The Math Around Us:

Encouraging and Supporting Mathematics Learning Outside of the Classroom

by

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ABSTRACT

The purpose of this project was to create a research-informed, responsive resource to help parents of Kindergarten to Grade 6 children incorporate mathematics learning into everyday family life. In Ontario, several publicly available resources discuss the important role parents play in their children's mathematics education, and the value of mathematical discussions and activities in everyday family experiences (Council of Ontario Directors of Education, 2015; Ontario Ministry of Education, 2010). While the recommendation for family mathematics learning is common and widespread, a document analysis completed for this project indicated a lack of concrete examples of what these activities and learning opportunities might look like. *The Math Around Us* is a book containing over 100 prompts and activities which incorporate mathematics learning into the places and spaces families frequent. Organized alphabetically by 18 unique locations, activities are explained in straightforward language, require few or no materials, and minimal or no preparation. This resource may be a valuable tool for parents interested in fun and informal ways to bring mathematical learning opportunities for their children into the home and world around them.

ACKNOWLEDGEMENT

I would like to thank my project supervisor, Dr. Lynda Colgan, for her guidance and constant support throughout my time in the Master of Education program. Her dedication to mathematics and science education is remarkable, and her passion is simply infectious. She has brought me on a journey of both research and outreach, and provided me with opportunities I will forever be grateful for. It was an absolute privilege to work alongside Dr. Colgan on countless initiatives over the past two years; my experience at Queen's University would not have been the same without her.

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Chapter 1: Introduction

The work of many researchers (e.g., Henderson & Mapp, 2002; Hoover-Dempsey et al., 2005; Jeynes, 2005, 2011) informs us of the value of parent involvement strategies for improved student achievement, but not necessarily the ways that schools put such strategies in place. In fact, Harris, Andrew-Power, and Goodall (2007) refer to the support of parents as "the single most important contributory factor to increased student achievement," and note that "in terms of raising school performance, parents matter significantly" (p. 2). While parents' engagement in their children's learning is widely accepted as having positive influence on children's academic success, there is strong evidence to suggest that parent involvement that is focused on student learning has the greatest impact on student achievement compared to other forms of involvement (Henderson & Mapp, 2002), and, in particular, family support of their children's learning at home is linked to improved student outcomes (Hoover-Dempsey et al., 2005; Jeynes, 2005).

Until recently, one of the most substantial bodies of research demonstrating the benefits of parent engagement to student achievement reported on literacy outcomes, and among those complementary studies, it was noted by many researchers that parents of young children shared a near-universal belief that reading together at home promotes their children's school achievement. In sharp contrast, it was noted that there is an equally widespread belief that the school bears the primary responsibility for mathematics education. Consequently, parents pay much less attention to supporting their children's mathematics learning at home even in the face of growing evidence to suggest that parental support at home is also the most salient dimension of parent involvement in their children's mathematics learning (e.g., Berkowitz et al., 2015).

As Stelmack (2013) pointed out, "parent programs that provide resources and assistance that parents may use with their children at home are more likely to have an effect on students' academic progress" (p. 3). Further, in their study of parent involvement across SES, Ho and Willms (1996) suggest that parent involvement at home, particularly talking about school-related activities, has the strongest effect on student achievement. Thus, tools and resources parents can use at home to support their children's mathematics learning have the potential to result in positive and profound changes in students' mathematics achievement.

Research tells us that there is a need to increase the number of parents who talk with their children about math in everyday interactions and concomitantly identifies the urgent need for supports and materials addressing the 'hows' of purposeful and practical parent partnerships in mathematics. Since there are very few highly accessible, user-friendly, step-by-step print or web-based resources, particularly in Ontario, Canada, this Master of Education project was undertaken to fill that gap through the development of a suite of more than 100 math activities that parents can do in familiar settings.

This chapter will provide an introduction to this Master of Education project, including a general synopsis of the project context, my experience as a resource developer, key terms, purpose, rationale, method, implications, and overview of the project.

Context of the Project

Ontario Ministry of Education Policy. Ontario has a parent engagement policy which provides schools with a framework for enhancing parent engagement to support positive outcomes for students, a rationale for the importance of parent engagement in education, as well as strategies for successfully fulfilling the Ministry of Education's vision of parent engagement.

This document, *Parents in Partnership: A parent engagement policy for Ontario schools* (Ontario Ministry of Education, 2010), calls upon educators to reassess their existing understandings of parent engagement and develop an awareness of barriers which may prevent parents' participation in school-related or learning activities. The policy document posits that schools can support parents as both partners and participants in students' education by (a) ensuring that parents feel welcomed by their school communities; (b) identifying ways for parents to become involved; (c) maintaining open dialogue between the school and home; and (d) providing the resources and tools necessary for their engagement to occur in meaningful and impactful ways.

In spite of this provincial policy document aimed at improving student outcomes by fostering and supporting parent engagement, it can be very challenging for school boards and schools to translate policy into effective action at the local level. Schools adopt different programs at different intensities to increase outreach, inclusion, and support for all families to become positively engaged in their children's learning. Among the most challenging parent-school partnerships are those aimed at fostering productive parent engagement in support of improved mathematics outcomes in spite of the fact that growing concerns have been raised by parents and other members of the public about the continuous decline in provincial mathematics achievement scores over time (Alphonso, 2017).

The Education Quality and Accountability Office. The Education Quality and Accountability Office (EQAO) is an independent agency that creates and administers large-scale assessments to measure Ontario students' achievement in reading, writing and mathematics at key stages of their education (Grade 3, 6, 9 and 10). All EQAO assessments are developed by

Ontario educators to align with the Ontario curriculum documents, and assessments of Grade 3 and Grade 6 students' skills in reading, writing, and mathematics are administered on an annual basis. EQAO provides schools and school boards with detailed reports about their students' achievement, as well as contextual, attitudinal, and behavioural information from questionnaires. The purpose of collecting this data was to provide insights that would enable schools to respond in a meaningful way, in order to improve specific areas of their programming and classroom instruction.

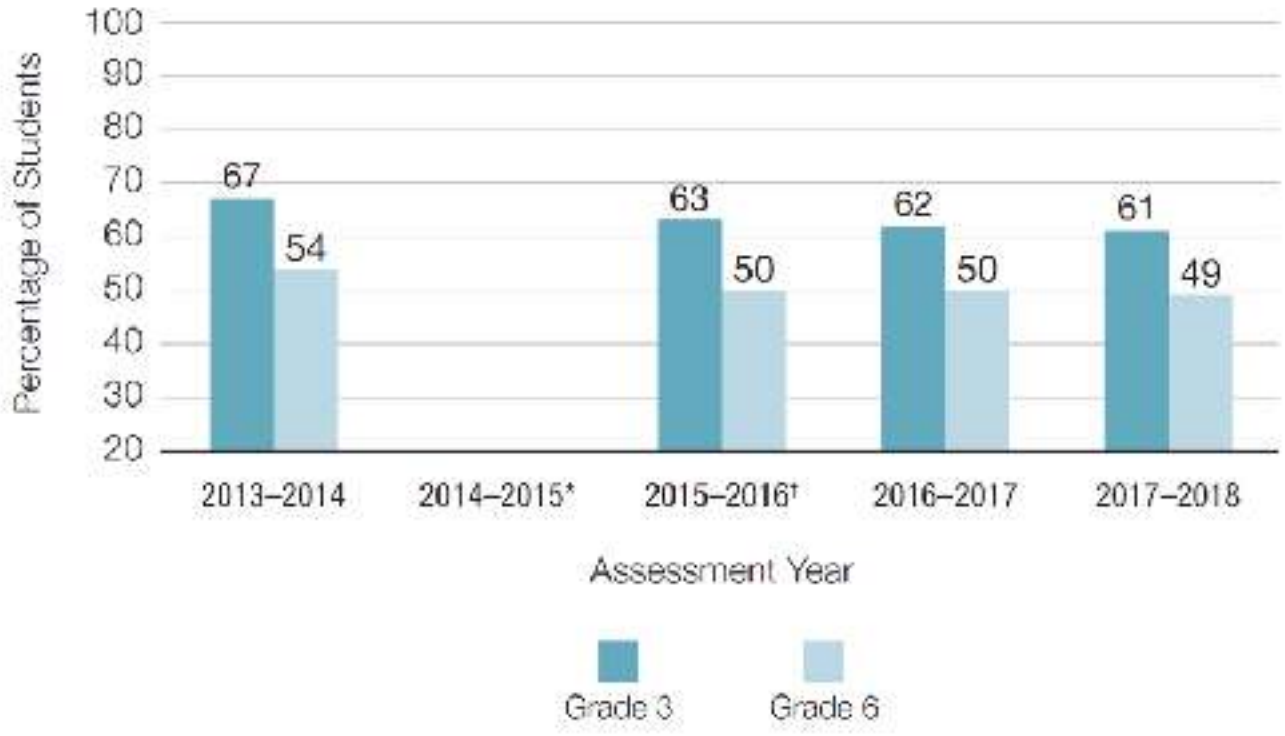


Figure 1. Percentage of Grade 3 and Grade 6 students at or above the provincial standard in mathematics (Education Quality and Accountability Office, 2018a).

It is important to compare results over time to identify trends in student learning. Such analyses help us to understand achievement within subject areas and course types and among groups of students. EQAO bases its observations on five-year trends for this reason (Education Quality and Accountability Office, 2018b).

In both Grade 3 and Grade 6, the number of students meeting the provincial standard in mathematics has either declined or remained stable in every annual test administered since the 2009-2010 school year. Results from the 2017-2018 school year are of grave concern because, for the ninth consecutive year, they represent a continued decline. In this most recent assessment, only 61% of Grade 3 students met or exceeded the provincial standard, and, for the third consecutive year, half or more than half of the province's Grade 6 students failed to meet the provincial standard (Education Quality and Accountability Office, 2018b).

The results from EQAO annual reports show that at the Grade 3 level, boys and girls have performed nearly identically each year: there is no significant difference in Grade 3 girls' and boys' achievement on the EQAO mathematics assessment over the five years examined. The same is true at Grade 6.

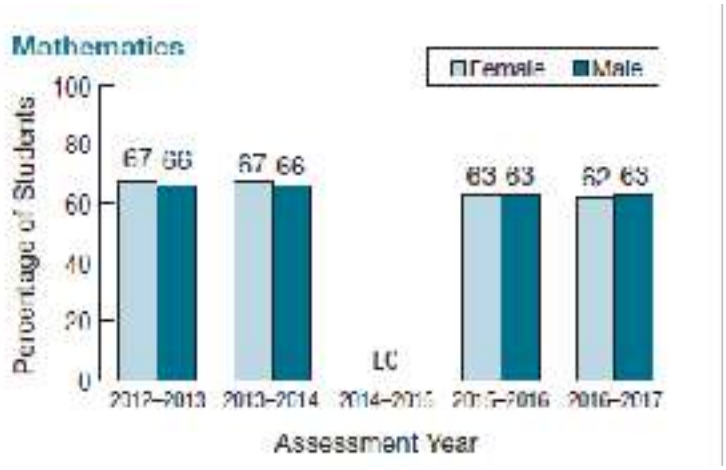


Figure 2. Percentage of Grade 3 students at or above the provincial standard in mathematics by gender (Education Quality and Accountability Office, 2017).

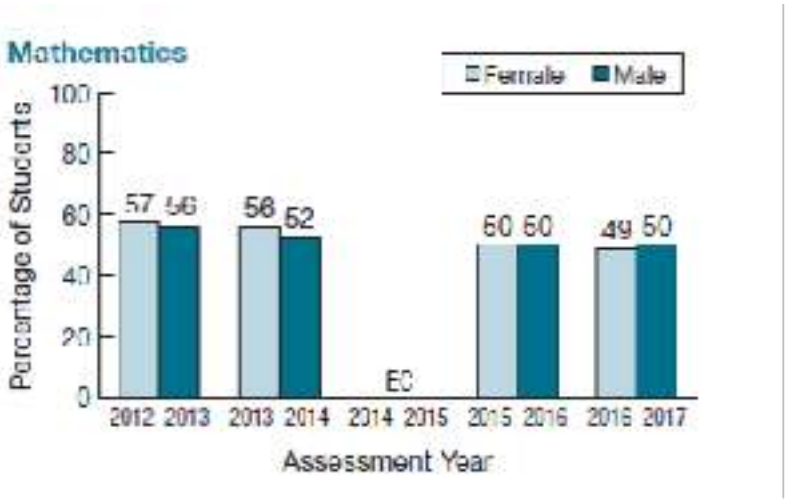


Figure 3. Percentage of Grade 6 students at or above the provincial standard in mathematics by gender (Education Quality and Accountability Office, 2017).

However, according to EQAO assessment in the 2016/17 academic year, only 49 per cent of Grade 3 girls in Ontario agreed with the statement they are good at math compared to 62 per cent of boys with the attitudinal gap widening by Grade 6, where just 46 per cent of girls said they were good at math compared to 61 per cent of boys.

Five-year trend tables display student responses to questionnaire items about parent involvement at home in learning activities. The responses show that participation in mathematics-specific engagement endeavours has been consistently lower than in reading, and has remained at a low level over time.

	2013–2014	2014–2015	2015–2016	2016–2017	2017–2018	2013–2014	2014–2015	2015–2016	2016–2017	2017–2018
	Female					Male				
Grade 3 students who completed the questionnaire	n = 60 219	EC	n = 59 170	n = 62 721	n = 61 939	n = 62 944	EC	n = 61 364	n = 65 256	n = 64 373
Percentage of students who indicated that they do the following "every day or almost every day" with a parent, guardian or another adult who lives with them:*										
Talk about the activities they do in school	50%	EC	55%	59%	60%	44%	EC	49%	49%	44%
Talk about the reading and writing work they do in school	32%	EC	34%	36%	33%	27%	EC	28%	29%	27%
Talk about the mathematics work they do in school	39%	EC	39%	39%	38%	34%	EC	35%	34%	34%
Read together	33%	EC	33%	29%	33%	26%	EC	29%	25%	26%
Look at their school agenda	57%	EC	54%	47%	47%	55%	EC	52%	45%	46%
Use a computer together	16%	EC	15%	15%	13%	16%	EC	15%	15%	14%

Figure 4. Grade 3 parental involvement student questionnaire results (Education Quality and Accountability Office, 2017).

	2013–2014	2014–2015	2015–2016	2016–2017	2017–2018	2013–2014	2014–2015	2015–2016	2016–2017	2017–2018
	Female					Male				
Grade 6 students who completed the questionnaire	n = 60 508	EC	n = 58 364	n = 61 577	n = 62 073	n = 62 663	EC	n = 61 087	n = 64 445	n = 64 360
Percentage of students who indicated that they do the following "every day or almost every day" with a parent, guardian or another adult who lives with them:*										
Talk about the activities they do in school	46%	EC	49%	50%	51%	39%	EC	42%	43%	45%
Talk about the reading and writing work they do in school	22%	EC	24%	23%	25%	19%	EC	20%	20%	20%
Talk about the mathematics work they do in school	34%	EC	35%	41%	36%	30%	EC	31%	37%	33%
Read together	7%	EC	7%	7%	8%	6%	EC	8%	7%	9%
Look at their school agenda	31%	EC	29%	25%	24%	33%	EC	29%	28%	25%
Use a computer together	8%	EC	9%	10%	9%	9%	EC	10%	11%	11%

Figure 5. Grade 6 parental involvement student questionnaire results (Education Quality and Accountability Office, 2017).

Ontario students' declining scores on EQAO elementary mathematics assessments and issues of gender parity and low parent involvement in mathematics at home have attracted

growing concern among parents and policymakers, and as a result, many new provincial and local initiatives have been embarked upon to improve mathematics curriculum, teacher knowledge, instructional strategies, equity, parent engagement, and, ultimately, student achievement scores.

The Renewed Math Strategy. In response to the negative trajectories in student achievement and disposition, and the dearth of parental support for math at home, in 2016, the Ministry of Education for the Province of Ontario launched the *Renewed Math Strategy* (RMS) and identified the following four key objectives:

1) increased student achievement, well-being and engagement in mathematics;
2) increased educator math knowledge and pedagogical expertise;
3) increased leader use of knowledge of effective mathematics pedagogy to provide the necessary supports and conditions for school and system improvement; and,
4) increased parent engagement in their children's mathematics learning.

Recognizing the integral role which mathematics plays in Ontarians' careers and everyday lives, the RMS also set a goal of 75 percent of all elementary students achieving Level 3 or higher scores on provincial mathematics assessments.

These goals were to be achieved by mandating that elementary school students receive at least 60 minutes of math instruction daily; appointing as many as three math-specialist teachers to every school; providing funding for increased professional development (including collaborative inquiry); and, improving support for learning at home through parent resources that provide helpful tips and information related to the mathematics curriculum (Ontario Ministry of Education, 2016b).

It is important to note that the RMS is aligned with *Parents in Partnership: A Parent Engagement Policy for Ontario Schools* (Ontario Ministry of Education, 2010), in recognizing that parents have a profound influence on their children's attitudes towards, and engagement with their learning in school, and mathematics learning in particular. The RMS also underscores that school and teacher practices can impact, either positively or negatively, whether and how parents engage with their children's schools and associated mathematics learning in school.

To better understand how Ontario elementary schools are working to develop and implement local practices to foster parent engagement in their children's mathematics learning as part of the RMS, the Ministry of Education's Parent Engagement Branch solicited research teams to study the implementation of local action plans for parent engagement initiatives in six low-achieving schools in order to develop scalable models and share knowledge mobilization tools resulting from the schools' various activities.

Drs. Lynda Colgan, Michelle Searle, Sandy Youmans and Lorraine Godden from Queen's University were awarded the contract for *Building parent engagement: A project to support the implementation of Ontario's Renewed Mathematics Strategy.* This is a ministry-funded project proposed in 2016 to assess, document, and share the experiences of a small cadre of Ontario elementary schools working to develop and implement strategies to foster parent engagement in their students' mathematics learning. This two-year project involved (a) supporting various initiatives such as math programs offered both in the afternoons and evenings at the participating schools (including Math Manipulative Fairs, Family Math Programs, Games Nights, Math Courses for Parents, and Classroom Open Houses); (b) the creation of take-home math bags and materials; (c) the establishment of math game libraries and the expansion of children's books

with a mathematics theme; and (d) the development of digital and print resources aimed at promoting parent engagement in mathematics.

This MEd project is the culmination of my participation in the Building Parent Engagement in Mathematics project as a research assistant, resource developer, program facilitator, conference presenter and team member.

Situating Myself as a Research-Based Resource Developer

Throughout my post-secondary education, I have produced a wide range of print and digital visual materials including posters, infographics, newsletters, and reports. I have always had an interest in design, and over the years I have continued to develop my abilities through incorporating these skills into my volunteer work, employment, and personal self-interest projects. I am completely self-taught, however I firmly believe in the effectiveness of quality visual resources as tools for sharing information and making knowledge accessible.

For example, during my Bachelor of Education program at the University of Windsor, one of the most enthusiastically-received projects I created was an infographic that demonstrated the development of number skills across the elementary grades (Appendix D). This was a unique way to show learning expectations at a glance as an alternative to having to comb through the curriculum document in search of this information.

From this, and other similar experiences, I learned first-hand that how information is presented influences how an audience interprets it, and therefore is a determining factor of its usefulness. Elements as simple as colour greatly influence engagement and memorability. I soon discovered that my intuitive and anecdotal observations were supported by research, i.e., when

assessing highly visual communications such as infographics, people can form reliable opinions within the first half-second of viewing the material (Harrison, Reinecke, & Chang, 2015).

During my first semester at Queen's University, some faculty members took note of materials such as handouts and posters I had created as part of my coursework. As a result, I was invited to contribute to research projects lead by Queen's faculty members. One such project is the *Building Parent Engagement in Mathematics* (BPEiM) project. My primary role in this project was to help design and develop resources for parents and teachers that would increase parents' engagement in their children's mathematics learning. Under the direction of the Research Team, I was asked to generate infographics for teachers and school councils on topics such as the importance of parent engagement, or strategies for increasing parental engagement (Appendix A & B). The initial infographics were followed by posters which summarized mathematics learning expectations for each year of the Kindergarten to Grade 8 curriculum (Appendix D & E). These second wave infographics were intended for both parents and educators, and were intended to provide visual, at-a-glance access to school mathematics content. We then progressed to our first activity-based poster which listed concrete mathematics activities for parents to do with their children in various areas of their homes.

As members of the team shared the resources with the participating schools, teachers responded positively to the activity-based poster, and their enthusiasm lead to subsequent activity-based posters listing ideas for mathematics learning in the garden (Appendix H) and mathematics learning using trees (Appendix I).

While working on the BPEiM project, I also had the opportunity to facilitate family mathematics events at elementary schools in and around the Kingston area. This volunteer work

allowed me to interact with families at school events, and to design take-home resources for families to continue using the mathematics activities at home (Appendix X). These family math events provided me with valuable insight as to what types of mathematics activities were most enjoyable and effective for families, and gave me an increased understanding of the barriers some parents face in becoming involved in their children's mathematics learning.

Taking into consideration the anecdotal feedback from the BPEiM project, observations and comments from parents at family mathematics events, along with my existing knowledge of creating visual resources, I decided that developing a visually appealing mathematics resource would be of importance, especially given the lack of confidence and negative feelings some individuals have surrounding mathematics.

Key Terms

Parent:

For the purposes of this project, the term "parent" will be used to refer to anyone with the sole or shared responsibility for the well-being and and raising of a child.

Parent Engagement:

The term "parent engagement" refers to the active role parents take in their children's education to facilitate learning and success (Ontario Ministry of Education, 2010). While sometimes interpreted as being exclusively homework help or volunteering at school, parent engagement also encompasses initiating, facilitating, and participating in meaningful discussions, games, and activities, as well as holding high expectations for their children.

Purpose

The purpose of this project is to address a gap in the existing body of resources readily available to parents regarding engagement in their children's mathematics learning. Using anecdotal feedback from parents and teachers involved in the BPEiM project and family mathematics events, in conjunction with a document analysis of existing resources, it became evident that accessible and practical resources were not readily accessible to families. As a result of this gap in the materials available to families, I decided to create a resource for parents which would easily and efficiently incorporate mathematics learning into their family lives. *The Math Around Us* is a collection of accessible mathematics activities for parents to carry out with their children in ordinary, everyday locations. The activities require minimal materials and many do not require materials at all, and are intended to be incorporated into the places and activities which are already a part of families' lives. The goal of this book is for parents to become engaged in their children's mathematics learning without feeling they need to teach a mathematics lesson, spend money, or take time to prepare complex activities. These activities can be as simple as parents engaging in appropriate mathematic conversations with their children while riding the bus, or making estimations together at the grocery store. It is my hope that through using this resource, parents who might otherwise have been disengaged will have ideas and supports to help them become meaningfully and actively involved in their children's mathematics learning. For parents who are already engaged, this resource will provide a larger collection of mathematics activities from which they can choose or become inspired to create original spin-off tasks on their own.

Rationale

In Ontario, parents recognize the importance of mathematics education. At least a basic understanding of mathematics is a prerequisite for the vast majority of occupations, and necessary for managing finances, making informed decisions, and functioning effectively in everyday life (Handler, 1990). Mathematics is incredibly prevalent in Canadians' lives, so it makes sense that 95 percent of Canadian parents believe mathematics to be an important skill—even more so than science or leadership abilities (Let's Talk Science, 2015).

There does however seem to be a disconnect between parents' beliefs and parents' actions surrounding their children's mathematics education. While nearly all parents believe mathematics to be important, less than half take the time to discuss mathematics learning with their children (Let's Talk Science, 2015). Ontario students' mathematics scores have been declining for years on both provincial and international standardized tests (Education Quality and Accountability Office, 2010; O'Grady, K., Deussing, M., Scerbina, T., Fung, K., & Muhe, N., 2016), yet a large proportion of parents continue to play only passive roles in their children's mathematics education (Let's Talk Science, 2015). Children spend over four times the number of waking hours outside of the classroom than they do in school between birth and age 18, resulting in parents having enormous potential to influence their children's success (Council of Ontario Directors of Education, 2015).

The relationship between parent engagement and students' success in the classroom is clear across grade levels and disciplines, including mathematics. When parents play an active role in their children's learning, there are noticeable benefits for students, parents, and educators (Ontario Ministry of Education, 2010). Thus, parent engagement is key to improving student

achievement and is central to actualizing elementary students' mathematics curricular outcomes in Ontario.

