ended questions, because these questions allowed me to explore respondents' perceptions of our resources in their own words (Creswell & Gutterman, 2019). Also, the open-ended questions gave respondents opportunities to provide detailed responses; thus, allowing a more in-depth understanding of respondents' perceptions. In the next section, I describe my thesis research in more detail, including a detailed description of my questionnaire and how I developed it.

Methods

My thesis project was divided into two phases, as shown in Figure 2. The first phase was the creation of the early childhood STEM resources, where I helped the STEM in the Early Years team develop the STEM learning experiences, a Pinterest page, and a host website. The second phase was the project's research component, where I explored users' perceptions of our STEM resources by developing and administering an online questionnaire, then analyzing the collected data. See Figure 3 for more detail about the processes of my thesis including the

procedures and products for each specific stage. In the following sections, I explain Phases 1 and 2 in greater detail.

Figure 2

Timeline

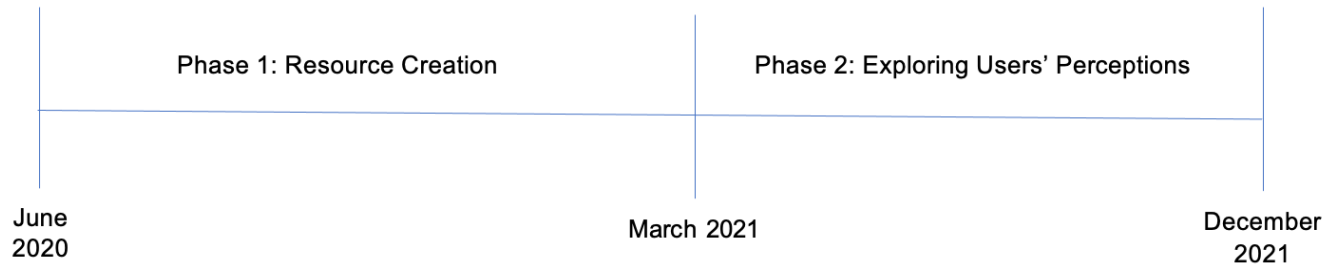
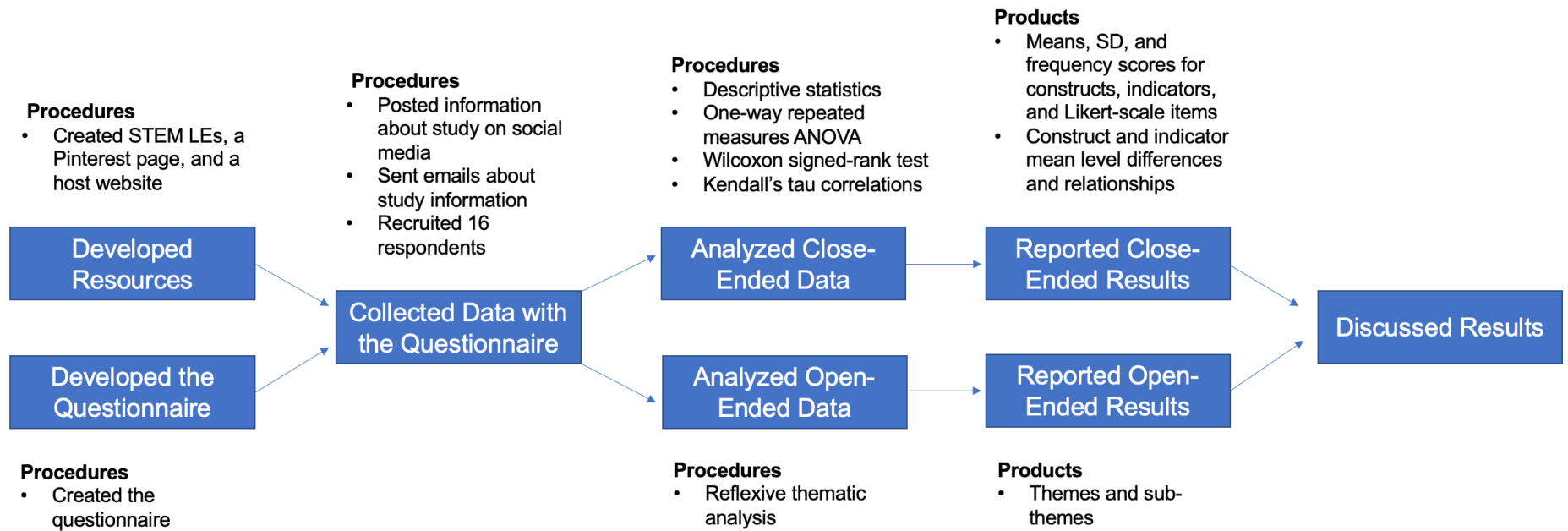


Figure 3

Research Process



Phase 1: Resource Creation.

During Phase 1, I worked with the STEM in the Early Years team to create online STEM resources for ECEs, parents, and caregivers to use. Our STEM resources consist of three elements: STEM learning experiences, the STEM in the Early Years' Pinterest page, and our host website. The team began the development of our resources by planning several STEM learning experiences for young children. Afterward, we created the STEM in the Early Years Pinterest page and a Pinterest pin for each of the planned STEM learning experiences; then posted each pin on our Pinterest page. On every pin, the team attached a link to our host website which we created to provide more detail about each STEM learning experience (LE), as well as more relevant supplementary information. The three elements of Phase 1 are outlined in greater detail in the subsections below.

STEM Learning Experiences. The team began the project by creating evidence-based early childhood STEM LEs for our Pinterest page. The LEs were developed by mobilizing the data from a project funded by a Social Sciences and Humanities Research Council Insight Development Grant, in which purposeful, play-based STEM LEs for young children (ages 1.5 to 5 years) were observed. The team also planned additional STEM LEs based on the practical experiences and ideas of the team, and used literature on STEM in early childhood.

The STEM LEs were developed using a social constructivist perspective and are play-based; thus, adhering to the common components in most Canadian early learning frameworks and Kindergarten curricula. The LEs provide children and adults (who are considered the knowledgeable others) opportunities to explore developmentally appropriate STEM content areas, material, and practices through purposeful play. All of our STEM LEs were created to capitalize on young children's interests, because the team developed the LEs from our observations of young children's interests in various play environments. We have also developed the LEs to further foster children's interest in the disciplines.

Although learning readiness is not the main focus in Canada's early learning frameworks, Kindergarten curricula, and the team's resources, our STEM LEs are intended to help children build a foundation for future STEM learning. Our LEs may help children build a foundation for future learning because children may develop STEM-related skills during the LEs, which children can use and further develop in formal schooling. Also, children can engage with and learn about developmentally appropriate STEM content and practices during the LEs, which they can also use and build on during formal schooling. Regardless of whether the LEs help

children become more equipped for learning in the formal years, our LEs offer children opportunities to experience and explore STEM and the world that exists around them.

Pinterest Page. The STEM LEs are housed and can be accessed on Pinterest. Our Pinterest page, *STEM in the Early Years*, contains a brief description of the STEM in the Early Years team and what the page is about. The page also has a board called *STEM Learning Experiences for Young Children* that holds a series of pins that capture our evidence-based STEM LEs. Each LE pin contains: a pin title, a pin image, a description of the pin, a link to the host website that houses more information about the pin, and options for users to curate the pin, as shown in Figure 4. The title of each pin contains a verb that describes the action that the children will be doing during the STEM LE and a noun that provides context. Also, every pin title includes “A STEM Learning Experience” to help Pinterest users understand what the pin is specifically about. Each pin image contains the title of the STEM LE, pictures related to the LE, and a succinct description of how the LE aligns with the disciplines. Also, the description box of each pin has keywords in the form of hashtags to help users find our content (e.g., #STEMinTheEarlyYears, #STEM, #Preschool). Every pinned LE is linked to a page on the host website that provides more information about the experience and other important information about our resources. Users are given the option to curate the pin with the option to save the pin to one or more of their Pinterest boards or share the pin via Twitter, Facebook, WhatsApp, email, and direct message to other Pinterest users.

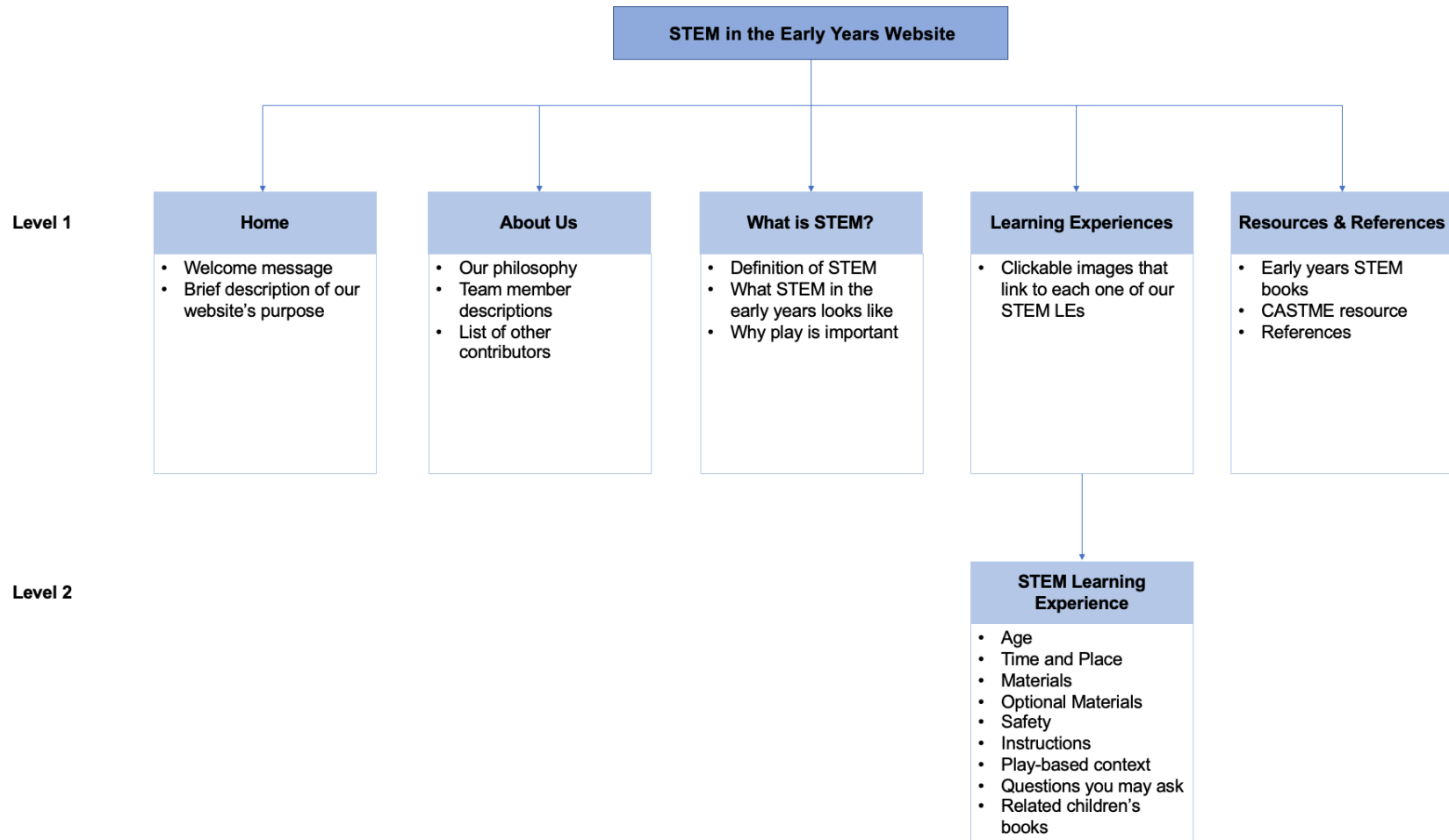
Figure 4

An Example of a STEM in the Early Years' Pin on Pinterest



Note. Blue boxes show the components of the pin, and the grey boxes show the aspects of the pin image.

The Host Website. The website that hosts the LEs has a number of tabs: Home, About Us, What is STEM?, Resource and References, and Learning Experiences. The Home page welcomes users and states our website's intention which is to inspire users to explore STEM with young children using our authentic play-based LEs. The About Us page contains information about the STEM in the Early Years team members (e.g., educational background and practical experiences with early childhood education). The What is STEM? page defines STEM as an integrated approach and describes the importance of incorporating STEM in a play-based context (STEM in the Early Years Team, n.d.). The Resources and References page contains a list of STEM books that the team recommends (e.g., Barbre, 2017; Moomaw, 2013) and a list of the references that inform the website. The Learning Experiences page is different from the other pages on the website because it is a portal page that has clickable images linked to specific STEM LE webpages. See Figure 5 for a sitemap, which includes an outline of our current website.

Figure 5*STEM in the Early Years' Sitemap*

Note. Level 1 boxes show the STEM in the early years' website tabs, and the information found within each tab. The learning experience tab contains links (via clickable images) to each one of our LEs; thus, Level 2 shows the information found within each linked LE webpage.

Every STEM LE webpage is structured similarly and includes the target age, time and place, materials (if applicable), safety considerations, instructions, play-based context, a list of inquiry-based questions adults may ask, and related children's books (if any) as shown in Figure 6. The target age section of each LE indicates the recommended age of the children, which the team determined by considering the content the children will explore and taking into account safety considerations (e.g., whether the children would be able to physically and safely engage with the LE). The time and place section outlines the ideal time of day to offer each LE and weather conditions for each LE, as well as whether each LE could be completed outside and/or inside a house and center. The recommended items and tools for each LE are found in the material section. The safety section for each LE states that children must always be supervised and includes other safety precautions relevant to the LE (e.g., children must be dressed in appropriate attire). An outline of how users may offer and facilitate each LE is presented in the instructions section. The play-based context section describes how each LE emerged from young children's interests and play for users to reflect on the STEM possibilities. A list of inquiry-based open-ended questions that users may ask children during each LE are provided in the questions you may ask section, to help adults guide the children to notice STEM, expand children's STEM thinking, and enhance children's STEM explorations. Most of the LEs have a related books section, where related children's books are listed for users to read with children to further engage the children with the LEs and foster their interests. Also, the list of books shows users how they may incorporate literacy with our STEM LEs.

Figure 6

An Example of a STEM in the Early Years' LE Webpage

STEM in the Early Years

Home
About Us
What is STEM?
Learning Experiences
Resources & References

Walking the Creek



Science: Children can explore the creek environment (soil, rocks, plants, and animals), the movement and temperature of the water.



Technology: Children can use nets and buckets to collect materials and catch small animals.



Engineering: Children can build a dam (e.g., using rocks) and observe how it affects water movement.



Math: Children can sort and/or classify the materials they collect.

Age

- 🕒 3 years and up

Time and Place

- 🕒 Any time of day
- 🌞 A hot and sunny day
- 🌳 Outdoors

Materials

- 🗑 Bucket and/or container
- 🕸 Net

Safety

- 👀 Supervise children at all times
- ⚠ Take extra precautions when playing with water
- ☀ Protect children from sun exposure (e.g., hats, sunscreen)
- 👕 Make sure children are dressed in appropriate attire (e.g., water shoes, bathing suits, and towel)

Instructions

Explore the creek and its surroundings. Provide children with opportunities to observe living and nonliving things in and around the creek. Encourage children to explore the water's temperature and movement (e.g., wading, splashing).

Questions You May Ask

- 🕒 What do you think we will find in the creek?
- 👁 What do you [see, hear, feel, smell]?
- 🕸 What can you use to catch [minnows, crayfish, other living organisms] in the creek?
- 🗑 What materials can you use to build a dam?
- 👀 What happens to the water as you build the dam?

Play-based Context

Children love to explore the natural world and they love playing with water on a hot summer day. As educators and children explored a creek, children asked questions about the living and nonliving things they observed. Children asked the educators to help them build a dam and watched how the water movement changed.



Related Children's Books

- 📖 *Up the Creek* by Nicholas Oldland
- 📖 *Creeksfinding: A True Story* by Jacqueline Briggs Martin
- 📖 *I am Sausal Creek* by Melissa Reyes














This website draws on research supported by the Social Sciences and Humanities Research Council.








In Phase 1, I assisted the STEM in the Early Years team members with creating our early childhood STEM resources. Specifically, I helped create STEM LEs, the STEM in The Early Years Pinterest page where the STEM LEs can be accessed, and the host website where additional information about the resources can be found.

Phase 2: Exploring Users' Perceptions

After I helped the team develop our STEM resources, I began Phase 2, which was the exploration of users' perceptions of our early childhood STEM resources. After receiving ethics approval from the University of Ottawa (see Appendix B for certificate), I explored users' perceptions of our resources by collecting data with a questionnaire that I created and then analyzed the data collected. In the following sections, I describe my respondents, questionnaire, and data analysis procedures in greater detail.

Participants. The target population for my study was users of our early childhood STEM resources. My sample for the questionnaire included ECEs, caregivers, and parents of young children who use our resources. All respondents for the questionnaire were recruited using convenience and snowballing sampling methods. I posted information about the resources and the questionnaire on social media (i.e., Pinterest, Twitter, Instagram, and Facebook) and our website. Additionally, I invited people on social media to share information about the resources with others who may be interested in participating. I also contacted early childhood organizations across Canada to share resources and information about the questionnaire with members. There were no participation restrictions regarding gender, sex, age, country residency, ethnicity, and race for the questionnaire. See Appendix C for recruitment scripts.

Questionnaire Components. The self-administered online questionnaire contained two components: demographics and user perceptions. Both components include closed-ended questions and open-ended questions. Closed-ended components helped me understand trends within the dataset; while open-ended components allowed me to understand respondents' thoughts in their own words and gave respondents opportunities to provide detailed responses. I describe the questionnaire's demographic and user perception components in greater detail below. See Appendix D for the questionnaire.

Demographics. The demographic component included open and closed-ended questions about the respondent and the child/children with whom they have used the resources. Closed-ended questions were asked when there were distinct predefined responses; open-ended questions were given when there could have been a wide range of possible answers and/or when there was a need for detailed responses.

User Perceptions. The user perceptions component included closed and open-ended questions that inquired about respondents' thoughts on our resources' pedagogical quality, technical/design quality, and user satisfaction. The closed-ended questions on the user perceptions component consisted of 5-point Likert-scale items. The open-ended questions were short answer questions where respondents could expand on their closed-ended responses and/or provide additional details about their perceptions of our resources. I discuss how I explored each construct with the questionnaire in greater detail below.

I explored the pedagogical quality of the team's resources by creating closed-ended Likert-scale items and open-ended questions about respondents' perceptions of the resource's information reliability (error-free and credible), information relevance (usability and workability), and context-dependent quality (characteristics of STEM in early childhood). Likert-scale items and open-ended questions were developed using the literature that explores perceptions of digital educational resources, and literature on STEM in early childhood.

