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Computational and Mathematics Thinking Workshops for Students with their Parents: Nature, Benefits, Challenges, and Feedback

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Abstract

This qualitative study explores the nature of engagement of pupils with their parents in mathematics thinking (MT) activities in the context of integration of computational thinking (CT). It specifically investigates the ways students and their parents interact during CT and MT activities, as well as the role, benefits and challenges of parental engagement with their children during these activities. The study was framed in the constructionist framework of learning by making and situated in literature on integration of CT in teaching school curricula as well as literature on parental involvement and on mathematics instructional reform.

In this instrumental case study of eight (parent-child) pairs' engagement observations, interviews, and reflection data during CT and MT workshops were collected and analyzed to determine the ways in which CT activities enrich mathematical concepts and encourage engagement between parents and children in the workshop. All children and parents that participated in the two workshop sessions felt that the CT activities (Symmetry, Sphero, and Scratch) enriched mathematical concepts. This study also found that CT activities encouraged parents and children to work together and engage together during the sessions. Several of the children and parents were excited about what they referred to as a more interesting and interactive way to learn math and learning how to code. Parents and children agreed that CT and MT activities should be integrated into mathematics curricula.

This study was limited in its sampling as it only focused on children in primary grades 3 through 6 in a religious-based private school. For future studies, the researcher suggests conducting a study that will include several schools including public schools and will involve more specific CT tools for teaching mathematics concepts. The researcher also recommends

conducting CT workshops over a three-day period so that children do one activity each day rather than all three distinct activities in one session. Implications for teachers and school principals are to offer CT and similar workshops for longer and consecutive sessions during which adequate devices are available and at which parents are educated about the benefits of involvement in their children's mathematics learning.

Key words: computational thinking (CT), reform in mathematics education, parental engagement.

Lay Summary

Several researchers and educators maintain that using computational thinking tools and activities in teaching school curricular contributes to learning in creative and imaginative ways. Also, computational thinking activities lead to an improved student achievement, interest and enjoyment in learning content that several students experience as difficult, boring, and less relevant.

This study investigates the ways that parents interact during their children learning, and this study was framed in the learning by making.

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Implications for teachers and school principals are to offer computational thinking and similar workshops for longer and consecutive sessions during which adequate devices are available and at which parents are educated about the benefits of involvement in their children's mathematics learning.

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To the memory of my lovely family (my husband MohammadNoor and my children Leen, Noor

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To the memory of my late father, late brother Firas, and my late mother in law.

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1. Introduction

Computational thinking (CT) is a developed set of skills. Wing (2006) claims that computational thinking will be one of the basic skills used by the students in the middle of the 21st Century. Aho (2012) further states "we consider computational thinking (CT) to be the thought processes involved in formulating problems, so their solutions can be represented as computational steps and algorithms. Finding appropriate models of computation with which to formulate the problem and derive its solutions is an important part of computational thinking." (p. 832). Researchers such as Curzon (2014), Gadanidis et al. (2017), Farris and Sengupta (2014), Kotsopoulos et al. (2017), and Namukasa et al. (2017) explored the integration of computational thinking and mathematics thinking in K-8 classrooms. These researchers have observed that CT tools, activities, and processes promise to make mathematics learning experiences for students more interesting, more productive and easier in more advanced mathematics. Gadanidis (2015) observed that there is a relationship between CT and mathematics, and he adds that children have the ability to learn complex and abstract concepts.

Working as a research assistant on CT projects in schools, I noticed that the integration of computational and mathematics thinking is a promising way of teaching mathematics to students. Integrating CT activities in mathematics lessons affords several advantages as noted by Gadanidis (2017). Wenglinsky (1998) maintains that using digital technologies, like CT technologies in teaching methods contributes to changing traditional teaching and learning methods and as a result, promises to create possibilities for improved student achievement, interest and enjoyment in the learning process.

Weintrop et al. (2016) indicate that there is an urgency in defining CT and providing the theoretical foundation for the method that should be used in school when integrating CT into

mathematics classes. Weintrop et al. (2016) seek to explore the ways in which CT tools such as computational modeling, computational designing and computational programming environments may be used in workshops for both students and their parents.

1.1 The Problem

Zakaria, Chin, and Daud's (2010) study of two secondary school programs found that many students find mathematics taught in school to be difficult, uninteresting, and irrelevant to their life experience. In my personal experience as a middle school teacher and parent of children in Grades K-10, this challenge in mathematics education appears to be a result of teaching style and the nature of the content. In addition to teachers, parents have been noted to play some major roles in supporting, or in some cases not supporting students, in learning mathematics (Marshal, Swan, & others, 2010). With changing curriculum and instruction, there is a growing need to build capacity among parents to support their children when teachers are teaching students using new methods or teaching more advanced content.

1.2 Research Questions

My research questions follow the theme of integration of CT in mathematics activities in which students engage with their parents.

The general research question is: *What is the nature of engagement of students with their parents during computational and mathematics thinking activities?*

The specific research questions are:

1. In what ways do students and their parents act and interact during computational and mathematics thinking activities? What is *the role of the parents*?

2. What are *the benefits and challenges* of parents' engagement with their children during computational and mathematics thinking activities?

3. What are *the views and feedback* of both students and parents after engagement with computational and mathematics thinking activities?

1.3 The Purpose

The purpose of this research is to explore the nature of engagement of students with their parents in computational and mathematics thinking activities. This study specifically intends to investigate the ways in which the students and their parents act and interact during computational and mathematics thinking activities, the benefits and challenges of parents' engagement with their children during these thinking activities, and the views of both students and parents on their engagement in the computational and mathematics thinking activities.

1.4 The Significance of the Study

This research involves conducting workshops for elementary students working with their parents. This research seeks to contribute to two areas: the exploration on the integration of CT and mathematics thinking, and the role of parents in supporting students in learning mathematics. This study is unique as it focuses not only on the children in a classroom setting but on the role of parents as well. The workshops are based on computational and mathematics thinking activities designed by Namukasa (2017) and Gadanidis (2017). Grover and Pea (2013) see the integration of "computational thinking in teaching school mathematics" as a promising way to teach mathematics in ways that make the subject more interesting, less intimidating and more accessible to students.

2. Theoretical Framework

Researchers in the field of CT trace the engagement of students in CT activities back to Papert's work exploring Logo Programming environments for children and youth. Papert (1980) developed the theory of learning referred to as constructionism. His work on computers and education was viewed by many in the field as a breakthrough in education (Denning & Tedre, 2016). He considered that constructionism is based on the idea of "learning by making." He defined the learning process as a process of reconstruction instead of a process by which knowledge is transferred, and that learning is more effective when the students can create a meaningful product as a part of their activities. Constructionism is related to the principles of knowledge, experiences and active learning by Bruner (2009), who points out that the students construct new ideas or concepts depending upon the existing knowledge.

In addition to constructionism, this research adopts the framework of social constructivism. Social constructivism emphasizes learning in social environments. Burke (2004) states that social constructivism grew from a movement in psychology that was a shift from behaviorism. Vygotsky (1980) maintained that intellectual growth is also a social addition to a biological nature, and the intellectual activity of the individual may not be separated from the intellectual activity of the group in which the individual belongs. Therefore, social constructivism is more interested in learning with other children and adults. Kotsopoulos et al. (2017) adopts social constructivism in their exploration of the four pedagogical experiences of CT activities, which include "unplugging," "tinkering," "making," and "remixing." Kotsopoulos et al. (2017) state that unplugged experiences apply to activities not using computers, while the tinkering experiences include activities that need engagements and adjustments. On the other hand, making experiences contain activities to create new objects, and remixing takes in

multiple experiences that makes use of old objects for a new purpose. The authors argue that these experiences are necessary for the students to have a full experience of CT activities.

Namukasa et al. (2017) observe that students are not just users of CT tools, they can create their own projects. Gadanidis (2017) argues that not only is CT similar to mathematics thinking, but CT also affords other possibilities such as agency, access, abstraction, automation and audience in the teaching of mathematics. Gadanidis et al. (2017) have also observed that CT tools, activities, and processes make students' mathematics learning experiences more productive and make it easier to learn more advanced mathematics.

During CT activities, as Bruner (2009) states, students are offered opportunities to experience learning as an active process, and as Papert (1980) states, students experience "learning by making." CT activities allow students to learn concepts when they are playing and working with computational thinking activities.

Thus, this study adopts a CT pedagogical framework established in constructionism (Papert, 1980) and social constructivism (Vygotsky, 1980). The study draws from Kotsopoulos et al.'s (2017) CT pedagogical framework of four pedagogical experiences: (a) unplugged, (b) tinkering, (c) making, and (d) remixing, as well as from Gadanidis (2017) in the many possibilities afforded in the teaching of mathematics that include (e) agency, (f) access, (g) abstraction, (h) automation and (g) audience.

3. Literature Review

To situate my study, I reviewed the following literature:

I.   Integration of CT activities in teaching mathematics

II.   Involvement of parents in students' learning of mathematics

III. Reform in mathematics teaching and learning

3.1 Integration of CT Activities in Teaching Mathematics

Sanford and Naidu (2016) state that "recent literature discusses the importance of adding 'computational thinking' as a core ability that every child must learn" (p. 23). Gadanidis (2015) has noted that CT contributes to changing traditional teaching and learning methods. In addition, Curzon et al. (2014) state that there are many countries that have introduced computing syllabuses in order to make CT an essential component of the curriculum. A few studies exist on integrating CT in teaching and learning as well as in the curriculum. The literature on integrating CT addresses the following aspects: definition/frameworks, the importance of CT, the benefits and activities of CT, and challenges to CT.

According to Farris and Sengupta (2014), computational aspects of mathematics at this moment in time are becoming integral and core parts of presentation for both mathematics and science in K-12 programs. Bienkowski et al. (2015), rightly point out how integrating CT in pre-college curriculum requires an interactive integration of different subjects and concepts in order to construct a grounded approach for CT. Furthermore, Lu and Fletcher (2009) represent the teaching of CT as an important skill to balance with reading, writing, and mathematics (arithmetic) in the category of fundamental knowledge. According to Ortiz, Bos and Smith (2015), the use of integrated science, technology, engineering and mathematics (STEM) helps

students, through the application of abstract concepts in the real world, to engage with real world situations. Furthermore, Barr and Stephenson (2011) believe that the fundamental changes in the traditional instructional setting require integration of math and computer science, which can lead to generating a reliable teaching technique based on CT. Furthermore, Yadav, Hong, and Stephenson (2016) recommended infusing CT into curriculum for all subjects, and also suggested, "moving students from merely being technology-literate to using computational tools to solve problems" (p. 565). In addition, Barr, Harrison, and Conery (2011) highly recommend that in the future, all the students are given opportunity to learn about CT skills, and to use it with different problems and in different contexts.

Based on Wesch and Shelli (2016), renewal in learning, such as adopting learning based on creative thinking to solve complex problems, is a challenge as this kind of learning is nurtured through practice and practicing in a community with other more helpful students. Further, it does not matter what devices students are using, but the way that children use the devices is more important to study. In addition, moving past proving the efficacy of a tool or reform approach (Friesen, 2009) demonstrates that innovation is of pedagogical value. Lavicza, Hohenwarter, Jones, Lu, and Dawes (2010) maintain that teachers need more than access to technology. They need support, collaboration and PD resources to integrate technology in their teaching practice.

3.1.1 Definition/Frameworks of CT.

Wing (2006) defines "computational Thinking as the processes that is involved in formulating a problem and expressing its solution in a way that a computer—human or machine—can effectively carry out" (p.7). Aho (2012) considers that CT is a thought process and includes formulating problems so the solutions of problems can be embodied as computational steps and algorithms. Aho (2012) also indicates that the important part of thought

process is to find appropriate models to formulate the problem and find its solutions. In addition, Sanford and Naidu (2016) add that nowadays, using digital computers for mathematical modeling is all related to expanding knowledge boundaries in varied disciplines.

3.1.2 Importance and Benefits of CT.

Computational Thinking, specifically the movement regarding K-12 education is motivated by two main premises. The first is that CT will prepare children for living in a world that is becoming increasingly digitized, and the second is that those who use computational thinking will be better problem solvers in all fields (Denning, 2017).

According to Resnick (1995), CT "can significantly influence not only what people do with computers, but also how they think about and make sense of the world" (p. 31). When students learn through CT, they can understand deeply the abstract concepts by promoting the reality to students' thinking. Sanford and Naidu (2016) define this era as the Digital Age, and they believe that CT concepts should be available in *our daily life* in order to enrich the quality of our life in modern society. In addition to this, from the grand vision for CT of Wing (2006), she declares that "computational thinking will be a fundamental skill that is used by everyone in the world from the era of 21st Century" (p. 2). Thus, Sanford and Naidu (2016) go beyond the limited applications of CT activities in classrooms and suggest that such activities can be used not only by the students but also by the parents as well.

3.1.3 Challenges to CT

The CT movement has been criticized and challenged for having vague and ambiguous definitions, and because the education community has had difficulty nailing down a specific definition of what CT is (Denning & Tedre, 2016). It has also been criticized for its bold claims

of universal benefit amongst disagreements over what should be taught, and how to assess CT (Denning & Tedre, 2016). It has become important to reinforce past refuted claims such as "the claim of automatic skill transfer from CT to different knowledge domains" (Denning & Tedre, 2016, p. 121). This claim was debunked in the 1980's but which was repeated so much that more recent works have to critique that specific claim about CT (Denning & Tedre, 2016). It is important to remember these things while addressing the integration of CT in teaching though some of it was worked out through debate over time from CT's infancy to the present (Denning & Tedre, 2016).

Challenges addressed in research on integrating CT in teaching include pedagogical, curriculum and assessment challenges:

Lee et al. (2011) recommend that in order to support the development of CT skills among the children and youth in classrooms several challenges need to be addressed including enriched learning environment, developing teachers' skills to facilitate using CT in classroom, and more research on CT. Atmatzidou and Demetriadis (2016) designed different activities based on CT and they noticed that it was not so easy to engage students in CT activities. However, as time passed by and students engaged in more diverse activities, students gradually became more comfortable and familiar with the nature of such activities. Lu and Fletcher (2009) noted some pedagogical challenges, including the role of computer programming and whether this role can be separated from teaching basic CT concepts. In terms of assessing progress in learning these concepts, Denning (2017) said it would benefit students for educators to learn to approach and assess CT as a skill requiring practice, rather than knowledge that is simply acquired in the classroom.

Recently, Angeli et al. (2016) highlighted the challenges that the educators are facing when the CT is made a part of curriculum. The first is the design of the curriculum framework for CT, specifically, whether CT curriculum designs should focus on real world problems. The second challenge is focused on the teachers, as teachers need knowledge, both technological and pedagogical, in order to teach CT curriculum and apply the ideas of CT in schools.

In addition, Angeli et al. (2016) indicate that there is a lack of experimental pieces of evidence in terms of effectiveness of the context of CT curriculum. Moreover, Brennan and Resnick (2012) state that the CT has been considered in the past years as well, but it still lacks strategies to assess students' learning.

3.1.4 CT activities

According to Gadanidis et al. (2017) and Namukasa et al. (2017), varied CT tools and activities are used in mathematics. Namukasa et al. (2017) observe that students have the ability to represent and simulate abstract, advanced and complex concepts. The abstract concepts might be understood by CT activities such as coding that involves students' exploration of mathematics concepts through robots and apps.

3.1.5 Summary

Overall, given the benefits of CT curriculum, its integration in the curriculum and research on its teaching and assessment, Angeli et al. (2016) forecasts that CT curriculum will be adopted into more school curricula in the coming years.

3.2 Contribution and Involvement of Parents

The literature on contributions and involvement of parents in students' learning addresses various aspects. They include the role of parents in teaching their children, the benefits of

contributions and involvement of parents, the importance of parents' involvement, and models of involving parents.

The researcher chose to investigate parental involvement as a part of the study in the context of computational thinking activities. Curzon (2014), Gadanidis et al. (2017), Farris and Sengupta (2014), Kotsopoulos et al. (2017), and Namukasa et al. (2017) focus on computational and mathematics thinking activities for students in the context of classroom learning and teaching. They explore the integration of computational thinking and mathematics thinking in K-8 classrooms. These researchers have observed that CT tools, activities, and processes promise to make mathematics learning experiences for students more interesting, more productive and easier in more advanced mathematics. However, none of these researchers focused on parental engagement in the context of children's computational thinking activities.

3.2.1 The role of parents in teaching their children

According to Civil et al. (2008), parents always teach their children in the manner in which they themselves learned during childhood. Many parents find it challenging to support students when learning in ways that are unfamiliar to them and or learning content that is more advanced. With changing curriculum and instruction, there is a growing need to build capacity among parents. This is evident in the increased availability of parent guides such as "Doing Mathematics with Your Child, Kindergarten to Grade 6 (2014)" provided to parents by the ministries and school board offices. In mathematics education, it has been noted that parents pass on their fear of mathematics to their children when, for example, they profess that they were never good at mathematics or that mathematics is difficult or not useful in life (Ontario Ministry of Education , 2014).

Epstein (1987) observes that the recent studies on parental involvement in schoolwork over the past two decades show that children have an advantage in school when their parents inspire and support them. Support provided by parents to their children varies with culture, socio-economic status and other background characteristics of the family. Families of high-achieving students, for example, would have emphasized high performance and achievement in their children from the earliest years of their lives. Liang (2013) mainly focuses on how diverse natures of families have an influence on their children's mathematics education. Liang (2013), for instance, examined the ways in which Chinese immigrant families are involved in the mathematics educational process of their children. The results of the study by Liang (2013) suggest that families can be involved in children's mathematics, with or without direct connections to schools and interaction with teachers. Teachers can assign additional exercise for students who may need to improve, and students can stay longer after school to practice more mathematical problems, but that needs more effort from students. Parents may provide tutoring activities for their children, but that depends on the income of families and, in my view, can encroach on the time students would be spending on other activities at home. In addition, parents and teachers may use social media to communicate regularly about the children's learning at school and at home, but some parents may not find social media convenient to use. Also, Civil et al.(2008) explain that the immigrant families face a gap between their expectations for their children's education and their experiences because they often do not consider the opportunities and challenges that students face due to cultural differences, social gaps and different languages.

3.2.2 The benefits of parental/guardian involvement

As Hoover-Dempsey, Walker, Jones, and Reed (2002) state, "parental involvement has been associated with stronger academic achievement by children and adolescents" (p. 843).

According to Van Voorhis et al. (2013), the involvement of family in supporting students learning mathematics fits into four categories: Family engagement in school activities, family engagement in the school activities students bring home, support of parent on home activities for their children, and family engagement at home without contact with the school. For example, focusing on learning tasks for children at home with their parents promote mathematics skills and the understanding of mathematical concepts (Civil et al., 2008). Also, the role of the school in facilitating the engagement of families is through encouraging families of students' and concentrating on parents' engagement in learning process. Liang (2013) states that parents can also provide tutors for their children.

3.2.3 Models of involving parents/guardians in students' mathematics learning.

Epstein (1987) indicates that the involvement of parents is one of the main roles in the educational process. Xiao, Namukasa, and Zhang (2016) present a workshop model for engaging children and their parents in mathematical activities. Similarly, Nohemy (2011) conducts a school family night workshop for children and their parents to investigate the rapport between student achievement and parents' contribution. Xiao et al. (2016) conclude that the parents appreciated workshops because they learned about how mathematics is currently taught in schools and appreciated the opportunities to interact with their children in the workshops. At the same time, Xiao et al. (2016) observe that the children enjoyed when they were learning mathematics concepts with their parents in workshop sessions. In addition, Scott (2015) saw that student mathematics achievement was improving when he/she was conducting workshops in mathematics and involving parents with them. As well, Scott (2015) noticed that the students whose parents joined math workshops improved in mathematics performance level more than students whose parents did not join math workshops.

3.2.4 Summary

Parents play a major role in supporting their children with what they learn at school. The engagement of students with their parents in school or community settings may be useful in providing support and parental/guardian involvement in their children's learning, and to study and inform productive learning interactions among parents and children.

3.3 Reform in Mathematics Education

Traditionally, in many countries, mathematics classrooms were the places where students used to listen quietly to their teacher's lectures on how to solve mathematics problems. By means of continuous independent practices in recalling and memorizing the basic facts and the word problems, the pedagogical goal was that the students would develop automaticity and proficiency in the skills that are being taught. In other countries, students learned quietly from practicing with textbook exercises at their desks. The students who encountered the difficulties used to receive additional help and practice in order to increase the accuracy and speed of their computations. Many students find this traditional style of teaching that many teachers and parents experienced at school both boring and difficult.

Mathematics education researchers strive to redefine instructional and teaching approaches to make mathematics more interesting, less intimidating and more accessible to students, as well as to support them in achieving more comfort, higher Grades, and productive learning skills in mathematics. Reforming mathematics instruction requires changing teaching practices, curriculum frameworks and learning resources. Marion (2010) explains that the educational reform allows designers of curriculum to create unique curricula for achieving the requirements of reforming of curriculum. The various literatures on reforming mathematics

teaching address the following aspects: the beginning of reform, the challenges of reform, the benefits of reform and reform in mathematics education and its purpose.

3.3.1 The beginning of the current mathematics education reform

According to Lawson and Suurtamm (2006), in the year 1989 the National Council of Teachers of Mathematics (NCTM) was one of the leaders in pushing the then current mathematical reforms in response to the research indicating that most of the students were learning the procedures in mathematics without conceptual understanding. Lawson and Suurtamm (2006) also indicate that in 1997, the provincial government of Ontario decided to revamp the kindergarten through Grade 8 (K-8) mathematics program, thus developing a new curriculum, provincial large-scale assessment and report card. Furthermore, Haeck, Lefebvre, and Merrigan (2011) state that the education of early 2000s reform is implemented in most schools, both public and private, and in some of the provinces in Canada in both primary and secondary schools.

3.3.2 The purpose of reform in mathematics education

According to Suurtamm et al. (2010), the central aim of the mathematics education reform was to help teachers develop a classroom environment which can support the development of mathematical reasoning through collaborative problem-solving methods. Haeck et al. (2011) further describe the purpose of the reform as being to improve the performance of the low-achieving or average students to bridge the gap in between high-achieving students and the lower-skilled students as well as to increase overall performance and reduce the rate of high school dropout.

According to Haeck et al. (2011), the reform in mathematics education values the mathematical inquiry as a method to engage the students with mathematical ideas and strengthen their understanding of mathematical concepts as well as encouraging the problem-solving approach to teach mathematics to the students. Recently, Vallera and Bodzin (2017) suggest that combining technology with authentic project-based learning challenges using real-world examples can help the students with enhanced understanding of the complex and abstract concepts.