The importance of parent engagement is widely understood among educators and researchers: the research over three decades is consistent and persuasive, i.e., student success is positively impacted by parent and family involvement regardless of background, socio-economic status, or parents' level of education (Jeynes, 2005). Not all forms of parent involvement are equally beneficial, however; parental participation that is focused on student learning has the greatest impact on student achievement compared to other forms of involvement (Henderson & Mapp, 2002). In particular, family support of their children's learning at home is linked to improved student outcomes (Hoover-Dempsey et al., 2005; Jeynes, 2005).

Although finding that parents of young children report more frequent participation in home literacy activities with their children, LeFevre et al. (2009) found that parents could also be effective in initiating both direct mathematics activities (such as counting and number recognition) and indirect mathematics activities (involving quantitative activities such as playing board games or cooking) when given the appropriate supports. This research was among the first to establish a robust relationship between the frequency of indirect home numeracy activities and mathematical proficiency.

This is consistent with the work of Stelmack (2013) who notes in her research brief for practitioners, "parent programs that provide resources and assistance that parents may use with their children at home are more likely to have an effect on students' academic progress" (p. 3). Thus, tools and resources parents can use at home to support their children's mathematics learning could effect a positive and profound change in students' mathematics achievement—in

particular contributing to closing the achievement gap between students and families facing challenging circumstances.

A number of resources are already available for both teachers and families. These resources include *Inspiring Your Child to Learn and Love Math*, a free, information rich resource with modules for parents of children in Kindergarten up to Grade 8 (Council of Ontario Directors of Education, 2015) and *Doing Mathematics with Your Child*, a guide for parents of Kindergarten to Grade 6 children to support learning in mathematics (Ontario Ministry of Education, 2014).

These are valuable resources for parents looking to learn about the important role they play in their children's mathematics learning. What these resources do not provide as thoroughly are specific and detailed examples of how to incorporate mathematics learning into everyday family life, particularly outside of the home. This is not to negate the valuable information these resources contain, but rather to identify a need for additional tools, such as the current project, to accompany this existing knowledge.

The Module 2 Resource Guide from *Inspiring Your Child to Learn and Love Math* makes one recommendation for incorporating mathematics learning into the kitchen: baking cookies (Council of Ontario Directors of Education, 2015). The process of baking cookies involves both measurement and geometry, which makes it an excellent way for children to both participate in a fun family activity and develop mathematics skills at the same time. However, this is the only example provided of family mathematics activities which take place in the kitchen. While many parents may be able to develop their own strategies for bringing mathematics learning into the kitchen, others may find this to be an obstacle to their engagement and require a greater number of specific ideas and examples to put parent engagement in mathematics into practice; thus, this

Master of Education project includes a broad range of accessible activities for 18 unique locations so that parents have a wide range of options to choose from. It may help parents develop a stronger concept of what parent engagement in mathematics can look like in order to create mathematical activities for their children that best suit their families' interests and needs.

Another area not thoroughly addressed in existing resources is the large potential for mathematics learning away from home. Of all the documents analyzed for this project, *A Guide to Mathematics in School* has the greatest number of specific activities suggested to parents. This resource has a total of 39 unique activities with detailed instructions. Unfortunately, just six of these activities are intended to take place outside of the home, and those that do only address mathematics learning at the grocery store and in transit (McDuff & White, 2001). Many families lead rich lives outside of the home, visiting libraries, malls, parks, and restaurants. Incorporating mathematics learning into family life means including mathematics learning in the places and spaces families live, which often includes locations throughout the community. This Master of Education project was developed to address this need. Parents should have access to a greater number of specific and straightforward family mathematics activities, and parents should be supported in facilitating family mathematics activities not just in the home, but in a wide range of locations.

Method

The desired result of *The Math Around Us* was to generate a research-based resource which would assist parents in becoming more engaged in their children's mathematics learning. The project was informed by a document analysis of the Ontario Curriculum documents for

mathematics; existing parent resources; anecdotal feedback from participants and researchers in the BPEiM project; as well as responses to BPEiM posts on social media platforms.

The book's layout is an original design which went through multiple revisions with a goal of creating a product that was unique and eye-catching, but also succinct, easy to understand, and ultimately useful to parents. The activities featured in the book are a combination of original self-devised activities, adaptations of activities created by Dr. Lynda Colgan, and activities which were inspired by a variety of sources such as blogs and videos, as well as experiences such as classroom teaching and volunteer work. Diagrams were created for a number of activities to provide parents with visual examples to augment the text-based instructions.

Implications

This project aims to satisfy a need for more concrete examples of family mathematics activities which can be incorporated into everyday life. While there are a number of examples already available to parents, they are spread out across a daunting number of resources, with the vast majority focusing on mathematics learning inside the home, and many requiring significant parent knowledge of mathematics content, vocabulary and processes.

The Math Around Us provides parents with accessible supports which allow them to easily bring mathematics learning into their family lives. While over 100 activities can be found in this book, there are hundreds more that families could devise using this resource as a model and source of inspiration. This book has the potential to spark mathematical games, discussions, and ultimately learning which can lead to benefits for children, both academically and in real-world applications.

Overview of the Project

This chapter introduced the background and context that led to the development of this Master of Education project by describing policies and initiatives aimed at supporting parent engagement in mathematics and establishing the need for a resource which effectively facilitates this engagement both inside and outside of the home. Chapter 2 presents a review of literature examining the importance of mathematics education, the present state of mathematics education, and the role parent engagement can play in mathematics education. Chapter 3 details the methodology used to design and review the project. Chapter 4 provides a discussion and the implications of the project. Chapter 5 introduces the book, *The Math Around Us*, developed for this Master of Education project.

Chapter 2: Literature Review

The following literature review is divided into three sections to provide the reader with background knowledge as to why a resource which encourages and supports parent engagement in mathematics can be beneficial and effective. The first section of this chapter explores the importance of mathematics in our everyday lives and how essential a basic understanding of mathematics is to be a fully participating member of society. The second section details the current status of both Canadian children's and adults' mathematics achievements and understandings. The third section of this review discusses the role parent engagement plays in students' education and the influence which parental participation can have on children's academic achievements.

The Importance of Mathematics Education

Mathematics is an essential skill for the majority of the Canadian population. At the very least, a basic understanding of mathematics is required for maintaining personal finances, making responsible consumer decisions, and simply navigating everyday life. Additionally, some form of mathematical competency is usually necessary for employment, with the majority of occupations in Canada requiring at least some mathematical ability. Our society is structured in a way which assumes an elementary mathematical competency among the general population, and those lacking in mathematical proficiency face a greater number of challenges. Innumeracy, or mathematical illiteracy, is a real disadvantage for many adults as "a lack of mathematical understanding affects personal decision making, career selection and advancement, and the ability to respond to changing workplace requirements" (Handler, 1990).

In an American survey of over 2,300 adults, 94% of participants reported using at least some form of mathematics in their occupations. This survey also indicated that the number of participants who were required to use some form of mathematics in their jobs was greater than those who reported needing to use some form of writing. While the types of mathematics used by employees varied among industries and organizations, the results of this survey indicated that at least a basic understanding of mathematics is a requirement for the vast majority of occupations in the United States (Handel, 2016).

While we may not always be actively aware and conscious of how frequently we use mathematics in our everyday lives, the majority of Canadian parents do recognize the value of mathematics education. In a 2015 national survey of 805 Canadian parents, 75% of participants believed that most occupations require at least a basic understanding of mathematics. Ninety-five percent of these parents considered understanding mathematics to be an important skill—more than the number of parents who considered understanding science, speaking a foreign language, or being able to lead a group to be important skills (Let's Talk Science, 2015).

The Present State of Mathematics Education

Despite the prevalence of mathematics in our everyday lives, and the large number of parents who recognize the importance of mathematics education, the current state of affairs does not appear to reflect these values, nor the fundamentality of mathematics in our society. While many Canadian parents value mathematics education, a significantly smaller portion of parents actually take an active role in their children's mathematics learning. A survey of 805 Canadian parents found that while 88% of parents believed they could help guide their children's learning, just 28% actually discussed the value of mathematics with their children (Let's Talk Science,

2015). For many parents, it appears that valuing mathematics education does not necessarily translate to being actively involved in this area of their children's learning.

International and national studies. The Trends in International Mathematics and Science Study (TIMSS) is a series of international assessments which measure trends in mathematics and science achievement across the globe. The test is administered to students in Grade 4 and Grade 8 in multiple countries every four years with over 580,000 students participating in the most recent assessment in 2015. When comparing the mathematics assessment results of Canadian Grade 4 students to the scores of Grade 4 students in 48 other participating countries, the majority of countries (26) scored higher than the Canadian average. Serbia, Australia, Italy, and Spain achieved statistically equivalent scores to Canada, while the United States, England, Japan, and 24 others scored higher. Canadian Grade 8 students scored higher than the global average, with the eighth highest overall average mathematics score among participating countries (Brochu, O'Grady, Scerbina, Khan, & Muhe, 2017).

The TIMSS assessment also asked students to report how many resources were available to them, such as children's books in their homes or if their parents had completed university degrees. A positive correlation was found to exist between countries' average mathematics scores and the number of students who reported having resources available to them at home, both at the Grade 4 and Grade 8 levels. Thirty-two percent of Canadian Grade 4 students indicated that they had many resources available to them at home, and only 21% of Canadian Grade 8 students indicated that they had many resources at home. At both the Grade 4 and Grade 8 level, several countries which outperformed Canadian mathematics assessment scores also had higher

percentages of students reporting that they had many resources available to them at home (Mullis, Martin, Foy, & Hooper, 2016).

The Programme for International Student Assessment (PISA) is a tool developed by member countries of the Organization for Economic Co-operation and Development (OECD) to improve understandings of what makes education systems successful. The assessment aims to measure the extent to which 15-year-olds in participating countries have acquired some of the knowledge and skills, in the areas of reading, mathematics, and science, which are essential for full participation in modern societies. In PISA 2015, the sixth cycle of the program and the fifth which included mathematics, Canadian 15-year-olds performed well in mathematics, with an average score of 516 which is above the OECD average score of 490. Only six of the 72 participating countries outperformed Canada in mathematics, while six other countries scored the same as Canada. Although Canadian students achieved above average scores in mathematics in the 2015 assessment, Canadian scores have actually declined or remained stable in every assessment since the program first included mathematics in 2003. In 2003, the average Canadian score in mathematics was 532, and by 2015, the average Canadian score in mathematics had dropped to 516. From the 2012 to 2015 assessment, the average Canadian scores in both reading and science improved, however, the average Canadian mathematics score continued to decline (O'Grady, Deussing, Scerbina, Fung, & Muhe, 2016).

The Pan-Canadian Assessment Program (PCAP) is an assessment administered every three years to Grade 8 students and focusses on reading, mathematics, and science. This testing allows for comparisons of student achievements in these three domains across the Canadian provinces and territories to determine how well their respective education systems are meeting

the needs of students and society. Between 2010 and 2016, Ontario students were the only provincial group in Canada who did not show a statistically significant improvement in mathematics over this six-year period.

Student course selections. While these assessments provide information about Canadian students' mathematical competencies in relation to students in other countries, or across Canadian provinces and territories, student course selections are also indicative of their attitudes towards mathematics. Since 1999, Ontario has offered academic and applied versions of grade nine and ten courses which lead to university preparation or college preparation courses respectively in Grades 11 and 12. Without taking a transfer course, taking applied mathematics in grade nine automatically excludes students from taking two of the three university-type mathematics courses in Grade 12—courses which are requirements for a variety of post-secondary programs in business, science, engineering, and mathematics (Ontario Ministry of Education, 2007). As of 2015, 28% of Ontario's Grade 9 students took applied mathematics versus the academic alternative. The majority of students who take the applied mathematics in Grade 9 do not take the transfer course, meaning that as students make course selections for their Grade 9 year, at around age 14, nearly one third of Ontario students are excluding themselves from hundreds of post-secondary programs which require mathematics courses. Students may unwittingly and unnecessarily be disadvantaging themselves at a very young age (People for Education, 2015). In Canada, less than 50 percent of secondary school graduates have completed Grade 11 and 12 level mathematics and science courses (Let's Talk Science, 2013).

Canadian adults' mathematics proficiency. Shortcomings in Canadians' mathematics education are not only noticeable in young students' test results and course selections, but can

also be observed in adults' mathematical abilities as well. The Programme for the International Assessment of Adult Competencies (PIAAC) conducted the Survey of Adult Skills which measured proficiency in literacy, numeracy, and problem solving among adults, with 24 countries participating in 2012. While Canadian adults scored above average in problem solving and average in literacy, Canada ranked below average in the numeracy category of the instrument. The PIAAC defines numeracy as "the ability to access, use, interpret and communicate mathematical information and ideas, in order to engage in and manage the mathematical demands of a range of situations in adult life". The numeracy portion of the assessment focused on understanding mathematical content and ideas, such as quantities and relationships, as well as the representation of that content, such as diagrams and graphs. When comparing the results from 2012 to those from 2003, a greater proportion of Canadians scored below average in numeracy in 2012. All Canadian provinces and territories scored at or below the international average in numeracy (Statistics Canada, 2013).

While the PIAAC assesses skills which not all Canadians may use in their occupations or day-to-day activities, other research has also indicated that Canadian adults lack fundamental mathematics knowledge. In a survey of 6,911 Canadians living across the country, only 42% of participants were able to correctly answer basic questions relevant to personal financial decisions (Boisclair, Lusardi, & Michaud, 2017).

The Impact of Parent Engagement on Education

Parent engagement refers to the active and involved role which parents play in their children's learning and educational success (Ontario Ministry of Education, 2010). Parent engagement has positive benefits for both students and schools and is known to result in gains in

student academic achievement. Positive impacts on classroom learning and school environments have been noted in schools which encourage and support parent engagement (Pena, 2000).

Parent engagement is frequently misinterpreted as attending school functions, communicating with teachers through journals, tutoring, or solely providing help with students' homework, when in fact, parents having regular and meaningful conversations with their children about their learning, and asking questions about their classroom experiences, can be far more effective. Talking about school, having reasonably high expectations, and engaging in activities together can be some of the most effective strategies for improving learning through parental engagement (People for Education, 2011). A study of 24,599 students in the United States found that parents who have discussions with their children about school had a greater impact on student academic achievement than parents who simply monitored students' homework or limited their recreational activities (Ho & Willms, 1996). In Ontario, less than half (46%) of Grade 3 students report talking to a parent "every day or almost every day" about their school activities, and by Grade 6 that number drops to 38% (Education Quality and Accountability Office, 2010).

In a longitudinal study of parental involvement, the greater number of years a teacher rated a child's parent as participating an average or greater than average amount in their child's education, the less likely that child was to drop out of school (Barnard, 2004). In a meta-analysis of 41 studies, it was found that there is a considerable and consistently positive relationship between parental involvement and academic achievement among urban students regardless of student gender or racial minority status. Greater parental involvement resulted in higher overall

academic achievement, standardized test achievement, and other academic measures (Jeynes, 2005).

The benefits of parental involvement in students' learning have been widely recognized, and this involvement is perhaps the most singularly important contributory factor to student achievement (Harris, Andrew-Power, & Goodall, 2007). In Ontario, a number of resources which aim to support parental engagement in mathematics already exist, and one of the most comprehensive is the Council of Ontario Directors of Education's (2015) *Inspiring Your Child to Learn and Love Math* toolkit. This collection of resources was developed for parents of Kindergarten to Grade 8 children with the goal of sharing research-based strategies to help support children's mathematics education. Resource guides which form part of this toolkit include a number of activities parents can do with their children in their everyday surroundings. For example, the Kindergarten resource guide includes a variety of activities and conversational prompts for the mathematics learning in the kitchen, bathroom, around the home, in the neighbourhood, and at the grocery store.

Another significant resource is *Doing Mathematics with Your Child, Kindergarten to Grade 6: A Parent Guide*, a free booklet provided by the Ontario Ministry of Education (2014). This guide offers a number of activities sorted by the five strands of the Ontario mathematics curriculum. Activity suggestions are accompanied by tips for parents and descriptions of the benefits of understanding each of the concepts.

No free resource created to provide parents with practical mathematics activities to use with their children in everyday locations currently exists. While activities can be found across

various websites or within other resources, there is no extensive collection of mathematics activities in one accessible location currently available to Ontario families.

Summary

This chapter has outlined research on the importance of mathematical literacy in our everyday lives, the present state of mathematics education, and the impact parental engagement can have. Although the research indicates a clear link between parent engagement and academic success, many parents still remain reluctant to become actively involved in their children's mathematics education. By analyzing parent resources currently available in Ontario, it is evident that there is a lack of readily accessible activity suggestions for parents to help integrate mathematics conversations and learning into everyday family life. Absence of this type of resource may further perpetuate the misunderstanding that parental engagement in mathematics is limited to assisting with homework or providing children with aids such as mathematics workbooks. By creating an accessible and straightforward tool for parents which includes an extensive collection of simple strategies for including mathematics learning in everyday experiences, I hope to expand the body of resources which are currently available to support parent engagement in mathematics learning in Ontario.

Chapter 3: Methodology

Process of Developing the Research-Based Resource

This Master of Education project was developed based on anecdotal findings from the BPEiM project, correlation with Ontario curriculum documents for mathematics, and a formal document analysis of existing parent engagement in mathematics resources.

My primary role in the BPEiM project was to help design and develop resources for parents and teachers that would increase parents' engagement in their children's mathematics learning. Under the direction of the research team, I was asked to generate infographics for teachers and school councils on topics such as the importance of parent engagement, or strategies for increasing parent engagement (Appendix A & B). The initial infographics were followed by posters which summarized mathematics learning expectations for each year of the Kindergarten to Grade 8 curriculum (Appendix D & E). These second wave infographics were intended for dual audiences: parents and educators, and were intended to provide visual, at-a-glance access to school mathematics content. We then progressed to our first activity-based poster which listed concrete mathematics activities for parents to do with their children in various areas of their homes, and we found that teachers responded positively. It was their enthusiasm and requests for additional materials of this type that lead to subsequent activity-based posters listing ideas for mathematics learning in the garden (Appendix H) or mathematics learning using trees (Appendix I).

In the spring of 2018, both the Queen's research team and staff members from the six participating schools met together for a day-long event held simultaneously in Kingston and in London, Ontario, and connected virtually by Zoom videoconference technology. The goal of the

day was to provide an opportunity for the teams from six schools (Windsor, Brantford, Verona, Selby and Napanee) to meet face-to-face to share experiences with parent engagement activities at their individual schools and to problem-solve some of the challenges and barriers to parental engagement in mathematics that they faced.

During this debriefing event, several teachers shared that they found parents had responded better to the mathematics activity ideas than they had to the earlier released infographics. The educators said that because of the particular contexts for their schools (including educational background, SES, and language), the earliest materials produced, though well-meaning in intent, were intimidating and inaccessible to many members of their communities and for these reasons, they had not been widely shared. This was disappointing to learn, given that the original purpose of the single page documents had been to include them as take-home materials, in school newsletters, and on school websites.

On the other hand, teachers reported that the short, highly visual and practical activity pages had proved more useful to parents than the text- and research-heavy materials. The school teams recommended that more collections of mathematics activities be created, and requested that simple language be used and that text be kept to a minimum.

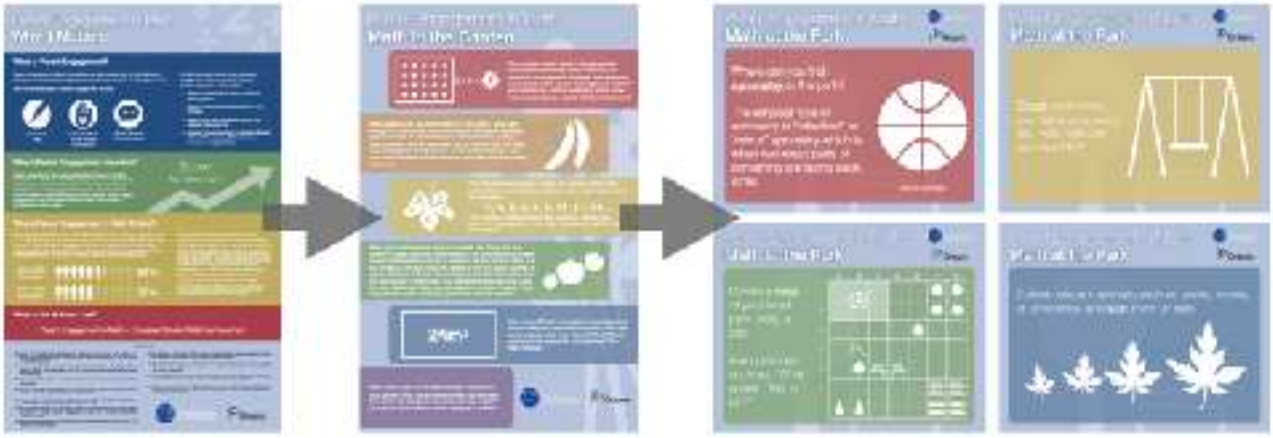


Figure 6. This figure depicts the evolution of materials produced for the BPEiM project, from the original infographic to the final weekly communique layout.

The advantage of the more recently developed resources, according to the teachers, was that they could more easily be shared on social media: a vehicle that the schools found valuable in their efforts to engage parents.

The field-based feedback and constructive suggestions from the 70 teachers and administrators involved in the project were a primary source of inspiration for my Master of Education project.

While the Ontario Grades 1 to 8 mathematics curriculum document (2005) discusses the role of parents as partners in mathematics education, it provides no concrete supports to parents to enable them to become active contributors to their children's mathematics education:

> Parents have an important role to play in supporting student learning. Studies show that students perform better in school if their parents or guardians are involved in their education. By becoming familiar with the curriculum, parents

> can find out what is being taught in each grade and what their child is expected to learn. This awareness will enhance parents' ability to discuss schoolwork with their child, to communicate with teachers, and to ask relevant questions about their child's progress. Knowledge of the expectations in the various grades also helps parents to interpret their child's report card and to work with teachers to improve their child's learning.
>
> There are other effective ways in which parents can support students' learning. Attending parent-teacher interviews, participating in parent workshops and school council activities (including becoming a school council member), and encouraging students to complete their assignments at home are just a few examples. The mathematics curriculum has the potential to stimulate interest in lifelong learning not only for students but also for their parents and all those with an interest in education. (page 5)

While the curriculum document supports the ideal of parental engagement in elementary mathematics, it was not included in the research analysis. There are a number of high-quality, ancillary resources (some developed by the Ministry of Education) to help parents understand why their engagement in their children's education is so important and these were selected for the document analysis because they also suggested general strategies for parents to use to help their children learn and succeed. For example, *Doing Mathematics with your Child* includes the following general recommendations:

- Build strong, positive attitudes about math. When children feel positively engaged and successful, they are more likely to stick with an activity or a problem to find a solution.
- Begin with activities that meet your child's level of mathematical understanding. Early success in solving problems will build your child's confidence. Gradually move to activities that provide more challenge for your child.
- If you and your child are more comfortable in a language other than English, use it. Your child will understand concepts better in the language that he or she knows best. (Page 2)

While the curriculum policy document and resources such as *Doing Mathematics with your Child* may be highly useful materials for some parents (i.e., those who are highly educated/ motivated, confident in math), there is a significant population for whom these documents and the general strategies they contain may not be accessible or actionable. This can include parents who feel they have a lack of time or interest, parents who feel out of their comfort zone, or those who are unable to read and comprehend these available documents.

While it is beneficial for parents to understand the curriculum and the important role they play in their children's learning, for some parents, the most effective way to help and promote involvement in mathematics is to provide straightforward and simple activities to do together. My own experiences as well as the information gained from the literature has allowed me to conclude that parents need practical suggestions situated in familiar and comfortable contexts if

they are to believe that they can be positive role models and become genuinely engaged with their children doing and learning mathematics.

The first step in completing the background research for such a project was to perform a scholarly document analysis of publicly available parent engagement in mathematics resources. This was essential in order to determine what types of materials families presently had access to in Ontario, and to know if a project developing a new research-based resource to support parent engagement in mathematics would fulfil a need.

Document Analysis

Document analysis is a systematic process of examining and interpreting a collection of documents for the purpose of gaining meaning, and developing an understanding (Bowen, 2009). In order to assess that my project would be meeting an identified need, the most prominent publicly available resources on this topic were selected for a data analysis. These documents included *Doing Mathematics with Your Child*, *A Guide to Mathematics in School*, *Inspiring Your Child to Learn and Love Math* Resource Guides from Modules One through Four, and *Parents in Partnership: A Parent Engagement Policy for Ontario Schools*. These seven documents are rich sources of information on the value of parent engagement in mathematics, and when combined contain 95 specific and unique examples of activities which promote family mathematics learning.