I explored the technical/design quality of our resources by creating closed-ended Likert-scale items and an open-ended question about respondents' perceptions of platform design (quality of text and media, as well as appeal of aesthetic) and browsing/navigation design (ease of use, organization of layout, and reliability of internal pages) of the Pinterest page and host website. Likert-scale items and the open-ended question were developed using the literature that explores perceptions of digital educational resources.

I explored user satisfaction by creating closed-ended Likert-scale items and an open-ended question about users' cognitive processes (expectation and need fulfillment), affect (feelings about the pedagogical quality, technical design, and overall experience) regarding the team's resources, and future behaviour intentions with our resources (reuse and recommendations). The creation of the Likert-scale items and the question were influenced by the literature that explores perceptions of digital educational resources and research on satisfaction.

Overall, the questionnaire contained a demographic component and a user perceptions component. The demographic component asks questions about participants and the children that they use our resources with. The user perceptions component asks participants about their thoughts on our resources, pedagogical and technical design quality, as well as their satisfaction with our resources. In the next section, I describe the questionnaire development process to ensure it was suitable enough for respondents before collecting data.

Questionnaire Development. I checked the quality of my questionnaire in three ways. I created a table of specifications, and I received feedback on my questionnaire via expert

reviews and individual respondent debriefings. I made a table of specifications (see Appendix E) to establish evidence of content validity (i.e., ensure that the questionnaire items accurately and effectively inquired about the three constructs) which, I developed with the assistance of experts in the field of STEM in early childhood. The table of specifications shows the three constructs, the indicators of each construct, the specific areas of the indicators that the questionnaire items address, and the alignment of each Likert-scale item and open-ended question.

I also received feedback on the quality of my questionnaire via expert reviews to collect content validity evidence and potential response process evidence. Experts can provide feedback regarding how well the questionnaire explores the constructs under study (Presser & Blair, 1994; Reul et al., 2018; American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 2014). Experts can also provide feedback on the overall structure (e.g., layout and organization) of the questionnaire and other potential item and administration problems (e.g., item wording, response options, and length of the questionnaire) (Presser & Blair, 1994; Rothgeb et al., 2007; Willis et al., 1999). I had two experts in the field of early childhood STEM education, who also have experience with survey research, review my questionnaire. The literature on expert reviews informed the aspects that experts checked during the reviews, including content validity (e.g., whether questions inquired about constructs), understandability of instructions and items, appropriateness of response categories, and overall questionnaire layout and length. As a result of the reviews, I added more items about user satisfaction to strengthen the content validity of the questionnaire. Additionally, I strengthened possible respondent process evidence by reducing respondent burden through modifying the wording of some items to be more straightforward, decrease the likelihood that respondents would misinterpret items, and be more open-ended; I also deleted unnecessary items. Furthermore, to make the questionnaire flow logically, I changed the layout and the order of items, and I added skip logic which is a feature that arranges questions based on respondents' answers.

After I made changes to my questionnaire based on the expert reviews, I received feedback on my questionnaire quality via individual respondent debriefings to collect response process validity evidence and to understand whether respondents thought the questionnaire accurately inquired about the three constructs. Individual respondent debriefings provide researchers with information about how respondents may interpret the questionnaire and identify other problems that could occur during the actual questionnaire administration (Grimm, 2010; Ruel et al., 2018; Thomas, 2011). Individual respondent debriefings can occur as semi-structured one-on-one interviews with people representative of the target population; during the

debriefings, the interviewer focuses on each respondents' unique reactions to the questionnaire (Kelly & Lavrakas, 2011; Ruel et al., 2018; Scanlan, 2011). I conducted individual respondent debriefings with the three respondents who were representative of my target sample: an early childhood educator, a caregiver, and a parent of young children. I met each respondent on the online platform Zoom for the semi-structured debriefing interviews after they completed the questionnaire. The literature on individual respondent debriefings and semi-structured interviews informed how I conducted the debriefings and the aspects that I checked during each debriefing including understandability of the items, problems with response categories and the layout of questionnaire, and whether respondents believed that the questionnaire items inquire about the constructs accurately. After the debriefings, I reviewed my meeting minute notes and respondents' questionnaires to see if the questionnaire needed modifications. I gained response process evidence because respondents believed that the items were clear and understandable, they completed the questionnaire in approximately 10 minutes, and they interpreted the questions the way I had intended. To improve the validity source of response process, I specified "our STEM learning experiences" for the demographic questions and the user perceptions instructions about our LEs as one respondent requested that I be more specific. I also added a Likert-scale item and open-ended question about the pedagogical quality of our resources to the users' perceptions component because respondents believed the questions would allow for a more in-depth understanding of our resources' pedagogical quality.

In summary, I checked the quality of my questionnaire in three ways. I created a table of specifications to establish content validity evidence for my questionnaire. To collect content evidence and response process evidence, I received feedback on the quality of my questionnaire from experts in early childhood STEM education who had experience with questionnaire research and three people who were representative of my target sample. After reviewing my table of specifications and making modifications according to the feedback, I recruited respondents, collected data with my questionnaire, and then analyzed the data. In the section below, I describe the analyses I conducted.

Data Analysis. I conducted statistical analyses and a thematic analysis on the collected data. Before conducting the statistical analyses, I explored the data and completed preprocessing procedures. I calculated descriptive statistics using the data collected from the demographic component to understand who the respondents were. In regard to the closed-ended data collected from the user perceptions component, I calculated descriptive statistics, one-way repeated-measures analysis of variance (ANOVA), Wilcoxon signed-rank test, and Kendall's tau correlations to explore respondents' perceptions of our resources. All statistical

analyses were conducted using the open-source program JASP which, functions similarly to SPSS (JASP Team, 2022). I conducted a reflexive thematic analysis (Braun & Clarke, 2006) on the open-ended responses from the user perceptions component to further explore respondents' perceptions of our resources.

Data Exploration and Preprocessing. I began my data analysis by exploring the dataset for missing data and respondents who were not eligible to participate in my study and calculated mean-item scores. After I exported the data from SurveyMonkey as an Excel file, I explored the data for missing item responses. Of the 38 people that agreed to participate, 13 respondents were deleted from the dataset because they did not fill out the demographic and the user perceptions component. Six additional respondents were omitted because they only completed the demographic component. Afterward, I explored whether respondents met the requirements of participation (e.g., completing at least one LE with a child). This exploration resulted in an additional three respondents being deleted because they did not do one of our STEM LEs prior to completing the questionnaire. After I explored the data, I was left with a total sample of 16 respondents who completed all the closed-ended Likert-scale items on the questionnaire.

Demographic Component: Descriptive Statistics. I calculated descriptive statistics for the closed-ended and open-ended data collected from the demographic component. Specifically, I calculated frequency scores and mode for categorical variable closed-ended questions (e.g., sites used to access STEM in the Early Years). I calculated frequency scores for the open-ended question that asked what country respondents were living in. I calculated a range for the responses to the open-ended questions that inquired about the number of children respondents did our STEM LEs with, the age of the children, and number of LEs respondents had completed, because some participants provided ambiguous, nonnumerical, and/or indefinite answers when explaining how many LEs they completed with their children (e.g., "a handful" and "more than 8").

For the open-ended question that inquired about the relation to the child, I coded responses as "ECE," "caregiver," and/or "parent" and then calculated frequency scores. The code "ECE" was applied to respondents who stated they received their ECE qualification and described doing the LEs with children in their care. Responses were coded as "caregiver" if they described doing the LEs with children in their family (e.g., aunt), or with children who they provided care for but did not have ECE qualifications (e.g., babysitter). I coded responses as "parent" if respondents indicated they did the LEs with their own children. Two codes were applied to respondents who indicated that they belonged to two relation categories (e.g., a

response would be coded “parent” and “caregiver” if the respondent wrote they used our resources with their own children as a parent, and as a caregiver for children in their family).

User Perceptions Component: Statistical Analyses. I conducted five statistical analyses using the closed-ended data collected from the user perceptions component to explore respondents’ perceptions of our resources. The first statistical analysis that I conducted was descriptive statistics for the constructs and indicator scales. The second statistical analysis was a one-way repeated-measures analysis of variance (ANOVA) using the construct and the pedagogical quality and user satisfaction indicator means. The third statistical analysis was a Wilcoxon signed-rank test using the technical/design indicator means. The fourth statistical analysis was descriptive statistics on the Likert-scale item responses. The fifth statistical analysis was Kendall's tau correlations to explore construct and indicator bivariate relationships.

I calculated descriptive statistics – means and standard deviations – for the construct and indicator scales. The means were calculated using the mean-item scores and would show the average response for each construct and indicator scale. I compared the construct and indicator means to Table 1 to understand what the averages would represent in terms of response category, as well as the degree of quality and satisfaction. The standard deviations would show the standard error of the means.

Table 1

Quality and Satisfaction Ranges

| Response Categories | Mean Range | Quality | Satisfaction |
|---------------------|--------------|-----------|------------------|
| Strongly agree | 4.50 to 5 | Excellent | Very Satisfied |
| Agree | 3.50 to 4.49 | Good | Satisfied |
| Neutral | 2.50 to 3.49 | N/A | N/A |
| Disagree | 1.50 to 2.49 | Poor | Unsatisfied |
| Strongly disagree | 1 to 1.49 | Very Poor | Very unsatisfied |

I conducted a one-way repeated measures ANOVA on the three construct means to explore if a construct significantly differed from another. Additionally, I conducted two, one-way repeated measures ANOVAs to explore whether indicator means differed within the pedagogical quality and user satisfaction construct. Mauchly’s Test of Sphericity indicated both one-way

repeated measures ANOVAs violated the assumption of sphericity; thus, I had to apply Greenhouse-Geisser or Huynh-Feldt correction to correct sphericity to use the one-way repeated measure ANOVA (Field et al., 2012; Girden, 1992). I applied the Greenhouse-Geisser correction rather than the Huynh-Feldt correction to both one-way repeated measures ANOVAs because the estimate of sphericity was less than .75 (Girden, 1992). If a significant result occurred, Bonferroni-corrected t-tests would be conducted to examine where the differences were (e.g., what construct was rated significantly higher or lower than others). Results from one-way repeated measures ANOVA and Bonferroni-corrected t-tests would allow me to understand if there were any differences in the means and where the differences were. Thus, results would show whether there were specific constructs or indicators that respondents perceived to be better (e.g., higher quality) than others, and if there were constructs or indicators that may need more improvement than the others. Although a one-way repeated measures ANOVA is commonly conducted in positivist studies, I conducted the analyses because it gave me a better understanding of respondents' perceptions of our resources and the areas that may need more improvement.

I conducted a Wilcoxon signed-rank test to explore whether there was a significant difference between technical/design quality constructs' indicators. A Wilcoxon signed-rank test was conducted instead of a dependent t-test because a Shapiro-Wilk test indicated that the assumption of normality for the difference of scores was violated; thus, I could not conduct a dependent t-test as normality for the difference of scores is an assumption of the test (Field et al., 2012). The Wilcoxon signed-rank test would show whether respondents rated a technical/design quality indicator significantly higher or lower than the other. Although Wilcoxon signed-rank tests are commonly used in positivist studies, I conducted the analysis because the test result would allow me to understand whether an indicator was perceived to be of better quality, and if there was an indicator that needed more improvement.

I calculated descriptive statistics – means and standard deviations – for each Likert-scale item on the user perceptions component to gain a more in-depth understanding of respondents' perceptions of our resources' pedagogical quality, technical/design quality, and user satisfaction. I explored the mean range for the Likert-scale items within each construct to better understand the lowest average response and the highest average response to the Likert-scale items. Afterward, I referred to Figure 6 to determine what the mean of each Likert-scale item would represent in terms of perceived quality and satisfaction. For each Likert-scale item, I also calculated frequencies for responses of “*strongly disagree*,” “*disagree*,” “*no opinion/neutral*,” “*agree*,” and “*strongly agree*”; which in turn, would allow me to understand how

the responses vary and where the majority of responses fell on the 5-point Likert scale for each Likert-scale item. Calculating means, standard deviations, and frequency scores would allow me to understand whether there were specific areas within each construct that were perceived as successful, and the areas that needed improvement.

I calculated Kendall's tau correlations to explore whether there were any relationships amongst the constructs and indicator scales. Kendall's tau correlations were used instead of Pearson's correlations because a Shapiro-Wilk test for bivariate normality indicated that the assumption of normality was violated. I used Kendall's tau rather than Spearman's rank correlations because of my small sample size and the presence of tied ranks within my dataset (Field et al., 2012). For comparison, I also computed Pearson's correlations and found that the patterns of relationships were very similar to those obtained with Kendall's tau correlations. The correlations would show whether changes in respondents' perceptions of one construct, and indicator, are met with similar changes in ratings of another construct or indicator. After calculating Kendall's tau correlations, I compared each significant correlation to Cohen's (1998) conventions to interpret effect size to understand how strongly related users' perceptions of the constructs and indicators were. According to Cohen's (1998) conventions, the effect correlations between .10 to .30 indicate a small effect, while relationships between .31 to .50 suggest a medium effect, and correlations between .51 to 1.0 indicate a large effect. The more similar the changes are between the two variables, the larger the effect size and stronger the relationship, which in turn, suggests that the relationship has more practical significance and is more meaningful in the real world (Howell, 2017).

User Perceptions Component: Reflexive Thematic Analysis. I conducted a reflexive thematic analysis (Braun & Clarke, 2006) on the open-ended data collected from the users' perception component; specifically, on the responses from the 13 respondents who completed the open-ended questions. Braun and Clarke (2006) outlined six steps to conducting reflexive thematic analysis: (1) familiarizing self with data, (2) generating initial codes, (3) generating themes, (4) reviewing themes, (5) naming and defining themes, and (6) producing the report. Before conducting the reflexive thematic analysis, I consulted Braun and Clarke (2013; 2019; 2020) and Braun et al. (2018) work, for their most recent recommendations on how to conduct the six steps. Although each step is listed linearly, the actual process was more recursive.

I began with Step 1, which was familiarizing myself with the data. I read the open-ended responses several times, focusing on what the respondents wrote, then I began writing my first set of notes about the interesting features of their responses. Next, I reread my literature review and my research question and sub-questions. I then reread participants' responses, and I wrote

a second set of notes about interesting features of their responses that gave insight into respondents' perceptions of our resources' pedagogical and technical/design quality, and respondents' satisfaction with our resources. I compared my first set of notes to my second set of notes, and I observed the similarities and differences.

I then began Step 2, which was generating initial codes on the open-ended responses. Coding was done deductively and inductively. While coding, I thought about my research questions, the constructs, and indicators; I also focused on generating other codes based on participants' responses that provided insights into respondents' perceptions of our resources. During coding, I concentrated on semantic content, capturing explicit meaning based on what respondents wrote. I coded by highlighting and labelling chunks of data. After I initially coded the data, I met with an expert on early childhood STEM who had experience conducting a thematic analysis to receive feedback on my codes; including, clarity of my codes and whether codes captured the meaning of the representative responses. Following the expert's recommendations, I relabeled a code ("accessibility" was relabeled "ease of use") and checked whether I could generate other codes when responses were organized based on the open-ended question. While coding responses to each question, I noticed I was highlighting and attaching the same labels as the previous round of coding. Thus, no new codes were generated when I re-coded the responses.

Next, I completed Step 3, generating themes, by collating the codes and representative responses to construct candidate themes. Once I had a set of candidate themes, I created a thematic map to visually explore the connections between themes and codes. While linking themes and codes, I realized that some codes could be turned into themes (e.g., "ease of use" turned into the theme "easy to use resources") and sub-themes (e.g., "navigation" turned into a sub-theme). I then explored the links between participants' responses, codes, sub-themes, and themes by adding the representative responses to the map. I found that responses were easily linked to the codes, sub-themes, and themes. I further explored my candidate themes and sub-themes by printing and cutting responses to each question and then sorting the responses into the sub-themes and themes. While sorting, I also made a conscious effort to notice other possible patterns. When I compared my sorted responses to the document that I had previously coded participants' responses and my thematic mind map, I found that I generally sorted the responses into the same sub-themes and themes. However, I found that I generated three other weaker candidate themes and sub-themes while sorting responses. I then made a list of all the final candidate themes, the sub-themes, and the representative responses.

After I completed Step 4, reviewing the candidate themes and sub-themes. I reread participants' responses to check whether each theme and sub-theme told a coherent, insightful story about the data and if they captured what was meaningful about the data. Also, while I reread the responses, I ensured that the candidate themes and sub-themes provided information about users' perceptions of our resources' pedagogical and technical/design quality, as well as their satisfaction with our resource to help answer my research question and sub-questions. I found that all candidate themes and sub-themes appeared to capture what was meaningful about the data and provided insights.

Next, I completed Step 5 by naming and defining each theme based on the central concept of representative quotes. I defined each theme and sub-theme by describing the central concept that unified the quotes. I then consulted with the expert again to ensure that the names of the candidate themes and sub-themes accurately represented the data and were clear. Some names were changed to capture the data more accurately and to be clearer (e.g., "supporting engagement with STEM" turned into "user learning").

Finally, I completed Step 6 by producing the written report of my reflexive thematic analysis, which can be found in the next chapter. See Appendix F for how I addressed each point on Braun and Clark's (2006) 15-point checklist of criteria for good thematic analysis.

In Phase 2, I explored users' perception of our STEM in the Early Years resources' pedagogical and technical/design quality, as well as user satisfaction. I created a questionnaire that included a demographic component and a user perception component, as well as closed- and open-ended questions, and then I recruited users of our resources to complete it. Afterward, I analyzed the data by conducting statistical analyses and Braun and Clarke's (2006) reflexive thematic analysis.

Methodology and Methods Summary

In this chapter of my thesis, I outlined my thesis methodology and methods. I began the methodology section by describing pragmatism because it was the worldview that influenced the development of our STEM in the Early Years resources and my thesis research. I then described survey research because I used a cross-sectional survey design for my research. After, I described questionnaires because it was the survey instrument that I used to collect data. In the methods section, I described Phase 1 which, was the development of our STEM resources, and then I outlined Phase 2 which, was the research component of my thesis.

Chapter 4: Results

In Chapter 4, I report results from the statistical analyses and reflexive thematic analysis that I conducted on the questionnaire data. I begin the chapter by reporting the descriptive statistics for the data collected from the demographic component. Afterward, I report statistical analyses for the closed-ended data collected from the users' perceptions component; including descriptive statistics, one-way repeated measures ANOVAs, Wilcoxon signed-rank test, and Kendall's tau correlations. I conclude the chapter by reporting the results of the reflexive thematic analysis, which I conducted on the open-ended data collected from the users' perceptions component.

Demographics: Descriptive Statistics

All 16 respondents indicated that they lived in Canada. The majority of the respondents identified as female, did not work in the field of STEM, and were not registered ECEs. The age range of respondents was 18 to 54, with the majority being 35 to 44 years old. Respondents accessed our content via Pinterest, Instagram, and/or Twitter. However, the majority (81%) of the sample indicated they used our website to access our content. See Table 2 for respondents' demographic characteristics.