According to Haeck et al. (2011), the reform schools have inquiry-based activities including asking questions, finding alternative solutions, discussion to make connections, and involving the hands-on learning and active participation. They spend more time working on projects, conducting research and solving problems that are based on their interests and concerns. The Ontario revised curriculum suggests that the teachers use problem solving in every strand as the foundation of the curriculum as problem solving can be embedded into each lesson (Lawson & Suurtamm, 2006). The purpose of curriculum is to help students think and work like a mathematician in making new conjectures, justifying their answers as well as evaluating the solutions of others. They further stated that the focus should be on encouraging students to share their ideas, discuss and debate them rather than just sitting and listening to the class lectures. Furthermore, Ross et al. (2002) state that classroom must be organized in groups or pairs to encourage the student-to-student interactions among them. A reform class is more dynamic and ever-changing and not just a fixed environment.

3.3.3 The challenges of reform

According to Ross et al. (2002), the reform does not entirely relate with the mandated tests which measure computational speed as well as accuracy, and it does not meet the

expectations of the parents regarding how mathematics should be taught to their children, and how it is being tested. Reformed ways of teaching make it more difficult for the students and the teachers to cover the whole curriculum, as it takes a longer time.

Suurtamm et al. (2010) state that the approach emphasizes using the challenging problem for students to construct various solution methods, discussions and to defend their mathematical ideas. According to Suurtamm et al., one of the most challenging implementations is the student discussions involving mathematical reasoning, finding out the balance between learning procedures, processes and understanding concepts as well as encouraging the construction of new knowledge without leaving students floundering.

Also, Haeck et al. (2011) mention that in the comprehensive school reform (CSR) in the United States, the students learn and discover the concepts through the process of reasoning and discussions. This provides no explicit opportunities for reviewing or practicing the mathematical concept.

3.3.4 The benefits of reform

According to Haeck et al. (2011), schools have moved away from the traditional or academic approaches of drills, memorization, and activity books, to a more comprehensive approach that is focused on learning in contextual settings in which the children are expected to find the answers for themselves. Children should have the opportunity to investigate as well as to explore mathematics problems with their teacher's assistance. It is very important to start with what a child already knows and activate his prior knowledge. According to Haeck et al. (2011), reform in mathematics education encourages the problem-solving approach to teach mathematics. The teachers who participated in Haeck et al.'s case studies used mathematics

student journals, in-class assignments, homework, performance tasks, observation record sheets, independent study projects, and quizzes as well as questioning and listening at the time of problem-solving activities as a part of their classroom practices. Ross et al. (2002) further state that the main characteristics of math education reform are broader in scope, use manipulations or mathematical tools to support learning, and use of complex and open-ended problems that are embedded in real-life contexts. Ross et al. (2002) observed in their case studies that when students solve more complex problems using more advanced strategies when they are confronted with obstacles, they gain deeper understanding as well. Reform curriculum also enables students to describe their thinking and adapt procedures in response to the problem requirements.

According to Arvidson (1998), there are many differences in the academic achievement of students who are in reform programs and students who belong to traditional programs. He stated that "a renewed emphasis on teacher education based on the NCTM standards, time for collaboration among teachers, and a 'call' for ongoing professional development in reform practices" (p. 9.) is required. Also, ICMI (2017) Study 24, indicates that technology has also helped in reforming mathematics curriculum.

3.3.5 Summary

Teachers along with parents need to assist children in sharing their mathematical ideas and knowledge, well as encourage them to explain how they have arrived at their answers. The more practice students have in explaining why they are doing math on top of following the rules of mathematics, the less difficulty they will have in meeting the high verbal, social, and cognitive expectations proposed in reform-based instruction.

4. Methodology

4.1 Research Method

This research shall rely on a qualitative research method because the research problem in this study needs to be explored in depth. Through qualitative research method, the researchers get an opportunity to learn more about their participants, and can further gain a deeper understanding and knowledge about the research object and its complexity (Creswell, 2015). Particularly, this research uses the method of case study. The researcher did not use other research styles such as action research. Action research would have been suitable only if this study sought to improve performance and solve problems facing the researcher in their professional practice. Action research improves the ability to effect the change required to achieve development (Baskerville & Myers, 2004). Case study research was found appropriate because the researcher sought to investigate the research topic in-depth. Case study methods allow the researcher to compile data regarding holistic and meaningful characteristics of the real-life events (Yin, 2009) as well as to collect rich data using various data collection methods, for example, triangulation (Yin, 2009).

According to Stake (1995), the case study can be classified into three categories: instrumental case, intrinsic case, and the collective case study. In case of intrinsic case study, the researchers are guided by their own interest in the case itself, for example, a child, clinic, conference or curriculum rather than in the extension of the theory or generalization across cases. The instrumental case study focuses on a particular issue and develops theory. The case study serves as an important tool for better understanding of similar situations. In the case of collective case study, there are multiple cases that are described and compared in order to provide an insight into a particular issue (Stake (1995). Collective case study is conducted by a researcher

who can select more than one case to provide a representative sample (Cousin, 2005). The

researcher in collective case study makes more generalizations and exploration of the concept in

further depth (Cousin, 2005). This research uses the instrumental case study to examine the

integration of CT activities in mathematics workshop for both students and their parents.

4.2 Site and Participants

Table 1. *Description of Participants in Workshop*.

(Parent-Child) and Teachers	*Gender*	*Grade*	*First/Second session*	*Interviewed (Yes or No)*
Pair 1	Mom/Boy	3	First session	Interviewed
Pair 2	Mom/2 Boys	4	First session	Interviewed
Pair 3	Dad/Boy	6	Second session	Interviewed
Pair 4	Dad/Girl	5	Second session	Interviewed
Pair 5	Mom/Girl	3	First session	Interviewed
Pair 6	Mom/Boy	4	First session	Interviewed
Pair 7	Mom/Boy	4	First session	Interviewed
Pair 8	Grandma/2 Boys	5	Second session	Not Interviewed
Teacher 1	Math Teacher	3 & 4	First session	Not Interviewed
Teacher 2	Math Teacher	5 & 6	Second session	Interviewed

Table 2. *Outline of the workshop.*

Workshops/Content	Day	Time	Activity	Resources
Workshop 1	Day 1 Grades 3 & 4	1 hour 15 minutes	1-Symmetry activity	http://researchideas.ca/sym/s2/ https://scratch.mit.edu/projects/editor/?tip_bar=home#editor
Workshop 2	Day 2 Grades 5 & 6	1 hour 15 minutes	2- Sphero 3- Scratch program	

Data for this study was gathered from CT and mathematics thinking parent-child workshops conducted at a religion-based private school. Children in Grades 3 to 6 along with their parents were invited to participate in computational and mathematics thinking activity workshops divided into two sessions. The researcher spoke to the school principal and received approval to conduct the workshops during school days. Research data was collected to answer the research questions of this study which are: generally, what is the nature of engagement of learners with their parents on computational and mathematics thinking activities?, and specifically, questions regarding the *ways students and their parents act and interact* during computational and mathematics thinking activities, and *the benefits and challenges* of parent's engagement with their children during computational and mathematics thinking activities. Data was collected on the views and *feedback* of both students and parents after engagement during computational and mathematics thinking activities.

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Data was gathered from observation, photos, audio records, photocopies, reflection forms from students and parents, and from interviews of the children and their participating family members. As well, interviews were conducted with a teacher to obtain feedback. The above tables, labeled Table 1 and Table 2 describe the participants who attended the workshops and an outline of the workshops held.

Engagement was measured as follows: I classified high engagement as when I observed the pair (child-parent) working together very well, medium as when I found when a pair (child-parent) occasionally engages together with some gaps of not engaging together, and low referred to observing bigger gaps among the few moments when a pair (child-parent) engaged together. The level of parent-children engagement varied among participants from low to high.

4.3 Research Materials

The workshops design was based on Xiao et al. (2016) and the workshop activities were based on computational and mathematics thinking activity workshops, designed by Namukasa (2017) and Gadanidis (2017). Namukasa (2017) offers CT activities in exploration centers based on CT tools; Gadanidis (2017) designs CT and mathematics activities for students centered on specific mathematics content. A selection of activities was adopted and implemented in the research.

4.4 Data Collection Method

Data was gathered from observation, photos, audio records, photocopies, reflection forms from students and parents, and from group interviews with children, parents and teachers as discussed in the Research Method section above.

On the question of the ways students and their parents act and interact during computational and mathematics thinking activities, the researcher made observations and completed an observation form and took field notes. The researcher was particularly interested in the *role of parents* when they are interacting with their children during computational and mathematics thinking activities, the role of children during interaction with their parents in the computational and mathematics thinking activities with children and parents and their interactions.

On the question of *the benefits and challenges* of parent's engagement with their children during computational and mathematics thinking activities, the researcher interviewed students, parents and teachers to share about what they see as the benefits and challenges. The researcher also made observations and took field notes. The researcher was particularly interested in the math and computation thinking that students conducted how the students experienced the activities, the views of parents.

On the question of the views and *the feedback* of both students and parents the researcher interviewed the students as well as made observations and took field notes. The researcher was particularly interested in the feedback on the interactions among the students and parents, what surprised them, what the difficulties they faced, and what they suggest being more helpful.

The data collection steps included collecting data by:

(1) observing the participants of the workshops,

(2) reviewing completed reflection forms from students, parents and one teacher, and

(3) interviewing students, parents and one teacher.

I organized the data by its nature: observation, reflection forms and interviews. I then analysed each data set independently. Firstly, for the observation data I did the following: (a) the engagement and the interaction of students and their parents were observed by researcher during computational thinking workshops, (b) field notes developed by the researcher from observations of computational thinking workshops, (c) I took photos of the working students with their parents in computational thinking activities. Secondly, for the reflection forms I did the following: (a) distributed the reflection forms for students after each activity and I gave parents one reflection form after the three activities. (b) photocopies of reflection forms of students and their parents were taken after conducting the workshops. Thirdly, for the interview data I did the following: I interviewed each student and parent who were attending the workshops. I was able to interview all participants (except Pair 8, and the math teacher for Grades 3 and 4 after workshops) with the interviews lasting about 15 minutes each. Audio recordings were taken for each interview, and the audio recordings were transcribed to analyze the data.

4.5. Research Instruments

Observations data: Cohen, Manion, and Morriboy (2013) state that "observation is highly flexible form of data collection that can enable the researcher to have access to interactions in a social context and yield systematic records of these in many forms and contexts, to complement other kinds of data" (p. 457). Cohen, Manion, and Morrison (2013) note that observation allows researchers to collect data on physical setting, human setting, interactional setting, and program setting. Also, Cohen, Manion, and Morrison (2013) mention that "observation data may be beneficial for recording non-verbal behavior, behavior in natural or contrived setting, and longitudinal analysis" (p. 457). Hence, observation data would permit researchers to enter and realize the case that is described.

I collected data by observation in a human and interactional setting, and I completed the observation template (see Appendix B) during and after the workshop.

Interview Data: As Cohen, Manion, and Morrison (2013) mention "interviews are a widely used instrument for data collection" (p. 409). I conducted a conversational interview. Student participants were interviewed to learn about the benefits and challenges of the computational and mathematics thinking activity workshop (see Appendix C for interview questions), and to determine the teacher's views about the nature and background of students' engagement in the workshop activities. Parents were also interviewed to determine their level of commitment and willingness to participate. (see Appendix C). Students were asked about their work and personal experiences in CT activities (see Appendix C). After conducting the workshop, students and parents were asked to complete reflection forms (see Appendix D).

4.6 Research Ethics

This research received permission under the Western NMREB ethics review protocol of Dr. Namukasa, file number 109494 entitled tool-based innovative learning and teaching practices and was approved on August 17, 2017. Letters of information and consent forms for teachers and parents as well as assent letters for students and recruitment emails as well as research instruments for the file number 109494 protocol were used in this research. A letter was sent to the school principal or to the director of the community organization, by email or in person seeking permission for the researcher and her supervisor to carry out the study in the school or the organization. Once the permission was obtained, letters of information and consent forms were distributed to the teachers and the teachers asked to send the parent and student letters of information, consent forms and assent forms home with the students. During the workshops data was collected from only the consenting participants. All data collected was kept confidential and

made available only to the investigators of the study. The potential risk in this study was low or

non-existent. The students, parents and classroom teacher were not asked any private information

related to them. Confidentiality of the respondents was maintained throughout the research. Their

responses and identities of participants were kept confidential.

4.7 Data Analysis

To carry out the data organization and analysis, the data was analyzed manually. The

analysis initially focused on making sure that the data was collected by observations, interviews

and feedback for students, parents and the teacher were sufficient to cover and answer my

research questions. The interview data was transcribed over time, typing up field notes, sorting

and arranging the data into different sources, then the data analysis was started before

commencing this research thesis to share its findings.

4.8 Validity and Trustworthiness of the Study

According to Cohen, Manion, and Morrison (2013) "more recently, validity has taken

many forms. For example, in qualitative data validity might be addressed through the honesty,

depth, richness and scope of the data achieved, the participants approached, the extent of

triangulation and the disinterestedness or objectivity of the researcher" (p. 179). In this study,

observation, photos, videos records, audio records, photocopies, reflection forms and interview

data from students, parent and teachers participating in the workshop were analyzed. The

research was conducted based on detailed record of the events directly from the field notes and

transcribed audio recordings. In the research report, the evidence and the interpretations were

kept separate from each other in the study report to add credibility to the study. Also, to achieve

the accuracy of the data, transcripts were checked for any errors, and adult participants were

allowed to review their responses to ensure that the responses of members were correct and

appropriate to share in the research report. When interpreting the findings, the researcher referred

to literature on integration of CT in teaching, parental involvement and on mathematics reform.

5. Findings

5.1 Overview

To reiterate, the main purpose of this study is to explore the nature of engagement of students with their parents in computational and mathematics thinking activities. The study's specific purpose is to investigate the ways in which the students and their parents act and interact during computational and mathematics thinking activities the benefits and challenges of parents' engagement with their children during these thinking activities and the views of both students and parents on their engagement in the computational and mathematics thinking activities. The main research question is: *What is the nature of engagement of learners with their parents during computational and mathematics thinking activities?*

The specific research questions are:

1. In what ways do students and their parents act and interact during computational and mathematics thinking activities? What is *the role of the parents*?

2. What are *the benefits and challenges* of parents' engagement with their children during computational and mathematics thinking activities?

3. What are *the views and feedback* of both students and parents after engagement with computational and mathematics thinking activities?

The following is a summary description of the participants of the study: five parents and six students from Grades three and four, two parents and two students from Grades five and six, and two math teachers. All participants were students and parents enrolled in one private school in an urban area of a city in South Western Ontario. The data was gathered over period of one month during the Spring of 2018. Participants were interviewed individually for approximately

15 to 20 minutes after attending the workshops. The workshops took place at the school during school hours. The workshop sessions took 90 minutes to complete. The teachers and the researcher observed the participants during the workshops. The researcher also collected participants' feedback on reflection forms to further triangulate the data from the interviews. The researcher took photographs and audio records of the interviews.

5.2 Data Analysis

In this chapter, I report findings from the participants' observations, feedback form entries, and interview transcripts. When analyzing data, I was guided by the following pre-existing themes reflected in the research questions. The two themes are: (1) remixing mathematics and computational thinking and (2) parental engagement.

In reporting the results for analysis, I followed the work of Cohen, Manion and Morrison (2007). I chose to organize the data by individuals where each participant's responses are presented. This maintains the integrity of the responses of each participant and creates a whole picture of the participants. As such, this enabled me to do both in-case (i.e., individual parent-child participants) and cross-case (i.e., compare participants) analysis to look for themes. I analyzed the data manually by clustering the typed-out researcher notes, reflection forms, the saved photo images, and the transcribed interview data into different codes. For each code I used a specific color to mark data which is related to the same code in the same color. I continued this process of coding and marking the data by applicable codes until I further clustered the codes in broader categories as well as related the codes to the two main research questions on how CT activities enhance learning and teaching mathematics and on the nature of parental engagement in their children's CT activities. I referred to these two broadest categories of codes and the broader subcategories as the data analysis themes and subthemes respectively.

As I mentioned previously, I elaborate each participant's work and response through observation, reflection forms and interviews. The participants included eight pairs of students and parents, and two math teachers. The following is description the work of all participants who were attending the workshop throughout the observation, reflection forms, and interviews.

Pair 1 (Boy and Mom)

Pair 1 was a boy with his mom. The boy was in Grade 3 and he spoke using English language during the workshop and the interview. They attended the first session of the workshop. Both the boy and his mother each filled out the reflection forms. After 3 weeks, I interviewed them at the school library in the afternoon. The following is description of the pair's participation in the workshops organized by observation, reflection forms and interviews.

Observation. In the observation stage, this Grade 3 boy and his mom were working together and followed the verbal and written instructions given to them, but they struggled in the beginning, especially the mom, because "it's a new way to learn" for her as she mentioned in the workshop. The boy took the lead and mainly did the work following the instructions step by step (i.e. he took the booklet of activities, read the first step and applied it, then the next and so on). His mom was mainly watching him, focusing on what her boy was doing to learn about computational thinking activities. Based on the questions related to the observation form (e.g., on levels of engagement, student's observed attitude, and level of interaction with their children and parents' attitudes--see Appendix B), the level of the boy's engagement with his mom was high with positive attitude during working on the workshop activities. The mom and the boy were working together, but not on each step, because for the mom, as I mentioned previously, her main role was watching her boy. I observed that the mom appeared positive towards the activities. For example, in the activities which related to the Sphero robot and Scratch block-

based programming, the boy wrote down or entered the commands to create a code to serve some geometrical mathematical concepts such as length, angles, and patterns, and in the Symmetry activity they applied rotation and reflection shapes, and his mom tried to understand what was going on in the activities. This was evidence that the boy's engagement was high, and the parent's attitude and the boy's attitude was positive. The parent's interaction level with the boy was medium.

Reflection forms. Regarding the questions that were written in the forms of each activity (Symmetry activity, Sphero robot, and Scratch program), the boy responded to each question. In the Symmetry reflection form the first question was: what did you learn in the Symmetry activity? He responded, "how to make code." The second question was: write or draw the path or shape you have made in the Symmetry activity. He drew a triangle shape. The third question was: do you like this activity? You can draw an emoji to express your feeling. What the thing that most surprised you? The boy responded: "yes, because it can teach you to learn about robots." The last question was: do you like working with your parents? He answered: "yes, because if something goes wrong, they tell me to repeat." In the Sphero robot reflection form, the first question was: list mathematical concepts you have learned from Sphero activities. for example, length, time, speed, angles, patterns, etc.... The boy's response was: "I learned that when I made a triangle, I had to put 120 degrees to make it work for the exterior angle." The second question: write or draw the path or shape you have made to make Sphero move. In response the boy drew a triangle shape. The third question was: do you like this activity? You can draw an emoji to express your feeling. What the thing most surprised you.? The answer to this question was: "yes, because it teaches me how to be good with text" perhaps referring to the written instructions that he had to read. The last question in Sphero activity form was: Do you

like working with your parents? Why? The Boy answered: "yes, because they support me." In the last activity in the workshop, which was the Scratch program, the first question was: list mathematical concepts you have learned from Scratch program activities. for example, length, time, speed, angles, patterns, etc.… The boy answered: "you can make it dance; you can play games etc.…" In the second question: Write or draw the path or shape you have made in Scratch program. The boy drew a triangle. The third question: do you like this activity? You can draw an emoji to express your feeling. What the thing most surprised you> The answer to this question was: "yes, because it teaches me to code." The last question was: do you like working with your parents? Why? The boy answered: "yes, because they support me."

The mom completed a reflection form about all the three activities where the following are the responses of the mom to the questions which included on the form. The first question was: Please, share with us why you selected to participate in this study? The mom answered: "to help my child learn." The second question was: In what ways you like or not like working with your child/children? Why? The response of mom was: "I do I always try to work with him." The third question was: Did you learn or observe something new about: the workshop, your child, yourself? The response was: "he was excited to learn about math." The fourth question was: Did you observe something new about mathematics? She answered: "yes I did." The fifth question was: What surprised you or did you dislike in this workshop? She answered: "I learnt something I didn't know." The last question was: What are your suggestions in future to improve these workshops? The mom answered: "keep it up!!! It is good program."

The reflection form findings of Pair 1, the boy spoke about learning several math concepts (polygons such as triangles, angles such as 120 degrees in a triangle and exterior angles, and transformations such as rotation). The boy's attitude and experiences towards the

activities were positive because they "learned to code" and it helped them "with text." The boy

likes to work with his parents because they "correct me" and "support me." For mom, she chose

to attend the workshop to "to help my child learn" and she discovered something new about her

boy in that "he was excited to learn about math." About her view of the workshop "I learnt

something I didn't know," and she suggested "keep it up!!! It is a good program."

Interview. I interviewed the boy and his mom after three weeks after the workshop. I met

first with the boy, then his mom at the school. Firstly, the boy defined himself by telling me his

age and Grade. He is 9 years old in Grade Three. His family has two boys and a girl, and his

family speaks two languages at home: English and an unofficial language. He then told me that

he likes mathematics, computer and digital devices. Second, the boy mentioned using

mathematics in daily life, such as going to the store, counting, and cutting things in equal parts.

He then mentioned about doing his homework by himself but getting some help from his parents

when he needs. Third, he told me about how his mom helped him during the workshop. He said,

"they helped me very well," and he said, "I like doing the math stuff with my mom." He also

mentioned that the action and interaction in the workshop was the same when comparing it with

another time or place.

Fourth, the boy told me the Sphero robot was his favorite session, and he said, "because

it's fun." He also told me the Scratch program was the least favorite session, "because it's hard."

In general, he mentioned these activities (e.g. Symmetry, Sphero and Scratch) enrich some

mathematical concepts, like length and angles. Finally, he mentioned that the workshop

encouraged him to work with his parents more because he liked it, as he mentioned during the

interview. He suggested for next workshop to make more activities with Sphero robot. Lastly, he

said about the workshop: it was "fun learning, so the good way."

Next was the interview with the mom. First, she told me her child is 9 years old in Grade Three. She said, "he's doing so-so (means he is at medium level)," and she added "he is not really genius with math." She said, "he's good," when I asked her how he is with digital devices. She also told me about using the robot and she said, "he never been used any robot devices, so it was his first time, but when he used it, he was enjoying it." She added "everything was enjoyable." Second, I asked her about doing his homework and she said, "he can do it and it's easy for him to do it by himself, but sometimes he needs help." She added about his achievement in mathematics that, "he is good." Third, she told me about the family. Their family has three children, two boys and a girl. She told me about her educational level. She has a diploma degree (driving training. She then told me they speak English and an unofficial language at home. Fourth, we talked about mathematics and curriculum. For example, we spoke about applying mathematics in daily life. She said "yeah, it does every single day when you go to stores. When you buy some, when you buy anything, counting, and sometimes, the kids they like to play with each other by mathematic. Like the games, mathematics games." Also, she talked about how she helps her children in mathematics. she said, "most of the time I download apps through the tablet like Android devices, so apps and plus through the paper and pencil," and she helps her children with homework when they ask for it.