Although a search of the internet led me to locate over 35 documents—ranging from short newsletters to multi-page booklets and websites—that had been generated independently by school boards and individual schools across Ontario or by provincial organizations (e.g., teacher federation, school administrator body, education consortium), I excluded them from the

formal document analysis because my initial review revealed that most shared considerable content, and with very few exceptions contained the same generic suggestions such as “have your child count toys or items of clothing” or “discover math while baking.”

To further refine the parameters for my document analysis, I made the decision to distinguish between activities which were intended to take place at home (or did not specify a particular location) and activities which were intended to take place outside of the home. For each of these two categories, I recorded whether these types of mathematics activities were discussed, the number of unique and specific examples of activities, and the number which had diagrams accompanying them. “Unique” meant that each activity had to explore a different concept or take place in a different location. For example, “Have your child skip count (counting by twos, fives or tens) using such objects as blocks, pasta pieces, toothpicks or buttons” would be recorded as one activity, despite offering many different opportunities for practicing skip counting. “Specific” meant that a particular mathematical concept or skill was identified and explored in the activity. For example, “Discover math while baking” would be too general to be considered an activity.

Table 1 summarizes the final outcome of the documents that were analyzed for the purposes of this project.

Table 1

Resources for Parents on Parent Engagement in Mathematics

Resource	Family Mathematics Activities Around the Home or at an Unspecified Location			Family Mathematics Activities for Specific Locations Outside of the Home		
	Was it Discussed?	Number of Unique and Specific Activities	Number of Activities with Diagrams	Was it Discussed?	Number of Unique and Specific Activities	Number of Activities with Diagrams
Doing Mathematics with Your Child	Yes	31	14	Yes	1	0
A Guide to Mathematics in School	Yes	33	0	Yes	6	0
Inspiring Your Child to Learn and Love Math: Module One (General Overview) Resource Guide	Yes	2	0	Yes	2	0
Inspiring Your Child to Learn and Love Math: Module Two (Kindergarten) Resource Guide	Yes	7	0	Yes	2	0
Inspiring Your Child to Learn and Love Math: Module Three (Primary) Resource Guide	Yes	9	1	No	0	0
Inspiring Your Child to Learn and Love Math: Module Four (Junior) Resource Guide	Yes	2	0	No	0	0
Parents in Partnership: A Parent Engagement Policy for Ontario Schools	Yes	0	0	No	0	0
TOTAL	**-**	**84**	**15**	**-**	**11**	**0**

Summary of Findings

Overall, the findings of the document analysis indicated a dearth of practical activity suggestions available to parents, and in particular, ideas for math which take place outside of the home. The potential for mathematics learning in public spaces was mentioned, but few concrete examples accompanied these recommendations. Additionally, activities often lacked diagrams to help explain the activity and add to the reader's experience.

In addition to the absence of specificity in activity suggestions, another conclusion from the document analysis was the stark contrast between the number of activities suggested for locations away from home and the number of activities suggested for inside the home or at an unspecified location. Over seven times more activities were provided for the home or unspecified locations than those provided for away from home locations. In fact, almost half of the resources included in this document analysis make no mention of informal mathematics learning in any specific locations other than the home.

Given the increasingly busy lives of modern families, the lack of activities designed to take place away from the home leaves a huge gap in the potential for family mathematics learning. Limiting mathematics learning to the classroom and the home could imply the wrong message to children that mathematics does not have a strong real-world application. If mathematics is known to be a necessity for functioning effectively in society, then children should experience mathematical activities in a variety of places and spaces. There are a wide range of opportunities in the real world for families to discuss and explore mathematics together, so parents should have access to resources which support this learning in a variety of locations.

A second observation of these resources is the lack of diagrams to help parents understand the activities. Diagrams and images both help to explain how the activity works, as well as break up large amounts of text. It is important to include visual aids which help parents to easily understand the activities as well as make the resource visually appealing and fun. Text-heavy resources can make resources appear more daunting, so the prevalence of images and colour is important when designing family-friendly resources.

Lastly, there is an overall lack of new and current activities available to parents. Fewer than 100 activities could be found in total across all the documents included, and in many cases, nearly identical activities appeared across resources. For an area of learning many parents are already hesitant to take an active role in, it is unrealistic to expect parents to have the task of developing original activities for their children, or to have to comb through multiple documents in order to have enough of a selection of activities from which to choose.

Resource Design

Due to the success of the activities produced for the BPEiM project and the scarcity of activity-based mathematics resources available to families, I decided to develop a collection of activities geared to parents of elementary children for this project. *The Math Around Us* was intended to help parents easily incorporate mathematics learning into their everyday family lives; therefore, the book needed to be straightforward and user friendly, and include suggestions for activities in a wide range of locations. It was also important for the book to be colourful and visually appealing to reinforce the message that mathematics exploration can be enjoyable and fun.

Aligning with the Ontario Curriculum for Mathematics. Activities featured in *The Math Around Us* were developed with consideration of the Ontario Grades 1 to 8 mathematics curriculum document (Ontario Ministry of Education, 2005). The mathematics curriculum for each elementary school grade is organized into five strands, or areas of learning.

The first strand is Number Sense and Numeration, where the focus is learning about numbers and operations and how to use numbers to describe and understand the world around us. By learning the content and processes in the Number Sense and Numeration strand, it is anticipated that children will develop strategies to solve problems involving number calculations efficiently and accurately, and be able to apply the knowledge and skills learned in this strand in all other strands.

The second strand is Measurement, which supports children's knowledge development so that they are able to estimate and measure lengths and distances, area, mass, volume, capacity, time, and temperature. In the Geometry and Spatial Sense strand, the curriculum focuses on the classification, comparison, and construction of angles, lines, and shapes, as well as the visualization and description of positions and motion in space. The properties of two-dimensional shapes and three-dimensional figures are emphasized in the elementary mathematics curriculum.

The Patterning and Algebra strand is aimed at supporting children's abilities to build models to represent real-life situations, identify patterns, and generalize and make predictions based on patterns by learning to use symbols and equations to describe mathematical relationships. The Data Management and Probability strand has two distinct foci. The first is

about collecting, organizing, displaying, and drawing conclusions from data. The second is about learning to use math to describe the likelihood that something will happen.

The ultimate goal of the Ontario mathematics curriculum is for learners to be able to apply the knowledge and skills acquired in these five strands to solve real-life problems in contexts that are appropriate at each grade level. In addition, the Ontario curriculum states that "making connections between the mathematics they learn at school and its applications in their everyday lives not only helps students understand mathematics but also allows them to see how useful and relevant it is in the world beyond the classroom" (Ontario Ministry of Education, 2005)

Ontario's kindergarten program does not have a separate mathematics curriculum document, however, overall expectations for students are provided and expectations 15, 16, 17, 18, and 19 align with the five strands included in the Grades 1 to 8 curriculum document in the same sequence. These expectations fall under the Demonstrating Literacy and Mathematics Behaviours frame, one of four major frames in the program. An example of this alignment would be the expectation that students "demonstrate an understanding of numbers, using concrete materials to explore and investigate counting, quantity, and number relationships" which is reflective of the Number Sense and Numeration strand for the Grades 1 to 8.

The five expectations in the Demonstrating Literacy and Mathematics Behaviours frame are comparable to each of the five mathematical strands although they are not classified with the same labels in the kindergarten program document (Ontario Ministry of Education, 2016a).

While the Ontario Mathematics Curriculum specifies the content that is required at each grade level in order to build understanding of mathematics concepts and work towards

proficiency with facts, skills and procedures, the policy also mandates that the implementation of the curriculum must create engagement in the mathematical processes and foster positive dispositions towards mathematics (EduGAINS, 2005).

Because of the breadth of content required by the Ontario Mathematics Curriculum and the affective elements, it was essential for the collection of activities and conversational prompts to address learning in all five strands of the mathematics curriculum by creating interesting every day mathematics experiences that could be drawn upon beyond the walls of the school.

While many activities in *The Math Around Us* weave together knowledge and skills from multiple strands, numerous others address specific strands.

Tables 2 and 3 summarize and provide specific examples of the alignment of the content in *The Math Around Us* with the Ontario Curriculum. Since concepts, facts, vocabulary, skills and strategies in the Number Sense and Numeration strand have application to all other strands and are foundational to later mathematics learning, the decision was made to include more activities in this strand than others.

Table 2

Activities Provided for Grade Divisions by Mathematical Strand in The Math Around Us

Curriculum Strand	**Kindergarten**	**Primary (Grades 1 to 3)**	**Junior (Grades 4 to 6)**
Number Sense and Numeration	7	36	39
Measurement	3	12	12
Geometry and Spatial Sense	11	21	13
Patterning and Algebra	5	17	5

Data Management and Probability	1	14	15

Note. Some activities are appropriate for, or include suggested modifications for, multiple grade divisions and have therefore been included in the totals for more than one division.

Table 3

Examples of Ontario Mathematics Curriculum Strands Explored in The Math Around Us

Curriculum Strand	**Example Activity from *The Math Around Us***
Number Sense and Numeration	**Licence Plate Addition** (Math on the City Bus) Find the sum of all the digits you see on any one license plate of the vehicles you see in traffic.
Measurement	**Cage Calculations** (Math at the Zoo) Estimate the dimensions or area of an enclosure. What non-standard units of measurement could you use to measure the enclosure? For example, the rhinoceros exhibit is 27 big steps wide.
Geometry and Spatial Sense	**Rink Geometry** (Math at the Arena) Determine the areas of different shapes on an ice rink using the following information: The large circle at centre ice typically has a radius of about 4.5 metres. Most hockey rinks are about 26 metres wide and the blue lines are about 15 metres apart.
Patterning and Algebra	**Food Patterns** (Math in the Kitchen) Make a pattern on your plate using different foods like berries or crackers. Introduce a greater number of different foods to create more complex patterns.
Data Management and Probability	**Graphing Seashells** (Math at the Beach) Collect 20 seashells along the shoreline. Create a graph, in the sand or on paper, that shows how many of each type of shell you found.

The Ontario mathematics curriculum document also discusses seven mathematical processes which students are to learn and apply to expectations within each of the five major

strands: problem solving, reasoning and proving, reflecting, selecting tools and computational strategies, connecting, representing, and communicating (Ontario Ministry of Education, 2005). The mathematical processes are a set of interconnected processes through which students acquire and apply mathematical knowledge and skills. Problem solving is a skill for, as well as an approach to math, encouraging students to reason their way to a solution or a new understanding. As students engage in reasoning, they become curious—asking questions, formulating conjectures—and they begin to "own" their solutions, defending them with words, numbers and diagrams. The communication and reflection that occurs during and after the process of problem solving opens the door to recognizing the range of strategies that can be used to arrive at a solution. By seeing how others solve a problem, students can appreciate that there are many ways to be "right," which contributes to positive attitudes about math and growth mindset.

The Ontario mathematics curriculum (2005) clearly states that the mathematical processes cannot be separated from the content knowledge and skills that students acquire through mathematics learning experiences; therefore, activities and tasks that require problem solving, communication, reasoning and reflection are to be included in all the strands in every grade. Table 4 provides examples from The Math Around Us to capture the ways in which the mathematical processes are embedded into the suggested activities.

Table 4

Examples of Ontario Mathematics Curriculum Processes Explored in The Math Around Us

Mathematical Process	**Example Activity or Prompt from *The Math Around Us***
Problem Solving	**Total Trip Time** (Math on the City Bus) Use a bus schedule to determine how long a trip will take. For example, if the bus picks you up at 1:05 PM and arrives at your destination at 1:40 PM, how long will you be on the bus?
Reasoning and Proving	**Planning a Path** (Math at the Mall) Use the mall map to determine the shortest possible route to walk from your location to a particular store. If you want to visit five stores and walk the shortest possible distance, in what order should you visit these stores?
Reflecting	**Questions to Extend Learning** Was there a mistake you made at first? What did you learn?
Selecting Tools and Computational Strategies	**Setting the Table** (Math in the Kitchen) Determine how many of various items are needed to set the table, based on the number of family members and guests. For example, how many plates will you need if two guests are coming to dinner? If each glass needs three ice cubes, how many ice cubes will be needed?
Connecting	**Questions to Extend Learning** When is another time you would use this strategy? Does this remind you of anything?
Representing	**Mapping the Park** (Math at the Park) Create a map of your local park using a grid. Ask questions such as “What would I find in D5?”
Communicating	**Family Survey** (Math in the Living Room) Conduct a survey about an upcoming family event, such as a dinner out or a game night. What activity would family members like to do most or what types of foods do most family members enjoy? How could you share these results with your family?

Before creating these activities, I developed a list of 15 public locations and 5 at-home locations where a Canadian family might visit. These included the arena, bank, beach, bus, coffee shop, gas station, grocery store, library, mall, movie theatre, park, post office, restaurant, subway, zoo, backyard, bathroom, bedroom, kitchen, and living room.

At this point, I began developing activities for each of these locations and organizing them by location in a simple text-based word processing file. The activities were either self-developed, adaptations of those provided by Dr. Lynda Colgan, or inspired by online sources such as blogs and videos or previous experiences such as classroom teaching or volunteer work. The goal for each entry was for the activity to require few or no materials and require minimal or no preparation. Many parents lead busy lives, so providing activities which require advanced planning and setup time could be a major barrier to their implementation. A large number of the activities which ended up in the final version of *The Math Around Us* are conversation-based or require nothing more than a pencil and paper.

The original number of entries to be included in the book was 200 prompts and activities to help parents incorporate mathematics learning into everyday life. In developing activities, I discovered that several of the locations that I selected had activities which were similar and overlapped. This duplication would make the book more difficult to use, as unique and original activities would be harder to find amongst the repetition. For example, an activity could be to determine how much change you would receive when paying for an item with a predetermined amount of money, such as five dollars. This activity could occur at a variety of locations included in the book, such as an arena concession stand, the coffee shop, the grocery store, the mall, the movie theatre, and the zoo. It would not be helpful to list a similar activity for every one of these

pages in the book. Once prompted, parents may recognize that having their children calculate change is a simple but useful mathematics activity, and then apply that same activity at any location where their family makes purchases.

To reduce repetition and information overload, the final book contains approximately 100 activities rather than the original goal of 200. While the final version of the book explores some similar activities in different locations, there is significantly less repetition and unique activities are easier to find than if activities were cross-listed under every possible location they could occur.

The location list also changed throughout the creation of the book. The first change was the removal of the subway. The subway and bus are both forms of public transportation and therefore similar activities could take place in either setting. Due to buses being more common than subways in Ontario cities, the subway was removed. The bus was retitled to the city bus so that it would not be confused with school buses where families do not ride together. The second change was the removal of the post office. While mail and packages allow for many opportunities to explore measurement and geometry and spatial sense, the post office is not as conducive to child participation as other locations. Measurement and weighing at the post office is typically completed by an employee, and most families prepare parcels at home before arriving at the post office. The last change to the location list was to separate the backyard into both summer and winter categories. Certain backyard activities were only appropriate for particular seasons, so this separation would make it easier for parents to find activities that can be used at whatever time of year they wish.

When organizing the book, locations and their activities were divided into those that took place away from home and those that took place at home. Within each of these two major categories, locations were sorted alphabetically to make it easier for parents to find them. Each location occupies one full page in the book, with the exception of the kitchen and summer backyard activities which have two each. Within each location page, activities are in order of grade level appropriateness. Each activity is assigned one or more grade level recommendations of Kindergarten, Grades 1 to 2, Grades 3 to 4, and Grades 5 to 6. While many of the activities can be easily altered and adapted to best suit the needs of children, it was important to provide general age categories as a starting point for parents.

The visual aspect of the book was important in creating a resource that was user friendly and fun. Each location has its own colour associated with it, and elements of eye-catching colour can be found from cover to cover. It was important that this resource did not resemble a textbook or manual. To help convey the overarching method that mathematics can be an enjoyable family activity, the book itself needed to look fun too. In addition to the use of colour throughout, a minimum of one coloured diagram is provided for every single location. These diagrams both capture the eye, as well as help clarify how the activity functions or what it could look like.

The final pages of the book contains one page of questions to extend learning, and two pages of one-centimetre grid paper. Engaging in conversations and asking children questions can extend the learning that takes place in these activities, as well as in homework and in-school learning experiences. Grid paper is provided in order to support a number of the activities which involve graphing. Many families do not regularly have grid paper available to use, so it may be useful in helping children develop skills in tracking and displaying data.

Chapter 4: Discussion and Reflections

Discussion

At the time this project was completed, no single resource in Ontario for supporting parent engagement in mathematics contained more than 50 unique and specific activities. A document analysis of the existing publicly available resources showed a gap in the materials available, and anecdotal observations from the BPEiM project indicated an interest and need for an accessible, activity-based resource. The goal of this project was to address this issue by providing a visually appealing, fun, and practical book to support parents in bringing mathematical experiences and learning opportunities into their families' everyday lives.

While the resources included in this project's document analysis are beneficial for helping many parents understand the important role they play in their children's mathematics education, there is also a significant population of parents for whom simple and straightforward activities are most useful. *The Math Around Us* was designed to help parents easily incorporate mathematics learning into their everyday family lives in a variety of locations. Many of the existing resources focused primarily on mathematics learning inside of the home, so it was important to reinforce the idea that mathematics can be found in a wide variety of locations, including throughout the community.

Intentions

To ensure that my book positively impacts as many families as possible, my goal is to distribute the content in two different ways. Firstly, I intend to make *The Math Around Us* publicly available for sale in book format through online retailers. My goal is for the book to be available for a reasonable price so that it is accessible to families, however, this will depend on a

printing company being able to produce the books at a cost that makes a low price point feasible. I also intend to explore distributing *The Math Around Us* in an e-book format.

Secondly, I would like to develop a website which contains the activities featured in the book, along with discussion prompts and printable mathematics materials. It is important to me that families have the option to access mathematical activities for free online as the cost of purchasing a book may be a barrier to families engaging in the mathematical activities together. I plan on developing this website in the summer months of 2019 with a goal of having a functional website for the beginning of the 2019-2020 school year.

If the website receives a positive response from families and educators, it is my hope that the website will continue to grow and expand beyond the activities featured in the original book produced for this Master of Education project. Additional activities can be added over time, resulting in an even larger and more useful bank of activities and resources for families looking to engage in mathematical learning together.

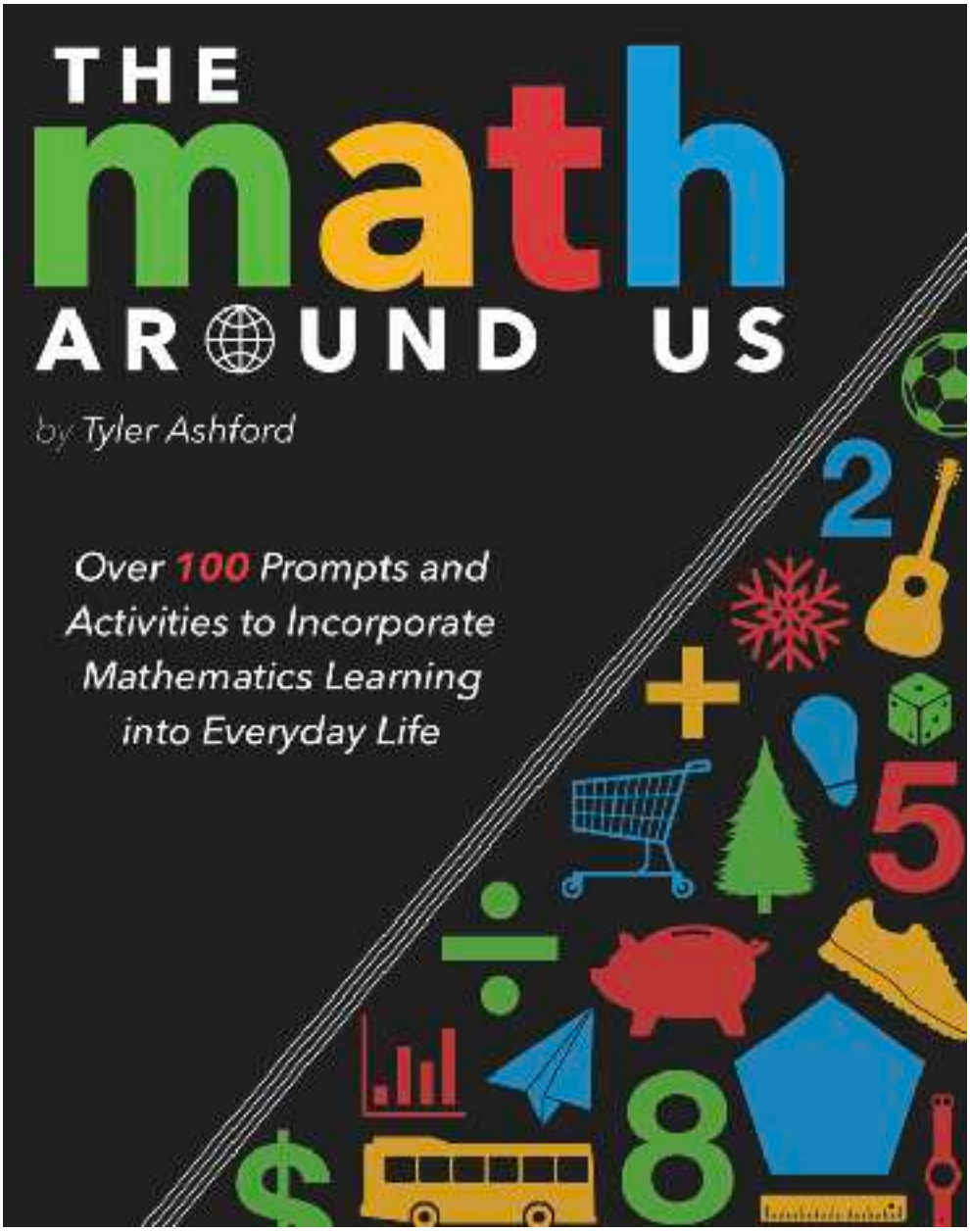
Final Thoughts

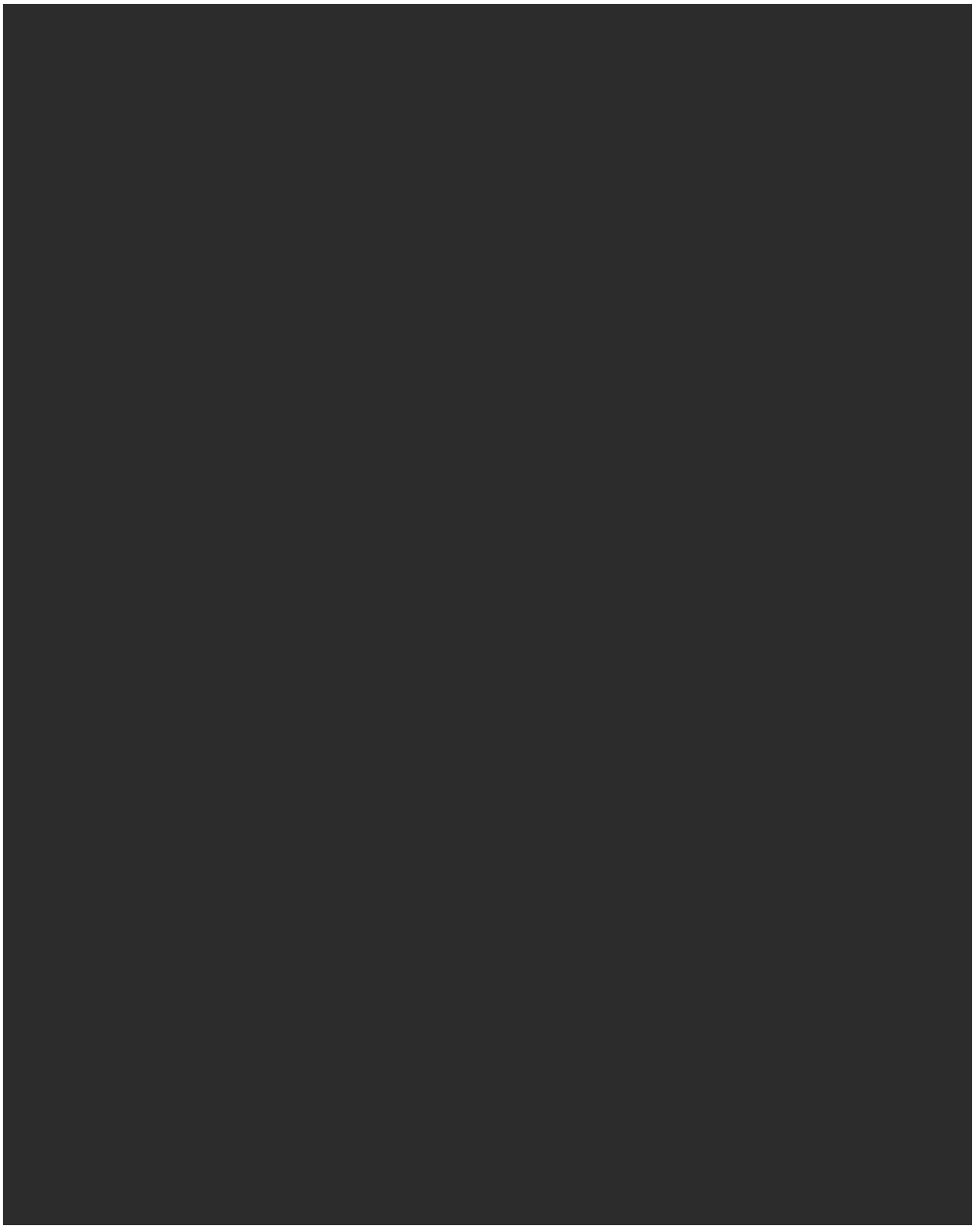
Completing this project has helped me develop my understanding of parent engagement by requiring me to reexamine how parents can support their children's mathematical learning in and out of the home. Through my involvement in the BPEiM initiative, volunteering as a family mathematics event facilitator, and my work creating this project, I have learned about the positive and powerful impact which parent engagement in mathematics can have on students' success both in and out of the classroom. This knowledge will aid me throughout my own career as a classroom educator as I work to make mathematics learning both accessible and enjoyable for all students. As a classroom teacher, I hope to be an ambassador for parent engagement in

mathematics education in my school, helping other educators see the value of parental involvement in children's mathematics learning, and working to facilitate events and initiatives which support and encourage this engagement. I am grateful to have had the opportunity to develop a wide range of mathematical resources during my time in the Master of Education program, and look forward to continuing to produce even more mathematical materials as I continue to improve my craft.