Table 2

Characteristics of Sample

| Demographic Characteristics | n | % |
|---------------------------------------|----|-----|
| Gender | | |
| Female | 14 | 88 |
| Male | 1 | 6 |
| Prefer not to answer | 1 | 6 |
| Prefer to self-describe | 0 | |
| Participant Age | | |
| 18-24 | 4 | 25 |
| 25-34 | 4 | 25 |
| 35-44 | 5 | 32 |
| 44-54 | 3 | 19 |
| 55-64 | 0 | |
| 65+ | 0 | |
| Country | | |
| Canada | 16 | 100 |
| Sites used to Access Resources | | |
| Pinterest | 7 | 44 |

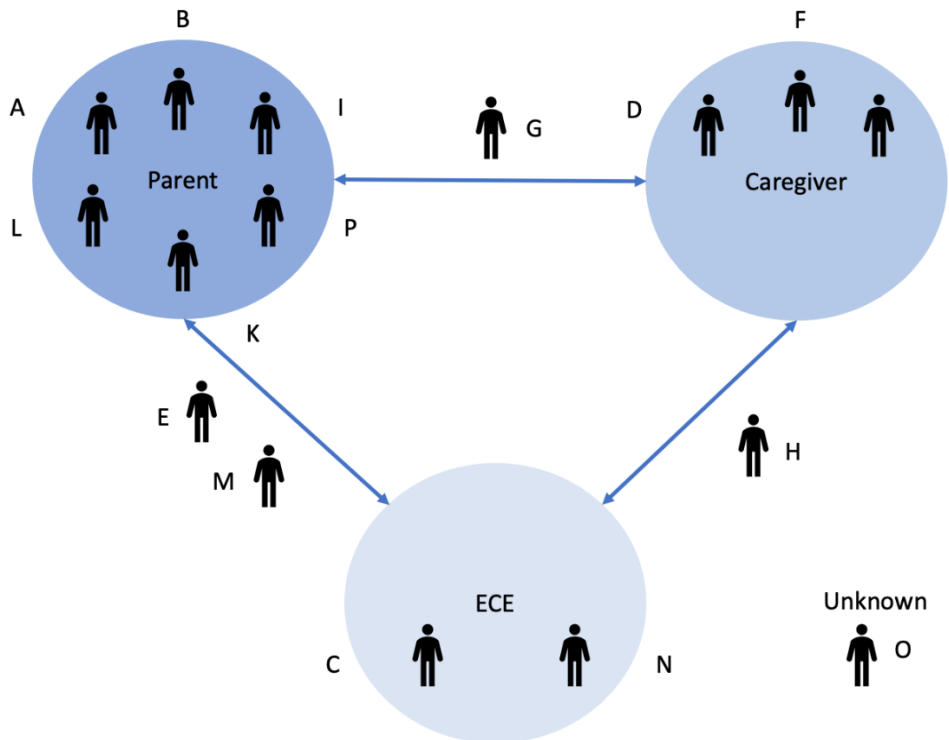
| | | |
|--------------------------------|----|----|
| Website | 13 | 81 |
| Twitter | 1 | 6 |
| Instagram | 5 | 31 |
| Registered ECE | | |
| Registered | 6 | 38 |
| Not Registered | 10 | 63 |
| Job | | |
| Works in the field of STEM | 3 | 19 |
| Does not work in field of STEM | 13 | 81 |

Note. N = 16.

Respondents reported completing a range of 1 to 36 LEs prior to doing the questionnaire, and with at least one child; the number of children that respondents reported completing our LEs with ranged from 1 to 30. Regarding respondents' relation to the children, participants described completing LEs with their own children and children that they take care of, as shown in Figure 7.

Figure 7

Respondents' Relation to the Children



Note. Respondents E and M indicated they used our resources as a parent and ECE. Respondent K indicated they used our resources as a parent but had an ECE certification. Respondent H indicated they

used our resources as an ECE and as a caregiver for children in their family. Respondent G specified they use our resources as a parent and caregiver for children in their family.

The age range of children was 1.5 to 8 years old; however, one respondent did not report the age of the children, instead the respondent stated that they used our resources in a Grade 3 to 8 Learning Centre classroom. Surprisingly, nine respondents indicated they used our resources with at least one child older than 5 years.

User Perceptions: Statistical Analyses

In the following paragraphs, I describe the results from conducting statistical analyses on the closed-ended data from the user perceptions component. First, I report the results of the descriptive statistics for the construct and indicator scales. I then describe the results from exploring construct and indicator mean differences via one-way repeated measures ANOVAs and a Wilcoxon signed-rank test. Afterward, I report the descriptive statistics for the Likert-scale items. I conclude this section of the chapter by reporting results from exploring construct and indicator relationships via Kendall's tau correlations.

Descriptive Statistics for Construct and Indicator Scales

The range for the means of the three construct scales was 4.13 to 4.43 (for the 5-point Likert-scales); thus, the means were within the *good* quality range or *satisfied* range. The mean range for the pedagogical quality indicator scales was 4.31 to 4.56, within the *good* to *excellent* quality range. In addition, the means for the technical/design indicator scales were 4.09 and 4.13, within the *good* quality range. Furthermore, the mean range for the user satisfaction indicator scales was 4.29 to 4.38, within the *satisfied* range. See Table 3 for descriptive statistics means, standard deviations, and range of Likert-scale item responses for each construct and indicator scale.

Table 3

Descriptive Statistics for Construct and Indicator Scales

| Constructs and Indicators | <i>M</i> | <i>SD</i> | Range ^a | Quality/Satisfaction |
|----------------------------|----------|-----------|--------------------|----------------------|
| Pedagogical Quality | 4.43 | 0.9 | 3-5 | Good |
| Information Reliability | 4.31 | 0.63 | 3-5 | Good |
| Information Relevance | 4.56 | 0.45 | 4-5 | Excellent |
| Context-Dependent Quality | 4.41 | 0.39 | 3-5 | Good |
| Technical/Design Quality | 4.13 | 0.63 | 1-5 | Good |
| Platform Design Quality | 4.13 | 0.72 | 1-5 | Good |
| Browsing/Navigation Design | 4.09 | 0.60 | 2-5 | Good |

| | | | | |
|---------------------|------|------|-----|-----------|
| User Satisfaction | 4.33 | 0.49 | 4-5 | Satisfied |
| Cognitive Processes | 4.34 | 0.47 | 4-5 | Satisfied |
| Affect | 4.29 | 0.56 | 4-5 | Satisfied |
| Future Behaviour | 4.38 | 0.47 | 4-5 | Satisfied |

Note. $N = 16$. ^a Range of possible values = 1.00-5.00.

Construct and Indicator Mean Differences

Results of a one-way repeated measures ANOVA conducted on construct means showed a significant effect, $F(2, 30) = 3.48, p = .044$. Bonferroni-corrected t-tests showed that pedagogical quality mean was significantly higher than the technical/design quality mean. Thus, the respondents rated the pedagogical quality higher than the technical/design quality of our resources. There were no significant differences between the means for user satisfaction and the two quality constructs (pedagogical and technical/design quality). The one-way repeated measures ANOVA conducted on pedagogical quality indicator means did not show a significant effect, $F(1.36, 20.45) = 2.12, p = .16$. Thus, respondents did not rate any of the pedagogical quality indicators significantly higher or lower than the others. The one-way repeated measures ANOVA conducted on the satisfaction indicator means did not show a significant effect, $F(1.35, 20.31) = 1.18, p = .31$. Thus, respondents did not rate any of the user satisfaction indicators significantly higher or lower than the others. The Wilcoxon signed-rank test conducted on the technical/design indicators did not show a significant effect, $t(15) = 38.50, p = 1.00$. Thus, respondents did not rate one technical/design quality indicator significantly higher or lower than the other. Overall, results from comparing the mean levels of the constructs showed that respondents rated our resources' pedagogical quality higher than the technical/design quality, and no significant differences were found between indicator means within each construct.

Responses to Individual Likert-scale Items

I further explored respondents' perceptions of our resources by calculating descriptive statistics and frequencies for pedagogical quality, technical/design quality, and user satisfaction Likert-scale items, as shown in Tables 4, 5, and 6, respectively. As shown in Table 4, the means for the pedagogical quality Likert-scale items ranged from 4.19 to 4.69, within the *good* to *excellent* quality range. Frequency results showed that at least 14 respondents agreed or strongly agreed with each pedagogical quality Likert-scale item. Table 5 shows the technical/design quality Likert-scale item means ranged from 3.94 to 4.31, within the *good* quality range. Frequency results showed that at least 10 respondents agreed or strongly agreed with each technical/design quality Likert-scale item. As shown in Table 6, the means for the user

satisfaction Likert-scale items ranged from 4.13 to 4.38, within the *satisfied* range. Frequency results showed that at least 14 respondents agreed or strongly agreed with each user satisfaction item.

Table 4*Descriptive Statistics and Response Frequencies for Pedagogical Quality*

| Indicator | Items | Mean (SD) | Quality | 1 = Strongly Disagree | 2 = Disagree | 3 = Neutral | 4 = Agree | 5 = Strongly Agree |
|---------------------------|--|-------------|-----------|-----------------------|--------------|-------------|-----------|--------------------|
| Information Reliability | The information is credible. | 4.38 (0.50) | Good | 0 | 0 | 0 | 10 | 6 |
| | The information is error-free. | 4.25 (0.86) | Good | 0 | 1 | 1 | 7 | 7 |
| Information Relevance | The STEM learning experiences are appropriate for children who are 2.5 to 5 years of age. | 4.63 (0.49) | Excellent | 0 | 0 | 0 | 6 | 10 |
| | The learning experiences use inexpensive material. | 4.63 (0.50) | Excellent | 0 | 0 | 0 | 6 | 10 |
| | The learning experiences can be modified to meet children's different needs. | 4.44 (0.62) | Good | 0 | 0 | 1 | 7 | 8 |
| Context-Dependent Quality | The learning experience allowed hands-on exploration of STEM. | 4.69 (0.48) | Excellent | 0 | 0 | 0 | 5 | 11 |
| | My child/children appeared to be interested during the learning experience. | 4.56 (0.51) | Excellent | 0 | 0 | 0 | 7 | 9 |
| | The learning experience may provide my child/children with a foundation for future STEM learning. | 4.50 (0.51) | Excellent | 0 | 0 | 1 | 6 | 9 |
| | I was able to confidently guide my child's/children's attention to the areas of STEM during the learning experience. | 4.38 (0.72) | Good | 0 | 0 | 2 | 6 | 8 |
| | My child/children explored developmentally appropriate areas of STEM during the learning experience. | 4.40 (0.51) | Good | 0 | 0 | 0 | 10 | 6 |
| | I found myself doing the learning experience along with my child/children. | 4.38 (0.50) | Good | 0 | 0 | 1 | 9 | 6 |
| | Doing the learning experience sparked my child's/children's interest in STEM related activities. | 4.31 (0.48) | Good | 0 | 0 | 0 | 11 | 5 |
| | I asked my child/children questions during the learning experience. | 4.19 (0.66) | Good | 0 | 0 | 2 | 9 | 5 |

Note. N = 16.

Table 5*Descriptive Statistics and Response Frequencies for Technical/Design Quality*

| Indicator | Items | Mean (SD) | Quality | 1 = Strongly Disagree | 2 = Disagree | 3 = Neutral | 4 = Agree | 5 = Strongly Agree |
|-----------------------------------|---|----------------|---------|-----------------------------|-----------------|----------------|--------------|--------------------------|
| Browsing/ Navigation Design | All the links and images I clicked took me to the correct pages. | 4.19 (0.83) | Good | 0 | 1 | 1 | 8 | 6 |
| | I was able to navigate the website easily. | 4.25 (0.68) | Good | 0 | 0 | 2 | 8 | 6 |
| | The website is well organized. | 4.06 (1.06) | Good | 0 | 1 | 2 | 7 | 6 |
| | The Pinterest page is well organized. | 3.94 (0.85) | Good | 0 | 0 | 6 | 5 | 5 |
| | I was able to navigate the Pinterest page easily. | 3.94 (0.77) | Good | 0 | 0 | 5 | 7 | 4 |
| Platform Design Quality | The font styles on the resources are readable. | 4.31 (0.70) | Good | 0 | 0 | 2 | 7 | 7 |
| | The images helped me understand how to engage young children with STEM. | 4.19 (0.98) | Good | 0 | 1 | 3 | 4 | 8 |
| | The images on the resources are clear (not blurry). | 4.13 (0.89) | Good | 0 | 1 | 2 | 7 | 6 |
| | The colours used for the resources are aesthetically pleasing. | 4.13 (0.96) | Good | 0 | 1 | 3 | 5 | 7 |
| | The Pins are aesthetically pleasing. | 4.13 (0.89) | Good | 0 | 0 | 5 | 4 | 7 |
| | The website is aesthetically pleasing. | 4.06 (1.06) | Good | 1 | 0 | 2 | 7 | 6 |
| | The font sizes on the resources are readable. | 4.13 (1.03) | Good | 1 | 0 | 1 | 8 | 6 |

Note. N = 16.

Table 6*Descriptive Statistics and Response Frequencies for User Satisfaction*

| Indicator | Items | Mean (SD) | Satisfaction | 1 = Strongly Disagree | 2 = Disagree | 3 = Neutral | 4 = Agree | 5 = Strongly Agree |
|------------------------|---|----------------|--------------|-----------------------------|-----------------|----------------|--------------|--------------------------|
| Cognitive Processes | The resources met my expectations. | 4.38 (0.50) | Satisfied | 0 | 0 | 0 | 10 | 6 |
| | The resources met my needs. | 4.31 (0.48) | Satisfied | 0 | 0 | 0 | 11 | 5 |
| Affect | I am pleased with the quality of the STEM learning experiences. | 4.38 (0.50) | Satisfied | 0 | 0 | 0 | 10 | 6 |
| | I had a positive experience using the resources. | 4.38 (0.50) | Satisfied | 0 | 0 | 0 | 10 | 6 |
| | I am pleased with the design quality. | 4.13 (0.80) | Satisfied | 0 | 1 | 1 | 9 | 5 |
| Future Behaviour | I would recommend the resources to a friend. | 4.38 (0.50) | Satisfied | 0 | 0 | 0 | 10 | 6 |
| | I plan on using the resources again. | 4.38 (0.50) | Satisfied | 0 | 0 | 0 | 10 | 6 |

Note. N = 16.

Overall, the means for the pedagogical Likert-scale items were within the *good to excellent* quality, and the majority of respondents agreed or strongly agreed with each item. In regard to technical/design quality, the means were within the *good* quality range, and the majority of respondents agreed or strongly agreed with each item. The means and frequency scores for the satisfaction Likert-scale items were within the *satisfied* range, and the majority of respondents agreed or strongly agreed with each item.

Construct and Indicator Relationships

To explore construct and indicator relationships, I calculated Kendall's tau correlations. As shown in Table 7, the technical/design quality and pedagogical quality constructs were strongly related (.52 and .67) with user satisfaction. Thus, as respondents' ratings of the resource's pedagogical and technical/design quality increased their satisfaction with the resources also increased. Although there was a moderate relationship (.31) between technical/design quality and pedagogical quality, the correlation was not significant.

Table 7

Correlations Between Constructs

| Construct | 1 | 2 | 3 |
|------------------------------|--------|---------|---|
| 1. Pedagogical Quality | — | | |
| 2. Technical/ Design Quality | 0.31 | — | |
| 3. User Satisfaction | 0.52** | 0.67*** | — |

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

As shown in Table 8, user satisfaction indicators (cognitive processes, affect, and future behaviour) were strongly correlated (.78 to .93). Similarly, the technical/design quality indicators (platform design quality and browsing/navigation design) were strongly related (.73). Regarding the pedagogical quality indicator correlations, only information relevance and context-dependent quality were strongly related (.70). These two indicators were moderately related with information reliability (.39 and .42); however, these relationships were not statistically significant. There were also significant correlations between technical/design indicators and user satisfaction indicators, as well as pedagogical quality indicators and user satisfaction indicators. No significant relationships were found between the pedagogical quality indicators and the technical/design quality indicators.

In regard to technical/design quality and user satisfaction indicator correlations, platform design quality and navigation/browsing design were strongly related with cognitive processes, affect, and future behaviour (.55 to .72). Regarding pedagogical quality and user satisfaction indicator correlations, information relevance was strongly related to cognitive processes, affect,

and future behaviour (.53 to .60). Furthermore, context-dependent quality was moderately related to cognitive processes and future behaviour (.44 and .46). Although context-dependent quality was moderately related to affect (.40), the relationship was not significant. Information reliability was moderately related to and the user satisfaction indicators (.31 to .41); however, the relationships were not significant.