She also spoke about attending the workshop, "honestly, yours it was the only one I attended, so no we haven't, and we would love to attend more and more. I was impressed and it was successful workshop." Then I asked her about acting and interacting during the workshop, and she said, "most of the time, I like to watch and then I can interfere when I feel I have or I need to, because I like to see what they can get by them self. I like without help," and she added about interacting her boy, "usually they are a good listener. They listen really well. So, I think it's

enjoyable to work with each other." Then she stated "we enjoyed Sphero because I enjoyed it because I love watching him enjoying it" when I asked her about the favourite session in the workshop. She added "it's kind of fun, fun way with teaching them how to draw something. Definitely, it's fun for them. That's why and that's what the kids want. They want to learn and in the same time they want to play. So, it's mixed playing and learning the same time." She also replied "I don't like the Scratch that much, it was the last part right, I don't like it that much maybe the Scratch, we needed more time with it. Or more practice? Maybe hard than others?" When I asked her about her least favorite session, and any difficulties or challenges in the activities, she said "there are challenges and mistakes, yes there is because with the Sphero they need to know how to draw really well. Think about angles. Because they need to think before they start drawing, they need to have plan before they do anything, also good, that teach them they have to have a plan with everything they do in their life same thing with math, same thing when they play." In her views, she finds that these workshops enrich mathematical concepts for students, like angles. Also, she finds workshops encourage her to engage with her children, and she added "I should work with them more and buy them more stuff." Finally, for her suggestion she said "I don't like groups (i.e. I used groups on the same desktop computer due to shortage of devices). I like the attention to be one and one." At the end, she added "I was impressed, excited, easy way to teach the kids. So, having fun time with the kids, in the same time teaching them."

Interview findings for Pair 1. I found the boy spoke about using mathematics in daily life like going to the store and doing his homework by himself but getting some help from his parents when he needs. He also spoke about action and interaction with his parent "I like doing the math stuff with my mom" and "they helped me very well." His favorite session was the Sphero activity and the least favorite session was the Scratch program. In addition, he found

these activities (e.g., Symmetry, Sphero and Scratch) enriched some mathematical concepts, like length and angles. He also found this workshop encouraged him to work with his parents, and he suggested for next workshop to make more activities with the Sphero robot because it was "fun learning, so the good way." For mom, she spoke about applying mathematics in the life "when you go to stores," and she said, "I was impressed, and it was successful workshop." Regarding action and interaction, she said, "most of the time, I like to watch and then I can interfere when I feel I have, or I need to" and "I think it's enjoyable to work with each other." Regarding her favorite activity, she said, "we enjoyed Sphero" "it's kind of fun, fun way teaching with them how to draw something" and "it's mixed playing and learning the same time." About her least favorite session, she said "I don't like the Scratch that much."

In addition, she found these workshops enriched mathematical concepts for students, like angles. She found this workshop encouraged her to engage with her children, saying "I should work with them more and buy them more stuff." She suggested "I don't like groups. I like the attention to be one and one." At the end, she added "I was impressed, excited, easy way to teach the kids. So, having fun time with the kids, in the same time teaching them."

Based on the three instruments (observation, reflection forms and interviews) I used, I found Pair 1 (Boy and his Mom) successfully completed the reflections, worked through the activities (Symmetry, Sphero robot and Scratch program), and it appears they engaged together and followed the direction in the activities in the workshop. Both the Boy and his mom found that the workshop activities enriched mathematical concepts, and that the activities encouraged both Mom and the Boy to engage together in mathematics activities more often, especially outside of the workshop.

Pair 2 (2 Boys and Mom)

Pair 2 was a mom and her two boys. The boys were in Grade 4. The boys and mom spoke the English language in the interview and during the sessions. They attended the first day of the workshop, and they completed the reflection forms. I was able to interview them after a couple of weeks after workshops in the library at the school. The following is description of the pair by observation, reflection forms and interviews.

Observation. During observation of participants, I saw the two boys in Grade 4 and their mom were interacting positively. For example, they asked their mother about activities to clarify them and the mom asked them about how they can do the activities. They followed the instructions carefully while highly engaged with their mom. For instance, they read every step in the booklet given them together, and they tried to apply the activities together as well. They finished the all tasks during the workshop in the right way, especially the activities related to the Sphero robot. The interaction with boys and their mom was high especially in the Sphero robot activities as they engaged together, and each took a turn as they moved with Sphero and they tried to figure out other shapes such as triangles beyond squares. This demonstrates that the two boys' engagement was high and the mom's attitude along with their attitudes were positive. The mom's interaction was high as well.

Reflection forms. In the Symmetry reflection form, the first question was: what did you learn in Symmetry activity? Boy 1 responded "we learned the shape looks the same, but the name is different, and it is in different position and degree." He was referring to when we applied the Symmetry activity by using square and rotation. He thought before that it was the same square, but when we labeled the corner of it, he found the different names of squares, meaning it was a different square but with the same properties. Boy 2 answered "we learned geometry." The second question was: write or draw the path or shape you have made in Symmetry activity. Boy

1 drew 4 rectangles with different names and marked dots in each corner showing 1234, 3124, 3412, and 2341. Boy 2 drew one rectangle and one triangle. The rectangle was divided into 4 parts, each part had in corner of it one dot, two dots, three dots, and four dots respectively from left to right. The triangle was divided into two parts and each part had three dots. The third question was: Do you like this activity? You can draw an emoji to express your feeling. What thing most surprised you? Boy1 responded: "yes, he did," and he drew a happy face, whereas Boy 2 drew a face without smiling and he wrote "a little." The last question in Symmetry activity was: do you like working with your parents? Boy 1 answered: "yes, it is fun," but Boy 2 wrote "no, they tell me to do stuff I don't want to do." In the Sphero robot reflection form, the first question was: list mathematical concepts you have learned from Sphero activities. for example: length, time, speed, angles, patterns, etc.… The response of Boy 1 was: "all of it, all!!!," and Boy 2 answered "length, time, speed, angels, patterns...." The second question was: write or draw the path or shape you have made to make Sphero move. Boy 1 wrote "triangle" and he drew a slanting and triangle shape, while Boy 2 drew a line. The third question was: do you like this activity? You can draw an emoji to express your feeling. What the thing most surprised you? The answer of Boy 1 was: "yes, Wow very impressed," and Boy 2 drew a happy face. The last question on Sphero activity form was: do you like working with your parents? Why? Boy 1 answered: "yes, it makes things more fun" but Boy 2 wrote "no, they tell you do to stuff you don't want to do." The last activity of the workshop was the Scratch program, the first question on the reflection form was: list mathematical concept you have learned from Scratch program activities. for example: length, time, speed, angles, patterns, etc.… Boy 1 answered: "not really, he was very confused with it," while Boy 2 responded "I learned that when it did a triangle, I had to put 120 as a degree." The second question was: write or draw the path or shape you have

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made in Scratch program. The response of Boy 1 was "didn't understand it," while Boy 2 drew a shape seemed like a rectangle. The third question was: do you like this activity? You can draw an emoji to express your feeling. What the thing most surprised you? The answer of Boy 1 was: "didn't have much to express," but Boy 2 answered "yes, cause I got to play with robots." The last question was: do you like working with your parents? why? Boy 1 answered: "he did!" Boy 2 answered "yes, because they are fun."

The mom filled out the reflection form on the three activities. where the following are the responses of the mom to the questions included in the form. The first question was: Please, share with us why you selected to participate in this study? The mom answered: "I like the way to conduct the workshop. So, I like to attend and see what will happen there." The second question was: In what ways you like or not like working with your child/ children? Why? The mom's response was: "I really like working with my children. So that make the relation stronger and near together." The third question was: Did you learn or observe something new about: the workshop, your child, yourself? The response was: "yes, the way to teach and learn math." The fourth question was: Did you observe something new about mathematics? She answered: "yes, how to learn math by this activity" The fifth question was: What surprised you or did you dislike in this workshop? She answered: "I like the activities e.g. (Sphero) robot and I like the work with my kids." The last question was: What are your suggestions in future to improve these workshops? The mom answered "it was interesting and helpful for students. I hope to do this always."

Findings from reflection forms of Pair 2. The boys spoke about learning several math concepts: polygons such as triangles, angles such as 120 degrees in a triangle and exterior angles, transformations such as rotation. The boys' attitudes and experiences towards the activities were

positive because they stated, "we learned geometry," and the boys liked the Sphero activity. Boy 1 said "wow very impressed" and Boy 2 drew a happy face. Boy 2 did not like Symmetry and Scratch activities as much, or as he said, "a little." Boy 1 was "confused" about Scratch program "I didn't understand." Boy 1 likes to work with his parents because they "it makes things more fun," but boy 2 does not "no, they tell me to do stuff I don't want to do." However, in last activity Boy 2 appeared to change his mind about working with his parents, saying "yes, because they are fun." For mom, she chose to attend this workshop to "see what will happen their," and she had a positive attitude towards working with her boys and the activities "I really like working with my children." She investigated something new "the way to teach and learn math." She also observed "how to learn math by this activity," and she like the activities: "I like the activities e.g. (Sphero) robot and I like the work with my kids." Finally, she said, "it was interesting and helpful for students. I hope to do this always."

Interview. I interviewed the two boys and their mom two weeks after the day of the workshop. I met first with Boy 1 then Boy 2 in the school library and then met their mom at the school in the staff room in noon time. The following is a description of the interviews for all three participants:

First, I will describe the interview of Boy 1. Boy 1 defined himself by telling me his age and Grade. He is 8 years old in Grade four. His family has two boys, and his family speaks two languages at home: English and an unofficial language. He told me about liking mathematics, computers and digital devices. Second, Boy 1 talked about using mathematics in daily life such as going to the store. Then he mentioned about doing his homework by himself but getting some help from his parents when he needs. Third, he told me that his mom did not help she just watched him during the workshop. When asked to compare the action and interactions with his

parents in the workshop with the action and interaction with another time or place, he said "the same." Fourth, Boy 1 told me that the Sphero robot was his favorite session. He said, "the way you coded, how, it does move." He also told me that the Symmetry activity was the least favorite session. He said it was "boring." In general, he mentioned these activities (Symmetry, Sphero and Scratch) enrich some mathematical concepts like lengths and angles. He mentioned that this workshop did not encourage him to work with his parents, and when I asked him to make a suggestion for the next workshop, he did not have any suggestions. Lastly, he said about the workshop: it was "amazing I love it."

The interview of Boy 2 followed the interview of Boy 1. First, the Boy 2 defined himself by telling me his age and Grade. He is 8 years old and in Grade four. His family has two boys, and his family speaks two languages at home: English and an unofficial language. Then he told me about liking mathematics, computers and digital devices. Second, the Boy 2 talked about using mathematics in daily life. He said "sometimes when we go shopping around mom. I try counting the prices." Then he mentioned about doing his homework by himself but getting some help from his parents when he needs. Third, he told me that he did not like working with his mom. He preferred to work alone or sometimes with his friends. He mentioned the action and interaction in the workshop was the same when comparing it with another time or place. Fourth, Boy 2 told me the that the Sphero robot was his favorite session, and he said, "because it's cool to code it, Cool, and make it move." However, when I asked him about his least favorite session, he said "no, I liked all of it." In general, he mentioned these activities (Symmetry, Sphero and Scratch) enrich some mathematical concepts like length and angles. He mentioned this workshop did not encourage himself to work with his parents, and he suggested for next workshop and said "yeah activities. more time," perhaps meaning, extended time for activities. Lastly, he said about

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the workshop: "It was interesting. I was excited."

The following is a description of the interview with the mom. First, she told me about her two boys. Each one is 8 years old and in Grade four. She added both of them are doing well at school, and they like mathematics. She also mentioned they are using digital devices and robot. Second, I asked her about helping them in their homework, and she said, "when they ask for help." She mentioned their achievement in mathematics saying, "they did well." Her response regarding homework help for her boys was same as what her two boys said. Third, she told me about the family; it contains two children (the two boys). She told me about her own educational level "I have a master. She told me they speak mostly English language and an unofficial language at home. Fourth, we talked about mathematics and curriculum. For example, applying mathematics in daily life. She said, "Yes I think it does apply in everyday life. When especially with the kids so we tried to do it in a way that they can enjoy. Also, when you're in the store (addition and subtraction), or in a bank or anything that may arise. We try to sometimes include that into the fun, the fun of learning math."

The mother added about how she was helping her children in mathematics she said, "we help them in homework, but we try to make math fun, so do like games when we are in the car, questions answer. Like games in mathematics," and she helps her children when they need. She also mentioned about attending mathematics workshops but not the same. I then asked her about action and interaction during the workshop and she said, "watching and trying to interact with my children through observation and having them see what they can do," and she added about interaction her boys well, saying "good, they do well. They wanted to show me how to do it. So, they were. It was empowering for them." She also said, "I like that they wanted to show me how to do it. they wanted. They wanted to kind of take ownership of their learning because it was

technology." She replied when I asked her for something that surprised her about her children "I just found myself found how much more practical it is for them to play of course they love electronics. You know If you can connect it to math in real life of course." She added, "they may have been me listening to how to do things with my children. So, this time I was with my children working. Like in other places, you're just listening like lecture but now in this workshop we are doing activities." When I asked her about her favorite session in the workshop, she replied "the favorite I think was the Sphero. They got to move and actually see it in front of them." She replied "the Scratch program we felt it was a little not as as fulfilling to them as Sphero I think" when I asked her about the least favorite session. She added "they enjoyed it but not as much as the other one. It's hard. They were able to get to do different things, but I don't think maybe they found that it wasn't doing what they wanted it to do or they weren't getting hundred percent. So, they need more practice. Maybe it's after the Sphero. Everything after Sphero. not as much as."

About difficulties and challenges in the activities, she said "I think we are trying to get the shapes, so we got it towards the end, but it was taking us a little longer to actually get." In her views, she said, "just diversifying how they learn about different mathematical concepts, like just different ways of learning helps, it's a good way." Also, she finds the workshop encouraged her to engage with her children, and she added "it's a fun activity to do with them and especially when kids are learning." Finally, for her suggestion, she said "just more ways that you can include. More ways. More activity You can include. Math with fun of learning. Different ways to learn different concepts." At the end, she added she found the workshop "nice, good, benefited from it."

The interview findings of Pair 2. I found the 2 boys spoke about using mathematics in daily life such as going to the store, and doing their homework by themselves, but getting some help from their parents when they need. They spoke about action and interaction with their parent and Boy 1 mentioned that his mom was just watching them, but Boy 2 preferred to work alone or sometimes with his friends. Their favorite session was the Sphero activity and the least favorite session was the Scratch program for Boy 1, but Boy 2 liked all activities. He did not have any activity he did not like. In addition, they found these activities (e.g. Symmetry, Sphero and Scratch) enrich some mathematical concepts, such as length and angles, but they did not find this workshop encouraging them to work with their parent. They suggested to make more time for activities for the next workshop. Boy 1 thought "amazing I love it," and Boy 2 felt "I was interesting. I was excited." For mom, she spoke about applying mathematics in the life: "I think it does apply in everyday life," and she said about the workshop "I was impressed, and it was successful workshop." Regarding action and interaction: "watching and trying to interact with my children through observation" and "I like that they wanted to show me how to do it." Her favorite activity was the Sphero robot, and her least favorite activity was the Scratch program. In addition, she found these workshops enrich mathematical concepts for students, concepts such as angles. She found this workshop encouraged her to engage with her children: "it's a fun activity to do with them and especially when kids are learning." She suggested "just more ways that you can include. More ways. More activity You can include." At the end, she added it was "nice, good, benefited from it."

Based on the three instruments (observation, reflection forms and interviews) I used, I found Pair 2 engaged together in the activities (Symmetry, Sphero robot and Scratch program) throughout the workshop, and followed the direction in the activities in the workshop. Both boys

found that the workshop's CT activities enriched their understanding of the mathematics concepts employed within the activities. Their mother felt similarly about the activities enriching the boys' understanding, as well as her own. Boy 1 felt the workshop encouraged him to engage with his parents, while Boy 2 felt the opposite. He did not feel encouraged to engage with parents but preferred to work alone or with friends.

Pair 3 (Boy and Dad)

Pair 3 was boy in a Grade six with his dad. They attended the second session of the workshop. They filled out the reflection forms, and I was able to interview them a month after they participated in the workshop. The boy spoke in English language during workshop and interview. The dad understands coding because it is his interest, and he told me that he is an IT person. Also, the boy has a background in coding as he mentioned in the workshop, and he told me that he had coded before using robots and programing apps. The following is description of the pair by observation, reflection forms and interviews.

Observation. In this pair especially, the boy asked his dad about each step in the booklet given to them, and his dad looked at the booklet and tried to help his child in each activity. They had a high engagement and interaction together, because the coding is related to dad's interests. As such, the boy had a positive interaction with his dad, and he responded to his dad's explanations. However, the boy also has a background in coding as he mentioned during the workshop, and I observed that he was playing easily with it. The boy's attitude was positive, and he directly dealt with the commands in the application, which is called Tickle, of the robot without waiting me to explain each detail. This may have helped him in the computational thinking activities, especially Sphero robot activity, because he had owned one before. This

shows that the Boy's engagement was high, and the dad's and boy's attitude was positive. The dad's interaction was high as well.

Reflection forms. Regarding to the questions written in the reflection forms of Symmetry, Sphero robot, and Scratch program activities, the boy responded to each question. In Symmetry reflection form, the first question was: what did you learn in Symmetry activity? He responded, "I learned about rotational Symmetry and flipping shapes and see if the Symmetry is the same." The second question was: write or draw the path or shape you have made in Symmetry activity. The boy drew a hexagon shape that was divided to 4 parts. The third question was, do you like this activity? You can draw an emoji to express your feeling. What thing most surprised you? The boy responded: "I liked this activity because I was surprised that there were Symmetry shapes, we can do it easily." The last question was: do you like working with your parents? The boy answered: "I like working with my parents because they help me a lot." In the Sphero robot reflection form, the first question was: list mathematical concepts you have learned from Sphero activities. For example: length, time, speed, angles, patterns, etc.… The response of the boy was: "go forward at 50% …. for 3 seconds and change color to green." The second question was: write or draw the path or shape you have made to make Sphero move. In response of the boy was: he drew himself and goes forward 5 steps. The third question was: do you like this activity? You can draw an emoji to express your feeling. What thing most surprised you? The boy's answer was: "I liked this activity because it can change math teaching from boring to fun." The last question in Sphero activity form was: do you like working with your parents? Why? The boy answered: "I like working with my parents because they help a lot." In the last activity in the workshop, the Scratch program, the first question was: list mathematical concepts you have learned from Scratch program activities. For example: length, time, speed, angles,

patterns, etc.… The boy answered: "we tried to do shapes, but it was too hard for me." The second question was: write or draw the path or shape you have made in Scratch program. The boy's response was: "I tried to do a straight line." The third question was: do you like this activity? You can draw an emoji to express your feeling. What thing most surprised you? The answer to this question was: "I didn't really like this activity because it is complicated." The last question was: do you like working with your parents? Why? The boy answered: "yes, they support me."

The dad filled out a reflection form on all the three activities. where the following are the responses to the questions included in this form. the first question was: Please, share with us why you selected to participate in this study? The dad answered: "to investigate new methodologies that might help me to help my kids." The second question was: In what ways you like or not like working with your child/ children? Why? The dad's response was: "I like to work with him in order to know where my kids might need help." The third question was: Did you learn or observe something new about: the workshop, your child, yourself? The response was: "yes, my boy was highly engaged, he started to brainstorm to draw a new shape. I learned that these technologies are very helpful." The fourth question was: Did you observe something new about mathematics? He answered: "yes, the workshop shows the m*ath in beautiful way* that we never expect see." The fifth question was: What surprised you or did you dislike in this workshop? The father answered: "I like the idea of robot; it makes my boy highly engaged." The last question was: What are your suggestions in future to improve these workshops? The dad answered: "give the kids more time."

The findings of the reflection forms of Pair 3. I found the boy spoke about learning several math concepts including polygons such as triangles, angles such as 120 degrees in a

triangle and exterior angles, and transformations such as rotation. The Boy's attitude and experiences towards the activities was positive because they "I liked this activity because it can change math teaching from boring to fun." However, he did not like the last activity (Scratch program "I didn't really like this activity because it is complicated." Boy likes to work with his parents because they "I like working with my parents because they help me a lot" and "yes, they support me." For dad, he chose to attend this workshop to "to investigate new methodologies that might help me to help my kids," and he had a positive attitude "I like to work with him in order to know where my kids might need help." Also, he observed "the workshop shows the m*ath in beautiful way* that we never expect see." Finally, he said, "I like the idea of robot, it makes my boy highly engaged" and he suggested "give the kids more time."

Interview. I interviewed the boy and his dad one month after the workshop. I met first with the boy, then his dad in the school staff room in the afternoon. First, the boy defined himself by telling me his age and Grade. He is 11 years old and in Grade six. His family has two boys and two girls, and his family speaks two languages at home: English and an unofficial language. He told me that he likes mathematics, computer and digital devices. He told me that he had not coded before during the interview, but on the day of the workshop he told me that he owned Sphero before and used coding with it. When I was observing him, he did well with Sphero. He can code easily, and it appeared he had experience with it. Second, the boy talked about using mathematics in daily life in sharing things with his siblings like "candy." He added "when I have five cookies, I share them. In equal parts." He then mentioned about doing his homework by himself but getting some help from his parents when he needs. Third, he told me about how his dad helped him during workshop. He said, "my dad helped me like if I did that wrong or Instruction you know to fix it." He added "he explains to me like a question. In the workshop he

tells me the instructions" and "telling the meaning." He also mentioned he did not do the activities with his parents before this workshop. He said, "I don't usually do activities with my parents. But in this workshop, I did." Fourth, the boy told me the Sphero robot was the favorite session, and he said "my favorite session was the robot's session, because it is a hands-on activity. We never used Robots before It was a very good experience using them." He may have meant in the math class because he mentioned on the day of the workshop that he owned one. When asked about his least favorite activity, he said "I guess Symmetry activity. I don't find it very fun, like boring." In general, he mentioned that these activities (e.g., Symmetry, Sphero and Scratch) enrich some mathematical concepts, such as length and angles, and he said, "when we do the angle and length in Sphero activity, it's more of visual way." He told me that he likes working with his dad, but he said, "he just watching me." He talked about the difficulties during the workshop and he said, "making the code for the Scratch activity and Sphero is difficult." He also added "everything is fine but some of the coding options weren't available, functional," and he suggested for next workshop to make more activities with Sphero robot. He said, "more time playing the Sphero." Lastly, he said " I find the workshop fun and helpful, and It's a better way to learn coding and in the same time doing math to learn, and also to see how angles like and it's a more of a way to see length to go two meters and do a line two meter long. It's a better way using the Sphero, it's a better way to see it."