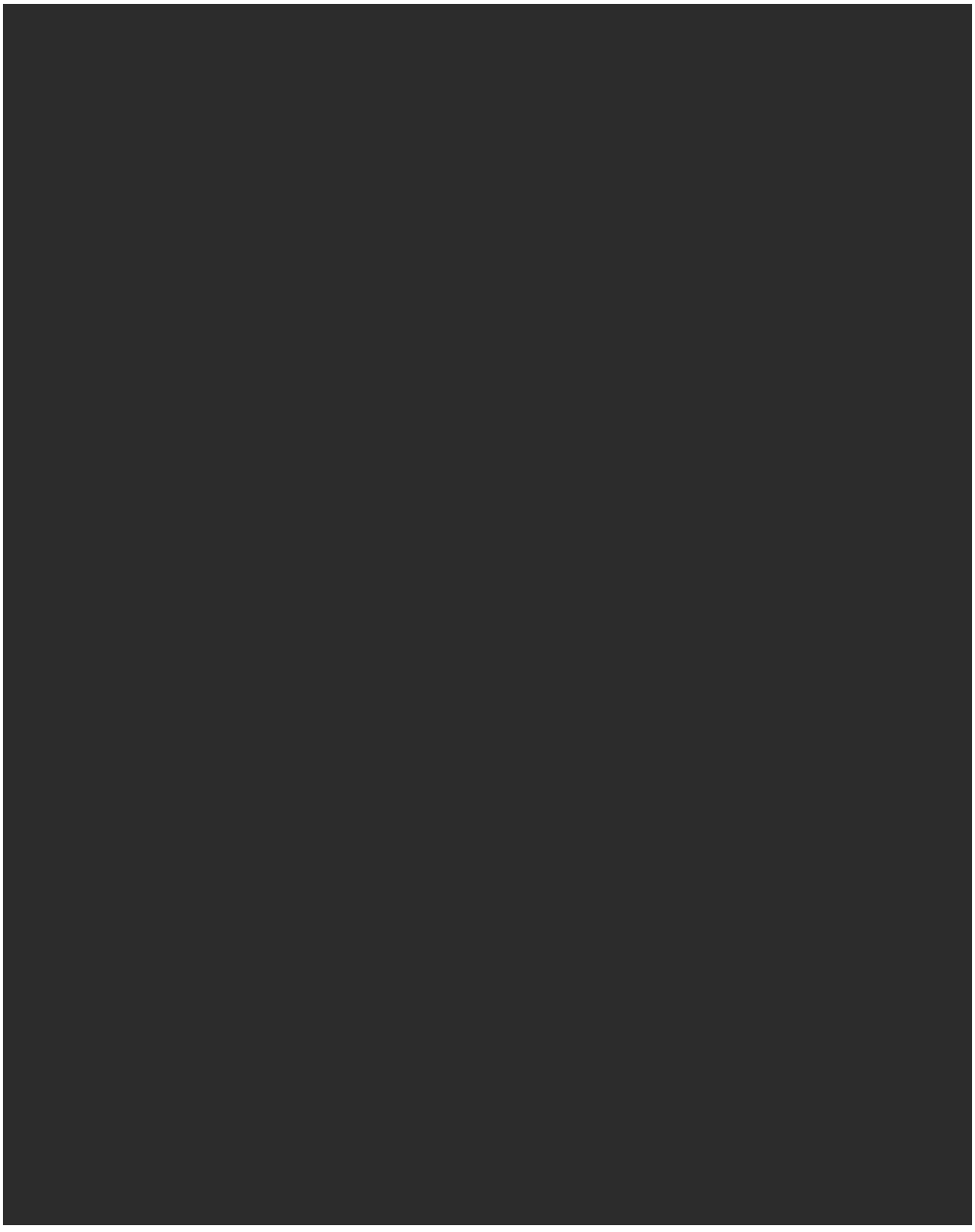
In conclusion, I hope *The Math Around Us* helps families explore mathematics together in unique and fun ways. I greatly look forward to releasing this resource publicly later on this year and am excited to see the positive impact it may have.

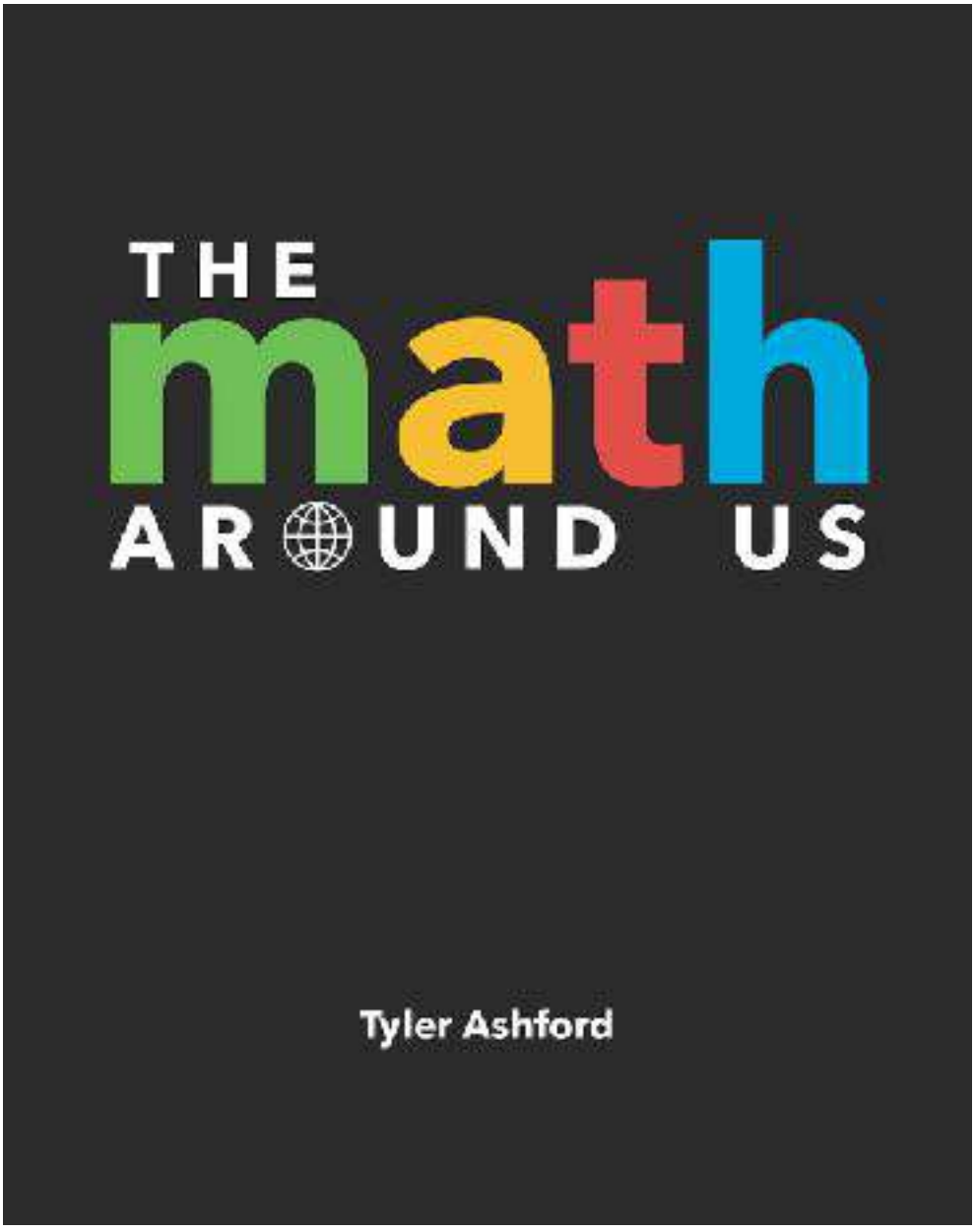
Chapter 5: The Project






THE
math
AROUND US




THE
math
AROUND US
Tyler Ashford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Math is EVERY

Math plays a important role in our everyday lives. While we may not always be aware of it, math can be found just about everywhere! Whether it be following a recipe, managing time, or simply making a purchase at the mall, we all use some kind of math skill on a daily basis.

Studies have shown that the majority of parents recognize the importance of math education, however less than one third of parents actively take the time to engage in math-related discussions with their children. This is quite unfortunate given the immense potential for learning outside of the classroom—most children spend less than one fifth of their waking hours in school!

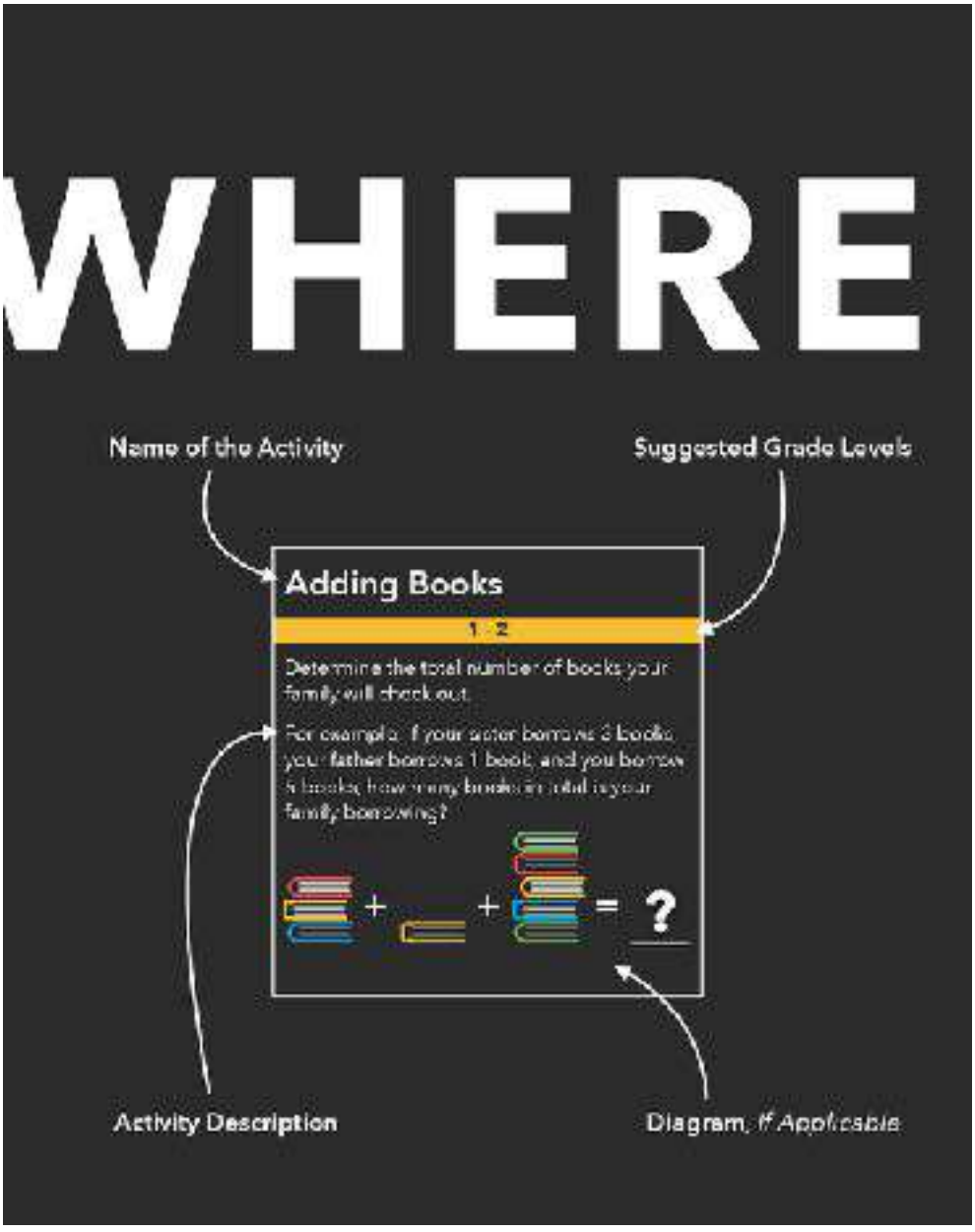
There are a number of barriers which can prevent parents from taking an active role in their own children's mathematics learning. Some parents feel that math is not an area in which they excel (understandably), and therefore have anxiety or misconceptions of their own. In today's increasingly busy world, others may feel they lack the time to teach or prepare math activities for their children. It is for these reasons that this book exists.

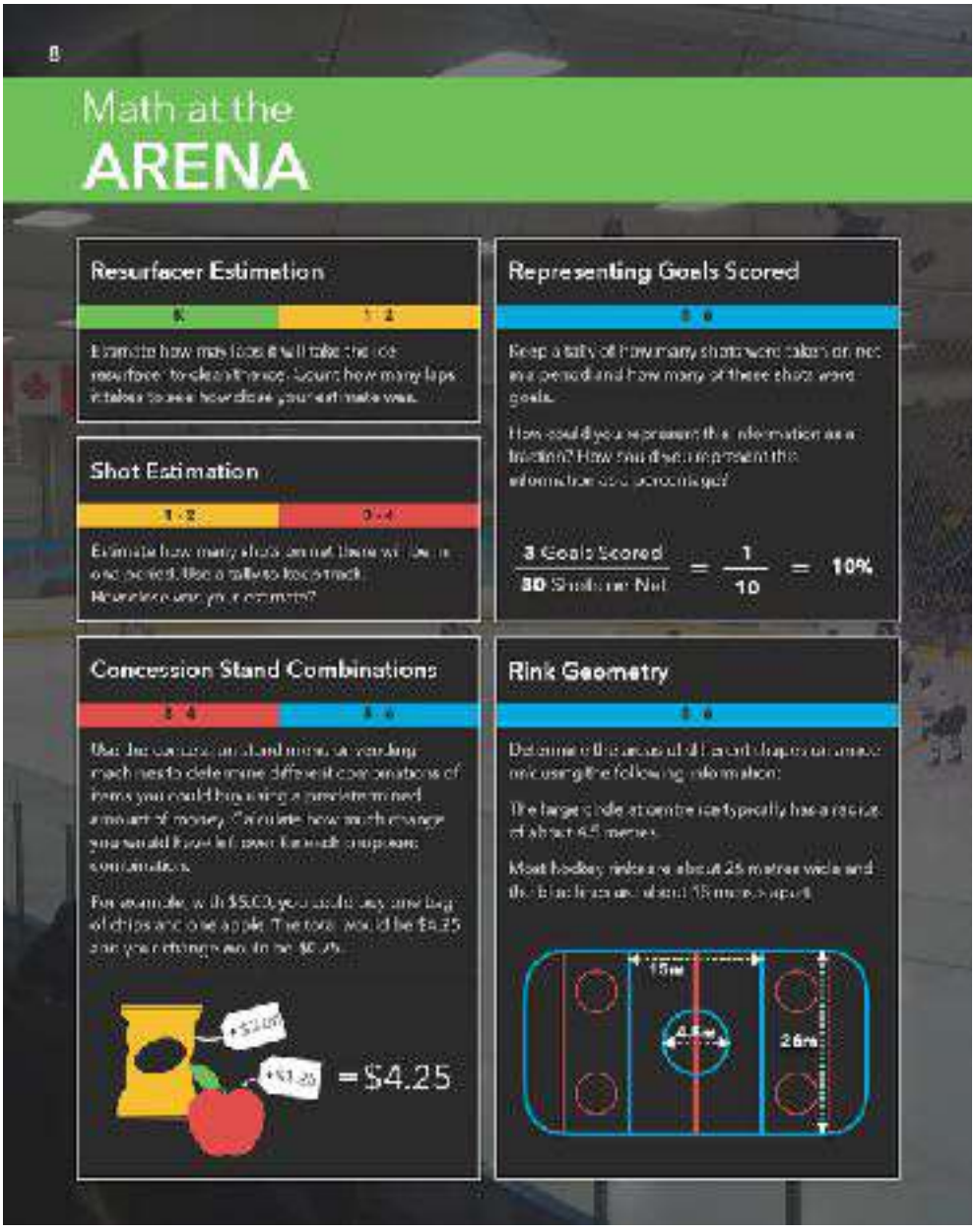
The Math Around Us contains over 100 prompts and activities to encourage mathematical learning at many levels. You don't need to be an expert mathematician and you don't need to dedicate hours to organizing complex activities. All the suggestions in this book are designed to be incorporated into the places and spaces families already frequent, and require little or no preparation.

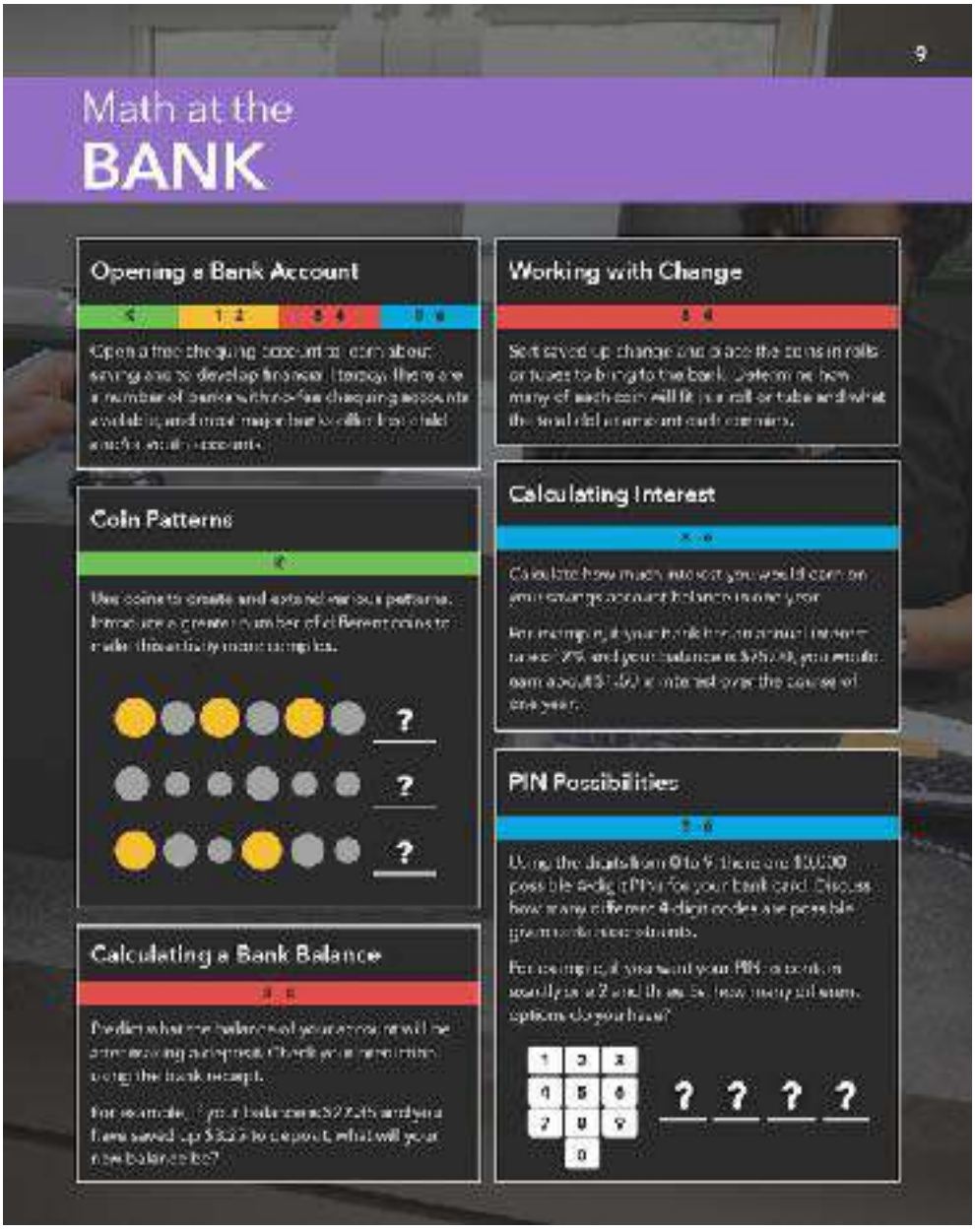
Having engaging mathematical activities and discussions with children, parents can improve both children's attitudes towards math and their academic math performance. Parent engagement is one of the key indicators of student achievement in school and can set students on a path to success. It is my hope that this book will help you easily create opportunities for math learning with your family by navigating mathematics in everyday occurrences we can support learning that will benefit children for a lifetime.