Table 8*Correlations Between Indicators*

| Constructs | Indicator | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|-----------------------------|-------------------------------|------|---------|-------|---------|---------|---------|---------|---|
| Pedagogical Quality | 1. Information reliability | — | | | | | | | |
| | 2. Information relevance | 0.42 | — | | | | | | |
| | 3. Context-dependent quality | 0.39 | 0.70*** | — | | | | | |
| Technical/Design Quality | 4. Platform design quality | 0.35 | 0.35 | 0.38 | — | | | | |
| | 5. Browsing/Navigation Design | 0.11 | 0.26 | 0.23 | 0.73*** | — | | | |
| Satisfaction | 6. Future Behaviour | 0.41 | 0.56* | 0.44* | 0.67** | 0.55* | — | | |
| | 7. Cognitive Processes | 0.38 | 0.60* | 0.46* | 0.64** | 0.64** | 0.93*** | — | |
| | 8. Affect | 0.31 | 0.53* | 0.40 | 0.70*** | 0.72*** | 0.78*** | 0.81*** | — |

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

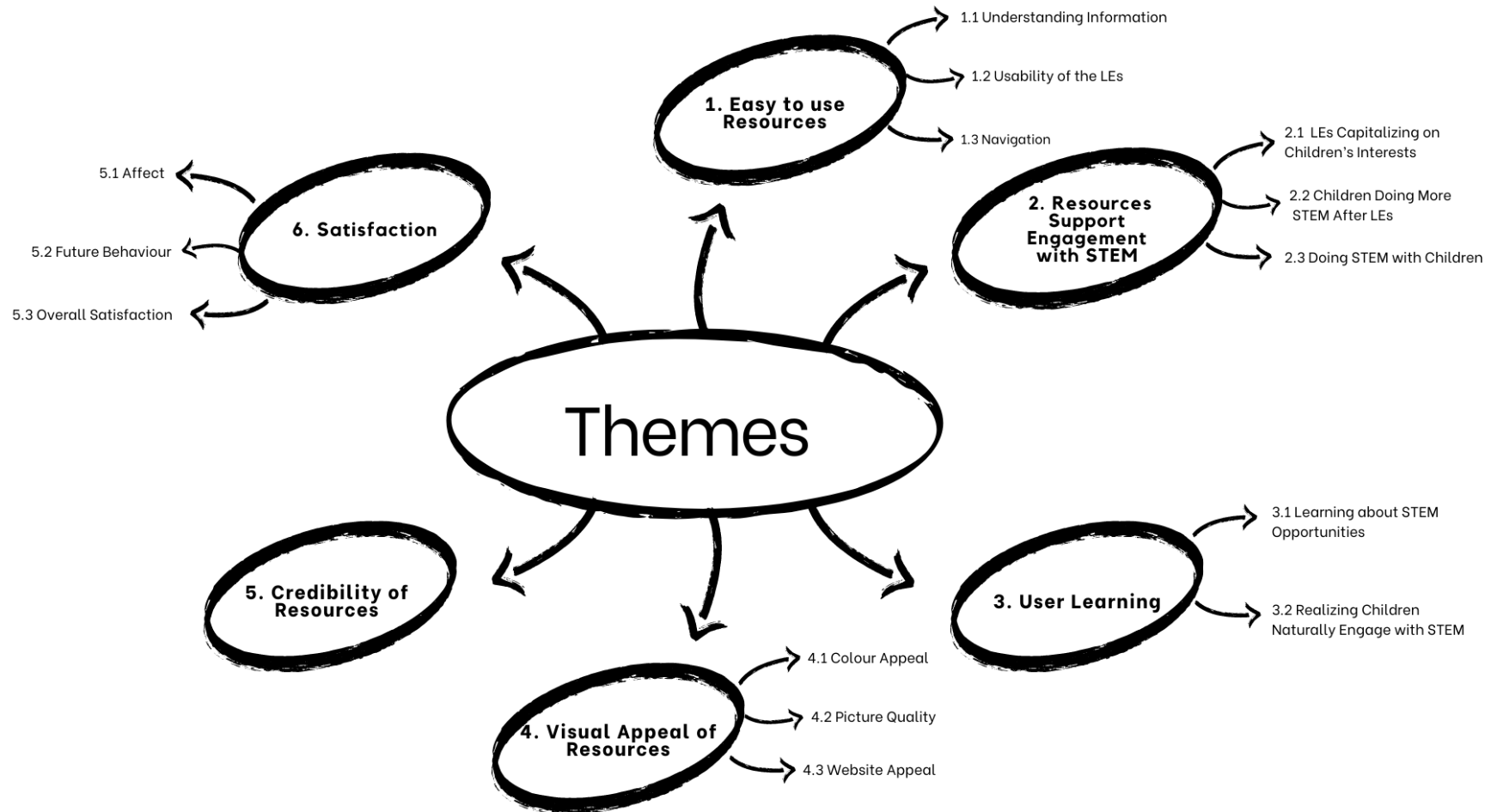
To summarize, significant relationships were found between and within constructs. There were significant relationships between the quality constructs and user satisfaction; however, technical/design quality was more strongly associated with satisfaction. Generally, the indicators within each construct were significantly related; however, information reliability was not significantly related to the other pedagogical quality indicators. The indicator correlations also showed that the technical/design quality indicators and the pedagogical quality indicator of information relevance were strongly associated with the three user satisfaction indicators. Furthermore, the pedagogical quality indicator of context-dependent quality was moderately related to the two user satisfaction indicators: cognitive processes and future behaviour.

Summary of Statistical Analyses

Overall, statistical analyses indicated that all respondents lived in Canada and that the majority of respondents were female, between 35 to 44 years old, did not work in the field of STEM, were not registered ECEs, and accessed our content via our website. Respondents were parents, ECEs, and/or caregivers and used our resources with children 1.5 and older. Respondents perceived the pedagogical quality to be of *good* to *excellent* quality, and technical/design quality to be of *good* quality, and that they were *satisfied* with the resources. However, respondents perceived our resources' pedagogical quality to be significantly better than their technical/design quality. Lastly, significant relationships were found between the two quality constructs and user satisfaction construct, as well with some of the quality indicators with the user satisfaction indicators.

User Perceptions: Reflexive Thematic Analysis

My reflexive thematic analysis on the open-ended responses resulted in six generated themes: easy to use resources, resources support engagement with STEM, user learning, visual appeal of resources, credibility of resources, and satisfaction, as shown in Figure 8. I describe each theme and any related sub-themes in the paragraphs below. See Appendix G for a description of themes and sub-themes, as well as representative responses.

Figure 8*Visual Representation of Themes and Sub-Themes*

Note. Circles present the themes, and the sub-themes are attached to the circles. Credibility of resources did not have sub-themes.

Theme 1: Easy to use Resources

Easy to use resources was the most prominent theme throughout participants' responses at the semantic level, and it was strongly evident in responses to the questions about perceptions of our resources' pedagogical and technical/design quality. Respondents noted the ease of use regarding the information in our resources and the design of our resources. The three sub-themes of easy to use resources that were generated are understanding information, usability of LEs, and navigation.

Sub-theme 1.1: Understanding Information. The first sub-theme was understanding information in our resources. Respondents wrote about how the information was easy to read and comprehend. Furthermore, respondents commented how the pictures on the resources aided in their comprehension of the textual information. For example, Respondent H stated,

I liked how easily accessible the resources were, they were simple to understand and read. The language was easy to understand. They were engaging to look at and the pictures made it more interesting and helped me understand how it may look when the children are engaged in the learning experience.

Respondents recommended that the STEM in the Early Years team provide video demonstrations of our STEM LEs in our resources to further support their understanding of the textual information. For example, Respondent J wrote, "The website could include videos, in addition to photos, for some activities. This may help guide some of the more complex activities."

Sub-theme 1.2: Usability of the LEs. The second sub-theme was the usability of our LEs. Respondents commented on how our LEs were usable by stating they could do the LEs with inexpensive material that could be found around the house or care centre. For example, Respondent E commented, "The learning activities are highly usable because they incorporate materials that many families/child care providers already have on hand."

Furthermore, respondents wrote that the LEs could be done with different age groups and with children who have different abilities/needs. For example, Respondent G stated, "Not only [do the STEM opportunities] relate to the age group, but [they] may be easily tweaked in order to fit an older age group which makes it easy to follow!"

Sub-Theme 1.3: Navigation. The third sub-theme was regarding the navigation of our resources. Respondents wrote that the resources were easy to navigate and well organized. For example, Respondent N wrote they "liked how easy the resources are to navigate." However, respondents recommended that similar LEs be linked and organized into categories based on similar characteristics. Respondent D stated their "Only thought could be organizing some of the

activities into categories (food related like making hot chocolate, outside the home like the playground) to help users know which resources suite their current needs! Otherwise fantastic.” Additionally, Respondent E commented, “If the collection of resources continues to grow it would be nice to have links within each resource to other similar resources. For example: If you enjoyed Observing Plants try Observing Worms on a Rainy Day.”

The theme of easy to use resources was written about in terms of understanding information in our resources, the usability of our LEs, and navigating our resources. Respondents reported that the information in our resources was easy to understand, they could do the LEs, and the resources were easy to navigate. However, respondents suggested adding video demonstrations, as well as linking similar LEs and organizing LEs into categories.

Theme 2: Resources Support Engagement with STEM

The second most prominent theme that I generated was resources supporting engagement with STEM, and it was strongly evident semantically in responses to questions about the pedagogical quality of our resources. Respondents wrote about how our resources helped engage children and themselves with STEM. The three sub-themes of resources supporting engagement with STEM that were generated are LEs capitalizing on children’s interests, children doing more STEM after LEs, and doing STEM with children.

Sub-theme 2.1: LEs Capitalizing on Children’s Interests. The first sub-theme was LEs capitalizing on children’s interests. Respondents described how children enjoyed doing the LEs and were interested while doing the LEs. Additionally, respondents reported how children seemed to be highly engaged and focused while doing the LEs. For example, Respondent H commented,

One of the learning experiences that my children loved was building sandcastles, they were really into making the sandcastles as high as they could, then we continued the learning by measuring how tall they made the sandcastles. They were engaged for over an hour.

However, Respondent P suggested that their 2-year-old became frustrated when they could not properly do an LE component; stating, “My 2 year old had trouble doing some activities. For example, she got frustrated when she couldn’t properly hang the clothespins to hold the blanket for her fort!” Respondent C suggested children appeared more focused in small groups than large groups, stating, “In small groups the children were much more focused. When presented during a group time it was more challenging.”

Sub-theme 2.2: Children Doing More STEM After LEs. The second sub-theme was children doing more STEM after LEs. Some respondents reported that they observed children

engaging with more STEM after completing our LEs. For example, Respondent H commented, “After building sandcastles, they started wanting to build more types of castles or towers out of many different materials, blocks, food towers, leaves, rocks, etc.” However, other respondents suggested that children did the same number of STEM-related behaviours post-LE. For example, Respondent I commented, “I would say the same amount” when writing about whether they observed STEM related behaviours after doing the LEs.

Sub-theme 2.3: Doing STEM with Children. The third sub-theme was respondents doing STEM with children during the LEs. Respondents described exploring STEM with children and guiding the children during the LEs. For example, Respondent J commented, “I guided the child that I babysat through 2 learning experiences. [...] We were able to complete the activities together.” However, Respondent N suggested that some children needed more guidance to expand their STEM ideas, while other children could independently engage with STEM; they commented, “Some children need more guidance to encourage critical thinking and their own ideas. Other children explore comfortably and curiously in their own.”

The theme of resources supporting engagement with STEM interests was written in terms of LEs capitalizing on children’s interests, children doing more STEM after LEs, and doing STEM with children. Respondents commented about children showing interest during the STEM LEs, observing children doing more STEM post LEs, and doing the LEs with children. However, one respondent stated that the child became frustrated during a LE, another respondent commented that children were more engaged in small groups, and a respondent stated some children could independently engage with STEM.

Theme 3: User Learning

The third theme that I generated was user learning. This theme was most apparent semantically in answers to questions about our resources’ pedagogical quality. The two sub-themes of user learning evident in respondents’ comments are learning about STEM opportunities and realizing children naturally engage with STEM.

Sub-theme 3.1: Learning about STEM Opportunities. The first sub-theme was learning about STEM opportunities. Respondents noted how the resources gave them ideas about how they can offer STEM LEs to children. For example, Respondent L commented, “I learned how to practice S[TEM] activities with my daughter.” A couple of respondents extended this idea by stating that the resources gave them ideas on how they can offer STEM opportunities based on children’s interests. For example, Respondent E stated, “The learning activities gave me ideas about how to promote STEM learning experiences based on observations of children's interests in play.”

Sub-theme 3.2: Realizing Children Naturally Engage with STEM. The second sub-theme was realizing children naturally engage with STEM. Respondents commented that the resources enabled them to see how children naturally engage with STEM and realize children were engaging with STEM during daily activities and explorations before using our resources. For example, Respondent J stated,

The child that I babysat is very curious and likes to explore. He was already engaging in STEM related activities without us actually noticing that they were STEM related. Examples are: opening doors and locks, measuring water and sand, popping soap bubbles.

Also, Respondent D wrote, “The resources made me notice how many daily activities kids do that are related to STEM so I am able to turn more experiences into learning ones.”

The theme of user learning was written about in terms of learning about STEM opportunities and realizing children naturally engage in STEM. Respondents suggested that the resources allowed them to understand how to offer STEM LEs to children. Furthermore, respondents suggested that the resources allowed them to realize that children engage with STEM during daily activities and exploration.

Theme 4: Visual Appeal of Resources

The visual appeal of our resources is the fourth theme that I generated, and it was most evident semantically in participants' responses to the technical/design quality question. Compared to the themes already described, the visual appeal of resources was a weaker theme because fewer responses contributed to it. However, I deemed the visual appeal of the resources theme important because it provided information that helped answer my technical/design sub-question. The three sub-themes of visual appeal of resources are colour appeal, picture quality, and website appeal.

Sub-theme 4.1: Colour Appeal. The first sub-theme was colour appeal of our resources. Respondents expressed how the colours were aesthetically pleasing. For example, respondent K stated, “I liked how colorful it is” when writing about their thoughts of our resources. Also, respondent J commented, “The colours and fonts were aesthetically pleasing.”

Sub-Theme 4.2: Picture Quality. The second sub-theme was the quality of the pictures in our resources. Respondent J responded positively to the picture quality in our resources, commenting, “The pictures were relevant and of good quality.” However, respondent E found the overall appeal of the resources was negatively affected by some of the photos because they stated, “I find the background images distracting. They take away from the overall visual appeal.”

Sub-theme 4.3: Website Appeal. The third sub-theme was our website appeal. Three respondents wrote about the appeal of our website. Respondent A responded positively to the website appeal because they commented, “The website is visually attractive to children.” However, Respondent I described the website as visually unappealing, stating, “It looked dated and designed poorly. The resources and information were great but the look and feel of the website were poor.” Additionally, respondent K suggested a change to make the website pages more appealing, writing, “The page for each learning experience is narrow and could be broader (landscape).”

The visual appeal of our resources was noted through comments about the colour appeal, picture quality, and website appeal. Respondents responded positively to the visual appeal of our resources, as they reported being pleased with the colours in our resources and the quality of our pictures, and one respondent thought our website was appealing to children. However, one respondent felt that background images were not appealing, and other respondents thought the website appeal could be improved.

Theme 5: Credibility of Resources

The fifth theme that I generated was the perceived credibility of our resources, and it was evident on a semantic level in responses to the questions that inquired about our resources’ pedagogical quality. Similar to the visual appeal theme, the credibility of resources theme was considered weak because there were not many responses contributing to it. However, I deemed the theme important because it helped answer my sub-question about the pedagogical quality of our resources.

Respondent H wrote that they perceived the information in our resources to be credible, by stating “I believe the information about the different learning experiences is very credible, accurate to the learning of young children.” Respondent K suggested that we could improve the credibility of resources by making the University of Ottawa logo larger on our website because they stated,

On the website, the signage from the University of Ottawa is very small at the bottom it should be larger, maybe on top and more visible to make it more credible. The website is focused more on the name of the website but not where it comes from.

Respondent I also suggested that it would be useful to know who wrote the LEs by stating, “The resources seem to be put together professionally. It would be useful to know who wrote the learning experiences.” Overall, respondents wrote about the creditability of our resources and provided recommendations on how the team may improve our resources’ credibility.

Theme 6: Satisfaction

The final theme generated from the open-ended data was satisfaction, which was most evident semantically in responses to the satisfaction question and the additional comments section. Although the satisfaction theme was considered weak, I deemed the theme important because it helped answer my user satisfaction sub-question. The three sub-themes of satisfaction are affect, future behaviour, and overall satisfaction.

Sub-theme 6.1: Affect. The first sub-theme was affect. Some respondents wrote about their positive feelings towards using our resources. For example, respondent H stated, “I really enjoy using these resources” and respondent L commented, “I like your website.”

Sub-theme 6.2: Future Behaviour. The second sub-theme was future behaviour. Respondent H wrote twice about their further plans with our resources, noting that, “I would use and continue to use the information provided to create fun and engaging learning experiences for the children in my care” and “I will also share these resources with my colleges, fellow educators, and anyone else that I believe can benefit from these resources.”

Sub-theme 6.3: Overall Satisfaction. The third sub-theme was overall satisfaction. Respondents commented on their overall satisfaction with our resources because they described the resources as good or great. For example, Respondent D wrote, “Great resources, thank you!” Additionally, some respondents indicated the resources met their needs and expectations. For example, Respondent F stated, “Yes they have” when writing about whether resources met their expectations and needs.

The theme of satisfaction was written about in terms of affect, future behaviour, and overall comments about satisfaction. Respondents indicated they were satisfied with our resources, they expressed positive feelings towards the resources, and one respondent stated they will use and recommend our resources. Also, respondents commented they were satisfied with our resources overall.

Summary of Reflexive Thematic Analysis

In summary, I generated six themes based on participants’ responses: easy to use resources, resources support engagement with STEM, user learning, visual appeal of resources, credibility of resources, and satisfaction with resources. Respondents wrote about easy to use resources in terms of understanding information, the usability of LEs, and navigating our resources. Supporting engagement with STEM was written about by respondents in terms of LEs capitalizing on children’s interest, children doing more STEM after LEs, and doing STEM with children. Respondents wrote about user learning through reporting that they learned about STEM opportunities and realized children naturally engage in STEM.

Respondents wrote about the visual appeal of resources in terms of our resources' colour appeal, picture quality, and website appeal. Respondents also commented on the credibility of our resources. Respondents wrote about user satisfaction in terms of affect, future behaviour, and overall satisfaction with our resources.

Summary of Results

In this chapter, I wrote about results obtained from calculating statical analyses and conducting reflexive thematic analysis on the collected data. Descriptive statistics for the demographic component provided information about respondents. The statistical analyses and reflexive thematic analysis conducted on the data collected from the users' perceptions component provided insights into how respondents perceived our resources' pedagogical and technical/design quality, as well as their satisfaction with our resources.

Chapter 5: Discussion

In Chapter 5, I discuss my findings regarding my sub-questions and main research question. I begin this chapter by answering my first sub-question regarding users' perceptions of our resources' pedagogical quality. Next, I answer my second sub-question regarding users' perceptions of our resources' technical/design quality. I then answer my third sub-question regarding user satisfaction. I conclude this chapter by answering the main research question about users' overall perceptions of our resources. Generally, while answering each question I present the closed-ended results, followed by related reflexive thematic analysis findings; then, if applicable, I compare my findings to past research or use literature to explain why certain findings occurred.

Sub-Question 1: What are Users' Perceptions of the Resources' Pedagogical Quality?

The first sub-question of my thesis was regarding users' perceptions of our resources' pedagogical quality. I explored this sub-question in terms of respondents' perceptions of our resources' information reliability, information relevance, and context-dependent quality. The descriptive statistics and one-way repeated measures ANOVA for pedagogical quality indicators suggested that respondents perceived our resources' information reliability and relevance, as well as context-dependent quality to be of *good* to *excellent* and equal quality. Results from the reflexive thematic analysis also suggested that respondents perceived our resources to be of good pedagogical quality; however, the thematic analysis additionally indicated aspects of our resources' information reliability and information relevance that respondents believed could be improved.

Perceptions of Information Reliability

To understand our resources' information reliability, I explored users' perceptions of our resources' information accuracy and credibility, as suggested by El Mhouti et al. (2013). Descriptive statistics for the Likert-scale items about information relevance suggested that most respondents agreed or strongly agreed that our resources' information was error-free and credible. Descriptive statistics for these items also suggested that respondents perceived our resources' information accuracy and credibility to be of *good* quality.