A description of the interview with dad followed. First, he told me about his boy. He is 11 years old and in Grade six. He also added "he's good in math." When I asked him about how he is with digital devices, he said "he uses them." Second, when I asked dad about his boy's homework, he said, "he's doing by himself. He asks for some sometimes for help." Dad added regarding his achievement in mathematics, "he's doing well in the school." Third, he told me

about the family. It contains four children, two boys and two girls. Dad told me about his

educational level, a "PhD degree." He then told me they speak two languages at home, English

and an unofficial language. Fourth, we talked about mathematics and curriculum, for example,

about applying mathematics in the life. He said "yeah for sure. In measurement, the house

purchasing, counting. Everything is math. and counting." He also added about how he is helping

his children in mathematics. He said, "sometimes if they have any difficulty in any question, they

ask us, and we try to help them." I asked him about action and interaction during workshop, and

he said, "just Supervising the kid, and watching them." He added about interacting with his boy:

"he was so happy so engaged." Then he added "the kids liked the topic and they deal with math

heavily. In order to make their codes in order to move them, the robots. They try to brainstorm

the ideas in order to be succeed. I tried to help them and see how they are taught in the school.

Sometimes if you go in the wrong direction, I returned him back in order to do it correctly." He

also added "it was very interesting. The kids like it. And I saw my boy and other kids. They were

heavily engaged." When I asked him about his favorite activity in the workshop, he said

"Sphero, because it's encouraged the kids to think, how they can write the code in order to

perform the task." When I asked him about his least favorite activity he replied "Symmetry,

because it wasn't interesting like other topics." Regarding difficulties and challenges in the

activities, he said "not that Much, the instructions were a clear. Just. I told you that the time

sometimes short for the task. You need more time of activities." In his views, he finds these

workshops enrich mathematical concepts for students, "for example, to draw a square, they need

to know that it has the same length at all edges and the angles, so it's involved in many concepts

together." Also, he found the workshop encouraged him to engage with his children, and he

added "for example, that the kids nowadays like technologies like uh interaction not abstract

math as we used to have. So, it gives you an opportunity to know about a new math." Finally, for

his suggestion, he said, "to have more time to focus on certain topics like, for example, a Sphero

only. Just one activity. one activity and give them more time in order to." Lastly, dad said, "it

was a good experiment for us. I saw the kids as highly engaged and love it. They don't want it to

be done at the end. So, I saw that their wish that they have more time to continue."

Interview findings of Pair 3. I found the boy spoke about using mathematics in daily life

like sharing "candy" with his siblings, and doing his homework by himself, but getting some

help from his parents when he needs. He also spoke about action and interaction with his parent

"my dad helped me like if I did that wrong or instruction you know to fix it." His favorite session

was the Sphero activity and his least favorite session was the Symmetry activity. In addition, he

found these activities (e.g., Symmetry, Sphero and Scratch) enriched some mathematical

concepts, like length and angles. He found this workshop encouraged him to work with his

parents, and he suggested for next workshop to make more activities with Sphero robot or "more

time playing the Sphero. I find the workshop fun and helpful." For dad, he spoke about applying

mathematics in the life "In measurement, the house purchasing, counting. Everything is math.

and counting." Regarding action and interaction, he was "just Supervising the kid, and watching

them." He added "he was so happy so engaged" regarding his boy. His favorite activity was

"Sphero, because it encourages the kids to think," and his least favorite activity was "Symmetry,

because it wasn't interesting like other topics." Dad found these workshops enriched

mathematical concepts for students as angles. He also found this workshop encouraged him to

engage with his children. Dad suggested "have more time to focus on certain topics." At the end,

he added "it was a good experiment for us. I saw the kids as highly engaged and love it."

Based on the three instruments (observation, reflection forms and interviews) used, I found Pair 3 completed the reflections, worked through the activities (Symmetry, Sphero robot and Scratch program), and it appears they engaged together and followed the direction in the activities in the workshop. Both the boy and his father both felt that the workshop activities enriched their understandings of mathematical concepts employed in the workshop. The boy and his father also felt that the activities encouraged engagement with each other, both during and outside of the workshop activities.

Pair 4 (Girl and Dad)

Pair 4 was a girl with her dad. The girl was in Grade 5, and she spoke English during the workshop and the interview. They attended the second session of the workshop. They filled out the reflection forms during the workshop. Directly after the workshop I was able to interview them at the school in the library in the afternoon. The following is a description of the pair by observation, reflection forms and interviews.

Observation. This pair took a longer time than others when they were following the instructions of the three activities in the workshop. However, they were accurate when they were applying computational thinking activities, which means they had a high level of engagement and interaction together. I observed the girl depended on her dad to make sure if she was correct or not. This indicated they had positive interactions together. This demonstrated that the girl's level of engagement was high, and the dad's and girl's attitudes were positive. The dad' s interaction level was high as well.

Reflection forms. In the reflection forms for the Symmetry activity, Sphero robot, and Scratch program, I received the responses of the girl and her dad. In the Symmetry reflection form, the first question was: what did you learn in the Symmetry activity? The girl responded, "I

learned about Symmetry in many shapes, in different angles." The second question was: write or draw the path or shape you have made in Symmetry activity. The girl answered, "the square, triangle, and hexagon." The third question was: do you like this activity? You can draw an emoji to express your feeling. What thing most surprised you? The girl responded: "I liked it! The many ways to have Symmetry." The last question was: do you like working with your parents? The girl answered: "yes because (her answer not completed). In the Sphero robot reflection form, the first question was: list mathematical concepts you have learned from Sphero activities. For example: length, time, speed, angles, patterns, etc.… The girl's response was: "triangle, square, hexagon, octagon and straight line. spinning, jumping, time, and speed." The second question was: write or draw the path or shape you have made to make Sphero move. In response the girl drew a Triangle, square, and hexagon. The third question was: do you like this activity? You can draw an emoji to express your feeling. What thing most surprised you? The girl's answer was: "I really liked it! That it can move using a code." The last question in Sphero activity form was: do you like working with your parents? Why? The girl answered: "yes." In reflection form for the last activity in the workshop, the Scratch program, the first question was: list mathematical concept you have learned from Scratch program activities. For example: length, time, speed, angles, patterns, etc.… The girl answered: "draw, sound, shape." The second question was: write or draw the path or shape you have made in Scratch program. The girl's response was: "square, line, spiral." The third question was: do you like this activity? You can draw an emoji to express your feeling. What thing most surprised you? Her answer to this question was: "yes, you can make shapes and have sounds". The last question was: do you like working with your parents? Why? The girl answered: "yes, because they help me."

The dad filled one reflection form of the three activities. The first question was: Please, share with us why you selected to participate in this study? The dad answered: "to encourage my girl to learn new stuff and ways of teaching." The second question was: In what ways do you like or not like working with your child/children? Why? The dad's response was: "I like that she likes the Sphero and the Scratch apps." The third question was: Did you learn or observe something new about: the workshop, your child, yourself? The response was: "my girl likes to explain and check all the available features in (Scratch) and see what happens." The fourth question was: Did you observe something new about mathematics? He answered: "I felt it is like more IT coding and ways of thinking than just pure math." The fifth question was: What surprised you or did you dislike in this workshop? Father answered: "like the coding technique that makes the child think in different ways." The last question was: What are your suggestions in future to improve these workshops? The dad answered: "more parents would join if they knew in detail about what will happen in the workshop, as it is very exciting and useful for both kids and parents. Thanks."

Findings from reflection forms of Pair 4. The girl spoke about learning several math concepts including polygons such as triangles, angles such as 120 degrees in a triangle and exterior angles, and transformations such as rotation. The girl's attitude and experiences towards the activities were positive: "I really liked it! That it can move using a code." The girl likes to work with her parents: "yes, because they help me." For dad, he chose to attend this workshop to "to encourage my girl to learn new stuff and ways of teaching." He liked working with his girl "like the coding technique that makes the child think in different ways," and he said, "it is very exciting and useful for both kids and parents."

Interview. I interviewed the girl and her dad directly after the workshop directly I met first with the girl then her dad at the school in the library and in the afternoon. First, the girl

defined herself by telling me her age and Grade. She is 10 years old and in Grade five. Her family has two girls and a boy, and her family speaks two languages at home: English and an unofficial language. She told me that she likes mathematics, computer and digital devices, but she had never coded before or used robots. Second, the girl talked about using mathematics in daily life, she said "I'm going to store to buy something to calculate some prices." Then she mentioned about doing her homework by herself. Third, she told me about how her dad helped her during workshop. She said, "they helped me learn how to code. My dad supports me. I had fun and I learned a lot of things." She also said, "I like my dad with me." When I asked her about if this workshop is different from other places to learn, she said, "yes, because we do experiments." Fourth, the girl told me the Sphero robot was her favorite session, specifically she said, "coding with a robot." She told me that the Symmetry activity was her least favorite session, and she said it was "boring." In general, she mentioned about these activities (e.g. Symmetry, Sphero and Scratch) enriched some mathematical concepts, and she said, "that helps. Like when you combine the angles and the movement," and she added "how you can code without using

wires and that kind of stuff." She mentioned that this workshop encouraged her to work with her parents more because she liked that, as she mentioned earlier on in the interview. She said, "it's difficult for kids." Last, she said about the workshop, "I really like it."

The following is a description of the interview with the dad. First, he told me about his child, stating that she is 10 years old and in Grade five. He added "she loves mathematics and science. She actually wants to be a scientist when she grows and does experiments and stuff like this." When I asked him about how she is with digital devices, he replied "just an iPad. She doesn't choose like coding and stuff." Second, I asked dad about helping his girl's homework, he

said "she does everything on her own." He spoke about his girl's achievement in mathematics.

He said, "she is maybe the best." Third, dad told me about the family. He said, "I am married

with three kids, two girls and one boy, 11 or 10, 7 and 3 years old." He told me they speak

English language and an unofficial language at home. Fourth, we talked about mathematics and

curriculum. For example, about applying mathematics in daily life. Dad said "yeah, mathematics

in every aspect of the life, like, when you make your budget for buying stuff." He added

"calculator, we cannot live without a calculator. So, everything is calculated by math." He

talked about helping his child in mathematics; he said "basically I don't study with her, but I do

tests with her. After she finished her study. I just sit with her for like 10 minutes, ask a couple of

questions. Make sure she understands, if she has a problem, I fix it. If not then she's good, like

when she was younger, she'd have problems between division and multiplication. I just tried to

give examples on how to think about that and that's it." He mentioned about never having

attended any workshops with his children. I asked dad about action and interaction during

workshop, he said "yes, I like the way of coding the way that you give orders and based on these

orders you can't see the square or the triangle or whatever. So, this makes you think how to draw

a square not just draw it like this. You know that it takes 90 degrees as it has four sides yah all

this. So, this is a good way to let them think. And then based on the way they are thinking they

see the outcome and then they can readjust what they have. They have used to make the proper

outcome." He added about interacting his girl "I just figure out that she wants to explore

everything. I don't know that I thought she would just do the basics and that's it, but I found that

she wanted to see what did that. What is that. What if we clicked here, what if we clicked there?

I didn't expect that. We could have just a little bit more time. So, we can learn about this coding

look we're doing this coding, but some tricks it takes some time so maybe more time, but as a

basic knowledge, this is good enough. Yeah but to go and explore more and more items, you need more time. That's why we need to download the app at home." He said, "haven't been to any other workshops with my girl, but this workshop was really good."

When I asked Dad about the favorite session in the workshop, he said, "the Scratch, because it's simpler like on the iPad I can just do it. I do have to buy this Sphero at the end of the day I don't want to pay. The Sphero I have to buy it, which is like a hundred bucks, but a Scratch it's just an online app. It has the same concept of coding and that way of thinking and seeing the outcome. So, it's more visible for everyone." Also, dad added "the Symmetry, it was pretty boring, is good but is boring, when You compare to others." When I asked dad about difficulties and challenges in the activities, he said "It is good. Especially, if you work step by step with your girl or boy to be." In his views, dad finds these workshops enrich mathematical concepts for students, and he said, "in terms of Triangle, draw triangle, draw hexagon, but I guess it can be for lower Grades even like my Grade 5. It can go to Grade 2 or 3, because it's a square and triangle definitions. Maybe for Grade one or two." He also found this workshop encouraged him to engage with his girl, and he added "it's very interesting. So, I like to sit with my girl and do it." Finally, for his suggestion, dad said "if you just let the parents knowing details what's going to happen. because I didn't know in detail that there will be a Sphero and Scratch the activity that we do. If they knew that there would be a Sphero and will do this and this and that it would be more interesting, they will come, and then it's very interesting so I'm happy I came. if I knew before I would have like a hundred percent come." At the end, dad said, "I'm very happy I came here. It's really nice." It should be noted here that I did send a letter and it said robots will be engaged in learning mathematics.

Findings from interviews of Pair 4. The girl spoke about using mathematics in daily life: "I'm going to store to buy something to calculate some prices" and doing her homework by herself. She also spoke about action and interaction with her parent "they helped me learn how to code. My dad supports me." Her favorite activity was the Sphero activity and her least favorite was the Symmetry activity. In addition, she found these activities (e.g., Symmetry, Sphero and Scratch) enriched some mathematical concepts for her: "that helps. Like when you combine the angles and the movement." She found this workshop encouraged her to work with her parents "I really like it." For dad, he spoke about applying "mathematics in every aspect of the life, like, when you make your budget for buying stuff," and he said about the action and interaction "I like the way of coding, This is a good way to let them think." He added about interacting his daughter: "I just figure out that she wants to explore everything." His favorite activity was "the Scratch, because it's simpler like on the iPad I can just do it," and his least favorite session was "the Symmetry, it was pretty boring." Dad found these workshops enrich mathematical concepts for students "in terms of triangle, draw triangle, draw hexagon." He found this workshop encouraged him to engage with his children. "it's very interesting. So, I like to sit with my girl and do it." Dad suggested "if you just let the parents knowing details." At the end, he added "I'm very happy I came here. It's really nice."

Based on the three instruments (observation, reflection forms and interviews) I used, I found Pair 4 (girl and her dad) completed the reflections, worked through the activities (Symmetry, Sphero robot and Scratch program), and it appears they engaged together and followed the directions for the activities in the workshop. Both the girl and her father both felt that the workshop activities enriched their understandings of mathematical concepts employed in the workshop. The girl and her father also felt that the activities encouraged engagement with

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each other, both during and outside of the workshop activities. The girl found her father to be supportive, and the father thought the activities let his daughter think.

Pair 5 (Girl and Mom)

Pair 5 was a girl with her mom. The girl was in Grade 3, and she spoke in English language during the workshop and the interview. They attended the first session of the workshop. They filled out the reflection forms during the workshop. After one week, I was able to interview them at the school in the staff room during the afternoon. The following is a description of the pair by observation, reflection forms and interviews.

Observation. During observing this pair, I found them working together which meant the mom and the girl had a positive attitude together, but mainly mom's work was watching the work of her child. This means the mom had a medium interaction with the activities, and the mom was trying to understand the computational thinking activities by watching the girl. The girl worked on the activities during the workshop, so she had a high level of engagement in computational thinking activities. This demonstrates that the girl's engagement was high, and the mom's attitude and the girl's attitude were positive.

Reflection forms. In the second stage of collecting data which is reflection forms of Symmetry activity, Sphero robot, and Scratch program, I obtained the responses of girl and her mom. In Symmetry reflection form, the first question was, what did you learn in Symmetry activity? the girl responded, "I learned that if you rotate the shape the numbers are different not the shape." The second question was, write or draw the path or shape you have made in Symmetry activity. The girl drew two had one dot, two dots, and three dots on their corners. The third question was, do you like this activity? you can draw an emoji to express your feeling. What the most thing surprised you? the girl drew a happy face. The last question: do you like

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working with your parents? The girl answered: "yes because they help me a lot." In Sphero robot

reflection form, the first question was: list mathematical concepts you have learned from Sphero

activities. for example, :(length, time, speed, angles, patterns, etc.…). The response of girl was:

"coding helps you make shapes with the right amount of speed." In the second question

was: write or draw the path or shape you have made to make Sphero move. The girl's response

was, she drew a square, a triangle, and a hexagon. The third question was: do you like this

activity? you can draw an emoji to express your feeling. What the thing most surprised you. The

answer of girl was she drew a happy face and thumbs up. The last question of Sphero activity

form was: do you like working with your parents? why? the girl answered: "yes they can help me

a lot!" In the last activity in the workshop, which was Scratch program, the first question was:

list mathematical concept you have learned from Scratch program activities. for example:

(length, time, speed, angles, patterns, etc.…). The girl answered: "I learned how you can make

shapes with Scratch." In the second question was: write or draw the path or shape you have

made in Scratch program. In response of girl was: "jumping" and she drew a boy is jumping. The

third question was: do you like this activity? you can draw an emoji to express your feeling.

What the thing most surprised you. The girl drew a happy face and thumbs up. In the last

question was: do you like working with your parents? why? the girl answered: "yes, my mom

help me a lot." The mother filled one the reflection form of the three activities. The first question

was: Please, share with us why you selected to participate in this study? the mom answered: "I

selected to participate as this is something new, which I never have experience." The second

question was: In what ways you like or not like working with your child/ children? Why? the

response of mom was: "I like to work with my child as in this way we learn together. Specially

my child has more knowledge of technology than me." The third question was: Did you learn or

observe something new about: the workshop, your child, yourself? the response was: "yes, for sure, with adding Sphero, Scratch other program, they love to learn more enthusiastically rather than old traditional way." The fourth question was: Did you observe something new about mathematics? she answered: "specially I learn about Symmetry, which I never knew as by adding coding the shape will remain same." The fifth question was: What surprised you or dislike in this workshop? mom answered: "I surprised to see Sphero. It works with putting different coding. I love this activity." The last question was: What are your suggestions in future to improve these workshops? The mom answered: "overall it was good but if they have more gadget maybe it will be more fun."

Findings of reflection forms of Pair 5. I found the girl spoke about learning several math concepts including polygons such as triangles, angles such as 120 degrees in a triangle and exterior angles, and transformations such as rotation. The girl's attitude and experiences towards the activities was positive and she drew a happy face and thumbs up. The girl likes to work with her parent "yes because they help me a lot." For mom, she chose to attend this workshop because "this is something new, which I never have experience." Mom liked working with her child: "I like to work with my child as in this way we learn together," and she observed "they love to learn more enthusiastically rather than old traditional way," The mom also said "overall it was good but if they have more gadget may be it will be more fun."

Interview. I interviewed the girl and her mom one week after the workshop in the afternoon. I met first with the girl and then her mom at the school in the staff room. First, the girl defined herself by telling me her age and Grade. She is 9 years old and in Grade three, and she said, "my favorite color is Purple. I have one brother and I have one sister." She told me that her family speaks English and an unofficial language at home. She also told me that she likes

mathematics, computer and digital devices. She has used a robot before and she said, "it was the same thing (she means Sphero), but it was called something else, I forgot what it was called, but something else." Second, the girl talked about using mathematics in daily life, she said, "it's like, when you going to the store, you can add up the money, like to see if you have a one dollar bill or a 20 dollar bill and you have like three items and they all cost like 15 dollar and like you know that you can buy." She added "when you cut things that you have when you need three onions for soup. You get three only you can't get four, it might get wrong." When I asked her about getting help from her parents, she answered "yeah. If I don't know that stuff." Third, the girl told me about how her mom helped her during the workshop. She said, "my mom helped me in the coding like the angles and or how much she does it like 360 or like 60." She also said "when I get home it's always on pieces of paper. It's like not like any other activities. It's like not anything different than that. and how we were on the computers doing Scratch and all that stuff and doing homework isn't like that. Like apps and Sphero robot." Fourth, the girl told me "I liked the Sphero robot activity, because I was trying to code it and it would move and like jump. It was fun." She also told me "I don't have a least favorite." She talked about difficulties and challenges she had during the activities: "it was hard for me to find out which angle would you use." In general, she mentioned that these activities (e.g., Symmetry, Sphero and Scratch) enrich some mathematical concepts, such as length and angles. She said, "it like help me to make sense about the angles." She mentioned that this workshop encouraged her to work with her parents more because she liked that, and she did not suggest anything for next workshop. Lastly, she said about the workshop: "it's fun, like, I can do it every day because it's really fun."

An interview with the mom followed. First, she told me about her girl. She is 9 years old and in Grade three. She added "she is good at math. She loved math, but only some things are

hard like fractions, is only hard part. Otherwise, she loves it." When I asked her about how she is with digital devices, she said, "she did well in digital devices. She can play the games." She said about robots: "she can manage more than me because I am not good at this stuff. She's good at it." Second, I asked her about doing her homework she said "she do it by herself. Sometimes she needs a help." Mom added about her child's achievement in mathematics: "she has always A plus student." Third, she told me about the family: "I have three children two girls and one boy." She told me about her educational level, and she has a master's degree. She said they speak English and an unofficial language at home. Fourth, we talked about mathematics and curriculum. For example, about applying mathematics in the life. She said "we apply math in every way especially as a mom. I relied on always in the baking and the kitchens stuff all the time, and especially shopping too we need the money and everything and the budget for the month. So, yeah, everything should be in the financing goes into that too." She talked about how she helps her children in mathematics. She said, "I have a computer apps for the math, if they need help doing it to computer, like some courses or sometimes they have a good Grade level math questions, and I did help too," and she said that she helps them in their homework.

She mentioned about attending the workshop: "we did lot of competitions like math camp that can do these types of things, but I don't think so would attend any Workshop." I then asked her about action and interactions during workshop, she said "yeah, I'd like if she needed help something, she's not getting it and as she's feeling shy to ask. So, I just helped her to do it. Sometimes hard for them to listen like it's not easy for them to understand English. They have it, so I just help her in the meaning of this." She added about interacting her girl: "she is good. Whatever, she need help, I just gave her help and we both interacted with each other, and we do like as a group." Then mom said, "the Symmetry was new, because I always think about the

square as just you said changing the position and putting the dots, this is something new, and the robots. I have no experience with these things." When I asked her about her favorite activity in the workshop, mom added "for myself, I love Sphero, because there are many things. After I came back home, and my daughter want to buy this. I have to buy this one. We can learn angles and pretty good." She did not mention her least favorite session. Regarding difficulties and challenges in the activities, she said "I am not good at coding, so it's hard for me." In mom's views, she finds these workshops enrich mathematical concepts for students, she said, "I don't know the other things like that with the things we learned for Symmetry and angles and other things so maybe in these things is helpful a lot" and "very interesting." She also found the workshop encouraged her to engage with her children, and she added "if even we both together make something together because this is something new of us. So, we want to engage with each other. In this way, they teach me the coding, so I will learn and then we go learn something new. So, I love to engage." Finally, for her suggestion, mom said "can have a one-to-one thing, more material. So, they can learn more easily and then they don't have to wait for the turns." She also added "I think you should just put these things in the school materials as soon as possible, because they then love the math. So, they should learn in a happy ending not like they hate math."