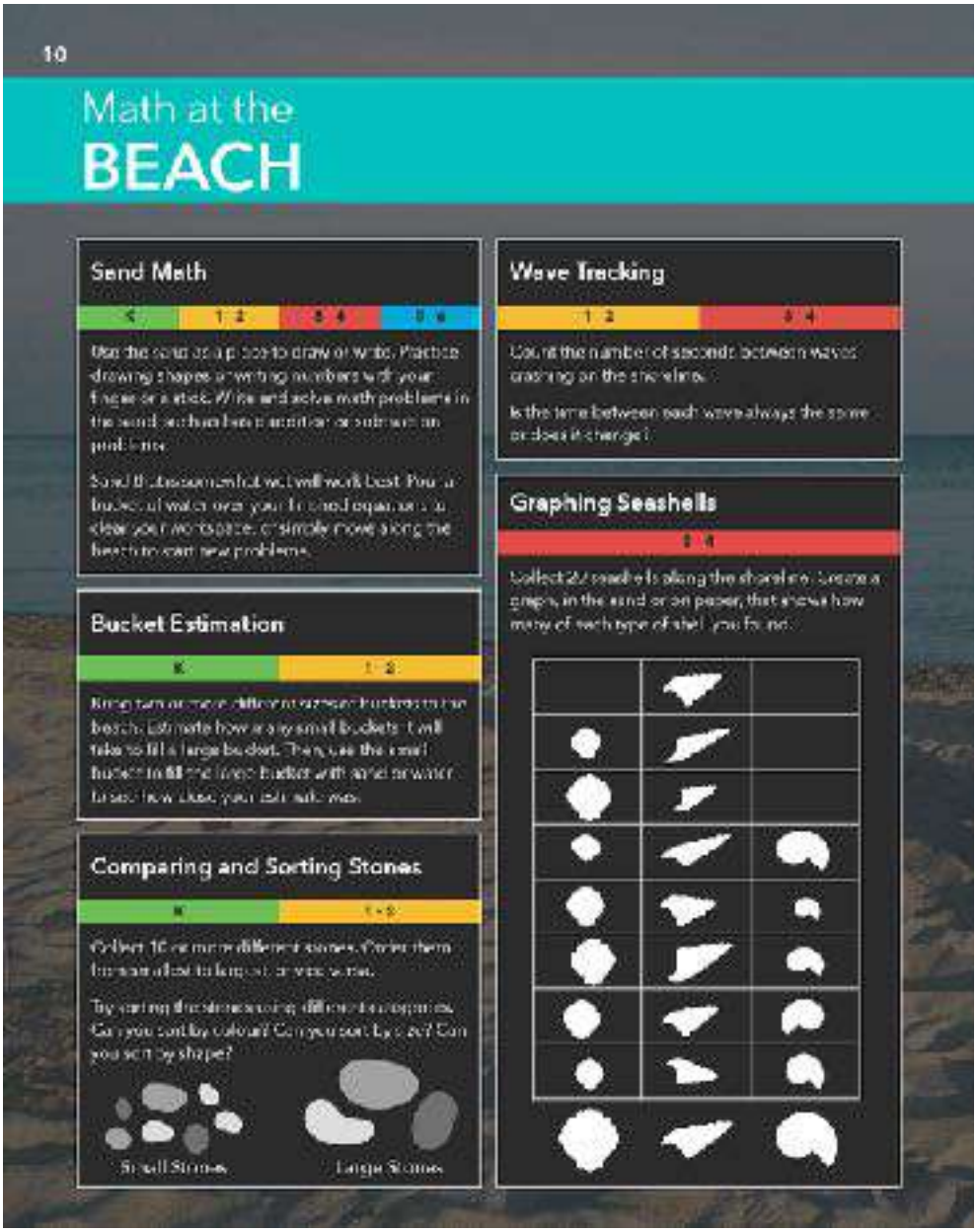
Happy Exploring,

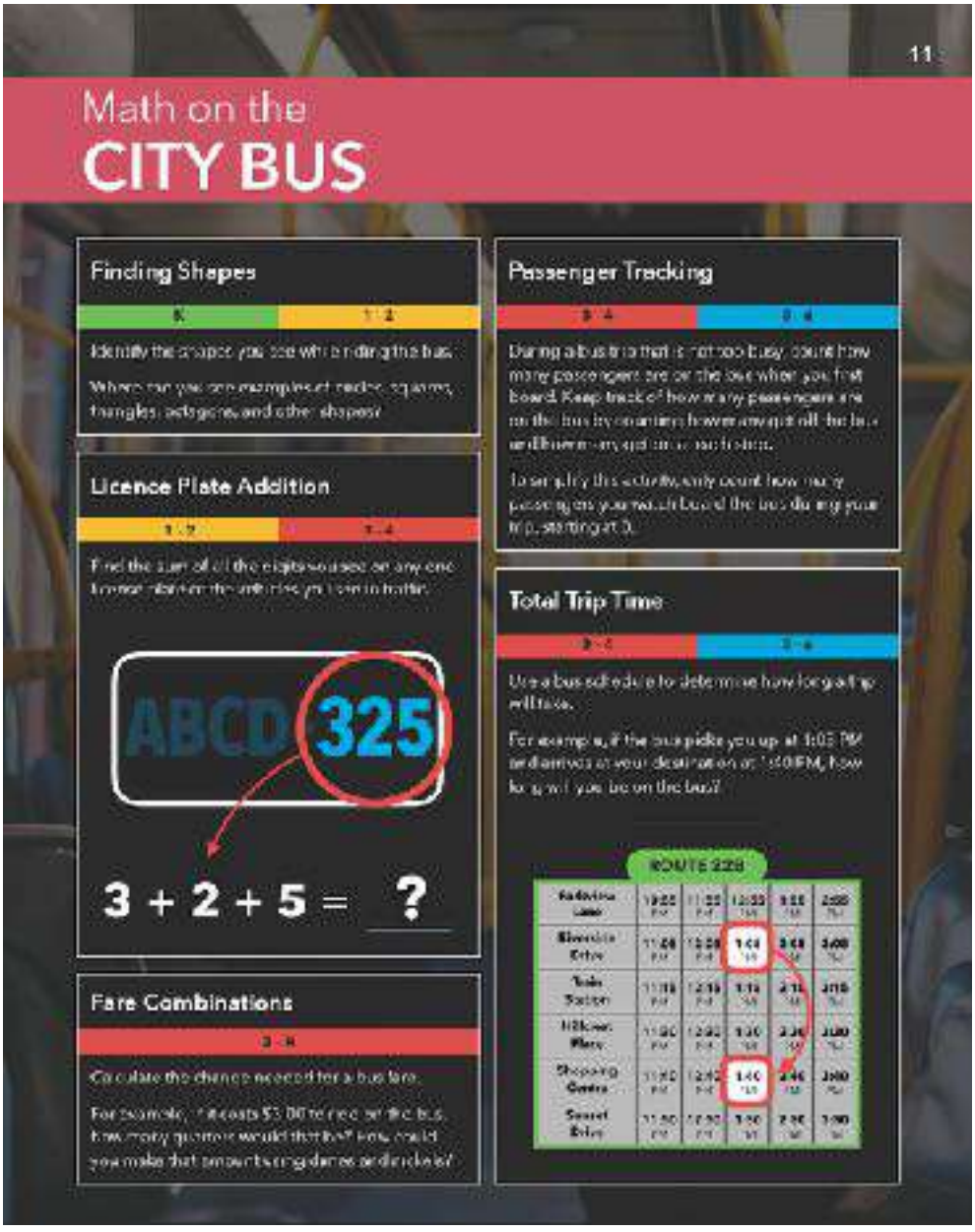
TYLER ASHFORD MEd, OCT, RCC

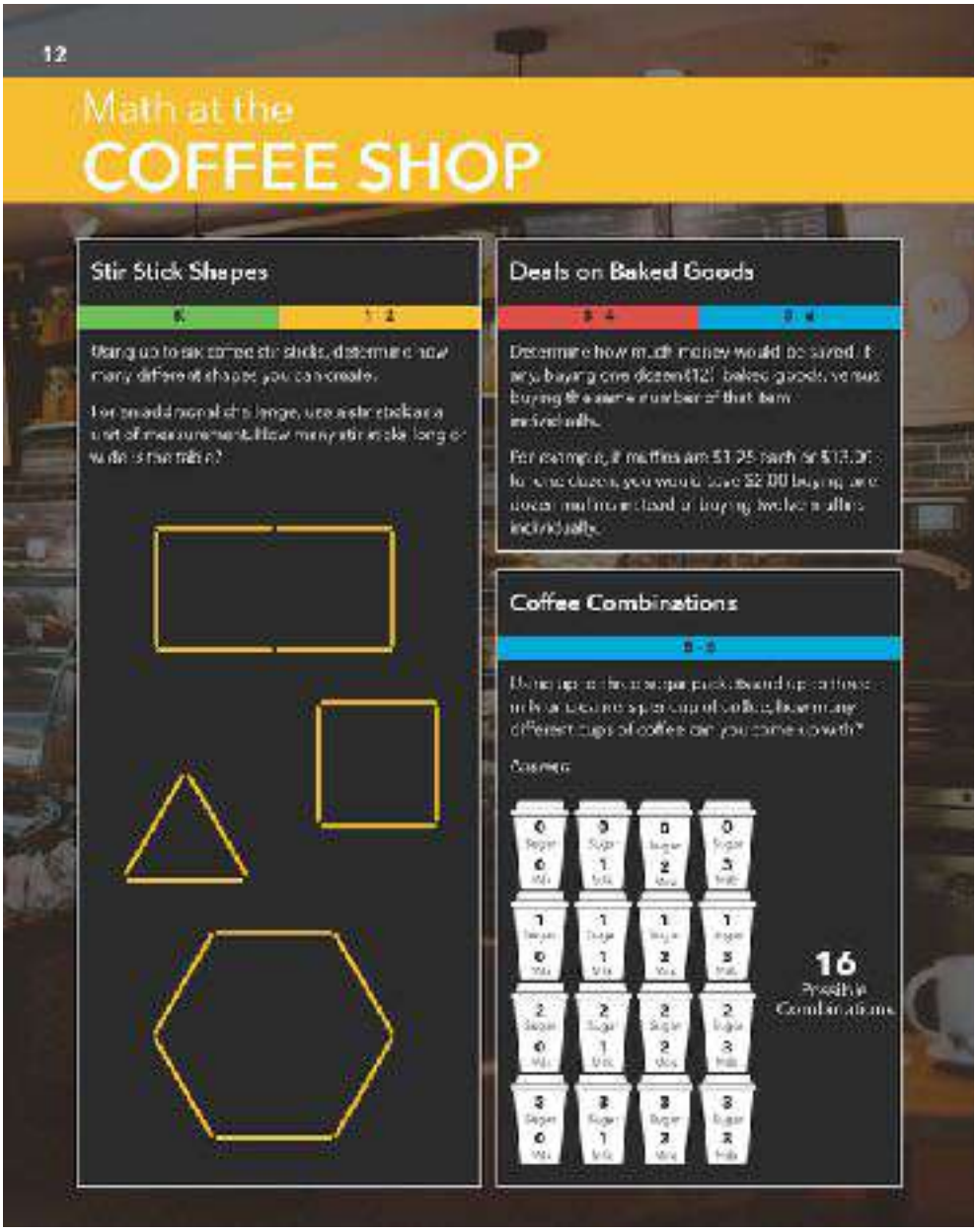

WHERE
Name of the Activity
Suggested Grade Levels
Adding Books
1 2
Determine the total number of books your family will check out.
For example: If your sister borrows 3 books, your father borrows 1 book, and you borrow 4 books, how many books in total is your family borrowing?
Activity Description
Diagram, If Applicable

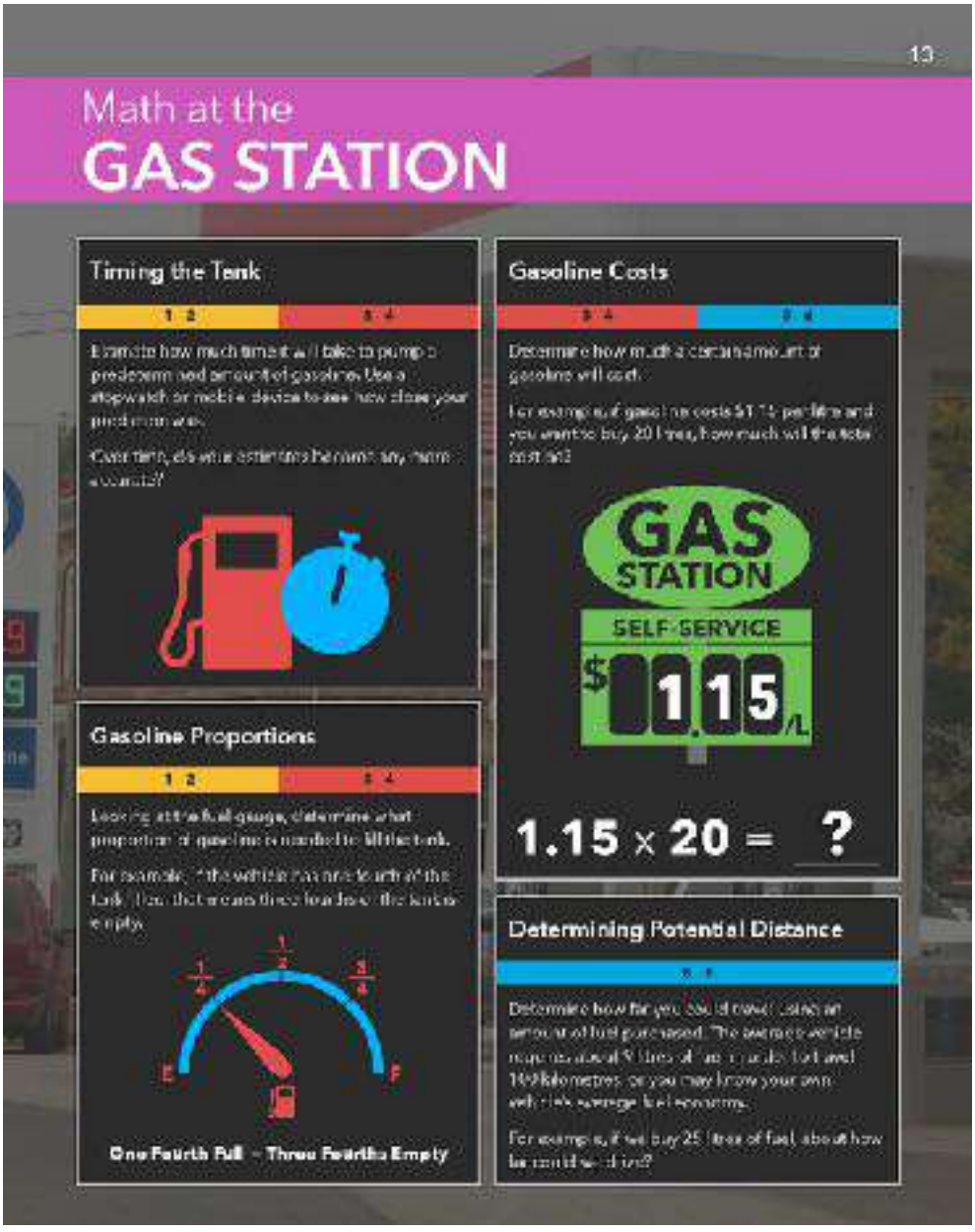

Math at the
ARENA
Resurfacer Estimation
Estimate how many laps it will take the ice resurfacer to clean the rink. Count how many laps it takes to see how close your estimate was.
Representing Goals Scored
Keep a tally of how many shots were taken on net in a period and how many of these shots were goals.
How could you represent this information as a fraction? How could you represent this information as a percentage?
3 Goals Scored / 30 Shots on Net = 1/10 = 10%
Shot Estimation
Estimate how many shots on net there will be in one period. Use a tally to track.
How close was your estimate?
Concession Stand Combinations
Use the concession stand menu as a reading math task to determine different combinations of items you could buy using a given amount of money. Calculate how much change you would have left over for each unique combination.
For example, with $5.00, you could buy one bag of chips and one apple. The total would be $4.25 and your change would be $0.75.
=$4.25
Rink Geometry
Determine the area of different shapes on a rink using the following information:
The largest ice resurfacer typically has a radius of about 6.5 metres.
Most hockey rinks are about 25 metres wide and the blue lines are about 15 metres apart.
15m
4.5m
26m


9
Math at the
BANK
Opening a Bank Account
Working with Change
Coin Patterns
Calculating Interest
Calculating a Bank Balance
PIN Possibilities
?
?
?

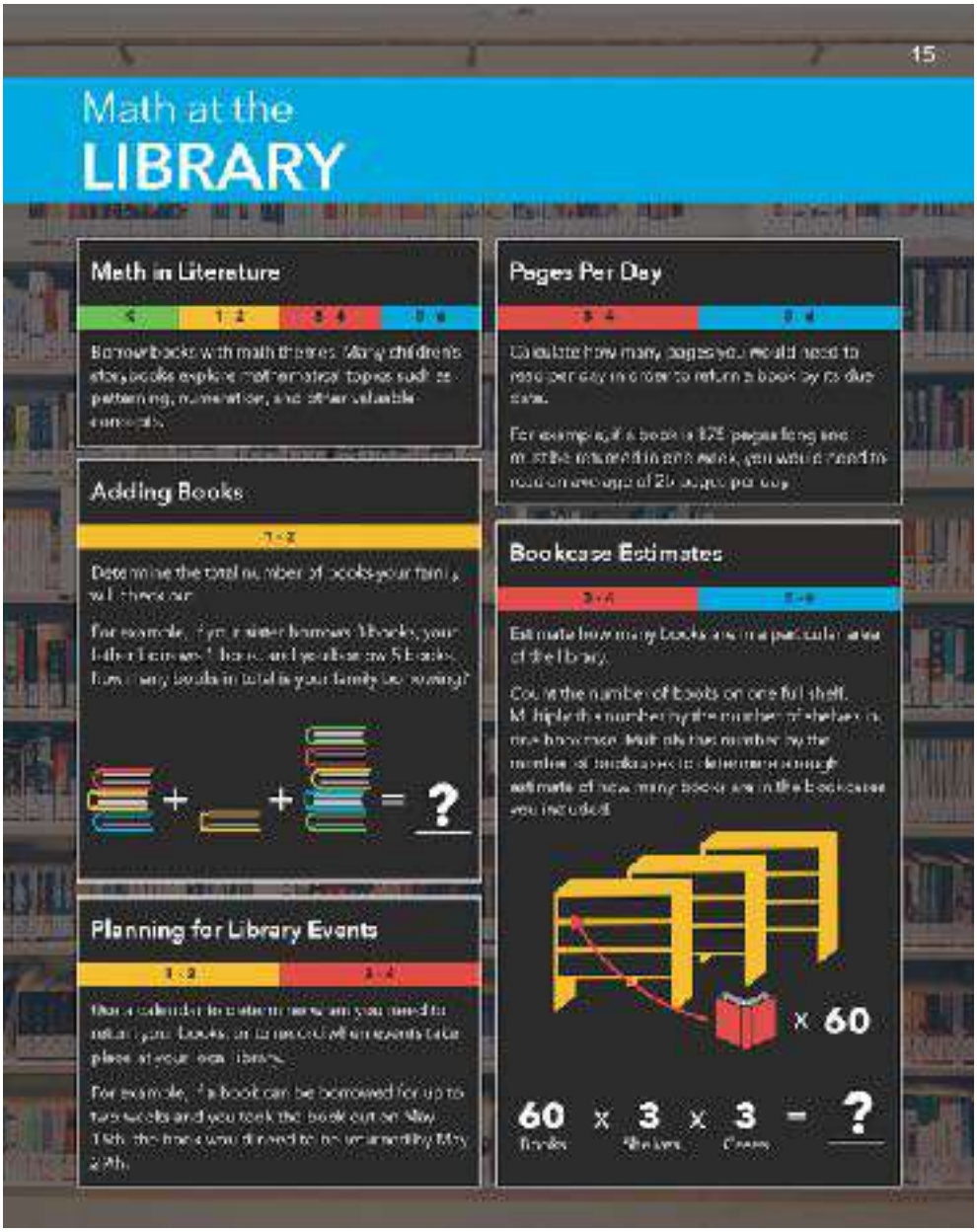

10
Math at the
BEACH
Sand Math
Wave Tracking
Count the number of seconds between waves crashing on the shoreline.
Is the time between each wave always the same or does it change?
Graphing Seashells
Bucket Estimation
Comparing and Sorting Stones
Small Stones
Large Stones


11
Math on the
CITY BUS
Finding Shapes
Identify the shapes you see while riding the bus.
Passenger Tracking
Licence Plate Addition
ABCD 325
3 + 2 + 5 = ?
Total Trip Time
Use a bus schedule to determine how long a trip will take.
Fare Combinations
Calculate the change needed for a bus fare.

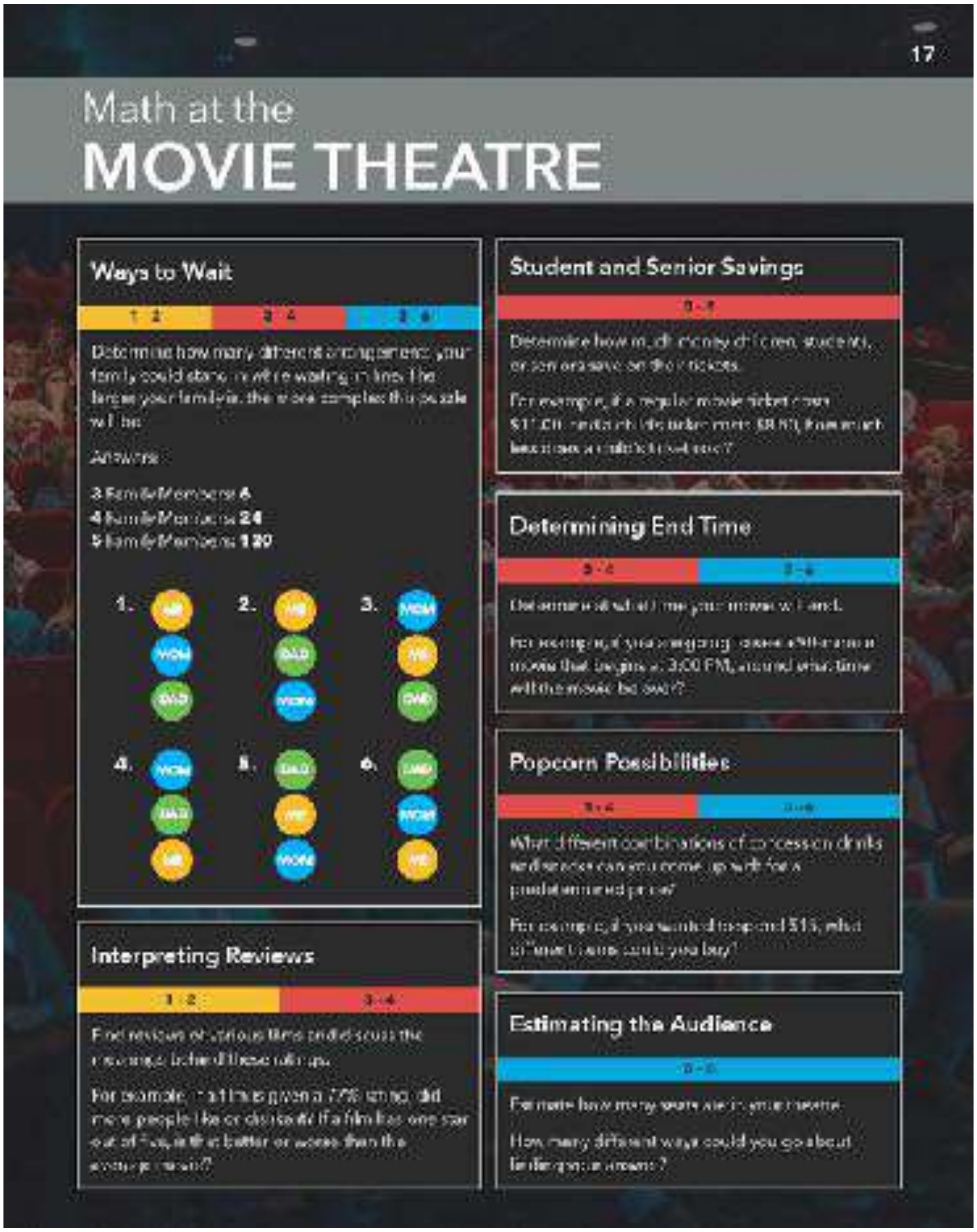

12
Math at the
COFFEE SHOP
Stir Stick Shapes
Deals on Baked Goods
Coffee Combinations
16
Possible
Combinations


13
Math at the
GAS STATION
Timing the Tank
Gasoline Costs
GAS
STATION
SELF-SERVICE
$1.15/L
1.15 x 20 = ?
Gasoline Proportions
One Fourth Full – Three Fourths Empty
Determining Potential Distance


14
Math at the
GROCERY STORE
Weight Predictions
K
1 - 2
Take two different items, holding one in each hand. Predict which item will weigh more. Check to see if you were correct using the grocery scale.
Grocery Store Scavenger Hunt
1 - 2
3 - 4
Make a list of three-dimensional shapes such as cube, rectangular prism, cone, and sphere. Try to find an example of each in the grocery store.
Find an object that is a ...
Cube
Rectangular Prism
Cone
Sphere
Cylinder
Volume and Weight to Quantity
1 - 2
3 - 4
When a grocery store wants to determine the quantity of a particular item you should buy.
For example, if you need one kilogram of apples, how many apples do you need to buy?
Determining Best Value
3 - 4
5 - 6
Determine what size of product is the better deal.
For example, is it better to buy 250 grams of peanut butter for $3.00 or to buy 750 grams of peanut butter for $8.00? Is there a savings by buying a larger quantity of a product?
Flyer Calculations
3 - 4
5 - 6
Look at a grocery store flyer to calculate the savings by purchasing discounted items.
For example, if a $2.99 item is on sale for $1.49, how much money will you be saving? If a $4.79 item is $2.00 off, how much will it be?
WAS $2.99
NOW $1.49
2.99 - 1.49 = ?
Comparing Brands
5 - 6
Compare the cost of items from different brands.
Do certain brands charge more or less than others for the same quantity of product?