The reflexive thematic analysis indicated that respondents commented on the credibility of resources in their open-ended responses. One respondent stated that they perceived our resources to be credible. However, two respondents suggested ways in which our team could improve our resources' credibility, as they recommended that the team indicate who wrote the LEs and make the University of Ottawa logo in the footer of our website larger. Respondents' suggestions are supported by literature, in that authorship is important to, and positively

associated with, perceived credibility (Fritch & Cromwell, 2001; Iding et al., 2008; Rieh & Belkin, 1998). Research has suggested that individuals can and do examine the developers' credentials to understand website credibility, especially more experienced web users (Flanagin & Metzger, 2000; Morrison et al., 2008; Rein & Belkin, 1998; Zhang et al., 2011). Thus, providing information about authors and their credentials may increase users' perceived credibility of a website (Fogg et al., 2001).

Although the STEM in the Early Years' About Us webpage includes information about the credentials of the people who contribute to our resources, the team does not provide the names or credentials of those who contribute to the development of each experience on the LE webpages. Given respondents' recommendations and previous research, the team will consider adding the names and credentials of the individuals who contributed to the development of each LE to enhance our resources' perceived credibility. Furthermore, since team members' credentials are linked to our institutional affiliations, we will consider increasing the size of all institutional logos in the footer of our website to further increase perceived credibility.

Perceptions of Information Relevance

Users' perceptions of information relevance can include their thoughts on information usability and workability, as suggested by El Mhouti et al. (2013). To understand our resources' information usability and workability, I explored users' perceptions of our resources' information communicating adaptable LEs, developmentally appropriate LEs, and that the LEs require the use of inexpensive material. Descriptive statistics for the Likert-scale items about information relevance suggested that most respondents agreed or strongly agreed that the information could be adapted to meet the needs of children, described LEs appropriate for children 2.5 to 5 years old, and indicated that LEs only required inexpensive material. Additionally, descriptive statistics for these items suggested that respondents perceived the usability and workability aspects of our resources were of *good* to *excellent* quality.

The reflexive thematic analysis indicated that respondents commented on the usability of our LEs. Similar to the descriptive statistics, respondents suggested that the information for the LEs was usable and workable because respondents commented that they could do the LEs with children of different age groups and children with diverse needs, and that they could do the LEs with materials that they had around their house or childcare centre. Unexpectedly, while conducting the reflexive thematic analysis, I found that respondents wrote about usability in terms of understanding the information in our resources. Results from the reflexive thematic analysis suggested that respondents perceived the information in our resources to be easy to comprehend, and the photos in our resources helped them understand the textual information.

However, respondents suggested that the team add video demonstrations of the LEs to our website to help users understand the textual information (e.g., for some of the complex activities). Consistent with this finding, Barton et al. (2017) found that teachers watched videos of certain activities for instruction clarity and found that teachers watched the videos because they lacked familiarity with the content that the activity addressed. Thus, adding video demonstrations to the LE webpages may help our users, especially those who lack familiarity with STEM in early childhood content, better understand the instructions for each LE and how they may facilitate each LE.

Literature has also suggested that there are other benefits to watching demonstrations. For example, observing tasks can enhance individuals' skill development (Chuang et al., 2018), perceived self-efficacy and competence (especially if the person who is modelling the task is similar to the observer; Bandura, 1969; Bandura, 1977; Hoogerheide et al., 2016) and observer's performance ability (Koran & Snow, 1971). Thus, users may not only watch the LE video demonstration for information clarity, but they may also use the information presented in the video to develop their skills, as well as enhance their self-efficacy, competence, and ability to offer high-quality STEM LEs and support children during the LEs. Therefore, given respondents' comments and the benefits of including demonstrations as suggested by research, the team will consider adding video demonstrations of the LEs to each LE webpage. If the team decides to add videos, we will ensure that the individual who models the LEs represents our user demographic to further enhance users perceived self-efficacy and competence towards facilitating the LEs.

Perceptions of Context-Dependent Quality

I explored our resources' context-dependent quality in terms of whether our LEs embody characteristics of STEM in early childhood. Specifically, I asked questions about users' perceptions of the following characteristics: social constructivism aspect of adults supporting children's learning, play-based learning, being developmentally appropriate, and helping children build a foundation for learning.

Social Constructivism. A key aspect of social constructivism is adults supporting young children's learning. This aspect is a characteristic of early childhood STEM (Ontario Ministry of Education, 2014, Sheehan et al., 2018; Sikder & Fler, 2018; Simoncini & Lasen, 2018). Adults can support young children in STEM by exploring STEM with children, guiding children to notice STEM during activities, and asking inquiry-based questions to expand children's STEM thinking (Barbre, 2017; Moomaw, 2013; Lange et al., 2019). Thus, I explored users' perceptions of supporting children's learning during the STEM LEs. Descriptive statistics for the Likert-scale

items suggested that respondents supported children's learning during the LEs because most respondents agreed or strongly agreed that they did the LEs with children, as well as confidently guided children's attention to STEM and asked the children questions during the LEs. Furthermore, descriptive statistics for these items suggested that the social constructivism aspect of our resources are perceived to be of *good* quality.

The reflexive thematic analysis indicated that respondents commented on doing STEM with children. Similar to the descriptive statistics, respondents reported exploring STEM with children and guiding children during the LEs. However, one respondent commented that some children independently engaged with STEM and did not need guidance. This comment may be attributed to the notion that although children can benefit from adults offering high-quality LEs, children do not always need adult interaction or guidance during play, and that children can benefit from free play and opportunities to explore on their own (Ellis et al., 2021; Murphy, 2020). Thus, it may be important that children are given opportunities to explore STEM concepts and practices independently during LEs. Future research is needed to explore the ideal amount of adult interaction and assistance during STEM LEs, and the impact that free play and independent exploration of STEM has on young children's growth.

Play-Based Learning. Play-based learning is a characteristic of early childhood STEM because literature has suggested that play-based LEs that are hands-on and capitalize on children's interests can help engage young children with STEM (Campbell et al., 2018; National Science Teachers Association, 2014; Simoncini & Lasen, 2018). Thus, I explored users' perceptions of our LEs capitalizing on and sparking children's interests and being hands-on to understand the degree to which our resources were play-based. Descriptive statistics for the Likert-scale items suggested that our LEs were perceived to be play-based because most respondents agreed or strongly agreed that the LEs capitalized-on children's interests, sparked interest in STEM, and were hands-on. Furthermore, descriptive statistics for these items suggested that respondents perceived the play-based aspects of our resources to be of *good* to *excellent* quality.

The reflexive thematic analysis indicated that respondents commented on LEs capitalizing on children's interests. Similar to the descriptive statistics, respondents indicated children expressed enjoyment while they explored STEM and were highly engaged during the LEs. However, group size may influence children's ability to explore their STEM interest during play because one respondent who was an ECE and cared for groups of sixteen, 2-year-old children commented that the children were more focused in smaller groups than larger groups. Similarly, Phillips and Twardosz (2003) found that 2-year-old children enrolled in early childcare

programs were more engaged and participated more in small groups than in larger groups during a storybook reading. Furthermore, studies suggest that group size may affect young children's engagement with activities, as a large group size can result in less participation (De Schipper et al., 2006; Sheridan et al., 2014; Williams et al., 2019) and opportunities for educator guidance and interaction with children during play (Sheridan et al., 2014; Williams et al., 2019). Large group size may also increase stress in children and educators (Organisation for Economic Cooperation and Development, 2012; Sheridan et al., 2014; Vermeer & Ijzendoorn, 2006; Williams et al., 2019), which in turn, could negatively influence children's ability to be focused on activities and explore their interests during play. Thus, group size may affect young children's ability to explore their interests during play-based STEM LEs. However, more research is needed to understand how group size influences young children's engagement during play-based STEM LEs.

The reflexive thematic analysis suggested that our resources may have sparked children's interest in STEM, as some respondents indicated they observed children doing more STEM after doing our LEs. However, other respondents stated that they witnessed children doing the same amount of STEM after doing the LEs. Some participants may have witnessed the same amount of STEM because children are naturally interested in engaging with STEM content and practices during play and everyday activities (Brophy et al., 2008; Petroski, 2003; Lange et al., 2019). Thus, these respondents could have been attuned to the children's interest in, and engagement with, STEM prior to using our resources. Future research should explore how play-based STEM LEs can spark children's interest in STEM more in-depth and investigate how caregivers' awareness of their children's natural STEM engagement influences their perceptions of play-based STEM LEs sparking their children's interest.

Developmentally Appropriate LEs. Learning experiences that allow children to explore developmentally appropriate areas and practices of STEM can help engage young children with STEM (Barbre, 2017; Moomaw, 2013; Lange et al., 2019). Thus, I explored users' perceptions of our LEs being developmentally appropriate. Descriptive statistics for the Likert-scale item indicated that LEs were perceived to be developmentally appropriate because most respondents agreed or strongly agreed that children explored developmentally appropriate areas of STEM during the LEs. Furthermore, the descriptive statistics for this item suggested that the developmentally appropriate aspect of our resources was perceived to be of *good* quality.

However, the reflexive thematic analysis indicated that respondents did not comment on the developmental appropriateness of our STEM LEs. The lack of comments regarding our LEs

being developmentally appropriate can be attributed to researchers have only just begun to explore how young children can and do engage with integrated STEM within the last decade. Thus, respondents may not have known how to expand their thoughts on the developmental appropriateness of our LEs in their written responses due to a lack of concrete information regarding developmentally appropriate integrated STEM content and practices that young children can and do engage with. Furthermore, the lack of comments about our LEs being developmentally appropriate can be attributed to the ambiguity regarding what is considered a STEM LE, because STEM can be used to refer to educational activities that include one of the individual disciplines, to activities where all four disciplines are fully integrated, or even to the disciplines themselves (National Academy of Engineering and National Research Council, 2014). Thus, respondents may not have written about the developmental appropriateness of our LEs because there is a wide range of activities that can be considered STEM, which may confuse caregivers as to what is empirically considered appropriate content and practices of early years STEM. More research is needed to explore the developmentally appropriate STEM areas that young children can explore and practices they can engage with. Furthermore, future research needs to explore caregivers' views on developmentally appropriate STEM content and practices for young children. Future research also needs to explore users' perceptions of the developmental appropriateness of our STEM LEs in their own words, and if users do not have any comments on the developmental appropriateness of our LEs, then research needs to explore why they do not.

Foundation for Future Learning. Offering high-quality STEM LEs in the early years may help children build a foundation for future learning in STEM (Duncan et al., 2007; Morgan et al., 2016; Kermani & Aldemir, 2015). Thus, I explored users' perceptions of our LEs building a foundation for future learning in the STEM disciplines. Descriptive statistics for the Likert-scale item suggested that LEs were perceived to help children build a foundation because most respondents agreed or strongly agreed that our LEs may have provided children with a foundation for future STEM learning. Furthermore, the descriptive statistics for this item suggested that the building a foundation for future learning aspect of our resources was perceived to be of *excellent* quality.

However, the reflexive thematic analysis indicated that respondents did not comment about the LEs building a foundation for future learning. The absence of responses regarding the LEs building a foundation for future learning may be due to the lack of awareness about the learning benefits of incorporating integrated STEM in early childhood, because research has focused on how incorporating the individual disciplines can lead to children's academic success

in the formal years of schooling (e.g., achievement in math, science, and reading) (Duncan et al., 2007; Kermani & Aldemir, 2015; Morgan et al., 2016). Respondents also may have not commented about the LEs building a foundation for future learning because there is a lack of high-quality assessments that caregivers can use to understand whether young children are learning and developing related skills during integrated STEM LEs (Hapgood, 2020). Thus, respondents may have commented on the LEs building a foundation for future learning if there was more of an understanding regarding the long-term learning benefits of incorporating integrated STEM in early childhood, and if there were more high-quality early childhood STEM assessments. More research is needed to explore the specific impacts that integrated STEM might have on children's academic success, and to develop high-quality assessments for caregivers of young children to use. Overall, results suggested that our LEs embodied the characteristics of STEM in early childhood.

In general, respondents perceived our resources to have good pedagogical quality because the statistical analyses and reflexive thematic analysis suggested that respondents believed that the resources had *good to excellent* information reliability, information relevance, and context-dependent quality. However, the reflexive thematic analysis results indicated respondents recommended aspects of our resources' pedagogical quality to improve. In terms of our resources' information reliability, respondents recommended adding the names of the people who contributed to each LE on the LE webpages and making the intuitional logos larger to enhance our resources' creditability; for information relevance, respondents recommended adding video demonstrations of the LEs to the LE webpages to help them understand the textual information. The reflexive thematic analysis results suggested that respondents did not recommend ways to improve our resources' context-dependent quality. The team will consider modifying the resources according to respondents' recommendations.

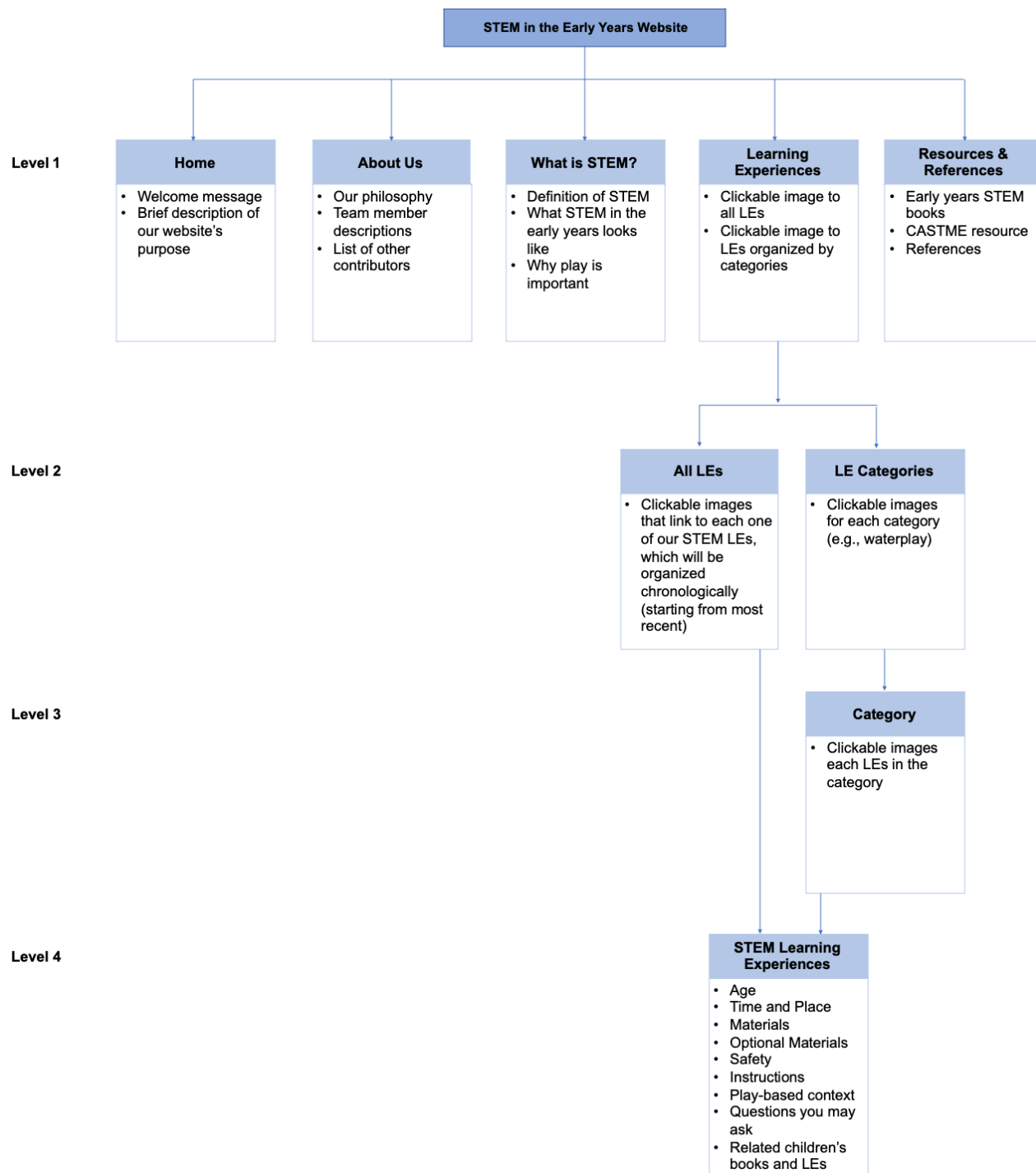
Sub-Question 2: What are Users' Perceptions of the Technical/Design Quality of the Resources?

The second sub-question was regarding users' perceptions of our resources' technical/design quality. I explored this sub-question in terms of our resources' navigation/browsing design and platform design quality. The descriptive statistics and Wilcoxon signed-rank test for the technical/design quality indicators suggested that respondents found the navigation/browsing design and platform design quality to be of *good* and equal quality. Results from the reflexive thematic analysis also suggested respondents perceived our resources to have good technical/design quality; however, the thematic analysis additionally indicated areas within both indicators that could be improved.

Perceptions of Browsing/Navigation Design

I explored users' perceptions of our website and the Pinterest page being easy to use in terms of navigation, the layout being organized, as well as the reliability of internal pages to understand our resources' browsing/navigation design, following other scholars who research digital resources (e.g., El Mhouti et al., 2013, Hsu et al., 2009, Xie, 2008). Descriptive statistics for the Likert-scale items about our resources' browsing/navigation design suggested that most respondents agreed or strongly agreed that they could navigate the website and the Pinterest page easily, our website and the Pinterest page were well organized, and the links took them to the correct pages. Furthermore, the descriptive statistics for these items suggested that our resources' browsing/navigation design was perceived to be of *good* quality.

The reflexive thematic analysis indicated that respondents commented on the navigation aspect of our resources. Similar to the descriptive findings for the Likert-scale items, respondents stated the resources were easy to navigate and well organized; however, respondents suggested that similar LEs could be linked together and that the LEs could be organized in categories. For example, STEM LEs that involve playing with water could be linked together in our website or organized into a 'waterplay' category. Therefore, the team will consider linking similar LEs and organizing our LEs into categories in our website and Pinterest page to increase our resources' browsing/navigation design quality. See Figure 9 for a sitemap that shows how our STEM in the Early Years' website may look if we restructure it according to respondents' comments on the navigation.

Figure 9*STEM in the Early Years' Redevelopment Sitemap*

Note. Level 1 boxes show the STEM in the Early Years' website tabs and the information found within each tab. As shown in Level 2, the learning experience tab contains links to different ways users can explore our LEs (via viewing all LEs or categories). Level 3 shows the category option, which will include

links (via clickable images) to the categories. Level 4 shows the information found within each LE webpage.

Perceptions of Platform Design Quality

I explored users' perceptions of the quality of text size and style, as well as photos in our resources, and the aesthetic appeal of our website, Pinterest pins, and colours to understand our resources' platform design quality, following other scholars who research digital resources (e.g., El Mhouti et al., 2013; Hsu et al., 2009). Descriptive statistics for the Likert-scale items about our resources' platform design suggested that most respondents agreed or strongly agreed that our resources' font sizes and styles were readable, images in our resources were clear and helped respondents understand how to engage young children with STEM, and our website, Pinterest pins, and resource colours were aesthetically pleasing. Furthermore, the descriptive statistics for these items suggested that our resources' platform design was perceived to be of *good* quality.