   Findings of interviews of Pair 5. I found the girl spoke about using mathematics in daily life "when you going to the store." She also spoke about action and interaction with her parent "my mom helped me in the coding like the angles." Her favorite session was the Sphero activity and she did not have a least favorite activity. In addition, she found these activities (e.g., Symmetry, Sphero and Scratch) enriched some mathematical concepts: "it like help me to make sense about the angles." She found this workshop encouraged her to work with her parents: "It's

fun, like, I can do it every day because it's really fun." For mom, she spoke about applying

mathematics in the life: "we apply math in every way especially as a mom." She said about

action and interaction: "if she needed help something, she's not getting it and as she's feeling shy

to ask. So, I just helped her to do it." Mom added about interacting her girl: "she is good.

Whatever, she need help, I just gave her help and we both interacted with each other." Mom's

favorite activity was Sphero, stating "I love Sphero, we can learn angles and pretty good." She

did not mention a least favorite activity. Mom found these workshops enrich mathematical

concepts for students and are "very interesting." She also found this workshop encouraged her to

engage with his children "I will learn and then we go learn something new. So, I love to engage."

Mom suggested "can have a one-to-one thing, more material" and would like to "put these things

in the school materials." At the end, she added "they should learn in a happy ending not like they

hate math."

Based on the three instruments (observation, reflection forms and interviews) used, I

found Pair 5 (girl and her mom) completed the reflections, worked through the activities

(Symmetry, Sphero robot and Scratch program), and it appears they engaged together and

followed the direction in the activities in the workshop. The girl and her mom both felt that the

workshop activities enriched their understandings of mathematical concepts employed in the

workshop. The girl felt that the workshop encouraged engagement with her mom with

mathematics activities, even though the engagement may take a different form outside of the

workshop. The mom agreed that the workshop encouraged engagement, saying that she likes to

help her children however she can.

Pair 6 (Boy and Mom)

Pair 6 was a boy with his mom. The boy was in Grade 4, and he spoke in English language during the workshop and the interview. They attended the first day of workshop. During the workshop they completed the reflection forms. One week after the workshop I was able to interview them at the school in the library during afternoon. The following is description of the pair by observation, reflection forms and interviews.

Observation. During the observation stage, I saw the boy in Grade 4 and his mom were working together and followed the instructions carefully. They were struggling in the beginning, the mom especially, because it is a new way to learn mathematics. They had a positive attitude together. The boy's mom was mainly watching him, and mom was trying to learn about computational thinking activities, meaning she had a medium interaction during the activities. I saw the boy's engagement in the activities was high with a positive attitude during the workshop. This shows that the boy's engagement was high, and the mom's attitude and the boy's attitude were positive. The mom's interaction with boy was medium.

Reflection forms. In the reflection forms for the Symmetry, Sphero robot, and Scratch program activities, I received responses from the boy and his mom. In the Symmetry reflection form the first question was: what did you learn in Symmetry activity? The boy responded, "the shape stays the same when it turns it's really changing." The second question was: write or draw the path or shape you have made in Symmetry activity. The boy drew a square that had one dot, two dots, three dots, and four dots in its corner. The third question was: do you like this activity? You can draw an emoji to express your feeling. What thing most surprised you? The boy responded: "yes when I saw the shape remained the same, I was surprised when I turned it it's really changed." The last question was: do you like working with your parents? The boy answered: "yes because mom tell me. Explain to help me out to understand." In the Sphero robot

reflection form, the first question was: list mathematical concepts you have learned from Sphero activities. For example: length, time, speed, angles, patterns, etc.… The response of boy was: "60, 6, 60 second, 60 for 6 times." The second question was: write or draw the path or shape you have made to make Sphero move. In response the boy drew a Triangle. The third question was: do you like this activity? You can draw an emoji to express your feeling. What thing most surprised you? The boy's response was: "yes, very impressed," and he drew a happy face. The last question in Sphero activity form was: do you like working with your parents? Why? The boy answered: "yes, it is more fun." in the reflection form for the last activity in the workshop, the Scratch program, the first question was: list mathematical concepts you have learned from Scratch program activities. for example: length, time, speed, angles, patterns, etc.… The boy answered: "30, 6, 50, 90...." The second question was: write or draw the path or shape you have made in Scratch program. The boy drew a line. The third question was: do you like this activity? You can draw an emoji to express your feeling. What thing most surprised you? His answer to this question was: "it was very useful." The last question was: do you like working with your parents? Why? the boy answered: "yes, it is fun."

The mother filled out one reflection form for the three activities. The first question was: Please, share with us why you selected to participate in this study? The mom answered: "I am interested to help my boy." The second question was: In what ways you like or not like working with your child/children? Why? The mom's response was: "I didn't like group working but I was satisfied." The third question was: Did you learn or observe something new about: the workshop, your child, yourself? Her response was: "yes, I did I found fun ways to teach the children the math." The fourth question was: Did you observe something new about mathematics? She answered: "the new tech is really helpful for the kids." The fifth question was: What surprised

you or did you dislike in this workshop? Mom answered: "everything was good, and I was impressed." The last question was: What are your suggestions in future to improve these workshops? The mom answered: "one on one it would be more useful."

Findings from reflection forms of Pair 6. The boy spoke about learning several math concepts including polygons such as triangles, angles such as 120 degrees in a triangle and exterior angles, and transformations such as rotation. The boy's attitude and experiences toward the activities were positive: "yes, very impressed" and "it was very useful." The boy likes to work with his parent: "yes because mom tell me. explain to help me out to understand" and "it is fun." For mom, she chose to attend this workshop because "I am interested to help my boy." Regarding liking working with her boy she said, "I found fun ways to teach the children the math"; "the new tech is really helpful for the kids." In her view "everything was good, and I was impressed," and she suggested "one in one it would be more useful," because "I didn't like group working but I was satisfied."

Interview. I interviewed the boy and his mom one week following the day of the workshop. I met first with the boy then his mom at the school library in the afternoon. First, the boy defined himself by telling me his age and Grade. He is 9 years old and in Grade four. His family has two boys and three girls, and his family speaks two languages at home: English and an unofficial language. He told me that he likes mathematics, computer and digital devices, but he did not use coding before the workshop. Second, when the boy talked about using mathematics in daily life, he replied that his mom tests him in mathematics. He then mentioned that he does his homework sometimes by himself. Third, he told me about how his mom helped him during workshop. He said, "sometimes when I am not focusing, she tells me to pay attention." He also said, "I like them play." Fourth, the boy told me the Sphero robot was the

favorite session, and he said it was "because I liked playing with, I like playing with robots and like other mechanical stuff." He told me the Scratch program was his least favorite session, and he said, "it was really complicated." In general, he mentioned that these activities (e.g., Symmetry, Sphero and Scratch) enriched some mathematical concepts, such as length and angles and he said, "when you were showing me the square thing, I thought it was the same thing, but then you guys showed me it was different, so then after, I showed it to my friends and they like nothing changed and I told them what, how it happened, then after I got to the hang of it, then I never knew it would get like think it would be difficult.. It was kind of good. I liked it." He mentioned that this workshop encouraged him to work with his parents more because he liked that as he mentioned earlier during the interview, and he said, "it's good, maybe it's confusing because it's a new stuff."

A description of the interview with the mom follows. First, she told me about her child, sharing he is 9 years old and in Grade four. She said "he is good in mathematics. He has his days up and down." She also said, "he like it," when I asked her how he is with digital devices, and she when told me about using robot she said, "I think he didn't know about coding before this." Second, I asked her about doing his homework she said, "he is improving a lot." Regarding his achievement in mathematics she said "we helped him all the time. Like we have to stay on top of him." Third, she told me about their family, which contains five children. She told me about her educational level. She has a "diploma." She also told me they speak English and an unofficial language at home. Fourth, we talked about mathematics and curriculum. For example, applying mathematics in daily life. She said "it applies now with my kids. Sometimes, we play like a little game multiplication, adding specially when the boys are young. So, we try to help them out to memorize this in early age." She said, regarding helping her children in mathematics, "we have

to help them not me the dad. If not the dad that girl like the sister. So, there's always somebody."
She mentioned she had not attended previous workshops, saying "no, just that one." I asked her
about action and interaction during the workshop and she said, "try to help the child
understanding, concentrate on things and show him that it's important to learn, I guess." She
added about interacting her boy "it was fun, he was having fun I don't think it made a difference
if I was there or not" and "it's just the workshop was totally different than homework at home.
We have it really got your ourselves introduced to something like this, but myself I don't know
with technology every day. You never know the kids know more about it than us." She told me
that Sphero was her favorite session, and she said, "it was very interesting." When I asked her
about the least favorite session? she replied "maybe the last one (it was Scratch program) he
didn't understand it. Maybe it was the last activity." When asked about difficulties and
challenges in the activities, she said "it's just the concept of getting the idea. once you get the
idea of it how it works then it gets easier maybe because it new." In her view, she did not find
this workshop to enrich mathematical concepts for students. She said this workshop is
encouraging her to engage with her children: "actually, if you want to work with him, it doesn't
have to be this. You could do it in a different way, any different ways to engage with your kids
doesn't have to be in the workshop." Finally, mom did not have any suggestions, and when asked
about how she found this workshop through context activity and engagement she said, "it's fine."

   Findings from interviews with Pair 6. The boy spoke about using mathematics in daily
life like his mom testing him in mathematics. He is doing his homework sometimes by himself.
He spoke about action and interaction with his parent "sometimes when I am not focusing, she
tells me to pay attention" and "I like them play." His favorite session of was the Sphero activity,
and the Scratch program was his least favorite session. In addition, he found these activities (e.g.

Symmetry, Sphero and Scratch) enrich some mathematical concepts: "it was kind of good. I liked it," and he found this workshop encouraged him to work with his parents: "it's good, maybe it's confusing because it's a new stuff." For mom, she spoke about applying mathematics in daily life: "we play like a little game multiplication," and she said about act and interact "we have to help them. Try to help the child understanding, concentrate on things." Mom added about interacting her boy: "he was having fun." Her favorite activity was the Sphero activity: "it was very interesting," and her least favorite session "maybe the last one (the Scratch program) he didn't understand it." Mom found these workshops enrich mathematical concepts for students: "it's just the concept of getting the idea. once you get the idea of it how it works then it gets easier maybe because it new." Also, she found this workshop encouraged her to engage with her children: "actually, if you want to work with him, it doesn't have to be this. You could do it in a different way, any different ways to engage with your kids doesn't have to be in the workshop." Mom did not suggest anything and at the end, she added "it's fine."

Based on the three instruments (observation, reflection forms and interviews) I used, I found Pair 6 (boy and his mom) completed the reflections, worked through the activities (Symmetry, Sphero robot and Scratch program), and it appears they engaged together and followed the direction in the activities in the workshop. Both the boy and his mother both felt that the workshop activities enriched their understandings of mathematical concepts employed in the workshop. The boy and his mother also felt that the activities encouraged engagement with each other, including outside of the workshop.

Pair 7 (Boy and Mom)

Pair 7 was a boy with his mom. The boy was in Grade 4, and he spoke English during the workshop and the interview. They attended the first session of workshop. They completed the

reflection forms during working in the workshop. I was able to interview them in the school

library in the afternoon three weeks after the workshop. The following is description of the pair

by observation, reflection forms and interviews.

Observation. For this Grade 4 student with his mom, I found their interaction depended

on following the instructions by the boy. His mom just was watching him. I saw the boy teaching

his mom about computational thinking activities like how to code. He was showing her the

coding and the outcomes from coding. In addition, the boy gave his mom some knowledge in

English words and some mathematics concepts. From observing this, I can say they had a

positive attitude together. During the session, the pair worked on the activities and completed the

tasks which means they had a high level of engagement and interaction with the activities. This

evinces that boy's engagement was high, and the mom's attitude and the boy's attitude were

positive. The mom's interaction was high as well.

Reflection forms. The second instrument I used to collect data was reflection forms for

the Symmetry activity, Sphero robot, and Scratch programs. I gathered the responses of boy and

his mom. On the Symmetry reflection form the first question was: what did you learn in

Symmetry activity? The boy responded, "I learned that lines of Symmetry are more like

transformations lines that separate the shape." The second question was: write or draw the path

or shape you have made in Symmetry activity. The boy drew a triangle with three axes one of

them is Symmetry line. The third question was: do you like this activity? You can draw an emoji

to express your feeling. What thing most surprised you? The boy drew a happy face and he

responded: "the thing that surprised me is how the code worked." The last question for this

activity was: do you like working with your parents? The boy answered: "I like working with my

parents because they have been learning more stuff than me and they teach me new stuff." On

the Sphero robot reflection form, the first question was: list mathematical concepts you have learned from Sphero activities. For example: length, time, speed, angles, patterns, etc.… The boy's response was: "length, time, speed, the shape, and etc.…" The second question was: write or draw the path or shape you have made to make Sphero move. In response the boy drew a cup and wrote "a cup." The third question was: do you like this activity? You can draw an emoji to express your feeling. What thing most surprised you? The boy drew a happy face and he wrote "I was surprised about how fast it went and all the codes it had." The last question in Sphero activity form was: do you like working with your parents? Why? the boy answered: "I like working with them because they know everything, and they teach me new stuff." In the reflection form for the last activity in the workshop, the Scratch program, the first question was: list mathematical concepts you have learned from Scratch program activities. For example: length, time, speed, angles, patterns, etc.… The boy answered: "length, time, speed, saying stuff, etc.…" The second question was: write or draw the path or shape you have made in Scratch program. The boy drew a line. The third question was: do you like this activity? You can draw an emoji to express your feeling. What thing most surprised you? The boy drew a happy face. The last question was: do you like working with your parents? Why? The boy answered: "because they teach me new stuff."

The mother filled out a single reflection form for all three activities. The first question was: Please, share with us why you selected to participate in this study? The mom answered: "to learn how to connect math with tech." The second question was: In what ways you like or not like working with your child/children? Why? Her response to this question was: "I like, to know my boy is know the work or not." The third question was: Did you learn or observe something new about: the workshop, your child, yourself? Her response was: "yes, I did, it's interested."

The fourth question was: Did you observe something new about mathematics? Mom answered: "yes, I did." The fifth question was: What surprised you or did you dislike in this workshop? Mom answered: "I like the workshop." The last question was: What are your suggestions in future to improve these workshops? The mom answered: "to know how to develop us (perhaps she means parents) to connect the math with tablet."

Findings of reflection forms of Pair 7. I found the boy spoke about learning several math concepts including polygons such as triangles, angles such as 120 degrees in a triangle and exterior angles, and transformations such as rotation. The boy's attitude and experiences towards the activities was positive. He said things like "the thing that surprised me is how the code worked" and "I was surprised about how fast it went and all the codes it had." The boy likes to work with his parent "I like working with my parents because they have been learning more stuff than me and they teach me new stuff." For mom, she chose to attend this workshop in order "to learn how to connect math with tech." Regarding liking working with her boy, she said "I like, to know my boy is know the work or not." She said, "I like the workshop" with the reason given "to know how to develop us (perhaps she means parents) to connect the math with tablet."

Interview. I interviewed the boy and his mom three weeks after the workshop session. I met first the boy then his mom at the school in the library in the afternoon. First, the boy defined himself by telling me his age and grade. He is 10 years old and in Grade four. His family has two boys and a girl, and his family speaks two languages at home: English and an unofficial language. He told me that he likes mathematics, computer and digital devices, but he said, "don't work with the robots." Second, the boy talked about using mathematics in daily life. He said, "yes, I do, when I make art. Like knowing how much degrees. When you want for example draw a square for example, house, like that, first thing I need to draw a square." He also talked about

doing his homework by himself. Third, he told me about how his mom helped him during workshop. He said, "they told me, if I did something wrong and help me". He also said, "my mom helps when I don't know what some questions in that, but mostly I do it alone." He talked about helping his parents also: "I teach them English (some concepts his mom does not know)." The boy found the action and interaction in the workshop was the same when comparing it with another time or place, but he added "but in workshop, It's a fun, but in homework sometimes it's boring." Fourth, the boy told me the Sphero robot was his favorite activity, "because it's makes me choose and if you want make a shape. I need to learn how to make it with robots. I like this studying." He also told me that the Symmetry activity was his least favorite session, "because the only thing I didn't. Symmetry is look at the code and I did the angles." In general, he mentioned that these activities (e.g., Symmetry, Sphero and Scratch) enriched some mathematical concepts, such as length and angles. He said the workshop encouraged him to work with his parents more because he liked that, as he mentioned during the interview, and he suggested for next workshop to make more activities. Lastly, he said about the workshop: "I find it very fun and teaches me more."

The mom was interviewed following her son and a description of the interview follows. First, she told me about her child. He is 10 years old and in Grade four. She said, "he is good in mathematics." Her response was "he like it" when asked about how her son is with digital devices, and she mentioned about he had not used a robot before. Second, I asked her about doing his homework. She said, "he did everything alone." She said, "he is good" regarding his achievement in mathematics. Third, she told me about the family. It contains three children, two boys and a girl. Her educational level is a "bachelor's degree in computer science." She told me they speak an unofficial language at home. Fourth, we talked about mathematics and curriculum,

for example, about applying mathematics in the life. She responded with "counting, degrees, cutting in equal parts for example, 1/3 2/3 like cutting the salad." She helps her children in homework when they ask for it, she said "sometimes." She mentioned about this the first time she attended these kinds of workshops. I asked her about action and interaction during workshop, she said it was "interesting." She also added about interacting her boy "he likes it." She said that the Sphero and the Scratch program were her favorite activities. Because, she said, "using the angles with the shape and how-to arrangement there, maybe the coding." She replied, "Symmetry because it is normal nothing new," when I asked her about her least favorite session. Regarding difficulties and challenges in the activities, she said she did not find any difficulties and challenges during this workshop. In her views, she found that the workshops enrich mathematical concepts for students, and she mentioned finding a touchable thing not like abstract, she talked about how the student can apply the mathematical concept in reality, like being touchable. She also found the workshop encouraged her to engage with her children. Finally, she said the workshop was "excellent, something intelligence, Interesting, not boring," and she recommended to change or reform mathematics curriculum to be more interesting and insert these kinds of activities into the curriculum.

Findings from interviews of Pair 7. The boy spoke about using mathematics in daily life "when I make art. Like knowing how much degrees." He is doing his homework by himself sometimes. He spoke about action and interaction with his parent: "my mom helps when I don't know what some questions in that, but mostly I do it alone." His favorite activity was the Sphero activity, and the Symmetry activity was his least favorite. In addition, he found these activities (e.g., Symmetry, Sphero and Scratch) enriched some mathematical concepts like length and angles, and this workshop encouraged him to work with his parents, saying "I find it very fun

and teaches me more." Mom spoke about applying mathematics in daily life through "counting, degrees, cutting in equal parts," and she found action and interaction during the workshop "interesting." Mom said about interacting with her boy: "he likes it." Mom's favorite activity was the Sphero activity and Scratch program due to "using the angles with the shape and how-to arrangement there, maybe the coding," and her least favorite activity was "Symmetry because it is normal nothing new." Mom found these workshops enrich mathematical concepts for students like finding a touchable concept. She also found this workshop encouraging her to engage with her children. Mom suggested to change mathematics curriculum to be more interesting and insert these kinds of activities inside curriculum. In the end, she added the workshop was "excellent, something intelligence, Interesting, not boring."

Based on the three instruments (observation, reflection forms and interviews) I used, I found Pair 7 completed the reflections, worked through the activities (Symmetry, Sphero robot and Scratch program), and they appeared to engage together, following the directions for the activities in the workshop. The boy and his mother both felt that the workshop activities enriched their understandings of mathematical concepts employed in the workshop. The boy and his mother also felt that the activities encouraged engagement with each other, both during and outside of the workshop activities. They boy said he helps his mom with some things, including language, and his mom helps him with things as well.

Pair 8 (2 grandchildren (boys) and Grandma)

Pair 8 was 2 boys with their grandma. The boys were in Grade 5, and they spoke English during the workshop. They attended the second session of workshop. They filled out the reflection forms. I was not able to interview them as they did not consent to completing the interview. The following is description of the pair by observation and through reflection forms.

Observation. The grandma of the two students in Grade 5 was unaware of computational thinking concepts, and she was just watching them with losing concentration. This meant they had a negative attitude together, and the grandma had a low interaction with her grandboys because she did not work on the activities with her grandboys. However, the boys were following the instructions carefully and applying the activities without interference from their grandma, meaning they had a low engagement with her. This demonstrates that the two boys' engagement was low, and the grandma's and grandboys' attitudes were negative. The grandma's interaction with the two boys was low as well.

Reflection forms. On the Symmetry reflection forms, the first question was: what did you learn in Symmetry activity? Boy 1 responded "I learned the about the Symmetry has more than code in every shape." Boy 2 answered "I learned Symmetry." The second question was: write or draw the path or shape you have made in Symmetry activity. Boy 1 drew a square with one dot, two dots, three dots and four dots in each corner of it, and he drew a triangle also with one dot, two dots and three dots in each corner of it. Boy 2 drew one triangle. The third question on Symmetry reflection form was: do you like this activity? You can draw an emoji to express your feeling. What thing most surprised you? Boy 1 responded: "yes," and he drew a happy face. Boy 2 also drew a happy face and thumbs up, writing "yes I like it." About last question in Symmetry activity, it was: do you like working with your parents? Boy1 answered: "yes, because she can help me," and Boy 2 wrote "yes, because we can play with robots." On the Sphero robot reflection form, the first question was: list mathematical concepts you have learned from Sphero activities. For example: length, time, speed, angles, patterns, etc.… The response of Boy 1 was: "to make a triangle you need 120 degrees angle and repeat 3 times", and Boy 2 answered "length, time, speed, angles, patterns, etc..." The second question was "write or draw the path or

shape you have made to make Sphero move. Boy 1 drew a triangle, and in the same time Boy 2 also drew a triangle. The third question was: do you like this activity? You can draw an emoji to express your feeling. What thing most surprised you? Boy 1's answer was: "yes" and he drew a happy face. Boy 2 drew a face and he wrote "I loved it." The last question in Sphero activity form was: do you like working with your parents? Why? Boy 1 answered: "yes, because they can help me," but Boy 2 wrote "no, they tell me to do stuff I don't want to do." On the reflection form for the last activity in the workshop, the Scratch program, the first question was: list mathematical concepts you have learned from the Scratch program activities. For example: length, time, speed, angles, patterns, etc.… Boy 1 answered: "he turns 15 degrees to left with ten steps and glides." Boy 2 responded "I learned how to code and that it's fun." The second question was: write or draw the path or shape you have made in Scratch program. Boy 1 drew a circle. Boy 2 also drew a circle. The third question was: do you like this activity? You can draw an emoji to express your feeling. What thing most surprised you? Boy 1's answer was: "yes" and he drew a happy face. Boy 2 answered "yes, it's really fun." The last question was: do you like working with your parents? Why? Boy 1 answered: "yes because they help me". Boy 2 answered "yes." The Grandma filled out a single reflection form for all three activities. Following are the responses of the grandma of the questions included in the for. The first question was: Please, share with us why you selected to participate in this study? The grandma answered: "because they invite me to attend, then I like this because it is a first time I work with my grandkids." The second question was: In what ways you like or not like working with your child/children? Why? The grandma's response was: "it was fun, I like it. I didn't do much but I just watching them."