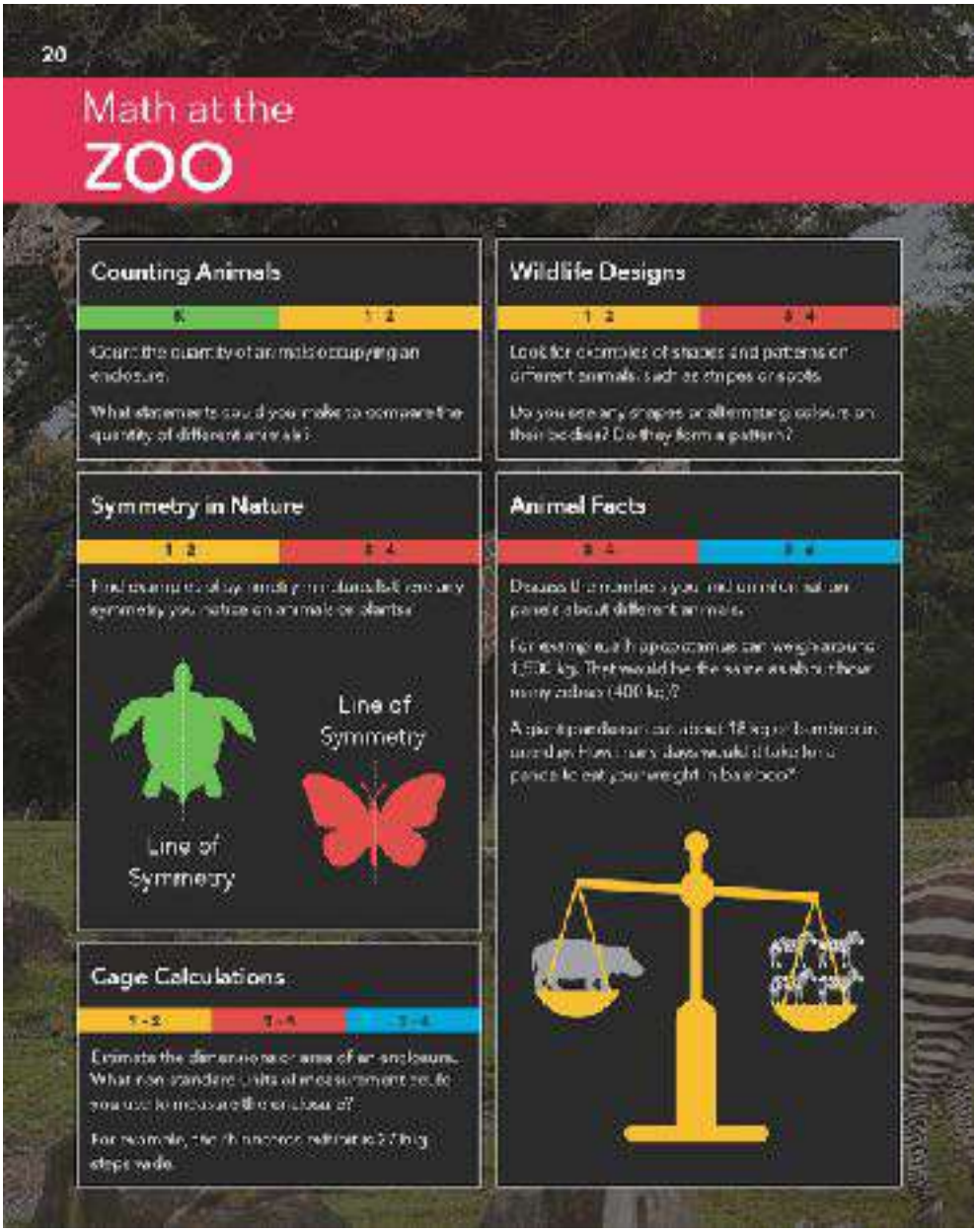

15
Math at the
LIBRARY
Meth in Literature
Borrow books with math themes. Many children's stories, books explore mathematical topics such as patterning, numeration, and other valuable concepts.
Pages Per Day
Calculate how many pages you would need to read per day in order to return a book by its due date.
For example, if a book is 825 pages long and it is due in one month, you would need to read an average of 28 pages per day.
Adding Books
Determine the total number of books your family will check out.
For example, if one sister borrows 10 books, your father borrows 7 books, and you borrow 5 books, how many books in total is your family borrowing?
+ + = ?
Bookcase Estimates
Estimate how many books are in a particular area of the library.
Count the number of books on one full shelf. Multiply the number by the number of shelves in one bookcase. Multiply the number by the number of bookcases to determine a rough estimate of how many books are in the bookcase you included.
x 60
60 x 3 x 3 = ?
Planning for Library Events
Use a calendar to determine when you need to return your books, or to run certain events that take place at your local library.
For example, if a book can be borrowed for up to two weeks and you took the book out on May 15th, the time would be up on Monday May 29th.

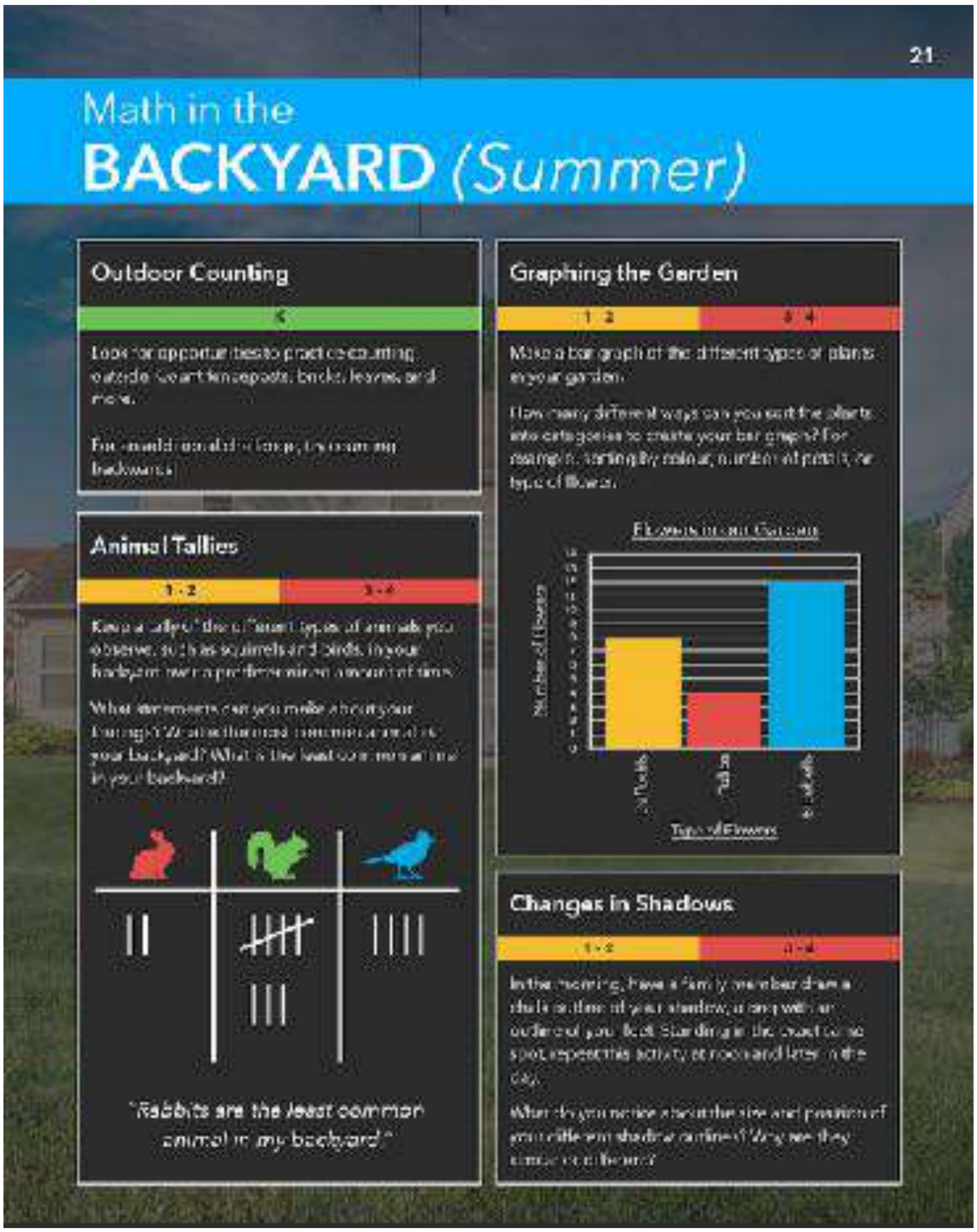

16
Math at the
MALL
Shopping with a Budget
Determine the number of items which could be purchased with a predetermined amount of money.
For example, if I have $20, how many $5 t-shirts could I buy?
Sales tax can be accounted for, or not, based on grade level appropriateness.
Sale Subtraction
Calculate the price of items using sale signs in the store.
For example, if jeans are 40% off and the original tag says $30, how much would the jeans cost?
Planning a Path
Use the mall map to determine the shortest possible walk from your location to a particular store.
If you want to visit five stores and walk the shortest possible distance, in what order should you visit these stores?
Which path is shorter, red or blue?
Discounts on Discounts
Determine the total discount a customer receives when multiple discounts are applied.
For example, if items are 50% off already, plus an additional 25% off, what is the total percentage saved?
Would you rather an item be 60% off with an additional 10% off, or 50% off with an additional 40% off? Does it make a difference?
50% OFF
+
EXTRA 25% OFF
What is the total percentage saved?


17
Math at the
MOVIE THEATRE
Ways to Wait
Answers
Student and Senior Savings
Determining End Time
Popcorn Possibilities
Interpreting Reviews
1 - 2
3 - 4
Estimating the Audience


18
Math at the
PARK
Keeping Score
Mapping the Park
Counting Swings
Treetop Estimation
Classifying in Nature
A B C D E
1
2
3
4
5
Red Leaves
Yellow Leaves
Green Leaves


19
Math at the
RESTAURANT
Bigger Than, Smaller Than
Dining Multiplication
Count the number of chairs at your table. How could you find the number of chair legs without counting the legs individually?
4 legs × 5 chairs = ?
Sorting on the Menu
Counting the Calories
Imaginary Bills
Tipping on the Total


20
Math at the
ZOO
Counting Animals
Wildlife Designs
Symmetry in Nature
Line of Symmetry
Line of Symmetry
Animal Facts
Cage Calculations



Math in the BACKYARD *(Summer)*

Outdoor Counting

K

Look for opportunities to practice counting outside. Count fenceposts, bricks, leaves and more.

For an additional challenge, try counting backwards.

Animal Tallies

1 - 2	3 - 4

Keep a tally of the different types of animals you observe, such as squirrels and birds, in your backyard over a predetermined amount of time.

What statements can you make about your findings? What is the most common animal in your backyard? What is the least common animal in your backyard?

"Rabbits are the least common animal in my backyard."

Graphing the Garden

1 - 2	3 - 4

Make a bar graph of the different types of plants in your garden.

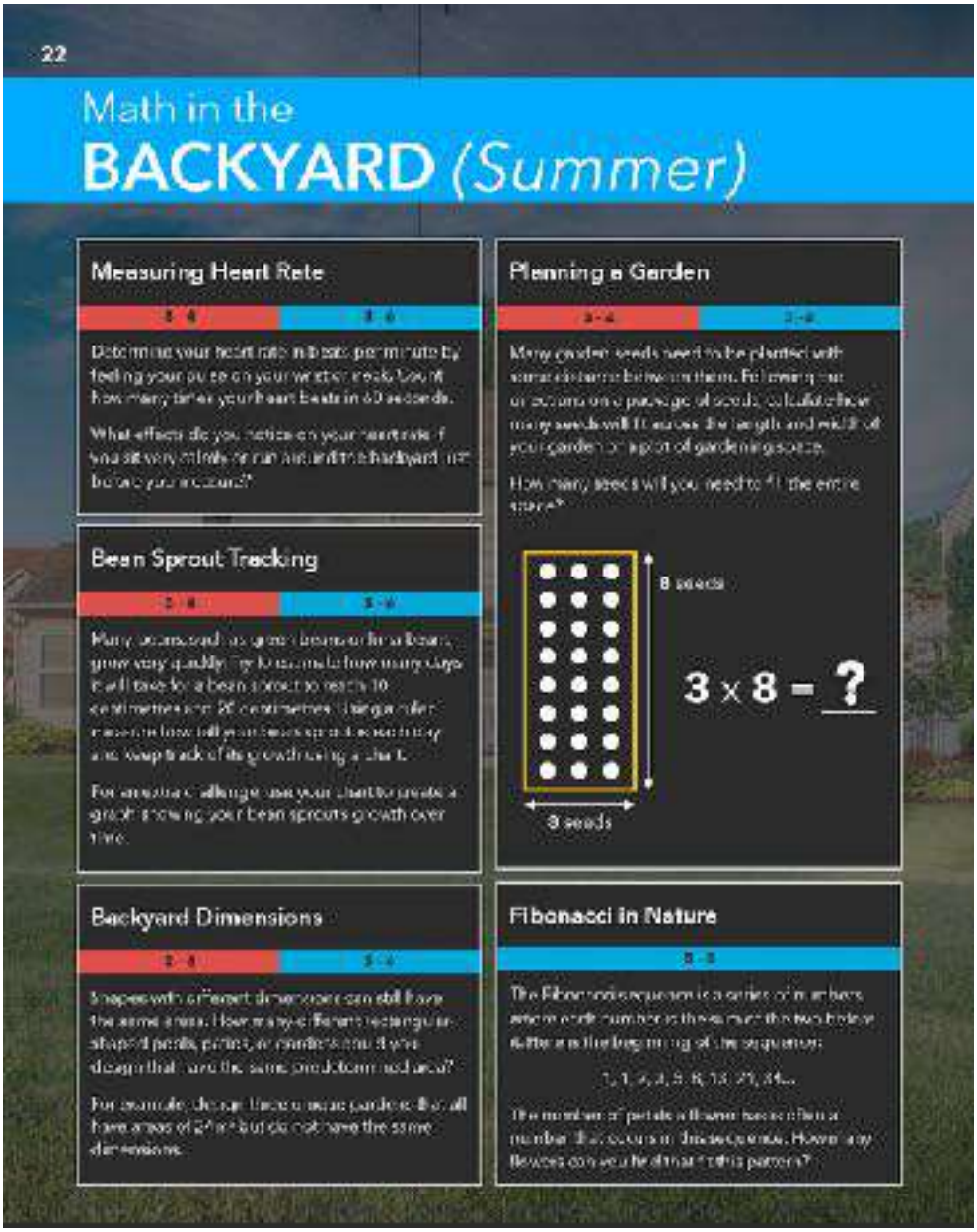
How many different ways can you sort the plants into categories to create your bar graphs? For example, sorting by colour, number of petals, or type of flower.

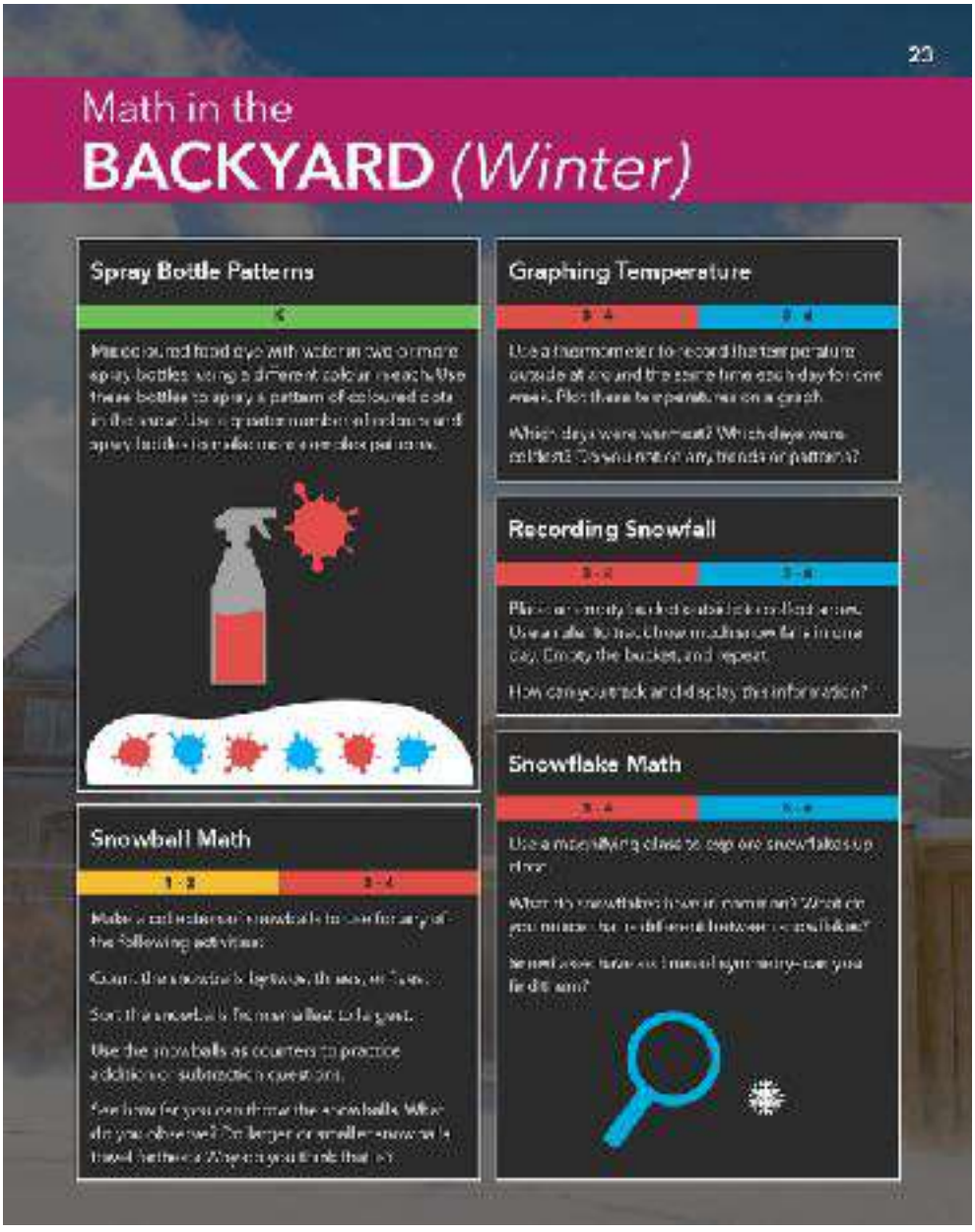
Changes in Shadows

1 - 2	3 - 4

In the morning, have a family member draw a chalk outline of your shadow, along with an outline of your feet. Standing in the exact same spot, repeat this activity at noon and later in the day.

What do you notice about the size and position of your different shadow outlines? Why are they similar or different?


22
Math in the
BACKYARD (Summer)
Measuring Heart Rate
Planning a Garden
Bean Sprout Tracking
8 seeds
3 seeds
3 x 8 = ?
Backyard Dimensions
Fibonacci in Nature

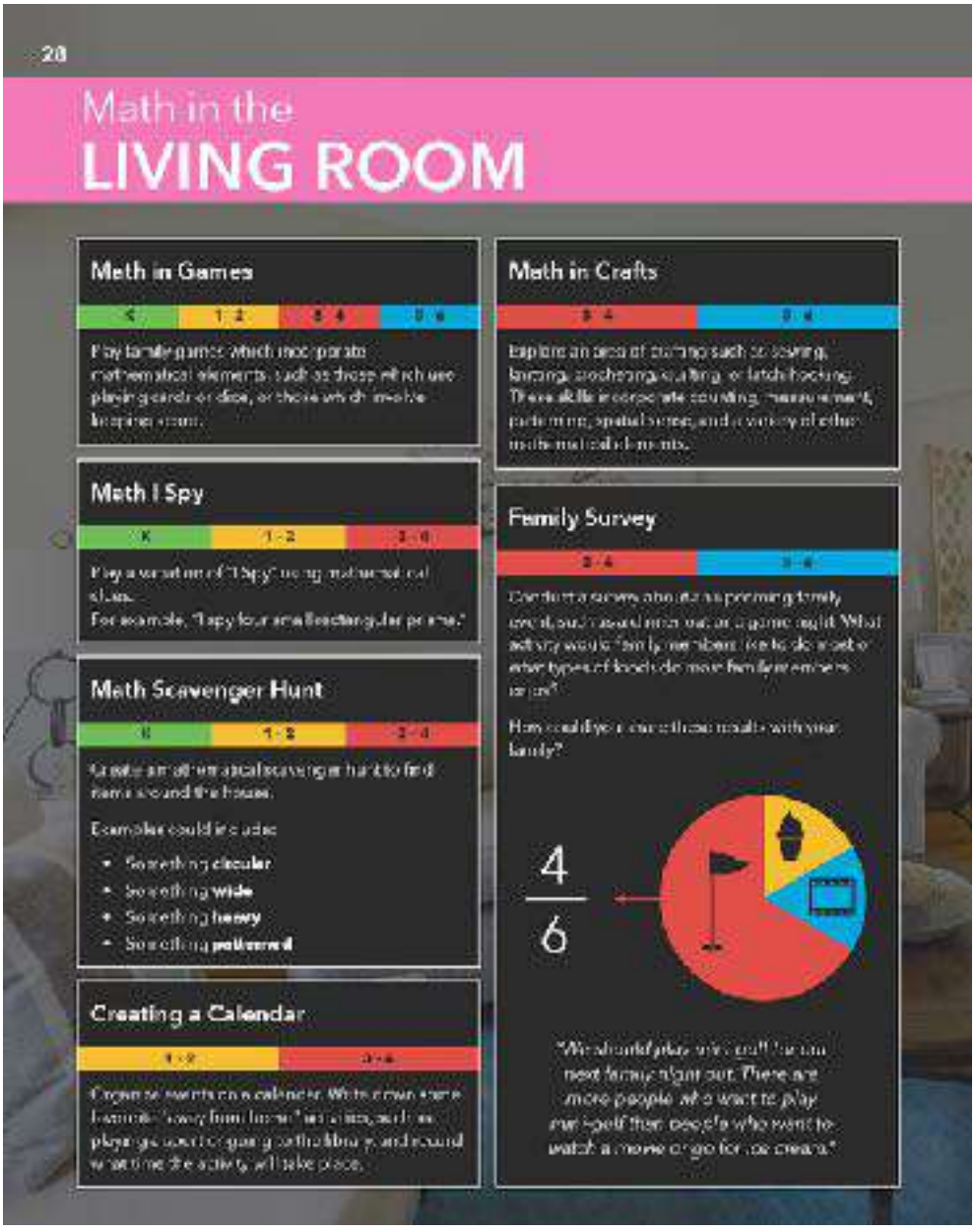

23
Math in the
BACKYARD (Winter)
Spray Bottle Patterns
K
Mix coloured food dye with water in two or more spray bottles, using a different colour in each. Use these bottles to spray a pattern of coloured dots in the snow. Use a greater number of colours and spray bottles to make more complex patterns.
Graphing Temperature
Use a thermometer to record the temperature outside at one and the same time each day for one week. Plot these temperatures on a graph.
Which days were warmest? Which days were coldest? Do you notice any trends or patterns?
Recording Snowfall
Place an empty, cylindrical container in a flat area. Use a ruler to measure how much snow falls in one day. Empty the bucket, and repeat.
How can you track and display this information?
Snowball Math
1 - 2
3 - 4
Make a collection of snowballs to use for any of the following activities:
Count the snowballs by twos, threes, or fives.
Sort the snowballs from smallest to largest.
Use the snowballs as counters to practice addition or subtraction questions.
See how far you can throw the snowballs. What do you observe? Do larger or smaller snowballs travel farther? Why do you think that is?
Snowflake Math
3 - 4
5 - 6
Use a microscope or magnifying glass to look at snowflakes up close.
What do snowflakes have in common? What do you notice to be different between snowflakes?
Several snowflakes are 6-fold symmetry—can you find one?