Similar to the descriptive statistics, the reflexive thematic analysis indicated that respondents commented on the visual appeal of our resources, as some suggested that the colours were aesthetically pleasing, they enjoyed how colourful our resources were, and the pictures were relevant and of good quality. However, one respondent suggested that our website appeared poorly designed and dated, and another respondent stated that the webpages could be wider. The team will reflect on the design of our website and will consider making the webpages wider. Since only one respondent thought the website design was poor and perceptions of aesthetics can be a personal preference, the team is unlikely to make any major changes to the appearance of our website based on my thesis results.

Future research should explore users' perceptions of our website's aesthetic design more in-depth because I only explored users' overall perceptions of our website, Pinterest Pins, and colour scheme aesthetic due to my thesis timeframe and my goal of making my questionnaire short for my target population. However, researchers who study aesthetics usually explore users' perceptions of design elements that can contribute to their overall aesthetic judgments (e.g., website symmetry, complexity, familiarity, evokes positive feelings, and novelty; Gabrieli et al., 2019; Robin & Holmes, 2008; Jiang et al., 2016). Furthermore, research has suggested that users' aesthetic judgement impacts satisfaction, credibility, usability, evaluations, and probability of website reuse (Gabrieli et al., 2019; Lavie & Tractinsky, 2004; Robins & Holmes, 2008; Schenkman & Jonsson, 2000). Thus, future studies should explore users' perceptions of our resources' aesthetics more in-depth.

However, researchers have reported challenges to exploring aesthetics (e.g., it is unknown whether views of beauty come from within the individual or if beauty comes from the properties of objects that are considered universally pleasing; Lindgaard et al., 2006; Tatarkiewicz, 1963; Zangwill, 2019). Despite the challenges, Lavie and Tractinsky (2004) developed a framework, and Jiang et al. (2016) modified Beardsley's framework to explore users' perceptions of website aesthetics. To better understand users' perceptions of our resources' aesthetics, future research could use or modify one of these frameworks to explore respondents' aesthetic judgements about our resources' design.

Overall, statistical analyses and the reflexive thematic analysis suggested respondents perceived our resources to have good technical/design quality in terms of browsing/navigation design and platform design quality. However, reflexive thematic analysis results indicated that respondents recommended aspects of our resources' technical/design quality that could be improved. Regarding the browsing/navigation design, respondents suggested linking similar LEs or categorizing the LEs based on a commonality; for the platform design quality, respondents suggested making the webpages wider and the website more aesthetically pleasing. The team will consider making these changes.

Sub-Question 3: How Satisfied are Users with the Resources?

The third sub-question was regarding how satisfied users were with our resources. I explored this sub-question in terms of respondents' cognitive processes, affect, and future behaviour. Descriptive statistics and one-way repeated measures ANOVA for the user satisfaction indicators suggested respondents were *satisfied* with our resources and indicated an equal amount of satisfaction through their cognitive processes, affect, and future behaviour. Results from the reflexive thematic analysis also indicated respondents commented on their satisfaction with our resources. Furthermore, Kendall's tau correlation results suggested that respondents' perceptions of our resources' quality influenced their satisfaction levels.

Respondents' Cognitive Processes

I explored whether our resources met users' needs and expectations to understand their cognitive processes, as suggested by Burgess (2016), Deng et al. (2010), and Palaci et al. (2019). Descriptive statistics for the Likert-scale items about users' cognitive processes showed that most respondents agreed or strongly agreed that our resources met their expectations and needs. Furthermore, the descriptive statistics for these items suggested that respondents were *satisfied* in terms of their cognitive processes. Similarly, the reflexive thematic analysis suggested that some respondents indicated that the resources met their expectations and needs when commenting on their overall satisfaction with our resources. Thus, respondents

indicated that our resources met their needs and expectations, suggesting this area of satisfaction was fulfilled. Therefore, the team does not need to greatly modify the resources to better meet the needs and expectations of our users; however, future research could explore users' expectations of our resources more in-depth.

In my questionnaire, I only inquired about the degree to which our resources met users' expectations. However, future research should explore whether our resources exceeded expectations because, according to the Expectation-Disconfirmation Theory, the more a product exceeds users' expectations, the more satisfied they are with the product (Deng et al., 2010; Oliver & DeSarbo, 1988; Oliver, 2010). Furthermore, future research should explore users' expectations prior to use because literature indicates that users may not have high expectations for the product; thus, reporting the product meets users' expectations may still suggest that they are not satisfied (Oliver, 2010). However, it is unlikely that users who responded to my questionnaire had low expectations for our resources because their responses were mostly positive, and there were no open-ended comments about their low expectations.

Respondents' Affect

I explored users' emotional response towards our resources to understand users' affect, as suggested by Giese & Cote (2000) and Palaci et al. (2019). Descriptive statistics for the Likert-scale items about affect showed that most respondents agreed or strongly agreed that they had a positive experience using our resources and were pleased with the quality of our LEs and the design of our resources. Furthermore, the descriptive statistics for these items suggested that respondents were *satisfied* in terms of their reported affect. Similarly, the reflexive thematic analysis indicated that respondents wrote about their affect by commenting that they enjoyed using our resources and were fond of our website. Thus, results from the descriptive statistics and reflexive thematic analysis suggested respondents experienced positive affect towards our resources, which can indicate they were satisfied.

Research suggests there are two overall dimensions of affect that are important to satisfaction, which are positive affect and negative affect (Oliver, 1981, 1993; Westbrook, 1987); with positive affect indicating higher levels of satisfaction and negative affect suggesting lower levels of satisfaction (Mano & Oliver, 1993; Oliver, 1993; Palaci et al., 2019;). These two dimensions of affect are multidimensional (e.g., positive affect can include feelings of being pleased and happy, as well as feeling enjoyment; Frank et al., 2014; Oliver, 1993; Wong, 2004). Oliver (1993) suggested that a positive product performance can evoke feelings of positive affect, whereas negative product performance can result in negative affect within users. Moreover, users may demonstrate certain feelings toward the different aspects of the product

based on the aspect's performance (e.g., users may feel positive affect towards parts of a product that performed well and demonstrate negative affect towards parts of the product that did not perform well; Oliver, 1993). Thus, descriptive statistics for the Likert-items and respondents comments suggested resources performed well and respondents expressed positive affect in terms of having a positive and enjoyable experience, as well as being pleased with the aspects of our resources that I explored. Therefore, affect, a source of satisfaction, was fulfilled, and there is not a great need for the team to change the resources to increase the users' positive affect.

Respondents' Future Behaviour

I explored users' plans to reuse and recommend our resources to understand respondents' future behaviour with our resources, akin to Delaney et al. (2012) and Razeen Davids et al. (2014). Descriptive statistics for the Likert-scale items about future behaviour showed that most respondents agreed or strongly agreed that they planned to use our resources in the future and suggest our resources to others who may be interested. Furthermore, the descriptive statistics for these items suggested that respondents were *satisfied* in terms of their future behaviour with our resources. Similarly, the reflexive thematic analysis indicated that one respondent wrote about their future behaviour with our resources by stating that they will continue to use our resources and will share our resources with others who may be interested in them. Thus, respondents indicated they will reuse and recommend our resources which suggests this area of satisfaction was fulfilled. However, future research should explore whether users reuse our resources post completing the questionnaire because their responses about intending to reuse the resources may be a poor predictor of their reuse behaviour.

According to marketing literature, consumer repurchase intentions questions are commonly used; however, intention questions are poor predictors of consumers repurchase behaviour (Dong et al., 2021). Less is known about whether intention questions about reusing resources are good or poor predictors of actual reuse. However, intention responses may be poor predictors of actual resource reuse. Dong et al. (2021) suggested that inconstancy between consumer repurchase intentions and behaviours can be due to intention responses being influenced by projection bias (respondents' lacking knowledge about their future situation) and lack-of-context biases (respondents' making predictions of repurchase based on their experiences with the brand and failing to consider future product quality). Both biases may also be present in users' reuse intentions responses. Projection bias may influence respondents' intention responses because users may indicate that they intended to reuse resources and fail to consider how they may find and use another resource in the future. Lack-of-context bias may

influence intention responses, as users' may state they intend on reusing the resources based on their positive experiences with the resource and fail to consider that they may stop using the resource if the material begins to lack quality.

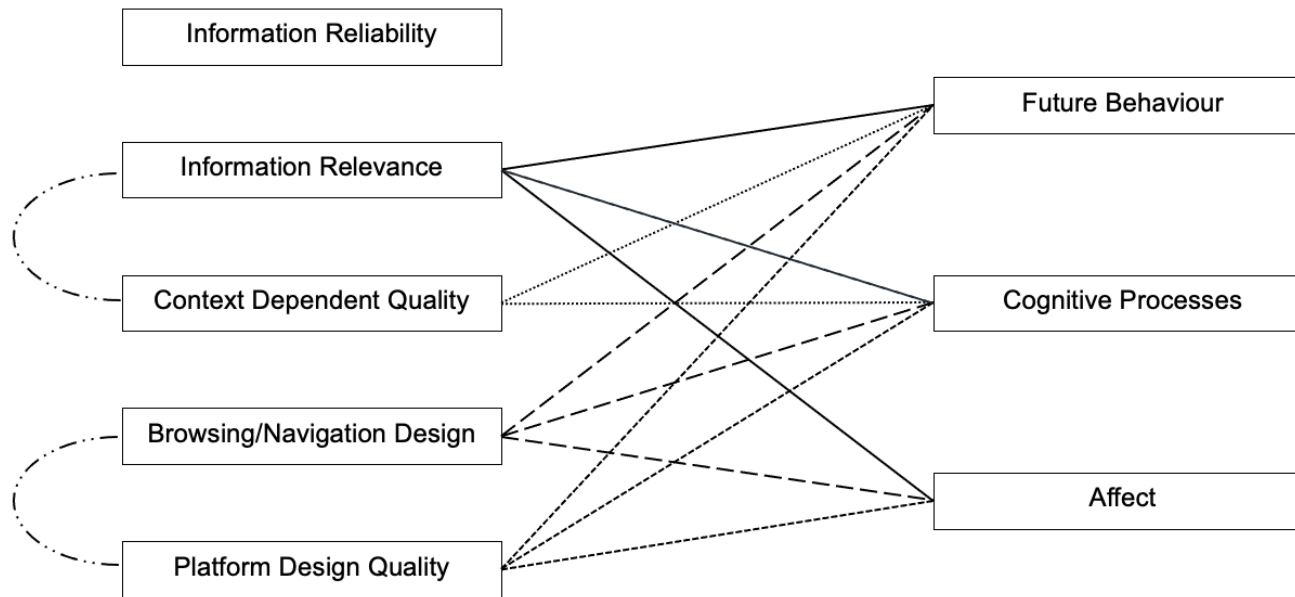
Therefore, responses about intending to reuse our resources may have projection and lack-of-context biases. Thus, respondents' intention responses may poorly predict whether respondents will reuse our resources. Although our resources are currently among the few evidence-based early childhood STEM resources, the team may continue to conduct research on the quality of our resources as other evidence-based STEM resources are produced to ensure that we are meeting the changing needs of users and exceeding users' expectations; the team will also continue to produce high-quality material. Regardless, future research should explore whether users' intentions to reuse our resources accurately predict their reuse. For example, adding a follow-up element to the next research project, where researchers contact respondents to ask whether they reused our resources.

Perceptions of Quality Influencing Satisfaction

Literature suggests that users' perceptions of product and electronic resource quality are related to satisfaction (Chang & Fong, 2010; Gök et al., 2019; Otieno et al., 2007). Thus, I explored whether users' perceptions of our resources' quality correlated to their satisfaction. Similar to previous research findings, results from correlating the constructs suggested that respondents' perceptions of our resources' quality were positively related to their satisfaction levels. However, the correlations showed that respondents' perceptions of our resources' technical/design quality had a stronger influence on their satisfaction levels. Therefore, respondents' beliefs about our resources' pedagogical quality and technical/design quality appeared to influence their satisfaction with our resources; users' satisfaction may increase if the team improves our resources' technical/design and pedagogical quality.

Indicator correlations suggested the specific aspects of the pedagogical and technical/design quality that may have influenced respondents' satisfaction, as shown in Figure 10. Correlations between the pedagogical quality and user satisfaction indicators suggested that the higher respondents rated our resources' information relevance quality, the more respondents indicated that (1) the resources met their needs and expectations, (2) they were pleased and had a positive experience with the resources, and (3) they would reuse and recommend our resources. Similarly, as respondents' ratings of our resources' context-dependent quality increased, the more they indicated that (1) the resources met their needs and expectations, and (2) they would reuse and recommend our resources. Additionally, correlations between the technical/design quality and user satisfaction indicators suggested the higher

respondents rated the browsing/navigation design and platform design quality, the more respondents indicated that (1) the resources met their expectations and needs, (2) they were pleased and had a positive experience with the resources, and (3) they would reuse and recommend our resources. Therefore, increasing the information relevance, context-dependent quality, browsing/navigation design, and platform design quality may result in higher user satisfaction.

Figure 10*Visual Representation of Indicator Correlations*

Note. Correlations between indicators within each construct and indicator correlations across constructs are shown with different line types. The lines left of the first column represent the within construct indicator correlations, whereas the lines between the columns represent correlations between construct indicators.

Although the reflexive thematic analysis suggested that respondents indicated the areas of the browsing/navigation design, platform design quality, and information relevance that could be improved, the analysis did not specify the perceived areas of context-dependent quality that could be improved. Thus, further research is needed to understand how the team could improve our resources' context-dependent quality to perhaps increase user satisfaction. However, since respondents' perceptions of our resources' technical/design quality were more strongly associated with their satisfaction levels, the team may be more concerned with considering improving our resources' browsing/navigation design and the platform design quality.

Overall, statistical analyses and reflexive thematic analysis suggested that respondents were satisfied with our resources in terms of their cognitive processes, affect, and future behaviour. However, respondents' satisfaction may increase if the team improves aspects of our resources' browsing/navigation design and platform design quality, as well as information relevance.

Research Question: What are Users' Perceptions of the Early Childhood STEM Resources Created by the STEM in the Early Years Team?

My main research question was regarding users' overall perceptions of our STEM in the Early Years resources. To answer this question, I explored users' overall perceptions of the three constructs, that is our resources' pedagogical quality, technical/design quality, and user satisfaction. Descriptive statistics for the three constructs and results from the reflexive thematic analysis suggested that respondents perceived our resources to have good overall pedagogical and technical/design quality and that respondents were generally satisfied with our resources. The reflexive thematic analysis showed that respondents only commented on ways to improve our resources' pedagogical quality and technical/design quality; however, respondents' satisfaction may increase if the team improves our resources' quality because relationships were found between both quality constructs and user satisfaction.

Results from the construct one-way repeated measures ANOVA suggested that technical/design quality was perceived as significantly better than pedagogical quality. These differences might be attributed to the STEM in the Early Years team having research and/or work experience in early childhood education prior to creating our resources; however, we did not have a professional background in the technical/design field.

In summary, results from the statistical analyses and reflexive thematic analysis suggested that our resources were perceived to be of good quality in terms of our resources' pedagogical quality, technical/design quality, and user satisfaction. However, the technical/design quality could need more improvement than the pedagogical quality. The

reflexive thematic analysis also indicated the areas of our resources that could be improved. Furthermore, results highlighted areas where more research is warranted. Overall, the results indicated that the team is producing high-quality STEM resources for our users and that the resources may need minor improvements, if any, to better the quality for our users.

Chapter 6: Conclusion

In Chapter 6, I summarize the previous five chapters, including information about the purpose of my research, respondents, methodology, methods, and the findings that answer my research question and sub-questions. I then write about some limitations to my thesis. I conclude with a description of how my thesis contributes to the field of education.

The COVID-19 pandemic highlighted the unfortunate fact that many of the hands-on learning resources available at no cost in the area of early childhood STEM are unsystematically presented and of low quality. Furthermore, research suggested that ECEs and other caregivers can benefit from more professional development and high-quality resources in STEM (McClure, 2017; Peterson et al., 2019). The purpose of my thesis research was to assist the STEM in the Early Years team with creating free high-quality and evidence-based online early childhood resources for ECEs, caregivers, and parents of young children to use during and after the pandemic; and to explore users' perceptions of our STEM in the Early Years resources.

The foundational theory for my thesis research was pragmatism because the team designed our resources to be practical, and I chose a methodology, data collection method, and data analyses that would best allow me to explore users' perceptions of our resources. I used a cross-sectional survey approach to explore users' perceptions of our STEM resources to better understand our resources' successes and the areas that might need to be improved. Specifically, I explored users' perceptions of our resources with a questionnaire that contained a demographic and user perceptions component. Both components included closed-ended and open-ended questions. The demographic component included questions about respondents and the children they use our resources with. The user perceptions component included questions about our resources' pedagogical quality, technical/design quality, and user satisfaction. The results from the statistical analyses and reflexive thematic analysis provided insights into respondents' demographic information and their perceptions of our resources' pedagogical and technical/design quality, and their satisfaction with our resources.

Demographic results indicated respondents were ECEs, caregivers, and/or parents of young children who use our STEM in the Early Years resources. All respondents were from Canada, and the majority were female, did not work in the field of STEM, and were not registered ECEs. Respondents indicated that they had completed at least one of our LEs with one or more children, and the majority of respondents accessed our content via our website. Surprisingly, some respondents indicated that they used our resources with children older than five, which is beyond our resources' intended age range.

The results from the analyses of the user perceptions component suggested users who participated in my research perceived our resources to have good pedagogical and technical/design quality and were satisfied with our resources. In regard to our resources' pedagogical quality, respondents perceived our resources to have good to excellent information reliability (credibility and error-free) and relevance (workable and useable), as well as context-dependent quality (characteristics of STEM in early childhood were evident). However, the team will consider respondents' requests to make the University of Ottawa logo larger and credit the people who created the LEs on each LE webpage to increase our information credibility, and we will consider adding video demonstrations of the LEs to improve our information usability. For our resources' technical/design quality, respondents believed that the browsing/navigation design (organization, ease of use, and reliability of internal pages) and platform design quality (aesthetic, quality of text and media) was good. However, the team will consider categorizing the LEs based on similar characteristics and linking similar LEs to improve the browsing/navigation design; also, the team will reflect on making the webpages wider and improving our website design to increase our resources' platform design quality as per respondents' suggestions. Regarding satisfaction, respondents indicated they were satisfied in terms of their cognitive processes (needs and expectation fulfillment), affect (feelings toward our resources' pedagogical and technical/design quality, and overall experience), and future behaviour (reusing and recommending our resources). However, respondents' satisfaction may increase if modifications are made to our resources' pedagogical quality and technical/design quality. Respondents' comments also indicated that the team fulfilled the need for high-quality STEM resources because respondents wrote about how the resources helped them learn how to offer STEM LEs to young children.