The third question was: Did you learn or observe something new about: the workshop, your child, yourself? Her response was: "the way is new (to me). the kids working well together as a group." The fourth question was: Did you observe something new about mathematics? She answered: "yes, the way to teach math." The fifth question was: What surprised you or did you dislike in this workshop? She answered: "I like it." The last question was: What are your suggestions in future to improve these workshops? The grandma answered: "nothing, it was fun."

Findings of reflection forms of Pair 8. I found the 2 Boys spoke about learning several math concepts like polygons such as triangles, angles such as 120 degrees in a triangle and exterior angles, and transformations such as rotation. The boys' attitude and experiences towards the activities was positive and Boy 1 drew a happy face. Boy 2 said "yes, it's really fun." Boy 1 liked to work with their grandparent, as he said "yes, because she can help me." However, Boy 2 felt differently, saying "no, they tell me to do stuff I don't want to do." Grandma chose to attend this workshop "because it is a first time I work with my grandkids." About liking like working with grandboys, she said "it was fun, I like it. I didn't do much but I just watching them." She also observed "the way is new (to me). The kids working well together as a group," and she likes the way of teachings math.

Based on the two instruments (observation and reflection forms) I used, I found Pair 8 (2 boys and their grandma) completed the reflections, worked through the activities (Symmetry, Sphero robot and Scratch program), and it appears they engaged together and followed the directions in the activities during the workshop.   The two boys felt that the workshop activities enriched their understandings of mathematical concepts employed in the workshop. Boy 1 said

that he liked working with his "parent" (grandmother), however Boy 2 disagreed, saying parents tell him to do things he doesn't want to do. Engagement in this observation pair was low.

Two math teachers

There were two math teachers: one of them teaches Grade 3 and 4, and she attended the first day of workshop. The second teaches Grade 5 and 6, and she attended the second day of the workshop. They did not complete reflection forms, because I did not plan to give them a reflection form. I was able to interview the teacher who teaches Grade 5 and 6, but I was unable to interview the Grade 3 and 4 teacher as she did not consent to participate in the interview. The following is description of both teachers by observation and one teacher's interview.

Observation. The remaining participants were two math teachers. One of them taught Grades 3 and 4, and the other one taught Grades 5 and 6. Both were watching the students and their parents, walking around them during the workshops. They also tried to follow the directions of activities and were helping students and parents to complete the tasks although they commented these kinds of activities were new to them.

Interview. I interviewed the teacher who teaches Grade 5 and 6, one week following the workshop at noon in the school staff room. First, I asked her about how she found the interaction of students during regular school days. She replied "I'm teaching them math. So, the interaction or how they react upon the lesson then after explaining the lesson they gave me their feedback by answering some questions." Second, we talked about the differences between the interaction in the workshop and during school days. She said "yes, definitely positively they were very enthusiastic about the ball (Sphero) and how it is, and how it moves, and they did some mistakes, but they were very fast learners. I really like their interacting and how they interfere and act with it. They want to deal with it. They want to do the coding themselves." She added "most of them,

actually I'd say 90% of the class were just interacting. I couldn't find any of them sitting doing nothing. They were just so excited about it." Third, when I asked her about the interaction of parents, she answered "sometimes as a math teacher we're suffering from the interference of the parents, because they don't know, or they are dealing with the problems on their own way, and in math, we have so many ways. So, we're confusing the kids, but when just sitting with the parents and explaining how things are going and how we deal with the problems and stuff, it becomes easy. So sometimes they're interfering positively, but most of the time it is negative." She also added " I noticed that we do have few parents in Grade five and six day they attended the Workshop, but though the parent was really happy, and they were really following their children, and they want to see that their children do the coding correct and definitely they are doing it perfectly and I think parents were having fun too."

Fourth, I asked the teacher about if she believes that the parents have a big role with engaging with their children. She said, "yeah, definitely. Sometimes talking about as a mother talking about your kids, you know your kid and you keep his capability more than anyone else even sometimes more than himself who so, you know, sometimes you want to upgrade this capability and you want them to integrate between different topics. So, as a teacher I can figure out also who is capable to integrate into a new era of explaining or using new tools to understand the concept. So, I'm with always having some new techniques, new skills and new tools to explain the concept, to modify and make it easy. Maybe sometimes you're taking something very complicated, but to make it easy to explain and to show." Regarding benefits and challenges through doing the workshops, the teacher said, "I didn't see any challenges during the workshop because as I told you, they were very fast learners and they are into technology, and this Sphero just meet their satisfactions." She said about the parents "it depends on where the parents are in

technology, not same as the kids. They are just like that, but they took a while till they feel comfortable with pressing all the buttons and order the coding and stuff." Next, she told me about benefits. She said, "yeah, it's a lot actually, first thing they learned so many topics at once, and parents learned so many ideas at once and answered so many questions at once." Regarding enriching mathematical concepts, she said, "I saw that drawing the shapes like the square is perfect. Maybe if we have the Sphero shoots on a screen in order to have the vision wider all the class, this will be a good idea. Just how things are going in that Sphero is just moving within the circle, and definitely it's a very nice, it was a perfect idea, and they get the coding how to move inside [perhaps she meant how code by using app and then see the Sphero moves] that is very challenging." She also talked about how the engagement of parents supporting their children in computational and mathematical thinking activities "I guess yes, they feel supported, and they feel happy because they are having and seeing the same thing together and doing it for the first time experience it the first time together. So yes, definitely," and she added "they struggled a bit in the beginning but by the guidance of the child maybe they will do better." Lastly, the teacher said "I think we can have more workshops here. We can deal together to give ideas about math projects and it's cool to have like a science fair. If we apply something like an idea of the coding, this will be a very nice one, so we can have more workshops. Interfering with the kids with their parents by using technology to help math or to serve math." She also said "we integrated the computer into our calculations like to calculate the profits or to calculate the taxes or to calculate things like that. So, we made like the spreadsheet and we put the formula so though, it's not in our curriculum. I want to give more but if we just do something like a movable. Always, challenging the kids or putting them in challenge will give the best in them."

Findings from observations and interview with teachers. I found the main work of the two teachers was observing the students and trying to help them in the three computational thinking activities (Symmetry activity, Sphero robot and Scratch program). They engaged and played in the activities, especially Sphero robot. In general, they mentioned after the computational thinking activities, these kinds of activities are effective for students to enrich mathematical concepts and at the same time to have fun.

5.3 Summary

In this section, I reported on the learning, engagement and interactions of the participants in the CT activities as evinced through observation, reflection forms and interviews, including: the description of the learning mathematics and CT, how they worked together, how participants engaged during the session, and what the views and suggestions for all participants (students, parents) with the exception of Pair 8. This pair, for personal reasons, did not consent to the interview, so their views are not included in this section. Questions about views, feedback and suggestions for future sessions were asked in the interview and were included only in the reflection forms for the participating parents. I observed Pair 8 and they also completed the reflection form. Their data is only in two forms and these two forms were used to infer their views and suggestions.

5.3.1 Learning of math and CT

This contains two subsections: the content of the workshops about computational and mathematics thinking, and how it is applies and serves mathematics in daily life.

5.3.1.1 Content of Workshops

For Students. In interviews and reflection forms of students, students mentioned about learning several mathematics concepts including polygons such as triangles, angles such as 120

degrees in a triangle and exterior angles, and transformations such as rotation. For example, Pair 1(the boy): "how to make code," "learned to code," Pair 2 (2 boys): "we learned geometry," Pair 3 (boy): "I liked this activity because it can change math teaching from boring to fun," Pair 4 (girl): "I really liked it! That it can move using a code," Pair 5 (girl): "coding helps you," Pair 6 (boy): "it was very useful," Pair 7 (boy): "the thing that surprised me is how the code worked," and Pair 8 (2 boys): Boy 1 mentioned about learning shapes and Symmetry, and Boy 2 said " I learned how to code." Thus, the pairs 1, 2, 3, 4, 5, 6, 7 and 8 talked about the mathematics and code concepts they learned. In the observation stage, I observed students highly engaged towards CT activities and they applied the activities by using iPads and desktops, then the children's attitudes and experiences towards the activities appeared positive as seen through researcher observation.

How students made sense of the activities is shown in Figures 1 to 4 below about geometry and transformation:

Figure 1. **Screenshot of the Symmetry activity of the school computer.**

Figure 2 gives more clarification of Figure 1

Figure 2. **Screen of the Symmetry activity used in the workshops.**

Source: http://mathsurprise.ca/apps/sym/rotation-reflection/

Figure 3. **Children participating in the Symmetry workshop activity.**

Figure 4. **Children engaging with their parents during the Symmetry activity.**

Figures 5 to 9 show how students deal with devices and code in Sphero robot and Scratch program:

Figure 5. **Sphero program screen**.

Figure 6. **Children interacting during the workshop in Sphero robot activity.**

Figure 7. **Children participating in the activity using the Sphero robot activity.**

Figure 8. **Student participating in the Scratch activity.**

Figure 9. **Students engaging with their parent during workshop in Scratch activity.**

For Parents. Parents commented on content of the workshop in the following ways: on the math learned, on the coding learned, on the math and code learned and on the way of learning

math. For example, Pair 1 (mom) mentioned that this workshop enriched mathematical concepts in a "fun way teaching with them how to draw something. It's mixed playing and learning the same time." Pair 2 (mom) said: "just diversifying how they learn about different mathematical concepts, like just different ways of learning helps, it's a good way, how to learn math by this activity." Pair 3 (dad) said: "for example, to draw a square, they need to know that it has the same length at all edges and the angles, so it's involved in many concepts together" and "I like the idea of robot, it makes my boy highly engaged," Pair 4 (dad) said: "in terms of triangle, draw triangle, draw hexagon," Pair 5 (mom) said the workshop was "very interesting," Pair 6 (mom) said: "it's just the concept of getting the idea. Once you get the idea of it how it works then it gets easier maybe because it new," Pair 7 (mom) mentioned that the activities in the workshop make the concepts touchable, and Pair 8 (grandma) said: "the way is new".

As seen above, all parents in pairs 1, 2, 3, 4, 5, 6, 7 and 8 found the CT workshop to enrich mathematical concepts. They had a positive attitude towards the content of the workshop. During my observation, I also observed parents engaged with the CT activities, and they tried to learn new things from the activities.

5.3.1.2 Applying math in daily life

During the interviews, Students and parents spoke about how they used mathematics outside classroom, and their thoughts about mathematics and how it is taught or learned in daily life such as: going store, cutting anything in equal parts, counting, and so on.

For Students. Students spoke about using mathematics in daily life like going to the store, more commonly about doing math during grocery shopping, as well as for some games, and tests at home. For example, Pair 1 (boy), the boy mentioned using mathematics in daily life such as going store, counting and cutting things in equal parts. In Pair 2 (2 boys), both boys

supplied answers to this effect. Boy 1 mentioned about using math in daily life such as going store, and Boy 2 said "sometimes when we go shopping around with mom. we try counting the prices." Pair 3 mentioned about sharing things with his siblings like "candy." Pair 4 (girl) said "I'm going to store to buy something to calculate some prices." Pair 5 (girl) said "it's like, when you are going to the store, you can add up the money." The boy from Pair 6 mentioned that his mom just tests him in mathematics. Pair 7 (Boy) said "when I make art. Like knowing how much degrees," and Pair 8, with two boys, was not interviewed.

For parents. Parents talked about applying mathematics in the life including similar examples to the children -- grocery shopping, games, tests as well as different examples like budgeting, memorizing games, and so on. For example, Pair 1 (mom) said "when you go to stores," Pair 2 (mom) said "I think it does apply in everyday life," Pair 3 (dad) said "in measurement, the house purchasing, counting. Everything is math, and counting," Pair 4 (dad) said "mathematics in every aspect of the life, like, when you make your budget for buying stuff," Pair 5 (mom) said "we apply math in every way especially as a mom," Pair 6 (mom) said "it applies now with my kids. Sometimes, we play like a little game multiplication, adding specially when the boys are young. So, we try to help them out to memorize this in early age," and Pair 7 (mom) said "counting, degrees, cutting in equal parts," and Pair 8 (grandma) was not interviewed. Thus, all parents of pairs were interviewed said they with their children applied math in daily life.

5.3.1.3 How they engaged during the session

It contains: The engagement and interaction for students and their parents in the workshops and acting and interacting of parents with their children in the workshops.

The engagement and interaction for students and their parents. During observation of students during the workshop, engagement varied with pairs: I found the level of students' engagement with their parents during doing activities was high for example, all pairs 1, 2 ,3, 4, 5, 6 and 7, aside from Pair 8 whose level of engagement with their parent was low. The participants' attitudes, both students and parents, toward the workshop was positive. For example, they were working together on the activities and trying to help each other to apply the activities except Pair 8, where the grandma's attitude appeared negative. For example, she did not focus on the work of her grandchildren. She let them work alone in some places without interference from her. In addition, the parents' interaction with their children was medium for Pair 1, Pair 5 and Pair 6, specifically the parents were mainly just watching the work of their children. The parents' interaction with their children was high for Pair 2, Pair 3, Pair 4, and Pair 7 as evidenced in following of instructions carefully while highly engaged with their children. Interaction of the parent of Pair 8 was low as it was noted that the grandboys were following the instructions carefully and applying the activities without showing any interference from their grandma. As a result, the engagements also varied within pairs from low to high.

Figure 10 to Figure 13 show how parents engage with their children in CT activities:

Figure 10. **Parents engaging with their children during the workshop in Sphero activity 1.**

Figure 11. **Parents engaging with their children during the workshop in Sphero activity 2.**

Figure 12. **Parent engagement with their children during the workshop in Symmetry activity.**

Figure 13. **Parents engaging with their children during the workshop in Scratch activity.**

Experience working with parents. Students expressed their attitudes on doing

mathematics with their parents and shared their rationale for these attitudes. All pairs enjoyed

working with their parents except two for students: Boy 2 from Pair 2 and Boy 2 from Pair 8).

They are not consistent as sometimes they said yes and sometimes, they said no. For example,

Pair 1(boy) likes to work with his parents because they "correct me" and "support me" "I like

doing the math stuff with my mom," Pair 2 (2 boys): Boy 1 said "it makes things more fun," but

Boy 2 said "no, they tell me to do stuff I don't want to do" but "yes, because they are fun." it is

possible this refers to the kind of the activity, but it cannot be confirmed. This means Boy 2 in

Pair 2 is not consistent in his comments on the reflection form as I mentioned previously, and he mentioned that he preferred to work alone without his parents. Pair 3 (Boy) said "I like working with my parents because they help me a lot" and "they support me," Pair 4 (girl) said she liked working with her parents "because they help me." Pair 5 (girl) said she liked it because "they help me a lot." Pair 6 (boy) liked working with his parents "because mom tell me, explain to help me out to understand" and "yes, it is more fun." Pair 7 (boy) stated "I like working with my parents because they have been learning more stuff than me and they teach me new stuff." Finally, in Pair 8 (2 boys), Boy 1 said "she can help me," but Boy 2 said "no, they tell me to do stuff I don't want to do."

During my observation, I found where participants were working as a pair (child- parent), they were working together. I then also noticed the main role of parents was watching the work of their children. In some places, they were doing well, and they tried to learn the new math seriously.

Action and interaction for parents. Parents reflected on their actions and interactions with their children while working with their children in the workshop. The mission of most of the parents appeared to be watching their children's work in the workshop, as I observed and as they mentioned in the reflection forms and interviews. For example, Pair 1 (mom) said "most of the time, I like to watch and then I can interfere when I feel I have, or I need to" and "I think it's enjoyable to work with each other." Pair 2 (mom) said "watching and trying to interact with my children through observation" and "I like that they wanted to show me how to do it." Pair 3 (dad) said, "I like to work with him in order to know where my kids might need help." Pair 4 (dad) thought "the coding technique makes the child think in different ways." Pair 5 (mom) shared "I like to work with my child as in this way we learn together." Pair 6 (mom) stated "I found fun

ways to teach the children the math." Pair 7 (mom) simply said it was "interesting," and Pair 8 (grandma) said "it was fun, I like it. I didn't do much, but I just watched them." Overall, during the sessions I found the main role of parents from three instruments (observation, reflection forms and interviews) was watching their children, and they said they enjoyed working with their children because …. In my observation, I saw different forms of parent-child actions and interactions including working together and interfering in ways such as correcting the children's work and learning the coding.

5.3.2 Participants (students, parents) experiences during the activities, their views; their suggestions on the sessions

5.3.2.1 Views about the session, and the ways math is taught

In this section, the views and feedbacks of participants (students, parents) are included, and how CT activities help students to understand mathematical concepts, and how they found these workshops through context, activity and engagement.

For students. Students views commonly reference their positive experiences working with their parents or of the session activities. For example, Pair 1 (boy) said it was "fun learning, so the good way." Pair 2 (2 boys) participants had similar views, Boy 1 said the workshop session was "amazing I love it," and Boy 2 said "it was interesting, I was excited." Pair 3 (boy) said "I find the workshop fun and helpful." Pair 4 (girl) found the workshop encouraged her to work with her parents: "I really like it." Students shared reasons why they liked to work with their parents. Pair 6 (boy) said "it is fun." Pair 7 (boy) said "I like working with my parents because they have been learning more stuff than me and they teach me new stuff." The boy in Pair 7 also said "I find it very fun and teaches me more." As a result, all students like the workshop between the activities the participated in and working with their parents.

For parents. Parents' views were similar to the children's views. Pair 1 (mom) said "I learnt something I didn't know" and said to "keep it up!!! It is a good program" and "I should work with them more and buy them more stuff." The mom also spoke of the workshop itself, saying "I was impressed, excited, easy way to teach the kids. So, having fun time with the kids, in the same time teaching them." Pair 2 (mom) said "it was interesting and helpful for students. I hope to do this always" and "it's a fun activity to do with them and especially when kids are learning," as well as "nice, good, benefited from it." Pair 3 (dad) said "it gives you an opportunity to know about a new math" and "it was a good experiment for us. I saw the kids as highly engaged and love it." Pair 4 (dad) said of the workshop: "it is very exciting and useful for both kids and parents." He also found this workshop encouraged him to engage with his children: "it's very interesting. So, I like to sit with my girl and do it." Pair 5 (mom) said "then we go learn something new" and "it's fun, like, I can do it every day because it's really fun." She also added "I will learn and then we go learn something new. So, I love to engage." Pair 6 (mom) said she thought "the new tech is really helpful for the kids" and of the workshop she said, "everything was good, and I was impressed." Pair 7 (mom) said "I was surprised about how fast it went and all the codes it had" and "I like to know my boy is know the work or not." About the workshop she said, "I like the workshop," and "to know how to develop us [perhaps she means parents] to connect the math with tablet." Mom also found this workshop encouraged hers to engage with her children. Pair 8 (grandma), said "it was fun, I like it. I didn't do much but I just watching them," and that she thought "the kids working well together as a group." Overall, parents commented favorably about working together with the children during the sessions and about the content of the workshop.

5.3.2.2 Suggestions

For students. Suggestions from the students were regarding more time, more activities and more clarity in the instructions. Pair 1 (boy) suggested for next workshop to make more activities with Sphero robot. In Pair 2 (2 boys), both boys suggested for the next workshop to make more time of activities. Pair 3 (boy) suggested for next workshop to make more activities with Sphero robot, specifically "more time playing the Sphero." Pair 4 (girl) said "it's difficult for kids." It is possible she meant make the activities easier, especially the Symmetry activity, as she mentioned in the interview, she thought it "boring." Pair 5 (girl) did not suggest anything for next workshop, and she said, "it's fun, like, I can do it every day because it's really fun." Pair 6 (boy) said, "it's good, maybe it's confusing because it's a new stuff." Perhaps he meant to make the activity clearer. Pair 7 (boy) suggested for next workshop to make more activities, and he said, "I find it very fun and teaches me more." Overall, the most important suggestions from students for future workshop are extended time for the workshop, doing more activities and more clarity in the instructions.

For parents. Parents suggestions were along the same lines as the students to improve the workshop. Suggestions included more time, more activities and more details, but also differed in the preference of three parents to not have group instruction and for there to be more physical materials. Parents also commented on the ways of teaching mathematics and they recommended inclusion of CT activities in mathematics curriculum. For example, Pair 1 (mom) said "I was impressed, and it was successful workshop," but she also said "I don't like groups. I like the attention to be one and one." Pair 2 (mom) suggested "just more ways that you can include, more ways, more activity You can include." Pair 3 (dad) suggested to "have more time to focus on certain topics." Pair 4 (dad) suggested "if you just let the parents knowing details,"

and he added "I'm very happy I came here. It's really nice." Pair 5 (mom) said "overall it was good but if they have more gadgets maybe it will be more fun." She also said, "can have a one-to-one thing, more material" and to "put these things in the school materials" because "they should learn in a happy ending not like they hate math." Pair 6 (mom) suggested "one in one it would be more useful," because "I didn't like group working but I was satisfied."

She also said "actually, if you want to work with him, it doesn't have to be this. You could do it in a different way, any different ways to engage with your kids doesn't have to be in the workshop." This mom was of course meaning there is no need to wait for a workshop to engage with children. Pair 7 (mom) suggested to change mathematics curriculum to be more interesting and insert these kinds of activities inside curriculum, and she added "excellent, something intelligible, Interesting, not boring" in reference to the workshop itself. As a result, the parents' suggestions are: more time, more material, knowing details before the workshop, more one on one (child-parent) work or activities, insertion of these activities in the math curriculum, and different ways to engage parents with their children.

6. Discussion and conclusion

This chapter discusses the findings of the study and attempts to answer the research questions using the two main themes that were identified as a result of a qualitative analysis of data collected during CT workshops: 1) learning mathematics and computational thinking and 2) parental involvement. To reiterate, the general research question is: What is the nature of parents' engagement with their children during computational thinking and mathematics activities?

The specific research questions are:

I.   In what ways do students and their parents act and interact during computational thinking and mathematics activities? *What is the role of parents*?

II. What are the challenges and benefits of parents' engagement with their children during computational thinking and mathematics activities?

III. What are the views and feedback of students and parents on their participation in computational thinking and mathematics activities?

6.1 Theme one: Remixing mathematics and computational thinking

This theme is a cluster of all views on how CT activities enhance learning and teaching mathematics. It shows the nature of integration of students learning in CT activities which emerged from the research questions of this study. This theme also encompasses subcategories in the context of the application of mathematics in daily life as well as the impact of CT activities on geometry, coding and games, and benefits and challenges of CT workshops.

6.1.1 Applying mathematics in daily life

The study participants spoke about how they used mathematics in daily life while shopping, cutting anything in equal parts to share with one another, counting, playing games, and

so on. Students mentioned going to the store and doing math during grocery shopping and when

playing games. They also used mathematics to practice tests at home. Parents spoke about using

mathematics with their children in various types of activities, which included grocery shopping,

playing games, testing, budgeting, doing number tables like multiplication games, and so on.