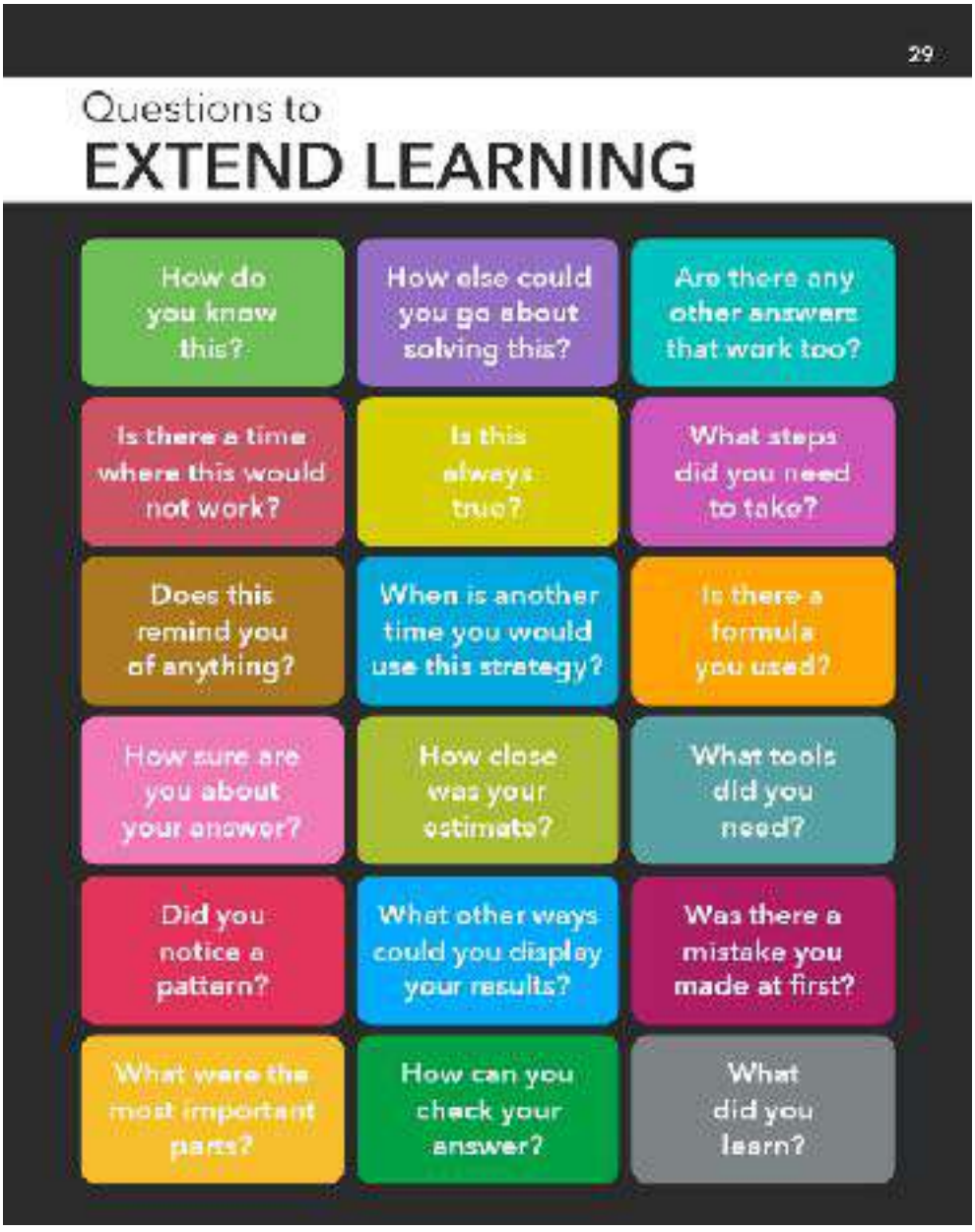

24
Math in the
BATHROOM
Toothbrush Timer
K
1 - 2
3 - 4
5 - 6
Use a two minute timer when brushing your teeth.
Can you guess when the timer is about to go off?
Do your guesses improve with practice?
Splash in the Bath
K
While in the bath, try dropping different bath toys from the same height.
What do you notice about the splashes different toys make? Do bigger toys or smaller toys make the biggest splashes? Do heavier toys or lighter toys make the smallest splashes?
Compering Containers
K
1 - 2
Play with different sized plastic cups and a large plastic container in the bath. Estimate how many of each cup will be needed to fill the large container, and check to see how close your estimates were.
=
Geometry in the Bathroom
K
1 - 2
Look for examples of shapes and patterns in tiles, flooring, and wallpaper. Describe the pattern or identify the shape you find.
Exploring Weight
1 - 2
3 - 4
Weigh family members and pets using a bathroom scale. What statements would you use to describe the information?
For example, "I weigh more than my sister but not as much as my little brother."
<
<


25
Math in the
BEDROOM
Cleaning Time
Set a timer to clean up your room.
Creating a Routine
Determine how much time you need to get ready for school. Including the time it takes to wash, dress, eat, and walk to the bus or school. Work backwards from the time school starts and use this to figure out what time you should wake up.
Event Probability
Have a discussion before bedtime about the probability of various hypothetical events. Decide whether something is certain, likely, unlikely, or impossible.
For example, you can ask that the sun will come up in the morning.
Outfit Tree Diagram
Pick out two to five tops, bottoms, and shoes. Draw a tree diagram with branches for the possible outfits which could be created from these items, assuming each of each is worn.
How many different combinations are possible?
Wardrobe Organization
Think of a sorting pattern to organize your clothes.
However many different ways could you organize them? For example, sorting them by colors or season.
Making a Floor Plan
Use a measuring tape to create a floor plan of your bedroom.
Could you rearrange your furniture in any other ways?
12 Combinations

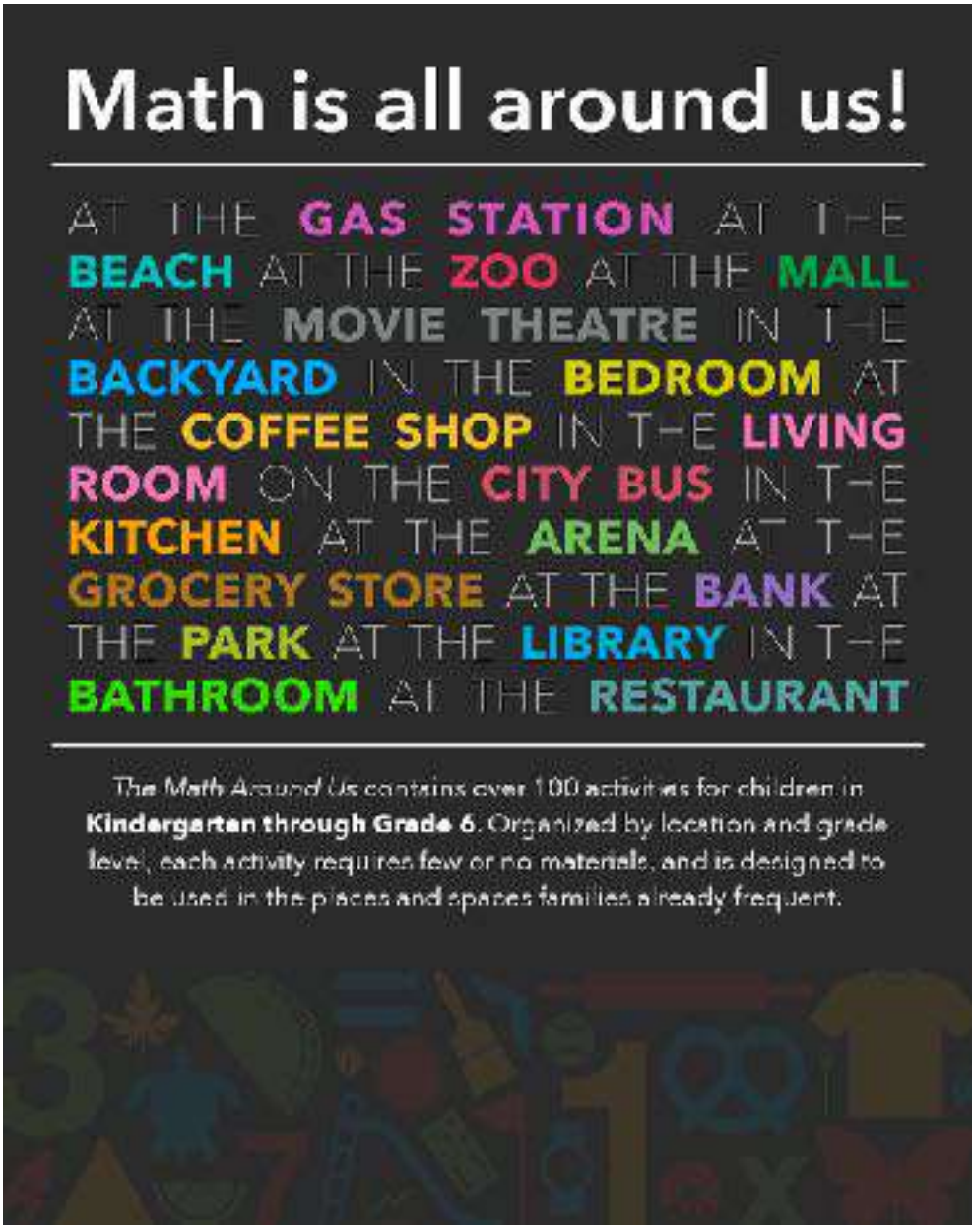

26
Math in the
KITCHEN
Measuring Volume
K
1 - 2
Count how many cups of dry pasta, popcorn kernels, or other small foods are needed to fill bowls of various sizes.
Mystery Predictions
K
1 - 2
Take turns hiding a mystery item in a paper bag. Have family members predict what might be inside based on its weight.
Other questions can be asked, such as:
• Is it heavier than an apple?
• Could it be a can of soup?
• Is it lighter than a shoe?
Food Patterns
K
1 - 2
Make a pattern on your plate using different foods like broccoli and carrots. Introduce a greater number of different foods or create more complex patterns.
?
?
Plate Proportions
1 - 2
3 - 4
5 - 6
Use your knowledge of fractions to fill up your dinner plate with different types of foods. It is recommended that one-half of the plate be fruits and vegetables, one-quarter be protein foods, and one-quarter be whole grain foods.
Baking a Bigger Batch
1 - 2
3 - 4
Observe how many cups or teaspoons of each ingredient are used in a recipe. Determine what changes would need to be made if you wanted to double the recipe or divide it in half.
Equal Servings
1 - 2
3 - 4
Determine how to divide a snack or dish among a family or group.
For example, if everyone needs an equal amount of pizza and the pizza has 12 slices, how many slices can each family member have?


27
Math in the
KITCHEN
Setting the Table
Volume Estimations
Icy Estimations
Seed Estimations
Reaching Room Temperature
Baking Numbers


20
Math in the
LIVING ROOM
Math in Games
Play family games which incorporate mathematical elements, such as those which use playing cards or dice, or those which involve keeping score.
Math I Spy
Play a variation of "I Spy" using mathematical clues.
For example, "I spy four small rectangular prisms."
Math Scavenger Hunt
Create an alternative to a scavenger hunt to find items around the house.
Examples could include:
Something circular
Something wide
Something heavy
Something patterned
Creating a Calendar
Organise events on a calendar. Work out how many months away from now an event is, such as playing a board game with siblings, and record what time the activity will take place.
Math in Crafts
Explore an area of crafting such as sewing, knitting, crocheting, quilting, or latch hooking. These skills incorporate counting, measurement, patterning, spatial sense, and a variety of other mathematical concepts.
Family Survey
Conduct a survey about a upcoming family event, such as what movie or game night. What activity would family members like to do next or what types of foods do most family members enjoy?
How could you share these results with your family?
4
6
"We should play mini golf for our next family night out. There are more people who want to play mini-golf than people who want to watch a movie or go for ice cream."


29
Questions to
EXTEND LEARNING
How do you know this?
How else could you go about solving this?
Are there any other answers that work too?
Is there a time where this would not work?
Is this always true?
What steps did you need to take?
Does this remind you of anything?
When is another time you would use this strategy?
Is there a formula you used?
How sure are you about your answer?
How close was your estimate?
What tools did you need?
Did you notice a pattern?
What other ways could you display your results?
Was there a mistake you made at first?
What were the most important parts?
How can you check your answer?
What did you learn?


31


Math is all around us!
AT THE GAS STATION AT THE BEACH AT THE ZOO AT THE MALL AT THE MOVIE THEATRE IN THE BACKYARD IN THE BEDROOM AT THE COFFEE SHOP IN THE LIVING ROOM ON THE CITY BUS IN THE KITCHEN AT THE ARENA AT THE GROCERY STORE AT THE BANK AT THE PARK AT THE LIBRARY IN THE BATHROOM AT THE RESTAURANT
The Math Around Us contains over 100 activities for children in Kindergarten through Grade 6. Organized by location and grade level, each activity requires few or no materials, and is designed to be used in the places and spaces families already frequent.

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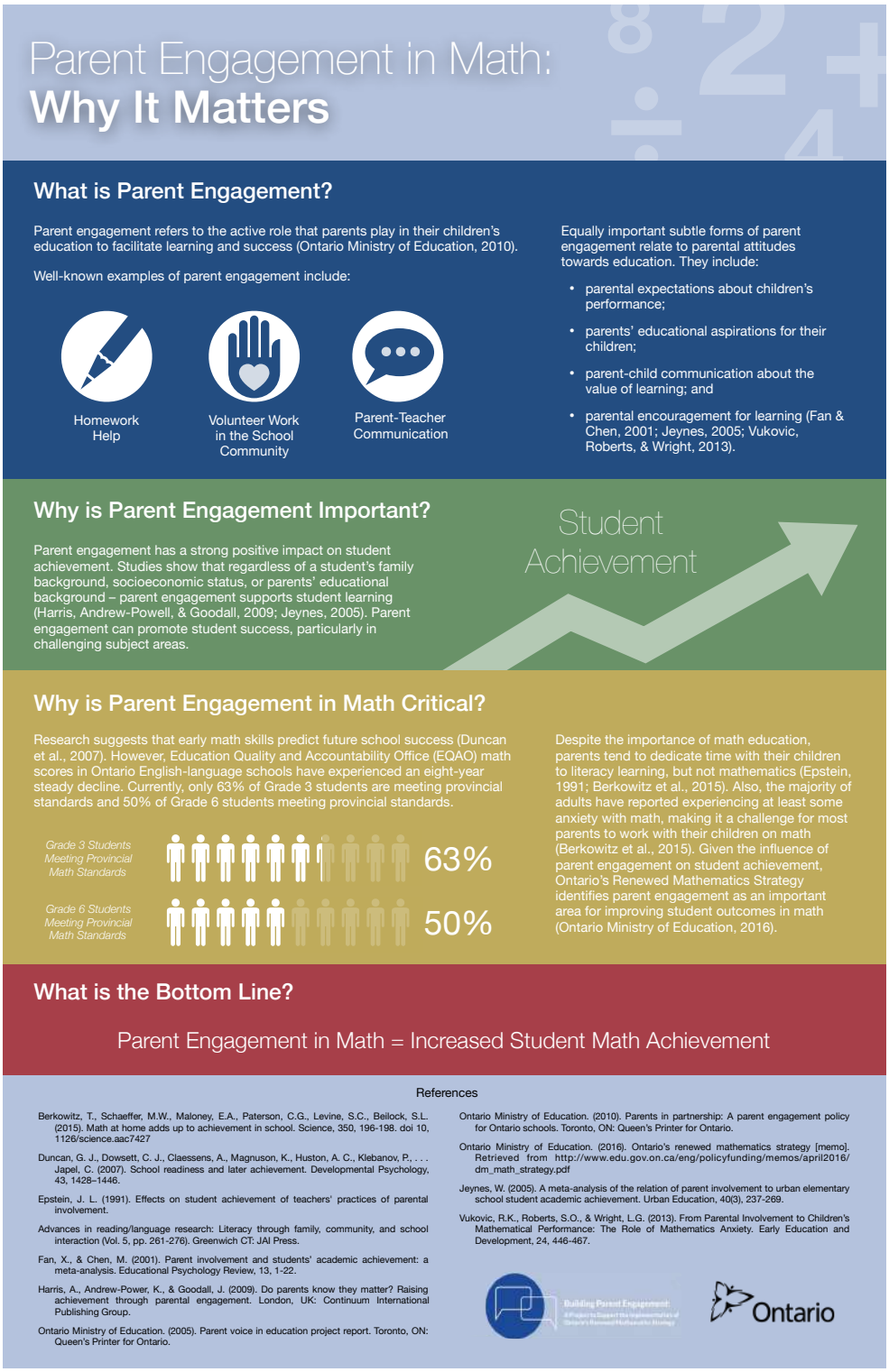
Appendix A


Parent Engagement in Math:
Why It Matters
What is Parent Engagement?
Parent engagement refers to the active role that parents play in their children's education to facilitate learning and success (Ontario Ministry of Education, 2010).
Well-known examples of parent engagement include:
Homework Help
Volunteer Work in the School Community
Parent-Teacher Communication
Equally important subtle forms of parent engagement relate to parental attitudes towards education. They include:
• parental expectations about children's performance;
• parents' educational aspirations for their children;
• parent-child communication about the value of learning; and
• parental encouragement for learning (Fan & Chen, 2001; Jeynes, 2005; Vukovic, Roberts, & Wright, 2013).
Why is Parent Engagement Important?
Parent engagement has a strong positive impact on student achievement. Studies show that regardless of a student's family background, socioeconomic status, or parents' educational background – parent engagement supports student learning (Harris, Andrew-Powell, & Goodall, 2009; Jeynes, 2005). Parent engagement can promote student success, particularly in challenging subject areas.
Student Achievement
Why is Parent Engagement in Math Critical?
Research suggests that early math skills predict future school success (Duncan et al., 2007). However, Education Quality and Accountability Office (EQAO) math scores in Ontario English-language schools have experienced an eight-year steady decline. Currently, only 63% of Grade 3 students are meeting provincial standards and 50% of Grade 6 students meeting provincial standards.
Grade 3 Students Meeting Provincial Math Standards
63%
Grade 6 Students Meeting Provincial Math Standards
50%
Despite the importance of math education, parents tend to dedicate time with their children to literacy learning, but not mathematics (Epstein, 1991; Berkowitz et al., 2015). Also, the majority of adults have reported experiencing at least some anxiety with math, making it a challenge for most parents to work with their children on math (Berkowitz et al., 2015). Given the influence of parent engagement on student achievement, Ontario's Renewed Mathematics Strategy identifies parent engagement as an important area for improving student outcomes in math (Ontario Ministry of Education, 2016).
What is the Bottom Line?
Parent Engagement in Math = Increased Student Math Achievement
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Ontario

Appendix B

Parent Engagement in Math: How to Get Started

What is Parent Engagement?

Parent engagement is the active role that parents take in their children's education to facilitate learning and success (Ontario Ministry of Education, 2010). It promotes student achievement and is essential for improving elementary students' math outcomes in Ontario (Ontario Ministry of Education, 2016).

Parent Engagement

How Can School Staff Facilitate Parent Engagement in Math?

School staff encourage parent engagement in math education by:

- remembering and valuing that parents are partners in their children's math learning;
- actively inviting parents to contribute to their children's math learning;
- sharing math games, books and resources (e.g., TVO's free math tutoring help) that make it possible for parents to engage in math at home; and
- providing opportunities for children to express appreciation of their parents' participation in their math learning (Green, Walker, Hoover-Dempsey, & Sandler, 2007).

Parents as Educational Partners

What Could Parent Engagement Plans in Math Focus On?

Useful parent engagement plans involve sustained efforts to equip parents as partners in their children's math education. These plans lay the groundwork for developing positive communication between the school and home (Epstein et al., 2009). Parent engagement plans in math might focus on:

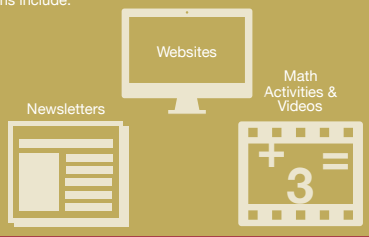
- sending home prompts and questions to promote 'math talk' that encourages children to explain their work out loud. Remind parents that if they see that their child is struggling or unsure about math homework, make a note in the child's journal and ask the teacher to provide remediation/support the next day. (Cankar, Deutsch, & Sentočnik, 2012);
- decreasing parents' anxiety with math and demonstrating how to provide effective math homework help (Maloney, Ramirez, Gunderson, Levine, & Beilock, 2015);
- making programs available that provide math resources and assistance for home use (Stelmack, 2013); and
- remembering that parents should never feel the pressure to teach math at home. Encourage their participation by reminding them that "If you don't know how to do it, ask your child to teach you, to show you how it's done." - *Teacher, Lauren Fine.*

Positive Communication

What Are Some Examples of Activities in Math Parent Engagement Plans?

Math parent engagement plans are most effective when they are tailored to meet the unique needs of individual school communities. One of the best ways to begin this type of parent engagement plan is to connect with parents about what they need to better support their children's math learning. Examples of activities in math parent engagement plans include:

- regularly featuring math in school newsletters and on the school's website;
- raising awareness about math and math activities through school-based social media;
- proposing ongoing math challenges for families;
- hosting family math nights throughout the school year that feature interactive math activities;
- developing math-in-a-bag kits that include children's books and activities for parents and children to enjoy together regularly; and
- capturing and sharing classroom videos to demonstrate to parents how math problems can be solved with multiple strategies (Colgan, 2017).



What's Next?

Work collaboratively to develop a vision and activities for your parent engagement plan in math. Remember to consult resources and connect with the Queen's Project Team during this process.

"*A clear vision, backed by definite plans, gives you a tremendous feeling of confidence*" - Brian Tracy

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Appendix C

Ideas for
Math Action Planning

10 Tips for Developing a Successful Math Action Plan

1. Clearly state your parent engagement goal(s)/objectives
2. Ensure the strategies and activities are math focused
3. Include parents as key partners in the planning, communicating and implementing
4. Check that the language is accessible when reviewing alignment between goal(s), objectivities, and strategies/ activities
5. Maintain a welcoming and encouraging tone
6. Keep track of what you are doing (e.g. samples of agendas, notices)
7. Collect data about what you are doing/have done (e.g. number of people who attend/website usage; descriptive feedback)
8. Review the data to see if your strategy/activity aligns with the goal(s) and contributes to your objectives
9. Support regular communication amongst Action Team members so that they can speak, using data, about the success of the Math Action Plan
10. Celebrate the Math Action Plan as part of a continuum of math learning

Action Planning Process

1. Gathering	Assemble your Action Team consisting of of interested staff, parents, and/or other members of your school community.
2. Scanning	Assess your school's strengths (assets) and areas in need of improvement (needs) focusing on parent engagement and mathematics.
3. Focusing	Select Year 1 priorities and identify a goal for action (to meet a need or build on existing strengths).
4. Planning	Define a clear goal and objective(s), and select strategies (such as those suggested in the resources provided). Complete the 1-page Action Planning Template and share with the Queen's team.
5. Acting	Put your Plan into action with support from your Action Team and the Queen's team.
6. Checking In	Collect data about strategies/activities to monitor progress and adjust the Plan along the way. Check in with your Queen's liaison and TeachOntario regularly!

Overview of Math Action Plan Categories

Strategy	Timing	Communicating	People	Resources	Success	Data
What is a strategy/activity you are using to achieve your goal(s)?	What is the proposed timeline for implementing this strategy? When will it take place, and for how long?	How will your Action Team communicate this strategy to others?	Who are the people involved: (a) Who is the lead person on the Action Team; (b) who will be involved; (c) who is the intended audience?	What resources are needed to bring this strategy to life?	How will you know if this strategy is a success? What indicators will you look for?	What data will you collect? What will you do with the data collected?