Overall, results suggested that the team is producing high-quality early childhood STEM resources for ECEs, caregivers, and parents of young children, in terms of our resources' pedagogical and technical/design quality and user satisfaction. The team will use my thesis results to reflect on our resources' successes and may redevelop our resources according to the areas that respondents indicated need improvement. Although my thesis provided insight into users' perceptions of our resources, there were some noteworthy limitations to my research.

Limitations

There were four limitations of my thesis in the areas of respondents' relationships with team members, sample size, reliability, and validity of my questionnaire. In the paragraphs

below I outline these four limitations in greater detail and provide ways in which they were or can be addressed in future research.

The first limitation is that respondents may have known members of the STEM in the Early Years team. Although the team promoted our resources on social media to people who did not know the team members, we also promoted our resources to people we knew. Thus, respondents may have known team members personally, which might have led to unintended pressure to participate and/or give answers they thought the team wanted (social desirability bias). However, my questionnaire was anonymous and confidential, thereby reducing the pressure to participate and preventing social desirability bias in their answers.

The second limitation is the low sample size. The low sample size may have been attributed to the nature of the COVID-19 pandemic throughout the duration of my thesis, as my target population may not have had the time to complete my questionnaire due to the lockdowns (e.g., school closures) and other unforeseeable time-consuming circumstances. Also, my study lacked an extrinsic incentive (e.g., money), which may have caused users to be less inclined to participate in the study, even though an intrinsic incentive would be better quality resources for their use. A consequence of having a low sample size is that my results may not represent the entire target population of users' perceptions of our resources. Additionally, a low sample size may have influenced findings of statistical significance of differences between users' perceptions of the constructs and indicators, and relationships between the constructs and indicators, due to low statistical power. Also, a low sample size may have resulted in a lack of rich open-ended responses. If my questionnaire is used in future studies, researchers should think about solutions to possible pandemic consequences (e.g., doing structured phone interviews to make participants' experience faster and more personable) and including an extrinsic instinctive.

The third limitation of my study is that my questionnaire may lack reliability. To establish test-retest reliability, the questionnaire would have to be administered to the same or similar samples multiple times, which was not feasible for the timeframe of my project. Furthermore, I could not calculate coefficient alpha to test for internal consistency of responses because I did not recruit enough participants to conduct the statistical procedure. However, reliability statistics for my questionnaire may be conducted in the future, if researchers re-use my instrument and if the sample size is large enough to complete the statistical procedures.

The fourth limitation is that although I provided evidence for the validity sources of content, response processes, and consequences, I could not provide evidence for the validity sources of internal structure and relation to other variables because of my low sample size and

lack of similar pre-existing questionnaires. Future research should conduct the rigorous statistical procedures to gain validity evidence of my questionnaire's internal structure, if my instrument is used in future studies and a larger sample is obtained. However, to gain a more accurate understanding of my questionnaire's internal structure, future research should consider adding more items to information reliability because information reliability was only measured by two Likert-scale items when research has recommended that indicators be measured by at least three items (Furr, 2018). Future research should gain evidence for the relation to other variables validity source, if more questionnaires are developed to explore users' perceptions of the pedagogical quality, technical/design quality, and user satisfaction regarding online early childhood STEM resources.

Contribution to the Field of Education

Despite these limitations, my thesis offers many contributions to the field of education, including early childhood education practice, research, and theory. My thesis contributes to early childhood practice through the development of resources. Prior to the STEM in the Early Years project, there was a lack of accessible high-quality early childhood STEM resources, despite research suggesting the benefits of incorporating the individual STEM disciplines in early childhood. Thus, the project and my research have contributed to the field of early childhood practice through the creation of high-quality and play-based online early childhood STEM resources for ECEs, caregivers, and parents of young children to use during and after the COVID-19 pandemic. Furthermore, the STEM in the Early Years team made our resources accessible on the no-cost social media platform Pinterest, which educators and caregivers commonly use. We chose Pinterest to enable more ECEs and caregivers to become aware of and use our resources, which may result in more children benefiting from engaging in high-quality STEM experiences at a young age. Thus, my thesis contributes to the field of early childhood practice by creating accessible early childhood STEM resources.

The STEM in the Early Years resources and my thesis also contribute to early childhood practice because ECEs and caregivers may develop their knowledge about STEM in early childhood and how to facilitate play-based STEM LEs as they use our resources. Furthermore, while using our resources, ECEs and caregivers may start to see how children can and do engage with STEM during daily activities. Additionally, ECEs and caregivers may begin to identify STEM learning opportunities while children play and create their own STEM LEs to offer young children. Thus, our STEM resources and my thesis may contribute to early childhood practice by providing opportunities for ECEs and caregivers to learn about STEM in early

childhood, expand their thinking about how they can incorporate early years STEM in their practice, and possibly create their own STEM LEs to offer young children.

The STEM in the Early Years project and my thesis also contribute to early childhood practice by bridging the gap between research and practice. The resource development was based on an innovative method of dissemination of previous research results. Additionally, I explored ECEs, caregivers, and parents' perceptions of our resources to ensure we were producing high-quality resources for their use, and the team may mobilize my research findings by modifying the resources to be of better quality for users. Furthermore, my findings highlight areas that resource developers and researchers may consider when creating early childhood resources (e.g., adding video demonstrations of LEs to aid users' comprehension of textual information). Together, the development of our resources, my exploration of users' perceptions, and the potential modification of our resources serve as a unique effort to narrow the gap between practice and research. Thus, my thesis contributes to the field of early childhood practice by bridging the gap between research and practice.

My thesis contributes to research methods with the development of a questionnaire that researchers could use or modify to explore ECEs' and caregivers' perceptions of early childhood resources. Furthermore, my thesis adds to the growing body of research on STEM in early childhood and digital educational resources. Therefore, my thesis contributes to research through developing a questionnaire and adding to the research literature.

My thesis contributes to the theories of play-based learning and social constructivism. My research contributes to play-based learning theory because my findings support the notion that play can be a vehicle for children to engage with STEM and may help children build a foundation for future learning. My results also highlight a gap in the theory regarding the amount of support needed from the more knowledgeable other while children explore STEM during play, and the role free play has on children's STEM learning. My findings also contribute to the literature on social constructivism, in that, educational resources can be used as a learning tool to help ECEs, caregivers, and parents understand how they can support young children's STEM learning during play-based LEs. Thus, my thesis contributes to play-based learning and social constructivism theories.

Education should ensure that all children are given equal opportunities to develop the skills and knowledge needed to be successful in the 21st century, and to foster a passion for learning and innovation. Literature suggests that occupations want employees to embody STEM skills, and more people will be expected to have a foundation of STEM knowledge and skills in the future (Tytler, 2020; Yildirim, 2020). Thus, children need to be equipped with STEM

knowledge, practices, and skills to succeed in the 21st century. Furthermore, STEM can foster children's passion for learning because the disciplines allow children to explore their innate interests and take control over their learning, and help children develop innovative thinking through experiential learning and inquiry (Moomaw, 2013). Thus, it is imperative that young children are given opportunities to explore STEM. The STEM in the Early Years project and my thesis have advanced the field of early childhood education by removing the barriers to accessing high-quality STEM resources through creating freely available evidence-based early childhood STEM resources that respondents, who are users of our resources, perceive to be of good quality and are satisfied with. I and other STEM in the Early Years team members expect that more children will be given opportunities to engage with STEM and experience the benefits of engaging with STEM through the creation of our resources. I and other STEM in the Early Years team members will continue to advocate for STEM in early childhood and eliminate barriers to accessing high-quality resources for educators, parents, and other caregivers.

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Appendix A

Information About the Team's Expertise

The team members are well suited position to create the resources. Since 2013, Dr. Tippett and Dr. Milford continue to conduct SSRCH funded research on STEM in Early Childhood. Outcomes of their research include, several peer-reviewed journal articles, numerous conference presentations/posters, and global recognition from researchers. Ms. Yanez Gonzalez is an experienced ECE and a college professor. She continues to be the lead research assistant for Dr. Tippett's SSHRC Connection Grant project, where STEM opportunities for young children were captured. Dr. Tippett, Dr. Milford, and Ms. Yanez Gonzalez have formed lasting professional relationships with ECEs and researchers in the area of early years STEM. I have worked with out-of-school programs for children (4-13 years old) and I am an active Pinterest user. The expertise of the group means we have the capabilities to develop the resources.

Appendix B
Ethics Certificate

04/03/2021

Université d'Ottawa

Bureau d'éthique et d'intégrité de la recherche

University of Ottawa

Office of Research Ethics and Integrity

CERTIFICAT D'APPROBATION ÉTHIQUE | CERTIFICATE OF ETHICS APPROVAL

Numéro du dossier / Ethics File Number

S-02-21-6314

Titre du projet / Project Title

Supporting early childhood
STEM education during the
pandemic (and afterwards):
Examining parents' and early
childhood educators' perceptions
of digital resources

Type de projet / Project Type

Thèse de maîtrise / Master's
thesis

Statut du projet / Project Status

Approuvé / Approved

Date d'approbation (jj/mm/aaaa) / Approval Date (dd/mm/yyyy)

04/03/2021

Date d'expiration (jj/mm/aaaa) / Expiry Date (dd/mm/yyyy)

03/03/2022

Équipe de recherche / Research Team

Chercheur / Researcher

Affiliation

Role

Hannah BRADLEY

Faculté d'éducation / Faculty of Education

Chercheur Principal / Principal Investigator

Christine TIPPETT

Faculté d'éducation / Faculty of Education

Superviseur / Supervisor

Conditions spéciales ou commentaires / Special conditions or comments

04/03/2021

Université d'Ottawa

Bureau d'éthique et d'intégrité de la recherche

University of Ottawa

Office of Research Ethics and Integrity

Le Comité d'éthique de la recherche (CÉR) de l'Université d'Ottawa, opérant conformément à l'*Énoncé de politique des Trois conseils* (2014) et toutes autres lois et tous règlements applicables, a examiné et approuvé la demande d'éthique du projet de recherche ci-nommé.

L'approbation est valide pour la durée indiquée plus haut et est sujette aux conditions énumérées dans la section intitulée "Conditions Spéciales ou Commentaires". Le formulaire « Renouvellement ou Fermeture de Projet » doit être complété quatre semaines avant la date d'échéance indiquée ci-haut afin de demander un renouvellement de cette approbation éthique ou afin de fermer le dossier.

Toutes modifications apportées au projet doivent être approuvées par le CÉR avant leur mise en place, sauf si le participant doit être retiré en raison d'un danger immédiat ou s'il s'agit d'un changement ayant trait à des éléments administratifs ou logistiques du projet. Les chercheurs doivent aviser le CÉR dans les plus brefs délais de tout changement pouvant augmenter le niveau de risque aux participants ou pouvant affecter considérablement le déroulement du projet, rapporter tout événement imprévu ou indésirable et soumettre toute nouvelle information pouvant nuire à la conduite du projet ou à la sécurité des participants.

The University of Ottawa Research Ethics Board, which operates in accordance with the *Tri-Council Policy Statement* (2014) and other applicable laws and regulations, has examined and approved the ethics application for the above-named research project.

Ethics approval is valid for the period indicated above and is subject to the conditions listed in the section entitled "Special Conditions or Comments". The "Renewal/Project Closure" form must be completed four weeks before the above-referenced expiry date to request a renewal of this ethics approval or closure of the file.

Any changes made to the project must be approved by the REB before being implemented, except when necessary to remove participants from immediate endangerment or when the modification(s) only pertain to administrative or logistical components of the project. Investigators must also promptly alert the REB of any changes that increase the risk to participant(s), any changes that considerably affect the conduct of the project, all unanticipated and harmful events that occur, and new information that may negatively affect the conduct of the project or the safety of the participant(s).

Kim THOMPSON

Responsable d'éthique en recherche / Protocol Officer

Pour/For **Barbara GRAVES** Président(e) du/ Chair of the **Comité d'éthique de la recherche en sciences sociales et humanités / Social Sciences and Humanities Research Ethics Board**

Appendix C

Recruitment Scripts

Pinterest

We are conducting a study to get feedback on our resources. We would appreciate if you let us know what you think of them.

Please click the link for more information: <https://www.surveymonkey.ca/r/SJQ39HK>

Feel free to share the link to our Pinterest page: <https://www.pinterest.ca/STEMintheEarlyYears>

Website

We are conducting a study to get feedback on our resources. We would appreciate if you let us know what you think of them.

Please click the link for more information: <https://www.surveymonkey.ca/r/SJQ39HK>

Feel free to share the link to our website: <https://www.stemintheearlyyears.com/>

Twitter

Have you used our resources? We are conducting a study exploring users' perceptions and would appreciate your feedback!

Click the link for more information: <https://www.surveymonkey.ca/r/SJQ39HK>

Please feel free to retweet or share this tweet.

Instagram

Have you used our resources? We are conducting a study exploring users' perceptions and would appreciate your feedback!

Click the link for more information: <https://www.surveymonkey.ca/r/SJQ39HK>

Please feel free to share this post.

PI Facebook Recruitment Script

For my master's thesis, I am exploring the perceptions of early childhood educators, caregivers, and parents of children ages 1.5 to 5 years about my team's early childhood STEM resources!

If you are 18 or older and interested, please try one of our STEM learning experiences with a young child/children and share your thoughts by completing an anonymous 10-minute questionnaire.

Our STEM learning experiences and link to the questionnaire can be accessed at <https://www.stemintheearlyyears.com> or through Pinterest @STEMintheEarlyYears.

Please feel free to share this post widely!

PI Twitter Recruitment Script

For my master's thesis, I am exploring the perceptions of early childhood educators, caregivers, and parents of children ages 1.5 to 5 years about my team's early childhood STEM resources!

If you are 18 or older and interested, please try one of our STEM learning experiences with a young child/children and share your thoughts by completing an anonymous 10-minute questionnaire.

Our STEM learning experiences and link to the questionnaire can be accessed at <https://www.stemintheearlyyears.com> or through Pinterest @STEMintheEarlyYears.

Please feel free to share this post widely!

Recruitment Script for Early childhood Facebook Groups

Hello everyone! My name is Hannah Bradley, and I am currently completing a MA in Education at the University of Ottawa.

For my master's thesis, I am exploring the perceptions of early childhood educators, caregivers, and parents of children ages 1.5 to 5 years about my team's early childhood STEM resources. I would appreciate your feedback!

If you are interested and are 18 or older, please try one of our STEM learning experiences with a young child/children and share your thoughts by completing an anonymous 10-minute questionnaire.

Our STEM learning experiences and link to the questionnaire can be accessed at <https://www.stemintheearlyyears.com> or through Pinterest @STEMintheEarlyYears.

Please feel free to share this post widely!

Message to Early Childhood Organizations

Hello,

I am reaching out to you because I am completing an MA in the Faculty of Education at the University of Ottawa, focusing on early childhood science, technology, engineering, and mathematics (STEM). I am helping a team of educators and caregivers develop free online early childhood STEM resources for ECEs, caregivers, and parents of young children (linked below). Our STEM learning experiences are developed with Canada's early learning frameworks in mind and are play-based, capitalize on young children's interests, and use inexpensive household materials. The resources are available in English, French, and Spanish. For my thesis research, I am exploring users' perceptions of our resources to reflect on our resources successes and the areas that need to be improved to better meet the needs and expectations of our users.

I am wondering if the [organization] would share information about our resources and my study with its members? For example, information could be shared in your newsletter, via an e-blast, on your website, and/or retweet my recruitment post (linked below).

I hope you are doing well despite the current challenging circumstances.

-Hannah

Our STEM Resources:

<https://www.stemintheearlyyears.com>

My Twitter recruitment post:

<https://twitter.com/HannahBradley/status/1376211586503823362?s=20>

Appendix D

Questionnaire

You are invited to participate in a study that explores users' perceptions of STEM in the Early Years resources. The study is being conducted to reflect on the resources' successes and redevelop the areas that need improvement. This study is funded by the Social Sciences and Humanities Research Council. If you choose to participate you complete an anonymous online questionnaire that will take approximately 15 minutes.

A benefit of participating in this study is the chance to contribute to the development of our resources by sharing your thoughts on what you liked and what you think could be improved.

Your participation in this study is completely voluntary. You do not have to answer all questions and you can exit the questionnaire at any time before submitting your responses. Once you submit your responses, you will not be able to withdraw from the study given the anonymous nature of your responses. All information provided will be kept confidential. At no point, will any identifying information about participants be included in any published materials or reporting, which could include conferences and journal articles. The researcher and her supervisor use password-protected computers that have antivirus and malware protection and your responses will be kept for at least 10 years.

This study has been reviewed and received ethics clearance through the Research Ethics Board at the University of Ottawa (REB file #S-02-21-6314). If you have any questions or require any further information about this study, please contact us using the contact information provided below. It is suggested that you print or save a copy of the consent form to keep for your personal records.

Researcher

Ms. Hannah Bradley, MA student
Faculty of Education, University of Ottawa

Supervisor

Dr. Christine Tippett, Associate Professor
Faculty of Education, University of Ottawa

If you have any ethical concerns regarding your participation in this study, you may contact the Protocol Officer for Ethics in Research, University of Ottawa, 550 Cumberland Street, Room 154, (613) 562-5387 or ethics@uottawa.ca

Thank you in advance for your participation in the study.

* By clicking on 'Yes, I agree to participate' below, I agree:

- That the researcher has my consent to use the information submitted as described
- That I am at least 18 years old

- Yes, I agree to participate
- No, I do not want to participate

Please consider the following definition of STEM before starting the questionnaire.

STEM stands for science, technology, engineering, and mathematics. These four domains are highly interconnected. The following are developmentally appropriate areas and practices of STEM that young children can engage with:

Science: Children can explore **physical science**, **earth science**, and/or **life science**.

Technology: Children can use **simple tools** (e.g. handheld magnifiers) and/or **complex tools** (e.g., cameras) to enhance play and exploration in the disciplines.

Engineering: Children can learn about **engineering practices** (e.g., problem-solving, designing, building).

Math: Children can engage with **number operations** (e.g., counting), **algebra** (e.g., patterns), **geometry** (e.g., shapes), **measurement** (e.g., comparisons), and/or **data analysis** (e.g., predicting and gathering information).

Demographic Information

Please provide the following information about yourself:

1) What is the gender you identify with?

- Female
- Male
- Prefer not to answer

Prefer to self-describe:

2) What is your age?

- 18-24
- 25-34
- 35-44
- 45-54
- 55-64
- 65+

3) What country are you currently living in?

4) What site(s) do you use to access STEM in The Early Years' content?

- Pinterest page
- Website
- Twitter
- Instagram

5) How many of our learning experiences have you tried with your child/children?

6) How many children have you tried our STEM learning experiences with?

7) Please describe your relation(s) to the child or children.

8) Please provide the age of the child or children.

9) Do you have an early childhood diploma and/or degree?

Yes

No

10) Do you or have you worked in the field of STEM?