They thought that all those activities helped their children improve basic math skills of addition,

subtraction, multiplication, and division

The most commonly referred to use of mathematics in everyday life was in the context of

grocery shopping. For example, the boy in Pair 1 mentioned "*going [to the] store."* One boy in

Pair 2 also spoke about "going to the store," and another boy in Pair 2 said, "sometimes, when

we go shopping around with mom, we try counting the prices," The girl in Pair 4 said, "when we

go to the store to buy something, we calculate some prices." The girl in Pair 5 said, "when you

are going to the store, you can add up the money," and the mother in Pair 1 said that she uses

math with her son "when you go to stores."

Some participants commented about using mathematics in sharing, counting and cutting

things in equal parts, like the boy in Pair 1 mentioned "counting and *cutting things in equal*

parts." The boy in Pair 3 also spoke about the sharing context of siblings, and the mother in Pair

7 said they use math while "counting, degrees, cutting in equal parts."

 Other participants mentioned testing in mathematics and playing games. The boy in Pair

6 said that his mother just tests him in mathematics. The mother in Pair 6 said, "it applies now

with my kids. Sometimes, we play a little game multiplying, adding, especially, when the boys

were young. So, we try to help them out to memorize this at an early age."

Participants also spoke about doing geometry. For instance, the boy in Pair 7 said, "when I make art, I like knowing how many degrees certain angles have." and the father in Pair 3 said they use math, "in measurement [the size of the rooms]."

Parents also spoke about using mathematics every day in each aspect of life. For example, the father in Pair 3 said they use math, "everything is math and counting." The father in Pair 4 also said that "mathematics is in every aspect of life like when you make your budget for buying stuff," and the mother in Pair 5 said, "we apply math in every way, especially, as a mom."

These comments demonstrate that the study participants used math in a few different contexts, mainly shopping and completing simple calculations on a regular basis and that parents were aware of the importance of helping their children develop skills through everyday activities. All parents also found useful ways to help their children develop math skills through basic daily activities, including sitting with them while completing homework.

6.1.2 Learning mathematics topics

Most of the students spoke about learning mathematics topics through CT activities offered during workshops. They thought that CT helped them to learn mathematics topics such as geometry, transformations, patterns, and angles. For example, the boy in Pair 1 said, "I learned that when I made a triangle, I had to put 120 degrees to make it work for the exterior angle." The boy in Pair 2 said, "we learned geometry," "length, time, angles, patterns…." The mother in Pair 2 said, "yes, how to learn math by this activity." The boy in Pair 3 said, "I liked this activity because I was surprised that there were Symmetry shapes, we can do it easily." The girl in Pair 5 said, "I learned that if you rotate the shape, the numbers are different, not the

shape." "it helped me make sense about the angles." The boy in Pair 3 said that he learned how to calculate speed and time, "go forward at 50% for 3 seconds and change color to green."

CT activities create better understanding in learning mathematics as observed in this study. This is confirmed by Lee et al. (2011) who concluded that in order to support development of CT skills in students, it is important to create a stimulating learning environment, and conduct more research on CT.

6.1.3 Coding + CT

Most of the students commented that they learned how to code and play coding games and apps. For example, the boy in Pair 1 said that he learned "how to make code" and that "you can make it [the Sphero robot] dance, you can play games, etc." The girl in Pair 4 also noticed that "it can move using a code," and the boy in Pair 7 was surprised by "how the code worked and how fast it [the robot] went and all the codes it had."

These comments echo the observation of Namukasa et al. (2017) that students can understand abstract and complex concepts through activities that use CT tools, robots, coding apps, and games. Researchers like Curzon (2014), Gadanidis et al. (2017), Farris and Sengupta (2014), Kotsopoulos et al. (2017), and Namukasa et al. (2017) explore the integration of computational thinking and mathematics thinking in K-8 classrooms. These researchers have observed that CT tools, activities, and processes promise to make mathematics learning experiences for students more interesting, more productive and easier in more advanced mathematics.

Coding was found to be useful since it involved exploration of mathematical concepts through robots and apps. In addition, CT activities helped students learn how to code and play

games, which made it easier for them to understand abstract mathematical concepts such as angle measurements. These findings support Kotsopoulos et al. (2017), and their exploration of the four pedagogical experiences of CT activities: "unplugging," "tinkering," "making," and "remixing." Kotsopoulos et al. (2017) state that unplugged experiences apply to activities not using the computers, while the tinkering experiences include activities that need engagements and adjustments. Making experiences use activities to create new objects, and remixing involves multiple experiences that make use of old objects for a new purpose. The authors argue that these experiences are necessary for the students to have a full experience of CT activities.

6.1.4 A new way to learn mathematics

Most participants commented that using CT activities was a new way to learn mathematics. In the beginning of the workshops, parents thought that CT and mathematics activities were difficult and that they needed more concentration but after following the researcher's instructions, they were able to fully engage in the CT activities and work with their children. For example, mother in Pair 6 said, "it's just the concept of getting the idea. Once you get the idea of how it works, then it gets easier, maybe, because it's new." Some children also initially had difficulty participating in the CT activities. For example, the boy in Pair 6 found them to be "confusing because it's a new stuff." However, once children understood what they were supposed to do, they together with their parents engaged in all three activities offered during each of the two workshops.

Most parents commented that they learned about how mathematics is currently taught. For example, the mother in Pair 1 said, "I learnt something [about mathematics and technology] I didn't know." The mother in Pair 2 also thought that using CT activities was "the [helpful] way

to teach and learn math." The mother in Pair 5 said, "I will learn and then we go to learn something new. So, I love to engage."

Almost all adult participants said that the two workshops gave them an opportunity to learn about CT and discover its beneficial effects on their children's perceptions of mathematics. The parent's views were that CT activities should be incorporated into teaching mathematics in elementary schools. For example, the father in Pair 3 said, "the workshops show math in a beautiful way that we never expected to see." The father in Pair 4 said that he likes "the coding technique that makes the child think in different ways," and the mother in Pair 5 said that "with adding Sphero, Scratch program, they [students] learn more enthusiastically rather than the old traditional way."

These comments support the findings of Xiao et al. (2016) being that the reason parents enjoyed taking part in workshops is because they learned a great deal about how mathematics is currently taught in schools. They also appreciated the opportunity to interact with their children and see for themselves the positive impact of CT activities on their understanding of mathematical concepts. Further, parents' comments about new ways of teaching and learning mathematics are in line with Gadanidis (2015) who observed that CT activities facilitate changes in the traditional methods of teaching and learning mathematics.

6.1.5 A new way to teach mathematics

Most participants spoke about a non-traditional way to teach mathematics using CT activities. For example, the mother in Pair 1 said, "fun way teaching them how to draw something" and "it's mixed playing and learning at the same time." The mother in Pair 2 commented about "how to learn math by this activity," and the father in Pair 3 said, "I like the idea of the robot, it makes my son highly engaged. I liked this activity because it can change

math teaching from boring to fun." The father in Pair 4 also enjoyed studying mathematics through CT activities and said that it is a better way of teaching mathematics than the way he was taught when he was young. The boy in Pair 6 also thought that CT activities were "very useful" and said that he was "very impressed." The mother in Pair 6 appeared thrilled and remarked that she found "fun ways to teach children math," and the grandmother in Pair 8 said CT- this was "the way to teach math."

This finding of parents and children speaking about how teaching math through CT is engaging reflects what Lu and Fletcher (2009) established in their work: teaching CT is an important skill that should be developed in students along with teaching reading, writing, and mathematics (arithmetic). It also supports Gadanidis et al. (2017) and Namukasa et al. (2017) who observed that various CT tools and activities facilitated students' comprehension of mathematical concepts.

6.1.6 The Nature CT activities

All participants commented about the easy and the difficult aspects of the CT activities. In general, the activity that involved the Sphero robot was found easy and liked by all pairs with the exception of the father in Pair 4, who preferred the Scratch program because, as he explained, he did not want to buy the Sphero robot that costs over $50. (He further argued that the Scratch program is based on the same concept of coding as the Sphero robot, which is why he decided that his son can still learn CT without using the Sphero robot.) This finding of many pairs finding the Sphero activity easier and more enjoyable may be related to the idea that the Mom in Pair 7 said "a touchable thing is not like abstract [she means that the student can apply the mathematical concept in reality like touchable]."

Pairs 2, 3, 4, and 7 commented that they found it difficult and did not much enjoy the Symmetry app. Their explanation was that this activity involving a website-based coding and mathematics app through which they assembled code to make geometrical shapes rotate and reflect is similar to basic math taught in classrooms. These views on the Symmetry app which is designed for exploration of mathematics topics might imply that certain children preferred workshop activities which were much different from the classroom mathematics of textbooks, notebooks, work sheet and computers.

Pairs 1, 2, and 6 did not enjoy the Scratch program, which involved a website-based CT app in which they designed for exploration of a mathematics topics and explained that they found it to be "hard." This reaction to the Scratch program can be explained by the fact that it was the last activity in the workshops and that there was not enough time to complete it.

The mother in Pair 7 equally found both the Sphero robot activity and the Scratch program useful and enjoyable.

Overall, almost all participants found the Sphero robot activities to be the most engaging because it allowed the students to play, move, touch and learn at the same time by simulating curricular concepts in the real world. This finding is similar to the results of the study conducted by Resnick (1995) who observed that CT is about "how they [students] think about and make sense of the world" (p. 31).

6.2 Theme two: Parental engagement in children's CT activities

The theme of the nature of parents' engagement in their children's CT activities includes the following sub-themes: (a) students' actions and interactions with their parents, (b) the benefits and challenges of parents' engagement with their children's in CT activities, and (c) the views and

feedback of participants on their participation in the workshops and their suggestions how to improve the workshops.

These sub-themes emerged from the observation, reflection forms and interviews data of each of the parent-child groups reported in the results chapter.

6.2.1   Act and interact

This sub-theme relates to the actions and interactions of parents with their children during CT workshops as summarized in the data from the researcher's observation of each of the parent-child/children groups as well as from the participants' feedback on the CT workshops. As noted in the literature review, learning of mathematics can be enhanced through children's' families being involved even without direct connection with the schools and interactions with teachers (Liang, 2013).

6.2.1.a Working together: While observing participants during the two workshops, the researcher found that all parents were actively observing and actively working with their children. All parents commented that they did not try to help their children in each activity step. They watched their children and, from time to time, offered them suggestions and encouragement. For example, the mother in Pair 1 said, "most of the time, I like to watch and then I can interfere when I feel I have, or I need to." The mother in Pair 2 said that she was "watching and trying to interact with my children through observation" and that she liked "that they wanted to show me how to do it." Parents in Pairs 3, 4, 5, 6, and 7 acted the same way and expressed similar views, and the grandmother in Pair 8 said that "it was fun" and that she just enjoyed "watching" children. This can be viewed as evidence to support Epstein (1987) regarding parents who support and inspire their children, which can give the children an advantage in learning mathematics.

Some parents did help their children when it was necessary. For example, the boy in Pair 3 said, "my dad helped me like if I did that wrong or instruction you know to fix it," and his father said, "I tried to help them and see how they are taught in school. Sometimes if he goes in the wrong direction [he did something wrong], I returned him back in order to do it correctly." The girl in Pair 4 mentioned about depending on her father to make sure that what she did was correct. She said that her parents helped her "learn how to code." She added that her father supports her and that she "had fun" and "learned a lot of things." In Pair 5, the mother was watching her daughter and offered help when the girl needed. She said that her daughter was very shy and felt uncomfortable asking for help in class, "so, I just helped her to do it." The girl said, "my mom helped me with the *coding* like the angles [she meant when she is doing angles in the code]."

In addition, some parents found the CT workshops to be beneficial because CT activities helped *them* learn CT and some mathematical concepts. If parents understand how math is taught today, they can assist their children more effectively both with their math homework and various activities that involve quantitative skills and abstract thinking. According to Civil et al. (2008), parents tend to teach their children in the same manner they were taught when they were children. This explains why many parents find it challenging to help their children when they learn in ways that are unfamiliar to them and/or with the content that is much more advanced than what they used to deal with. With an ever-changing curriculum and instructional methods, there is a growing need to support parents become more involved in their children's learning.

While conducting the two workshops, the researcher observed that some parents learned CT activities and then helped their children. For example, the mother in Pair 6 tried to learn about CT activities and "help the child's understanding, concentrate on things and show him that

it's important to learn." She added that interacting with her son "was fun" and that "he was having fun" as well. The mother in Pair 7 was just watching her son who tried to teach her how to code. He explained to her how the coding process works and with what outcomes and said when his parents need help, they ask him, "they told me, if I did something wrong [during the workshop], help me." The boy also added that his mother "helps [at home] when I don't know the answers to some questions, but mostly, I do it alone."

The participant self-reported data gathered during this study show that the engagement of parents in CT workshops was taken by the participants to be beneficial both for children and parents: children received help from their parents, and parents received help from their children. In addition, parents learned new mathematical concepts, and children spent time with their parents doing school curriculum learning they said they enjoyed and learned some math, coding, new ways of learning and learning together with their parents.

Most children commented that they usually received a lot of help from their parents at home when they had difficulty doing mathematics. For example, the boy in pair 1 said that "they help me a lot" and "they support me." The girl in Pair 4 also mentioned that her parents help her, and the girl in Pair 5 said that her parents "help me a lot." The boy in Pair 8 also said that his mother "can help me." The son in Pair 7 commented that he mostly does not get or need help: "my mom helps [at home], but mostly I do it alone."

On the other hand, parents commented that they interacted and helped their children during CT workshops. For example, the mother in Pair 1 said, "most of the time, I like to watch and interfere when I feel I have, or I need to." The mother in Pair 2 said that she tries "to interact with my children through observation." Some parents commented that they like to know how their children work and what they need. The mother in Pair 2 said, "I like that they wanted to

show me how to do it," and the father in Pair 3 said, "I like to work with him in order to know where my kids might need help."

The findings were on a range of interaction, from parents helping their children when needed, to helping the child when they were shy to ask for help in a classroom to having the children help their parents understand before the parents in turn helped the kids. This suggests that parents should be more supportive of their children and encourage them to ask questions when something is not clear to them. As Epstein (1987) pointed out, studies on parental involvement in schoolwork conducted over two decades found that children succeed in their studies when their parents inspire and support them. Therefore, it is important to raise awareness among parents about the benefits of engagement in their children's learning.

This finding on engagement of parents with their children confirms Epstein's observation (1987) that parental involvement plays a critical role in children's ability to do well in school and is a key to their academic success. Further, children need to know that their parents are interested in what they learn and how they learn so that they could ask them questions and discuss their school-related achievements and concerns.

6.2.1.b The reflection of working together

All parents said that they liked working with their children, and most children, with the exception of two, said that they enjoyed interacting with their parents. For example, one of the sons in Pair 2 said, "it makes things more fun," but the other son said, "no, they tell me to do stuff I don't want to do." The comments of the second son in Pair 2 show that a student may not like one activity but can be happy doing another. The second son also preferred to work alone than with his parents and, overall, was "very impressed" with the workshops.

As per Scott (2015) these students will likely improve their interest and achievement in mathematics performance as a result of their parents showing interest and choosing to participate in the mathematics workshop as a part of this study.

Some parents commented that their children were completely absorbed in CT activities. For example, the father in Pair 3 said, "it was a good experiment for us. I saw the kids as highly engaged and love it." Most parents said that the workshops motivated them to engage with their children more often. For example, the daughter in Pair 4 found that the workshops encouraged her to work with her parents, and her father said that the workshops encouraged him to engage in his children's learning activities, "I like to sit with my daughter and do it." However, the mother in Pair 6 thought that "if you want to work with him [son], it doesn't have to be this. You could do it in a different way, engage with your kids. Doesn't have to be in the workshop."

6.2.1.c The level of engagement and the attitude of participants

The two most commonly observed types of engagement between parents and their children during CT activities were parents watching/closely observing their children and parents learning from their children how to code robots, apps, and games. As it was mentioned earlier, many of the parents appeared to need extra guidance at the beginning of the workshops due to their limited experience with the CT activities. Once they understood what was expected of them during the workshops, they became more comfortable working with their children and learning with them to code the mathematics objects in the math coding app, the characters in visual programming language and the robot to simulate mathematical and other curricular concepts.

In the observation as stated in Chapter 4, I classified high engagement as when I observed the pair (child-parent) working together very well, medium as when I found when a pair (child-parent) occasionally engages together with some gaps of not engaging together, and low referred

to observing a bigger gap among the few moments when a pair (child-parent) engaged together. The level of parent-children engagement varied among participants from low to high. It was high for Pairs 2, 3, 4, and 7 and low for Pair 8. The two grandsons in Pair 8 followed the workshop instructions carefully and applied them during CT activities, but their grandmother chose not to closely interact with them and at some point, appeared to have her eyes focused away from the children. The level of parents' engagement with their children was medium for Pairs 1, 5, and 6 because they mainly watched their children's participation in CT activities.

Most of the participants displayed a positive attitude toward CT activities, appeared to and reported reflection and interview responses to enjoy them. The attitude of the grandmother in Pair 8 was neutral. Overall, most parents and children thought that CT workshops were very useful and interesting. The laid-back nature of engagement of the grandmother in her grandsons' CT activities could be explained by her relation to the children as a grandparent as opposed to a parental/guardian relationship or by her generation's limited interaction with digital tools in the context of school.

6.2.2 The benefits and challenges of parent engagement

The parent met challenges with sharing devices, and I observed a language barrier for some who appeared to be recently immigrated (to Canada) parents and understanding the instructions or using instructions easily understood by the participants.

Some parents mentioned that they faced some challenges of sharing devices with others, because there were not enough devices available. This resulted in have making groups of pairs share one device during the activities. Some parents, as with Pair 1, commented that working in small groups made them feel uncomfortable and they made a suggestion to provide them with

more devices next time. Overall, the showed engagement with other pairs during the small group activities.

In explaining to parents, the nature of CT activities, children helped those parents whose native language is not English understand certain words used during workshops. As the boy in Pair 7 said, "I teach them [parents] English whenever I can." Thus, parents not only learned mathematical concepts, but also expanded their English vocabulary. The interaction of parents and children during CT workshops was mutually beneficial in many ways (learning how to use CT, learning about English words for math concepts, and parents and children working together on math and coding) and should always be encouraged by both teachers and school administrators.

Both parents and children experienced some challenges during CT activities. For example, the father in Pair 4 found that his daughter likes to explore learning activities that he was not aware of before. Also, Pair 5 tried to code more than what was required in the task offered in the session. For example, they tried to code a triangle and had some difficulties with angles of turns for the path they were coding the robot to follow the directions of code, they struggled, persevered, and in the end, they were able to figure out now to use the exterior, instead of the commonly used interior, angle in coding a triangle. In addition, some students tried to use code uses several motion and change appearance coding blocks in Scratch and with the app for coding the robot in their activities and looked confused in the process of using several coding blocks in the limited time during the workshop.

On the benefits of CT and mathematics workshops, parents commented mainly about what they learned, specifically new ideas about technology used, coding, thinking, parents

learning together with their children as well as a more fun way of teaching mathematics. For

example, the mother in Pair 1 said, "I learned something I didn't know," and the mother in Pair 5

said, "then we go learn something new." The mother in Pair 6 said, "the new tech is really

helpful for the kids," and the mother in Pair 7 said, "I was surprised about how fast it went and

all the codes it had." The father in Pair 4 said that the coding technique "makes the child think in

different ways." The mother in Pair 5 said, "I like to work with my child as in this way we learn

together," and the mother in Pair 6 said, "I found fun ways to teach the children the math."

The majority of the student participants also spoke about new things they learned

together with their parents during CT workshops. For example, the boy in Pair 5 said, "I will

learn and then we go learn something new. So, I love to engage." The boy in Pair 7 said, "I like

working with my parents because they have been learning more stuff than me and they teach me

new stuff," and his mother said, "to know how to develop us [parents] to connect the math with

tablet."

Parents and children also commented on the benefits of working on the CT and MT

(mathematics thinking) activities, the interaction and engagement that brought them closer

together. As the mother stated in Pair 2 "I really like working with my children. So that make the

relation stronger and near [closer] together."

Overall, the benefits and challenges of parents' engagement particularly with their

children in CT activities from the participants' self-reported data appeared to outweigh some of

the frustration and confusion they experienced at the beginning of the two workshops.

6.2.3 Participants' views and feedback on parent engagement

Views

Participants' views on CT activities were mostly positive. For example, in Pair 1, the mother thought that it was "a good program" and "a successful workshop." One of the two boys in Pair 2 said, "amazing I love it," while his brother added that "it was interesting, I was excited." Their mother thought that CT workshops were "nice, good, I benefited from it." The boy in Pair 3 also found them to be "fun and helpful." The mother in Pair 5 said, "it's fun, like, I can do it every day because it's really fun." The mother in Pair 7 said, "excellent, something intelligent, interesting, not boring."

These comments confirm the findings of Vallera and Bodzin (2017) suggesting that combining technology with authentic project-based learning challenges while using real-world examples can help children better grasp complex and abstract concepts. This finding supports the promise of incorporating CT activities in teaching mathematics and as part of mathematics curriculum.

Feedback

At the end of the study, most parents said that they were glad they participated in CT workshops and that they enjoyed being involved in their children's CT activities. Some parents said that the CT workshops helped them not only learn new mathematical concepts, but also strengthen their relationship with their children such as the mother stated in Pair 2, "I really like working with my children. So that make the relation stronger and near together."

Some parents commented that they liked learning math using CT activities and that they and their children were "having fun." For example, the mother in Pair 1 said, "I was impressed, excited, easy way to teach the kids. So, having fun time with the kids, at the same time teaching them," "I think it's enjoyable to work with each other." The mother in Pair 2, said, "it's a fun activity to do with them and especially when kids are learning," "it was interesting and helpful

for students. I hope to do this always." The father in Pair 4 said, "it's very interesting...I'm very happy I came here. It's really nice...it is very exciting and useful for both kids and parents." The mother in Pair 5 said, "they should learn in a happy ending not like they hate math."

These comments support the conclusion of Wing (2006) that "computational thinking will be a fundamental skill that is used by everyone in the world in the 21st century" (p. 2). The comments also validate the recommendation of Sanford and Naidu (2016) that CT activities, which are more recent learning activities, should be offered to parents as well.

Most of the participants commented about how much they enjoyed the workshops. For example, the boy in Pair 3 said, "I like working with my parents," and the boy in Pair 6 said, "it is fun," while his mother said, "everything was good, and I was impressed." The mother in Pair 7 said, "I like to know my son knows the work or not" and added that she found workshops to be "interesting." Also, her son said, "I find it very fun and teaches me more."

6.2.4. Participants' suggestions on the design of the workshop

Participants shared several suggestions to improve the design of CT activities and the workshops in general. Some of them thought that it would be best to do more activities and spend more time in the workshops, especially with their favorite workshop activities. For example, the boy in Pair 1 suggested that the next workshops include more activities with the Sphero robot. The boy in Pair 3 also preferred "more time playing with the Sphero," and his father suggested to "have more time to focus on certain topics." The two boys in Pair 2 recommended to allocate more time to CT activities, and their mother suggested "just more ways that you can include, more ways, more activity."

Some participants, suggested solving the limitations of working in small groups with other pairs sharing the same gadget, recommended providing more electronic devices and

gadgets like robots in the workshops. For example, the mother in Pair 5 said, "overall it was good, but if they have more gadgets, maybe it will be more fun." Other participants' suggestions related to changing mathematics curriculum offered to students in schools. For example, the mother in Pair 7 recommended to include CT activities in the mathematics curriculum to make it more interesting.

The suggestions of the workshop participants are similar to the ones discussed by Yadav, Hong, and Stephenson (2016) who recommended incorporating CT into the curriculum for all subjects with the goal of "moving students from merely being technology-literate to using computational tools to solve problems" (p. 565). Barr, Harrison, and Conery (2011) also suggested that in the future, all students should be given an opportunity to learn CT skills and use them in different contexts.

6.3 Summary

In this chapter I have discussed the findings from the study under two themes which are related to the general research on the *nature of engagement of students with their parents during computational and mathematics thinking activities.* Within in each of the two themes I have discussed findings on the two specific research questions: the *ways through which students and their parents act and interact during computational and mathematics thinking activities*, *and the role of the parents during computational and mathematics thinking activities; the benefits and challenges of parental engagement; and the views and feedback of both students and parents after engaging with computational and mathematics thinking activities*.

Theme One focused on remixing mathematics and computational thinking. It was in response to the research question on *the nature of CT and MT activities.* Most of the students commented

on how they learned how to code and play coding games and apps and the mathematics concepts that were involved. The subthemes on *the nature of CT and MT activities* branched into the following items: applying mathematics in daily life, learning mathematics topics, learning coding and CT, a new way to learn mathematics, a new way to teach mathematics, and the nature of CT activities. For example, the boy in Pair 1 said that he learned "how to make code" and that "you can make it dance, you can play games, etcetera." Most participants commented that using CT activities was a new way to learn mathematics, and most participants preferred to include CT activities in mathematics curriculum to be a way of teaching mathematics at school. In addition, almost all adult participants said that the two workshops gave them an opportunity to learn about CT integrated with learning mathematics and discover its beneficial effects on their children's perceptions of mathematics. The parents' views were that CT activities should be incorporated into teaching mathematics in elementary schools. For example, the father in Pair 3 said, "the workshops show math in a beautiful way that we never expected to see." The mother in Pair 1 said, "fun way teaching them how to draw something" and "it's mixed playing and learning at the same time." The mother in Pair 2 commented about "how to learn math by this activity," and the father in Pair 3 said, "I like the idea of robot, it makes my son highly engaged. I liked this activity because it can change math teaching from boring to fun." At the end, all participants, students and parents, reflected that they enjoyed doing computational and mathematics thinking activities and learn something new, and they found the CT activities to be helpful way to learn and teach mathematics.

Theme Two focused about parental engagement, and it branched into the following sub themes: act and interact, the benefits and challenges of parents' engagement, and participants views and feedback on parents' engagements. This theme responded to the research question

addressing *the nature of engagement* of students with their parents during computational and mathematics thinking activities, and *the action and interaction* of parents with their children during computational and mathematics thinking activities, *the benefits* and *challenges of parents' engagement* with their children during computational and mathematics thinking activities, and *the views and feedback* of both students and parents after engagement with computational and mathematics thinking activities.

The data evinced that parents actively observed and working well with their children. All parents commented that they did not try to help their children in each activity step. They watched their children. For example, the mother in Pair 2 said that she was "watching and trying to interact with my children through observation", and some parents did help their children when it was necessary. For example, the boy in Pair 3 said, "my dad helped me like if I did that wrong or instruction you know to fix it," and his father said, "I tried to help them and see how they are taught in school. …, I returned him back in order to do it correctly."

In addition, some parents found the CT workshops to be beneficial because CT activities helped *them* learn CT and some mathematical concepts. All parents also said that they liked working with their children, and most children, with the exception of two, said that they enjoyed interacting with their parents. For example, one of the sons in Pair 2 said, "it makes things more fun," but the other son said, "no, they tell me to do stuff I don't want to do." The comments of the second son in Pair 2 show that a student may not like one activity but can be happy doing another. The second son also preferred to work alone than with his parents but said overall was "very impressed" with the workshops.

At the end of the study, most parents said that they were glad they participated in CT and MT workshops and that they enjoyed being involved in their children's learning activities. Some parents said that the CT and MT workshops helped them not only learn new mathematical concepts, but also strengthen their relationship with their children. For example, as the mother stated in Pair 2, "I really like working with my children. So that makes the relation stronger," and the boy in Pair 3 said, "I like working with my parents."

Overall, the benefits of parents' engagement particularly with their children in CT activities from the participants' self-reported data appeared to outweigh some of the frustration and confusion they were observed by the researcher and the teachers to experience at the beginning of each of the two workshops when grappling with the instructions on coding robots, screen characters and visualizations to simulate mathematics concepts.

6.4 Study limitations

The main purpose of this study was to understand the nature of parent engagement with their children during CT and mathematical activities conducted during the two workshops. Since this is a qualitative study, its findings cannot be empirically generalized to other contexts and populations. The study encountered many limitations.

This study was limited in its sampling as it only focused on children in primary grades 3 through 6 in a religious-based private school. This does not provide enough of a spread to be able to comfortably generalize to other populations even with in the region where the study took place. The total number of study participants was limited to eight child-parent/grandparent pairs (10 students, 7 parents, and 1 grandparent) and two math teachers. Data collection for this study was carried out over a period of one month during Spring of 2018, which was closer to the end of the school year and only two workshops were planned and implemented to fit the schools' and

participants' schedules. The findings of the study would likely be different if the research period was longer or the study was conducted earlier in the school year.

In addition, this study encountered some logistic limitations and technical issues including an insufficient number of devices used in the CT activities. The classroom where the workshop was held had only three desktop computers, which were necessary to conduct the Symmetry app activity and Scratch program. There were also only three iPads to connect to the Sphero robot with the five pairs on the first day of the workshop, though this did not pose as much of a problem with the three pairs on the second day.

The study was also limited due to internet connectivity issues, as the devices would suddenly stop working causing interruptions in coding activities. Finally, each workshop was limited to 1 hour and 15 minutes. This was not a long enough period to complete the activities that were designed with the Sphero robot.

6.5 Recommendations for Practice and Policy as well as Parental involvement

Based on participants' views and feedback, as well as the researcher's own observation, this study makes several recommendations related to the design of CT workshops, parent involvement, teaching mathematics, and future research.

Suggestions for conducting the Parent-Child Learning Workshops:

1.   Conduct CT workshops over a three-day period so that children do one activity per each day and increase the amount of time spent on each activity from 1 hour 15 minutes to 2 hours.

2.   Provide more devices so that each student has an individual device and uninterrupted learning experience.

3.   Offer CT workshops throughout the school year so that they are available for those who can attend them whenever it is convenient for them.

Suggestions for the Parent engagement:

4.   Educate parents about the benefits of involvement in their children's mathematics learning both in school by participating in CT workshops and outside of school while helping them with their homework and doing everyday activities like shopping and budgeting.

Suggestions for Future Studies:

5.   Conduct a study that will include several schools, including public schools, and will last for an extended period.

6. Conduct a study that will involve studying more specific CT tools and mathematics concepts.

6.6 Overall Summary and Concluding Remarks

Several researchers and educators maintain that using CT tools and activities in teaching school curricular contributes to learning in creative and imaginative ways. As a result, it promises to lead to an improved student achievement, interest and enjoyment in learning content that several students experience as difficult, boring, and less relevant. Even when there is a long history on offering CT learning to children from Papert and his contemporaries, researchers have noted that more needs to be researched on how to use them well and on resources to support teachers who select to use them. Drawing from computational and mathematics thinking activities designed by Namukasa (2017) and Gadanidis (2017) for use in elementary schools, in my study, I research the nature of engagement of learners with their parents in a school setting on CT activities when they are integrated with mathematics activities. Gadanidis (2017) argues that not only is CT similar to mathematics thinking, but CT also offers many affordances such as agency, access, abstraction, automation and audience.

In this study, observations, reflection forms, and interviews of eight parent-child pairs were reviewed to determine if CT activities enrich mathematical concepts and if they encourage

engagement between parents and children in and outside of the workshop. All children and parents that participated in both workshop sessions felt that the activities employed in the workshop: Symmetry, Sphero, and Scratch, all enriched mathematical concepts for them. Children and parents both also found enjoyment in completing the CT activities, especially the activity involving coding to make a robot move. Several of the children were excited about a more interesting and interactive way to learn math and learning how to code. Parents and children both reviewed the importance of using math and CT in daily life through different methods, including shopping and sharing. Parents recognized and embraced the workshop activities as new and exciting ways to learn mathematics. With the exception of two children, saying they either preferred to work alone or with friends, and that they felt their parents just made them do things they didn't want to do: All parents felt engagement with their children was encouraged, and they were motivated to engage with their children more outside of the workshops as well. Most of the children who participated in the workshop activities with their parents also felt encouraged to engage with their parents more.

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Appendix A

A.1 Design Workshop

Researcher's Copy

Grade three, four, five and six Computational and Mathematical Thinking Tasks in Two Sessions

Notes: -   total time of each session of this workshop is one hour and fifteen minutes

- *It was the same plan for first day and second day, but the first day for Grades 3&4, and the second day for Grades 5&6*

1- Introductions, Thanks and Welcomes for:

   a. The school principal and teachers
   b. The Session participants (students and parents)
2- Information and Procedure of the study
   a. Assuring confidentiality of their data.
3- Share from Research, briefly share what research says on the role and benefits of parents taking time to follow and engage with their children in mathematics learning.
   Using general CT tools (robots, software, and apps) to meet a mathematics learning goal from Ontario curriculum expectations. Ontario Ministry of Education (2005) states that "this curriculum recognizes the benefits that current technologies can bring to the learning and doing of mathematics. It therefore integrates the use of appropriate technologies, while recognizing the continuing importance of students' mastering essential arithmetic skills" (p. 4). Also, Ontario Ministry of Education (2005) indicates that "overall and specific expectations in mathematics are organized into five strands, which are the five major areas of knowledge and skills in the mathematics curriculum. The five strands are Number Sense and Numeration, Measurement, Geometry and Spatial Sense, Patterning and Algebra, and Data Management and Probability" (p. 8).
4- Brainstorm and use presentation on CT and coding in real life.
      15 minutes

5- The first activity, An app for programming geometry (math app) at http://researchideas.ca/sym/s2/
       i.   Introduce them to show a video was created by Dr. Gadanidis
      ii.   Share a square paper and colors for each group
     iii.   Ask the children and parents to apply the Symmetry activity as they see in the previously video
      iv.   Start to work in chrome (by desktop) to apply the Symmetry at http://researchideas.ca/sym/s2/
       v.   Let the students and parents play with coding Symmetry activity in different shapes
      vi.   Give students reflection forms to get their feedback.
                     20 minutes
6- The second activity, Programming a robot activity (Sphero) with a geometry learning goal.
       i.   Introduce them to use an app (tickle) to program a robot

      ii.   Share a simple sequence of code for a robot to move in a shape without loops such as straight line and square.

     iii.   Ask the children and parents to create code using tickle app

     iv.   Let the students and parents play with the software and let them to make Sphero moves as square, rectangle and triangle

     v.   For Grade 5-6, ask students with their parents to create a maze then let the Sphero moves inside it.

     vi.   Give students reflection forms to get their feedback.

<div align="center">20 minutes</div>

7- The third activity, computer software activity (Scratch) in which a screen character is programmed to https://scratch.mit.edu/projects/editor/?tip_bar=home#editor

     i.   Introduce them to use the software to draw a shape

     ii.   Share a simple sample Scratch activity https://scratch.mit.edu/projects/editor/?tip_bar=home#editor

     iii.   Ask the children and parents to modify this activity and do their own shape drawing activities

     iv.   Share a more complex (e.g., uses loops, and more blocks, changes pen color) sample activity and offer challenges for children and parents to remix or create their own. http://scratch.mit.edu/projects/33928720/#editor

     v.   Let the students and parents play with the software

     vi.   Give students reflection forms to get their feedback.

8- Give parents reflection forms to get their feedback after all three activities.

<div align="right">20 minutes</div>

<div align="center">134</div>

Appendix B

B.1 Observation Form

Name of researcher/researchers: _____

Date and Time: _____

Grade: _____

Number of Students: _____

Number of parents: _____

What instruments I use through the workshop? _____

What is the level of students' engagement with their parents during doing activities?

   a) Low   b) Medium   c) High

What is the students' attitude?

   a) Positive   b) Negative

How do the parents interact with their children?

   a) Low interact   b) Medium interact   c) Highly interact

What is the parents' attitude?

   a) Positive   b) Neutral   c) Negative

Observations on ways of and acting interacting and on roles (e.g., doing, writing and touching)

_____

Observations on possible benefits from engagement of students and parents on computational and mathematics thinking activities workshop

_____

Observations on challenges coming from engagement of students and parents on computational and mathematics thinking activities workshop

_____

_____

Further Comments

Appendix C

C.1 Interview Questions for Parents

The responses of interview questions that give researchers an impression of the nature of engagement of learners with their parents on workshop. Through the following aspects, I can get the answers of my research questions:

Demography

Child

a) Could you please tell me about your child (Prompts if needed: what Grade, how they do at school, in math, with digital devices, robots, coding, homework, achievement)

Family (Parent, home and other)

b) Could you please tell me about yourself and your family (Prompts if needed: How many children are in the family? What is the parents' educational level? ---------------
--- What is your economic status (very low, low, average, above average, far above average) What is the language do you speak at home?) ---
----

About mathematics and curriculum

c) Could you please share with me your thoughts about mathematics and how it is taught or learned (Prompts if needed: Does mathematics apply in your life and how?

---------How do you help your children in learning mathematics such as helping them in their H.W or providing tutor of them?)--
----

----

d) Did you attend any mathematics workshop with your child/ children activity? -------
-------------Which one was it? ---
---How did you find it---

Act and interact.

e) Could you please tell me about how you acted and interacted during these workshops? (Prompts if needed: What is the role of parents? ----------------------------
------------how your children doing with you? ------------------ Are there something

surprized you or you like in the interaction during these workshops --------------------
------------------ what do you do not like in the interaction during these workshops?)
other comments

----

f)   How is your action and interaction in this workshop different from elsewhere/before
(e.g. other workshops, homework)?

Benefits, challenges

g) Tell me about how you found these workshops (Prompts if needed: what was your
favourite session/aspect and why? What was your least favourite and why) -----------
----
--- Do you find some
difficulties or challenges in these activities, and How? ------------------------------------
----

Views and feedback

h) In your views, do you find these workshops enrich mathematical concepts for
students? How? ---

Do you find these workshops encourage you to engage with your children or give
you a guide to how you can engage with your children? ----------------------------------
----
Do you have any suggestions for next workshops? ---
----

i) Totally, how do you find these workshops? Through context, activity and
engagement?

C.2 Interview Questions for Students

The responses of the interview questions which give researchers an impression for the nature
of engagement of learners with their parents on workshop. Through the following aspects, I can
get the answers of my research questions:

Demography

Child

a) Could you please tell me about yourself (Prompts if needed: How old are you? What Grade? -------------------------------- Do you like mathematics? ---------------------------- Do you like computer? ----------------------Do you work with digital devices, robots, coding? --- ---

Family (Parent, home and other)

b) Could you please tell me about your family (Prompts if needed: How many children are in the family? -- What is the language do you speak at home?) --- ------------ --- --- -----------------

About mathematics and curriculum

c) Could you please share with me your thoughts about mathematics and how it is taught or learned (Prompts if needed: Do you use mathematics in daily life such as: going store, cutting anything in equal parts, counting, and so on? --- -- Do you do your homework with your parents? --Do you have anyone teach you mathematics after school such as tutor?)-------------------------------------- --- ---

d) Did you attend any mathematics workshop with your parents? --------------------Which one was it? --How did you find it- --- --

Act and interact.

a) Could you please tell me about how you acted and interacted during these workshops? (Prompts if needed: How your parents help you? ----------------------------- ------------------------------ Is there anything that surprised you or you liked in the interaction during these workshops with your parents? ------------------------------------- --- what do you do not like in the interaction during these workshops?) other comments--- ---

b) How is your action and interaction in this workshop different from elsewhere/before (e.g. other workshops, homework)? -- ---

Benefits, challenges

a) Tell me about how you found these workshops (Prompts if needed: what was your favourite session/aspect and why? What was your least favourite and why) -----------

----
----Do you like the work with your parents? --
---- Do you find some difficulties in these activities, and How? ------------------------
----

Do you have any suggestions for next workshops? --

Views and feedback

a) In your views, do you find these workshops help you to understand mathematical concepts such as: length, angles, etc.? how? --
----

Do you find these workshops encourage you to work with your parents? ---------------
----
-------------------- Do you have any suggestions for next workshops? --------------------
----

b) Totally, how do you find these workshops? Through context, activity and engagement? ---
----

C.3 Interview Question for Teacher

I am going to ask the teacher who is teaching the classroom which I will conduct the workshop in about students' background information. For example, I am going to ask:

1. Please! Tell me about how your students interact in their usual day during schooldays?

   ----

2. Did you find that they interacted differently in the workshop than during schooldays?

   ----

3. Did you notice any differences in how that slow and the fast learners interacted in normal schooldays and in this workshop? --
   ----
   ----

4. In what extent parents act and interact with their children in usual such as: mathematics tasks or in school building?

   ----

5. Do you find the engagements of parents in these workshops effectively? How?

----

6. Do you believe parents have a big role when they engage with their children? How?

----

7. Do you find benefits and challenges through doing these workshops when parents engage with their children? What is it?

----

8. In your view, tell me what you think about these workshops, such as:

   Does coding enrich mathematical concepts? How? --

   Does the engagement of parents support their children in computational and mathematics thinking activities? ---
----
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9. Do you have any additional comments or suggestions?---

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Appendix D

D.1 Reflection Form 1 of Students

Sphero Robot

Complete the following questions, please!

1- List mathematical concept you have learned from Sphero activities. For example: length, time, speed, angles, patterns, etc.…)

2- Write or draw the path or shape you have made to make Sphero move.

3- Do you like this activity? You can draw an emoji to express your feeling. What the thing most surprised you?

4- Do you like working with your parents? Why?

I wish you had enjoyable and beneficial time during this workshop

D.2 Reflection Form 2 of Students

Scratch Program

Complete the following questions, please!

1- List mathematical concept you have learned from Scratch Program activities. For example: length, time, speed, angles, patterns, etc.…)

2- Write or draw the path or shape you have made in Scratch program.

3- Do you like this activity? You can draw an emoji to express your feeling. What the most thing surprised you?

4- Do you like working with your parents? Why?

I wish you had enjoyable and beneficial time during this workshop

D.3 Reflection Form 3 of Students

Symmetry

Complete the following questions, please!

1- What did you learn?

2- Write or draw the path or shape you have made in Symmetry activity.

3- Do you like this activity? You can draw an emoji to express your feeling. What the most thing surprised you?

4- Do you like working with your parents? Why?

I wish you had enjoyable and beneficial time during this workshop

D.4 Reflection Form of Parents

Complete the following questions, Please!

1- Please, share with us why you selected to participate in this study?

2- In what ways you like or not like working with your child/ children? Why?

3- Did you learn or observe something new about: the workshop, your child, yourself?

4- Did you observe something new about mathematics?

5- What surprised you or dislike in this workshop?

6- What are your suggestions in future to improve these workshops?

I wish you had enjoyable and beneficial time during this workshop

Appendix E
Ethics Approval

Western
Research

Western University Non-Medical Research Ethics Board
NMREB Delegated Initial Approval Notice

Principal Investigator: Dr. Immaculate Namukasa
Department & Institution: Education\Faculty of Education,Western University

NMREB File Number: 109494
Study Title: Tool-based innovative learning and teaching practices

NMREB Initial Approval Date: August 17, 2017
NMREB Expiry Date: August 17, 2018

Documents Approved and/or Received for Information:

Document Name	Comments	Version Date
Western University Protocol	Received July 31, 2017	
Recruitment Items	Recruitment Email	2017/08/01
Letter of Information & Consent	Teacher Participants	2017/08/01
Letter of Information & Consent	Parent/Guardian	2017/08/17
Assent		2017/08/17
Instruments	Teacher Initial Survey	2017/08/01
Instruments	Interview/survey - Teachers	2017/08/08
Instruments	Interview/survey - Parent	2017/08/01
Instruments	Instrument Focus Group Discussion	2017/06/20

The Western University Non-Medical Research Ethics Board (NMREB) has reviewed and approved the above named study, as of the NMREB Initial Approval Date noted above.

NMREB approval for this study remains valid until the NMREB Expiry Date noted above, conditional to timely submission and acceptance of NMREB Continuing Ethics Review.

The Western University NMREB operates in compliance with the Tri-Council Policy Statement Ethical Conduct for Research Involving Humans (TCPS2), the Ontario Personal Health Information Protection Act (PHIPA, 2004), and the applicable laws and regulations of Ontario.

Members of the NMREB who are named as Investigators in research studies do not participate in discussions related to, nor vote on such studies when they are presented to the REB.

The NMREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000941.

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Ethics Officer, on behalf of Dr. Randal Graham, NMREB Chair or delegated board member

EO: Erika Basile___ Grace Kelly ___ Katelyn Harris ___ Nicola Morphet___ Karen Gopaul___ Patricia Sargeant___

Appendix F
Curriculum Vitae

Name: Rawia Zuod
Post-secondary Yarmouk University
Education and Irbid, Jordan
Degrees: 1998-2002 B.A in Mathematics Education.

The University of Western Ontario
London, Ontario, Canada
2016-2019 M.A. in Curriculum Studies (Mathematics Education)

Honours and **Grad Pact '91 Education**
Awards: 2016-2017, 2017-2018

Related Work Mathematics Teacher
Experience Abu Dhabi Education Council,
Abu Dhabi, UAE
2008-2011

Mathematics Teacher
Ministry of Education,
Ajlun, Jordan
2006-2008

Mathematics Teacher
Private School,
Abu Dhabi, UAE
2006-2008

Mathematics Teacher
Private School,
Amman, Jordan
2002-2005

Publications:

Zuod, R., Namukasa, I., (2018). Computational Thinking and Mathematics Thinking Activities Workshops for Students with Their Parents: What is the Nature of Activities, Benefits, Challenges and Feedback, Poster presented at: Robert Macmillan graduate Research in Education Symposium, Faculty of Education, University of Western Ontario, London, Ontario, Canada.