Yes

No

11. Please provide the job title or brief description of the job.



Your Thoughts About our STEM Resources

Your honest feedback means a lot to us, as it will allow us to understand our resources' successes and areas that need to be improved.

1. For each statement, please indicate how much you agree. After reading the information on the website and/or Pinterest page, I believe:

| | Strongly Disagree | Disagree | No Opinion/Neutral | Agree | Strongly Agree |
|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| A) The information is error-free. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| B) The information is credible. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| C) The STEM learning experiences are appropriate for children who are 2.5 to 5 years of age. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| D) The learning experiences can be modified to meet children's different needs. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| E) The learning experiences use inexpensive material. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

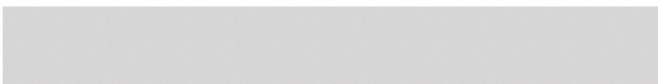
2. Please share your thoughts on the credibility, accuracy, and/or usability of the information.

3. When responding to the following statements, please think of a specific time when you tried one of our learning experiences with your child or children.

| | Strongly Disagree | Disagree | No Opinion/Neutral | Agree | Strongly Agree |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| A) My child/children explored developmentally appropriate areas of STEM during the learning experience. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

| | Strongly Disagree | Disagree | No Opinion/Neutral | Agree | Strongly Agree |
|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| B) My child/children appeared to be interested during the learning experience. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| C) The learning experience may provide my child/children with a foundation for future STEM learning. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| D) Doing the learning experience sparked my child's/children's interest in STEM related activities. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| E) The learning experience allowed hands-on exploration of STEM. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| F) I was able to confidently guide my child's/children's attention to the areas of STEM during the learning experience. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| G) I asked my child/children questions during the learning experience. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| H) I found myself doing the learning experience along with my child/children. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 4. Please provide additional comments about how you and your child/children engaged with the learning experience. | | | | | |
| <div style="background-color: #cccccc; height: 30px; width: 100%;"></div> | | | | | |

5. Did you see your child/children engaging in more/other STEM related activities after the learning experience? If yes, please describe.



6. When responding to the following statements, please think about the design quality of our resources (Pinterest page, pins, and website).

| | Strongly Disagree | Disagree | No Opinion/Neutral | Agree | Strongly Agree |
|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| A) The font styles on the resources are readable. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| B) The font sizes on the resources are readable. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| C) The images on the resources are clear (not blurry). | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| D) The images helped me understand how to engage young children with STEM. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| E) The colours used for the resources are aesthetically pleasing. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| F) The Pins are aesthetically pleasing. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| G) The Pinterest page is well organized. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| H) I was able to navigate the Pinterest page easily. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| I) The website is aesthetically pleasing. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| J) The website is well organized. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| K) I was able to navigate the website easily. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| L) All the links and images I clicked took me to the correct pages. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

7. Please tell us more about what you liked and did not like about the design of the resources.

8. When responding to the following statements, please think about your satisfaction with our resources.

| | Strongly Disagree | Disagree | No Opinion/Neutral | Agree | Strongly Agree |
|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| A) The resources met my expectations. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| B) The resources met my needs. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| C) I am pleased with the quality of the STEM learning experiences. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| D) I am pleased with the design quality. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| E) I had a positive experience using the resources. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| F) I would recommend the resources to a friend. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| G) I plan on using the resources again. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

9. How have the resources met your expectation and needs? How can the resources be improved?

10. Additional comments:

Please click the Submit button to submit your responses.

Appendix E

Table of Specifications

| Research Question | Construct | Indicator | Indicator Area | Area Explanation | Likert-Scale Items | Open-Ended Questions |
|--|---|---------------------------|--------------------------------|--|--|--|
| 1. What are users' perceptions about the resources' pedagogical quality? | Pedagogical Quality: Regarding (1) the information on the website, Pinterest page, and pins; and (2) quality of the LEs | Information Reliability | Error-free | The accuracy of information | 1 a) The information is error-free. | 2. Please share your thoughts on the credibility, accuracy, and/or usability of the information. |
| | | | Credible | The credibility of information | 1 b) The information is credible. | |
| | | Information Relevance | Usability | LE information conveyed developmentally appropriate STEM LEs | 1 c) The STEM learning experiences are appropriate for children who are 2.5 to 5 years of age. | |
| | | | Workability | Information for the LEs was abatable to meet children's needs and conveyed inexpensive items can be used to do the LE | 1 d) The learning experiences can be modified to meet children's different needs. 1 e) The learning experiences use inexpensive material. | |
| | | Context-Dependent Quality | Social constructivism | Social constructivism aspect of adults supporting children's learning through exploring STEM with children, guiding children's attention to STEM, and asking children questions during the LEs | 3 f) I was able to confidently guide my child/children's attention to the areas of STEM during the learning experience. 3 g) I asked my child/children questions during the learning experience. 3 h) I found myself doing the learning experience along with my child/children. | 4. Please provide any additional comments on how you and your child/children engaged with the learning experience. 5. Did you see your child/children engaging in more/other STEM related activities after the learning experience? If yes, please describe |
| | | | Play-based learning | Play-based learning aspect of capitalizing on children's interests, generating children's interests in STEM, and being hands-on | 3 b) My child/children appeared to be interested during the learning experience. 3 d) Doing the learning experience sparked my child's/children's interest in STEM related activities. 3 e) The learning experiences allowed hands-on exploration of STEM. | |
| | | | Developmentally appropriate | Children explored developmentally appropriate areas of STEM during LEs | 3 a) Children explored developmentally appropriate areas of STEM during LEs. | |
| | | | Foundation for future learning | LEs may have helped the children build a foundation for future learning in STEM | 3 c) The learning experience may provide my child/children with a foundation for future STEM learning. | |

| | | | | | | |
|--|---|--|---|--|---|--|
| <p>2. What are users' perceptions of the technical/design quality of the resources?</p> | <p>Technical/Design Quality: Regarding the website, Pinterest, pins</p> | <p>Browsing/ Navigation Design</p> | <p>Organization of layout</p> | <p>Pinterest page and website being well organized</p> | <p>6 g) The Pinterest page is well organized. 6 j) The website is well organized.</p> | <p>7. Please tell us more about what you liked and did not like about the design of the resources.</p> |
| <p>Ease of use</p> | <p>Being able to navigate website and Pinterest page</p> | <p>6 h) I was able to navigate the Pinterest page easily. 6 k) I was able to navigate the website easily.</p> | | | | |
| <p>Reliability of internal pages</p> | <p>Links and clickable images go to correct page</p> | <p>6 l) All the links and images I clicked took me to the correct pages.</p> | | | | |
| <p>Platform Design Quality</p> | <p>Quality of text</p> | <p>Readability of font style and size</p> | <p>6 a) The font styles on the resources are readable. 6 b) The font sizes on the resources are readable.</p> | | | |
| <p>Quality of media</p> | <p>Images were clear (not pixelated/blurry) and communicated information to support respondents' comprehension of the textual information</p> | <p>6 c) The images on the resources are clear (not blurry). 6 d) The images helped me understand how to engage young children with STEM.</p> | | | | |
| <p>Appeal of aesthetic</p> | <p>Resources' colours, website, and Pinterest pins being aesthetically pleasing</p> | <p>6 e) The colours used for the resources are aesthetically pleasing. 6 f) The Pins are aesthetically pleasing. 6 i) The website is aesthetically pleasing.</p> | | | | |
| <p>3. How satisfied are users with the resources?</p> | <p>User Satisfaction: Regarding all aspects of the resources (LEs, Pinterest, website)</p> | <p>Cognitive Processes</p> | <p>Expectation fulfillment</p> | <p>Meeting user expectations</p> | <p>8 a) The resources met my expectations.</p> | <p>9. How have the resources met your expectations and needs? How can the resources be improved?</p> |
| <p>Needs fulfillment</p> | <p>Meeting users' needs</p> | <p>8 b) The resources met my needs.</p> | | | | |
| <p>Affect</p> | <p>Technical/design quality</p> | <p>Pleased with design quality of the resource</p> | <p>8 d) I am pleased with the design quality.</p> | | | |
| <p>Pedagogical quality</p> | <p>Pleased with the quality of the STEM LEs</p> | <p>8 c) I am pleased with the quality of the STEM learning experiences.</p> | | | | |
| <p>Overall experience</p> | <p>Had an overall positive experience with resources</p> | <p>8 e) I had a positive experience using the resources.</p> | | | | |
| <p>Future Behaviour</p> | <p>Recommendation</p> | <p>Recommend our resources to a friend</p> | <p>8 f) I would recommend the resources to a friend.</p> | | | |
| <p>Reuse</p> | <p>Reuse our resources</p> | <p>8 g) I plan on using the resources again.</p> | | | | |

Appendix F

15-point Checklist of Criteria for Good Thematic Analysis (adapted from Braun & Clarke, 2006)

| Possess | No. | Criteria | Addressed |
|----------------|-----|---|---|
| Transcription | 1 | The data have been transcribed to an appropriate level of detail, and the transcripts have been checked against the tapes for 'accuracy.' | Yes. Responses to the open-ended questions were downloaded as an excel file and were transferred verbatim to a Microsoft Word document. |
| | 2 | Each data item has been given equal attention in the coding process. | Yes. All responses were carefully read before and during the coding process. |
| Coding | 3 | Themes have not been generated from a few vivid examples (an anecdotal approach), but instead the coding process has been thorough, inclusive, and comprehensive. | Yes. I generated themes based on the entire data set. However, due to my small sample size, some themes were considered weak as there were not many responses contributing to them. These weaker themes were still included in my report because they provided insights into users' perceptions of our resources. |
| | 4 | All relevant extracts for each theme have been collated. | Yes. All response extracts were collated when I generated themes. |
| | 5 | Themes have been checked against each other and back to the original data set. | Yes. I checked the themes while I reviewed the candidate themes. |
| | 6 | Themes are internally coherent, consistent, and distinctive. | Yes. I checked the themes while I reviewed and defined them. |
| Analysis | 7 | Data have been analysed-interpreted, made sense of- rather than just paraphrased or described. | Yes. The generated themes reflect a pattern of shared meaning. |
| | 8 | Analysis and data match each other-the extracts illustrate the analytic claims. | Yes. My data analysis matches the data set. |
| | 9 | Analysis tells a convincing and well-organized story about the data and topic. | Yes. The analysis provided insights about users' perceptions of our resources' pedagogical and technical/design quality and their satisfaction with our resources. |
| | 10 | A good balance between analytic narrative and illustrative extracts is provided | Yes. Analytic comments and relevant extracts are equally included in the results. |
| Overall | 11 | Enough time has been allocated to complete all phases of the analysis adequately, without rushing a phase or giving it a once-over-lightly. | Yes. I spent approximately three months researching the reflexive thematic analysis method and spent an additional three months analyzing the data set. |
| Written Report | 12 | The assumptions about, and specific approach to, thematic analysis is clearly explicated. | Yes. I have clearly outlined reflexive thematic analysis in the data analysis. |
| | 13 | There is a good fit between what you claim you do, and what you show you have done-i.e., described method and reported analysis are consistent. | Yes. The data analysis description is consistent with the results. |

| | | |
|----|--|--|
| 14 | The language and concepts used in the report are consistent with the epistemological position of the analysis. | Yes. Although my thesis is situated in pragmatism, I recognized that the reflexive thematic analysis is suited for researchers who situate their research in the qualitative worldviews; specifically, researchers who conduct experiential (e.g., contextualist) and critical (e.g., constructionist) research (Braun & Clark, 2020). Thus, while conducting the reflexive thematic analysis, I viewed my knowledge as a resource, and I was reflexive on how my interpretations of the data constructed my report. Furthermore, I recognized that respondents constructed the narrative based on their own unique experiences and what they were willing to share on my questionnaire. I viewed the data and my analysis as contextual, situated, and positioned. These views are present throughout the data analysis and report. |
| 15 | The researcher is positioned as active in the research process; themes do not just 'emerge'. | Yes. Themes were considered generated by me, the primary researcher. |

Appendix G

Theme Descriptions and Response Examples

| Theme 1 | Description | |
|--|---|--|
| Easy to Use Resources | The ease of use in terms of the information in our resources, and design of the resources. | |
| Subthemes | Descriptions | Representative Responses |
| 1. Understanding Information | Easy to understand information. Photos supported comprehension of information; recommended adding videos to enhance understandability of information. | <p><i>"I liked how easily accessible the resources were, they were simple to understand and read. The language was easy to understand. They were engaging to look at and the pictures made it more interesting and helped me understand how it may look when the children are engaged in the learning experience." - Respondent H</i></p> <p><i>"The website could include videos, in addition to photos, for some activities. This may help guide some of the more complex activities." -Respondent J</i></p> |
| 2. Usability of the LEs | Learning experiences could be done with household material and with all children regardless of age and ability. | <p><i>"The learning activities are highly usable because they incorporate materials that many families/child care providers already have on hand." -Respondent E</i></p> <p><i>"Not only [do the STEM opportunities] relate to the age group, but [they] may be easily tweaked in order to fit an older age group which makes it easy to follow! The things needed for the learning experiences are easy to find (or are already on hand) which makes this very reliable." -Respondent G</i></p> |
| 3. Navigation | Resources were easy to navigate. However, organizing LEs into categories and linking similar LEs together were recommended. | <p><i>"Liked how easy the resources are to navigate." -Respondent N</i></p> <p><i>"Only thought could be organizing some of the activities into categories (food related like making hot chocolate, outside the home like the playground) to help users know which resources suite their current needs! Otherwise fantastic." - Respondent D</i></p> <p><i>"If the collection of resources continues to grow it would be nice to have links within each resource to other similar resources. For example: If you enjoyed Observing Plants try Observing Worms on a Rainy Day." -Respondent E</i></p> |
| Theme 2 | Description | |
| Resources Support Engagement with STEM | Engaging children and respondents with STEM. | |
| Subthemes | Descriptions | Representative Responses |

| | | |
|---|---|---|
| 1. LEs Capitalizing on Children's Interests | Children's enjoyment and engagement while doing the LEs. | <p>"One of the learning experiences that my children loved was building sandcastles, they were really into making the sandcastles as high as they could, then we continued the learning by measuring how tall they made the sandcastles. They were engaged for over an hour." -Respondent H</p> <p>"In small groups the children were much more focused. When presented during a group time it was more challenging" -Respondent C</p> <p>"She was engaged the same as with any other activity outside of the house." - Respondent L</p> <p>"My 2 year old had trouble doing some activities. For example, she got frustrated when she couldn't properly hang the clothespins to hold the blanket for her fort! And for baking cookies, she enjoyed using different measuring tools [.]" - Respondent P</p> |
| 2. Children Doing More STEM After LEs | Noticing STEM related behaviours after completing the LEs. | <p>"After building sandcastles, they started wanting to build more types of castles or towers out of many different materials, blocks, food towers, leaves, rocks, etc" - Respondent H</p> <p>"I would say the same amount" -Respondent I</p> |
| 3. Doing STEM with Children | User and children interaction and activity while doing the LEs. | <p>"I guided the child that I babysat through 2 learning experiences. [...] We were able to complete the activities together." -Respondent J</p> <p>"We asked questions and hypothesize a lot about our activists" -Respondent F</p> <p>"Some children need more guidance to encourage critical thinking and their own ideas. Other children explore comfortably and curiously in their own." - Respondent N</p> |

| Theme 3 | Description |
|---------------|--|
| User Learning | Users learned about STEM opportunities to offer young children and developed an awareness of how STEM occurs naturally in early childhood. |

| Subthemes | Descriptions | Representative Responses |
|--|---|--|
| 1. Realizing Children Naturally Engage with STEM | Observing STEM in children's everyday activities. | <p>"The child that I babysat is very curious and likes to explore. He was already engaging in STEM related activities without us actually noticing that they were STEM related. Examples are: opening doors and locks, measuring water and sand, popping soap bubbles." - Respondent J</p> <p>"The resources made me notice how many daily activities kids do that are related to STEM so I am able to turn more experiences into learning ones." - Respondent D</p> |
| 2. Learning About STEM opportunities | Understanding how to offer young children STEM LEs. | <p>"The learning activities gave me ideas about how to promote STEM learning experiences based on observations of children's interests in play." -Respondent E</p> <p>"I learned how to practice S[STEM] activities with my daughter." -Respondent L</p> |

| Theme 4 | Description |
|----------------------------|--|
| Visual Appeal of Resources | Comments about the visual appeal of resources. |

| Subthemes | Descriptions | Representative Responses |
|-----------|--------------|--------------------------|
|-----------|--------------|--------------------------|

| | | |
|--|---|---|
| 1. Colour Appeal | Perceptions of the colour of our resources. | <i>"I liked how colorful it is." -Respondent K</i> <i>"The colours and fonts were aesthetically pleasing" -Respondent J</i> |
| 2. Picture Quality | Thoughts regarding photos in resources. | <i>"The pictures were relevant and of good quality" - Respondent J</i> <i>"I find the background images distracting. They take away from the overall visual appeal." - Respondent E</i> |
| 3. Website Appeal | Perceptions about the appeal of our website. | <i>"The website is visually attractive to children" -Respondent A</i> <i>"It looked dated and designed poorly. The resources and information were great but the look and feel of the website were poor." -Respondent I</i> <i>"The page for each learning experience is narrow and could be broader (landscape)." -Respondent K</i> |
| Theme 5^a | | |
| Description | | |
| Credibility of Resources | | |
| Comments about the credibility of our resources. | | |
| Subthemes | Descriptions | Representative Responses |
| | | <i>"I believe the information about the different learning experiences is very credible, accurate to the learning of young children." -Respondent H</i> <i>"On the website, the signage from the University of Ottawa is very small at the bottom it should be larger, maybe on top and more visible to make it more credible. The website is focused more on the name of the website but not where it comes from." -Respondent K</i> <i>"The resources seem to be put together professionally. It would be useful to know who wrote the learning experiences." -Respondent I</i> |
| Theme 6 | | |
| Description | | |
| Satisfaction | | |
| Expressing satisfaction with our resources. | | |
| Subthemes | Descriptions | Representative Responses |
| 1. Affect | Feelings towards our resources. | <i>"I like your website" -Respondent L</i> <i>"I really enjoy using these resources and will definitely continue to use them in the future." -Respondent H</i> |
| 2. Future Behaviour | Reuse and recommendation intentions. | <i>"I will also share these resources with my colleges, fellow educators, and anyone else that I believe can benefit from these resources." -Respondent H</i> <i>"I would use and continue to use the information provided to create fun and engaging learning experiences for the children in my care." -Respondent H</i> |
| 3. Overall Satisfaction | Describing the resources as great and indicating the resources have met expectations and needs. | <i>"Useful resource and good learning experiences overall!" – Respondent J</i> <i>"Great resources, thank you!" -Respondent D</i> <i>"Yes they have" -Respondent F</i> |

Note. ^a The grey opaque boxes indicate that there were no sub-themes.