Criteria for a "Good" Action Plan

1. It is completed by the Action Team
2. It is clearly written in accessible language
3. It is detailed enough to provide a vision but streamlined enough to show what is possible
4. It is well organized and aligns with school needs in mathematics
5. It incorporates multiple people using multiple processes
6. The ideas documented reflect the current work while also leaving room for new opportunities
7. It promotes dialogue, intentionality and reflection
8. It gets done

Resource adapted from:
Action Schools, BC (2016). Action Planning Guide. Available online.
http://helloalive.com/action-plan-template/effective-action-plan-template-with-table-layout/
http://ctb.ku.edu/en/table-of-contents/structure/strategic-planning/develop-action-plans/main

Building Parent Engagement

Ontario

Appendix D

Ontario Number Sense and Numeration Curriculum Expectations

Quantity Relationships

By the end of the corresponding grade, students will:	1	2	3	4	5	6
Represent, compare, and order whole numbers to…	50	100	1,000	10,000	100,000	1,000,000
Represent, compare, and order decimal numbers from…					0.01	0.001
Read and print in words whole numbers to…	Ten	Twenty	One Hundred	One Thousand	Ten Thousand	One Hundred Thousand
Demonstrate an understanding of place value in numbers from…			1 to 999	0.1 to 10,000	0.01 to 100,000	0.001 to 1,000,000
Estimate, value, and represent the value of a collection of coins with a maximum value of…	$0.20 (representing only)	$1	$10			
Demonstrate the concept of conservation of number and estimate the number of objects in a set.	✓					
Compose and decompose, in a variety of ways and using concrete materials, numbers up to…	20	99	999			
Relating numbers (or fractions*) to the anchors of…	5, 10			0, 1/2, 1 *		
Divide objects into parts and identify and describe equal-sized parts of the whole.	✓	+ comparing number and size of fractional parts	+ diving sets of objects into equal parts	+ using fraction words and standard fractional notation		
Rounding, using concrete materials, numbers to…		The Nearest 2-Digit Number				
Read and represent (and write*) money amounts to…			$10	$100	$1,000*	
In problems arising from real life situations, round numbers with…			2 Digits	4 Digits	Decimals	
Represent and explain the relationship among…			1, 10, 100, 1,000			
Compare and order fractions, explain equivalent fractions.				✓	+ Improper Fractions	
Represent, compare, and order decimals to…				Tenths		
Solve problems that arise from real- life situations with whole numbers up to…				10,000	100,000	1,000,000
Demonstrate and explain equivalent representations of decimal numbers.					✓	
Use estimation when solving problems involving…					Addition, Subtraction, Multiplication	
Represent, compare, and order fractional amounts with…					Like Denominators	Unlike Denominators
Identify composite and prime numbers.						✓

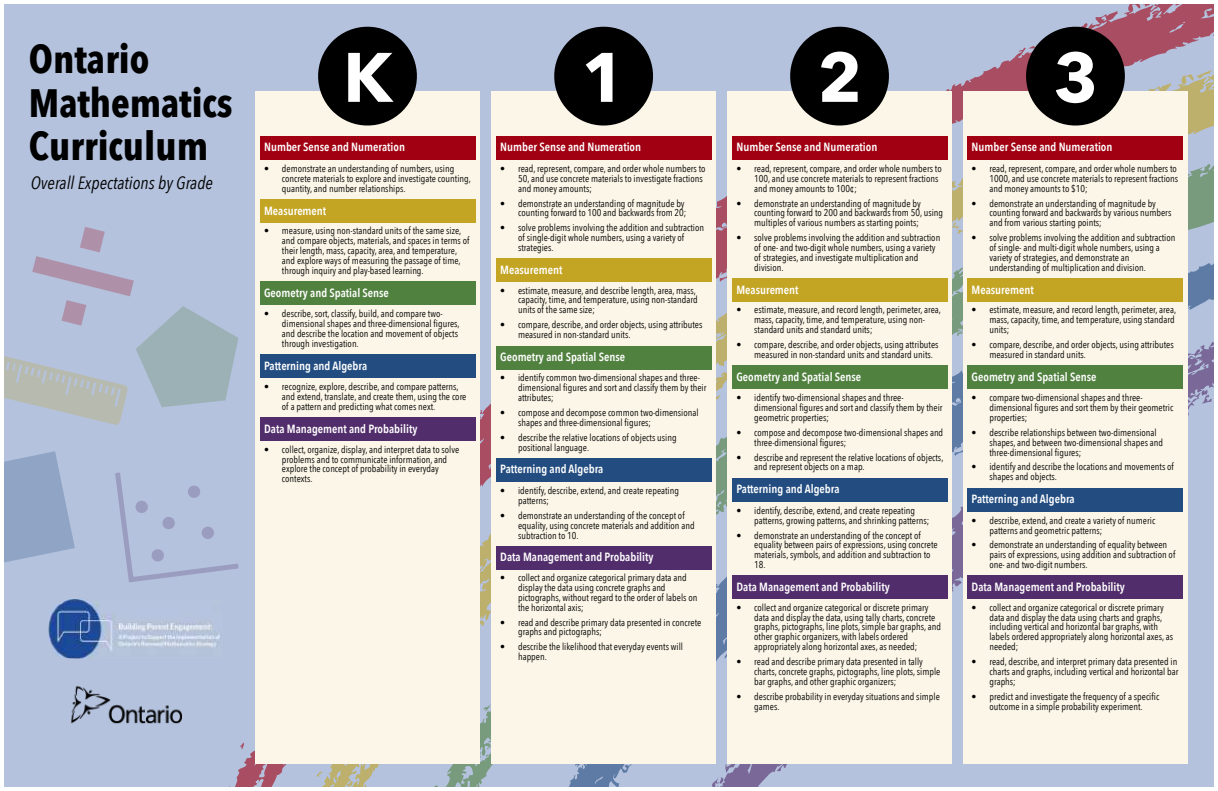
Grade 7 Quantity Relationships Expectations

- represent, compare, and order decimals to hundredths and fractions, using a variety of tools
- generate multiples and factors, using a variety of tools and strategies
- identify and compare integers found in real-life contexts
- represent and order integers, using a variety of tools
- select and justify the most appropriate representation of a quantity for a given context
- represent perfect squares and square roots, using a variety of tools
- explain the relationship between exponential notation and the measurement of area and volume

Grade 8 Quantity Relationships Expectations

- express repeated multiplication using exponential notation
- represent whole numbers in expanded form using powers of ten
- represent, compare, and order rational numbers
- translate between equivalent forms of a number
- determine common factors and common multiples using the prime factorization of numbers

Appendix E


Ontario Mathematics Curriculum
Overall Expectations by Grade
K
Number Sense and Numeration
• demonstrate an understanding of numbers, using concrete materials to explore and investigate counting, quantity, and number relationships.
Measurement
• measure, using non-standard units of the same size, and compare objects, materials, and spaces in terms of their length, mass, capacity, area, and temperature, and explore ways of measuring the passage of time, through inquiry and play-based learning.
Geometry and Spatial Sense
• describe, sort, classify, build, and compare two-dimensional shapes and three-dimensional figures, and describe the location and movement of objects through investigation.
Patterning and Algebra
• recognize, explore, describe, and compare patterns, and extend, translate, and create them, using the core of a pattern and predicting what comes next.
Data Management and Probability
• collect, organize, display, and interpret data to solve problems and to communicate information, and explore the concept of probability in everyday contexts.
1
Number Sense and Numeration
• read, represent, compare, and order whole numbers to 50, and use concrete materials to investigate fractions and money amounts;
• demonstrate an understanding of magnitude by counting forward to 100 and backwards from 20;
• solve problems involving the addition and subtraction of single-digit whole numbers, using a variety of strategies.
Measurement
• estimate, measure, and describe length, area, mass, capacity, time, and temperature, using non-standard units of the same size;
• compare, describe, and order objects, using attributes measured in non-standard units.
Geometry and Spatial Sense
• identify common two-dimensional shapes and three-dimensional figures and sort and classify them by their attributes;
• compose and decompose common two-dimensional shapes and three-dimensional figures;
• describe the relative locations of objects using positional language.
Patterning and Algebra
• identify, describe, extend, and create repeating patterns;
• demonstrate an understanding of the concept of equality, using concrete materials and addition and subtraction to 10.
Data Management and Probability
• collect and organize categorical primary data and display the data using concrete graphs and pictographs, without regard to the order of labels on the horizontal axis;
• read and describe primary data presented in concrete graphs and pictographs;
• describe the likelihood that everyday events will happen.
2
Number Sense and Numeration
• read, represent, compare, and order whole numbers to 100, and use concrete materials to represent fractions and money amounts to 100c;
• demonstrate an understanding of magnitude by counting forward to 200 and backwards from 50, using multiples of various numbers as starting points;
• solve problems involving the addition and subtraction of one- and two-digit whole numbers, using a variety of strategies, and investigate multiplication and division.
Measurement
• estimate, measure, and record length, perimeter, area, mass, capacity, time, and temperature, using non-standard units and standard units;
• compare, describe, and order objects, using attributes measured in non-standard units and standard units.
Geometry and Spatial Sense
• identify two-dimensional shapes and three-dimensional figures and sort and classify them by their geometric properties;
• compose and decompose two-dimensional shapes and three-dimensional figures;
• describe and represent the relative locations of objects, and represent objects on a map.
Patterning and Algebra
• identify, describe, extend, and create repeating patterns, growing patterns, and shrinking patterns;
• demonstrate an understanding of the concept of equality between pairs of expressions, using concrete materials, symbols, and addition and subtraction to 18.
Data Management and Probability
• collect and organize categorical or discrete primary data and display the data, using tally charts, concrete graphs, pictographs, line plots, simple bar graphs, and other graphic organizers, with labels ordered appropriately along horizontal axes, as needed;
• read and describe primary data presented in tally charts, concrete graphs, pictographs, line plots, simple bar graphs, and other graphic organizers;
• describe probability in everyday situations and simple games.
3
Number Sense and Numeration
• read, represent, compare, and order whole numbers to 1000, and use concrete materials to represent fractions and money amounts to $10;
• demonstrate an understanding of magnitude by counting forward and backwards by various numbers and from various starting points;
• solve problems involving the addition and subtraction of single- and multi-digit whole numbers, using a variety of strategies, and demonstrate an understanding of multiplication and division.
Measurement
• estimate, measure, and record length, perimeter, area, mass, capacity, time, and temperature, using standard units;
• compare, describe, and order objects, using attributes measured in standard units.
Geometry and Spatial Sense
• compare two-dimensional shapes and three-dimensional figures and sort them by their geometric properties;
• describe relationships between two-dimensional shapes, and between two-dimensional shapes and three-dimensional figures;
• identify and describe the locations and movements of shapes and objects.
Patterning and Algebra
• describe, extend, and create a variety of numeric patterns and geometric patterns;
• demonstrate an understanding of equality between pairs of expressions, using addition and subtraction of one- and two-digit numbers.
Data Management and Probability
• collect and organize categorical or discrete primary data and display the data using charts and graphs, including vertical and horizontal bar graphs, with labels ordered appropriately along horizontal axes, as needed;
• read, describe, and interpret primary data presented in charts and graphs, including vertical and horizontal bar graphs;
• predict and investigate the frequency of a specific outcome in a simple probability experiment.
Building Parent Engagement
Ontario
4
Number Sense and Numeration
• read, represent, compare, and order whole numbers to 10 000, decimal numbers to tenths, and simple fractions, and represent money amounts to $100;
• demonstrate an understanding of magnitude by counting forward and backwards by 0.1 and by fractional amounts;
• solve problems involving the addition, subtraction, multiplication, and division of single- and multi-digit whole numbers, and involving the addition and subtraction of decimal numbers to tenths and money amounts, using a variety of strategies;
• demonstrate an understanding of proportional reasoning by investigating whole-number unit rates.
Measurement
• estimate, measure, and record length, perimeter, area, mass, capacity, volume, and elapsed time, using a variety of strategies;
• determine the relationships among units and measurable attributes, including the area and perimeter of rectangles.
Geometry and Spatial Sense
• identify quadrilaterals and three-dimensional figures and classify them by their geometric properties, and compare various angles to benchmarks;
• construct three-dimensional figures, using two-dimensional shapes;
• identify and describe the location of an object, using a grid map, and reflect two-dimensional shapes.
Patterning and Algebra
• describe, extend, and create a variety of numeric and geometric patterns, make predictions related to the patterns, and investigate repeating patterns involving reflections;
• demonstrate an understanding of equality between pairs of expressions, using addition, subtraction, and multiplication.
Data Management and Probability
• collect and organize discrete primary data and display the data using charts and graphs, including stem-and-leaf plots and double bar graphs;
• read, describe, and interpret primary data and secondary data presented in charts and graphs, including stem-and-leaf plots and double bar graphs;
• predict the results of a simple probability experiment, then conduct the experiment and compare the prediction to the results.
5
Number Sense and Numeration
• read, represent, compare, and order whole numbers to 100 000, decimal numbers to hundredths, proper and improper fractions, and mixed numbers;
• demonstrate an understanding of magnitude by counting forward and backwards by 0.01;
• solve problems involving the multiplication and division of multi-digit whole numbers, and involving the addition and subtraction of decimal numbers to hundredths, using a variety of strategies;
• demonstrate an understanding of proportional reasoning by investigating whole-number rates.
Measurement
• estimate, measure, and record perimeter, area, temperature change, and elapsed time, using a variety of strategies;
• determine the relationships among units and measurable attributes, including the area of a rectangle and the volume of a rectangular prism.
Geometry and Spatial Sense
• identify and classify two-dimensional shapes by side and angle properties, and compare and sort three-dimensional figures;
• identify and construct nets of prisms and pyramids;
• identify and describe the location of an object, using the cardinal directions, and translate two-dimensional shapes.
Patterning and Algebra
• determine, through investigation using a table of values, relationships in growing and shrinking patterns, and investigate repeating patterns involving translations;
• demonstrate, through investigation, an understanding of the use of variables in equations.
Data Management and Probability
• collect and organize discrete or continuous primary data and secondary data and display the data using charts and graphs, including broken-line graphs;
• read, describe, and interpret primary data and secondary data presented in charts and graphs, including broken-line graphs;
• represent as a fraction the probability that a specific outcome will occur in a simple probability experiment, using systematic lists and area models.
6
Number Sense and Numeration
• read, represent, compare, and order whole numbers to 1 000 000, decimal numbers to thousandths, proper and improper fractions, and mixed numbers;
• solve problems involving the multiplication and division of whole numbers, and the addition and subtraction of decimal numbers to thousandths, using a variety of strategies;
• demonstrate an understanding of relationships involving percent, ratio, and unit rate.
Measurement
• estimate, measure, and record quantities, using the metric measurement system;
• determine the relationships among units and measurable attributes, including the area of a parallelogram, the area of a triangle, and the volume of a triangular prism.
Geometry and Spatial Sense
• classify and construct polygons and angles;
• sketch three-dimensional figures, and construct three-dimensional figures from drawings;
• describe location in the first quadrant of a coordinate system, and rotate two-dimensional shapes.
Patterning and Algebra
• describe and represent relationships in growing and shrinking patterns (where the terms are whole numbers), and investigate repeating patterns involving rotations;
• use variables in simple algebraic expressions and equations to describe relationships.
Data Management and Probability
• collect and organize discrete or continuous primary data and secondary data and display the data using charts and graphs, including continuous line graphs;
• read, describe, and interpret data, and explain relationships between sets of data;
• determine the theoretical probability of an outcome in a probability experiment, and use it to predict the frequency of the outcome.
7
Number Sense and Numeration
• represent, compare, and order numbers, including integers;
• demonstrate an understanding of addition and subtraction of fractions and integers, and apply a variety of computational strategies to solve problems involving whole numbers and decimal numbers;
• demonstrate an understanding of proportional relationships using percent, ratio, and rate.
Measurement
• report on research into real-life applications of area measurements;
• determine the relationships among units and measurable attributes, including the area of a trapezoid and the volume of a right prism.
Geometry and Spatial Sense
• construct related lines, and classify triangles, quadrilaterals, and prisms;
• develop an understanding of similarity, and distinguish similarity and congruence;
• describe location in the four quadrants of a coordinate system, dilatate two-dimensional shapes, and apply transformations to create and analyze designs.
Patterning and Algebra
• represent linear growing patterns (where the terms are whole numbers) using concrete materials, graphs, and algebraic expressions;
• model real-life linear relationships graphically and algebraically, and solve simple algebraic equations using a variety of strategies, including inspection and guess and check.
Data Management and Probability
• collect and organize categorical, discrete, or continuous primary data and secondary data and display the data using charts and graphs, including relative frequency tables and circle graphs;
• make and evaluate convincing arguments, based on the analysis of data;
• compare experimental probabilities with the theoretical probability of an outcome involving two independent events.
8
Number Sense and Numeration
• represent, compare, and order equivalent representations of numbers, including those involving positive exponents;
• solve problems involving whole numbers, decimal numbers, fractions, and integers, using a variety of computational strategies;
• solve problems by using proportional reasoning in a variety of meaningful contexts.
Measurement
• research, describe, and report on applications of volume and capacity measurement;
• determine the relationships among units and measurable attributes, including the area of a circle and the volume of a cylinder.
Geometry and Spatial Sense
• demonstrate an understanding of the geometric properties of quadrilaterals and circles and the applications of geometric properties in the real world;
• develop geometric relationships involving lines, triangles, and polyhedra, and solve problems involving lines and triangles;
• represent transformations using the Cartesian coordinate plane, and make connections between transformations and the real world.
Patterning and Algebra
• represent linear growing patterns (where the terms are whole numbers) using graphs, algebraic expressions, and equations;
• model linear relationships graphically and algebraically, and solve and verify algebraic equations, using a variety of strategies, including inspection, guess and check, and using a "balance" model.
Data Management and Probability
• collect and organize categorical, discrete, or continuous primary data and secondary data and display the data using charts and graphs, including frequency tables with intervals, histograms, and scatter plots;
• apply a variety of data management tools and strategies to make convincing arguments about data;
• use probability models to make predictions about real-life events.

Appendix F

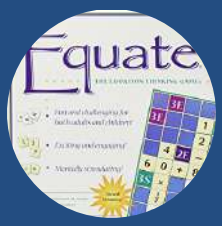
Math Games

Benefits of Building a Math Game Library for Use at Home

The advantages of using board games are well documented. These include:

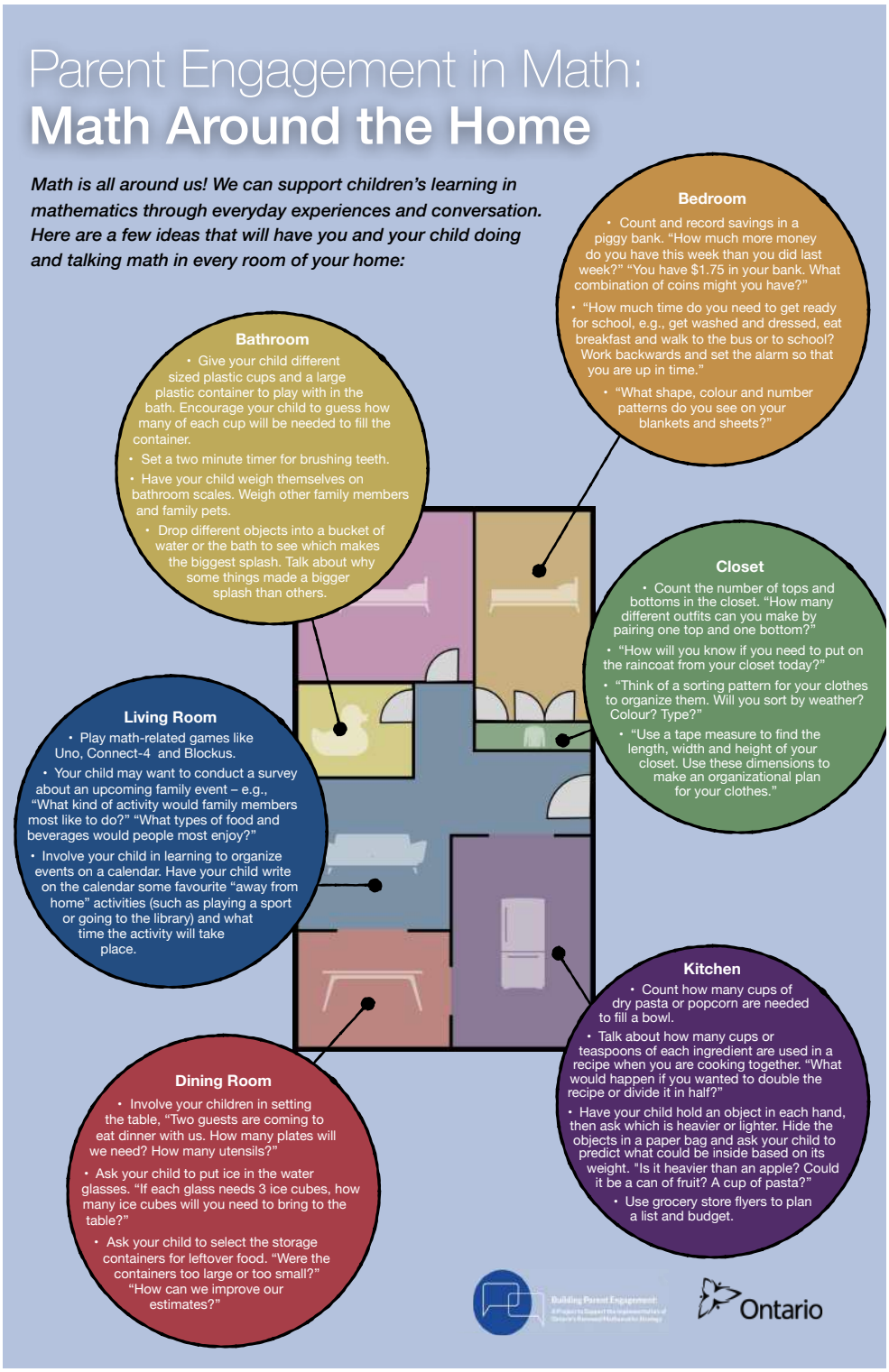
- Meaningful situations for the application of mathematical skills are created by games
- Motivation - children freely choose to participate and enjoy playing
- Positive attitude - Games provide opportunities for building self-concept and developing positive attitudes towards mathematics, through reducing the fear of failure and error
- Increased learning - in comparison to more formal activities, greater learning can occur through games due to the increased interaction between children, opportunities to test intuitive ideas and problem solving strategies
- Different levels - Games can allow children to operate at different levels of thinking and to learn from each other. In a group of children playing a game, one child might be encountering a concept for the first time, another may be developing his/her understanding of the concept, a third consolidating previously learned concepts
- Assessment - children's thinking often becomes apparent through the actions and decisions they make during a game, so it is possible to diagnose and assess learning in a non-threatening situation
- Independence - Children can work independently of the teacher. The rules of the game and the children's motivation usually keep them on task.

Few language barriers - an additional benefit becomes evident when children from non-english-speaking backgrounds are involved. The basic structures of some games are common to many cultures, and the procedures of simple games can be quickly learned through observation. Children who are reluctant to participate in other mathematical activities because of language barriers will often join in a game, and so gain access to the mathematical learning as well as engage in structured social interaction.



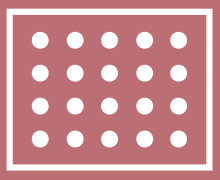
Ontario

Appendix G


Parent Engagement in Math:
Math Around the Home
Math is all around us! We can support children's learning in mathematics through everyday experiences and conversation. Here are a few ideas that will have you and your child doing and talking math in every room of your home:
Bedroom
• Count and record savings in a piggy bank. "How much more money do you have this week than you did last week?" "You have $1.75 in your bank. What combination of coins might you have?"
• "How much time do you need to get ready for school, e.g., get washed and dressed, eat breakfast and walk to the bus or to school? Work backwards and set the alarm so that you are up in time."
• "What shape, colour and number patterns do you see on your blankets and sheets?"
Bathroom
• Give your child different sized plastic cups and a large plastic container to play with in the bath. Encourage your child to guess how many of each cup will be needed to fill the container.
• Set a two minute timer for brushing teeth.
• Have your child weigh themselves on bathroom scales. Weigh other family members and family pets.
• Drop different objects into a bucket of water or the bath to see which makes the biggest splash. Talk about why some things made a bigger splash than others.
Closet
• Count the number of tops and bottoms in the closet. "How many different outfits can you make by pairing one top and one bottom?"
• "How will you know if you need to put on the raincoat from your closet today?"
• "Think of a sorting pattern for your clothes to organize them. Will you sort by weather? Colour? Type?"
• "Use a tape measure to find the length, width and height of your closet. Use these dimensions to make an organizational plan for your clothes."
Living Room
• Play math-related games like Uno, Connect-4 and Blockus.
• Your child may want to conduct a survey about an upcoming family event – e.g., "What kind of activity would family members most like to do?" "What types of food and beverages would people most enjoy?"
• Involve your child in learning to organize events on a calendar. Have your child write on the calendar some favourite "away from home" activities (such as playing a sport or going to the library) and what time the activity will take place.
Kitchen
• Count how many cups of dry pasta or popcorn are needed to fill a bowl.
• Talk about how many cups or teaspoons of each ingredient are used in a recipe when you are cooking together. "What would happen if you wanted to double the recipe or divide it in half?"
• Have your child hold an object in each hand, then ask which is heavier or lighter. Hide the objects in a paper bag and ask your child to predict what could be inside based on its weight. "Is it heavier than an apple? Could it be a can of fruit? A cup of pasta?"
• Use grocery store flyers to plan a list and budget.
Dining Room
• Involve your children in setting the table, "Two guests are coming to eat dinner with us. How many plates will we need? How many utensils?"
• Ask your child to put ice in the water glasses. "If each glass needs 3 ice cubes, how many ice cubes will you need to bring to the table?"
• Ask your child to select the storage containers for leftover food. "Were the containers too large or too small?" "How can we improve our estimates?"
Ontario

Appendix H

Parent Engagement in Math:
Math in the Garden



Many garden seeds need to be planted with some distance between them. Following the directions on a package of seeds, calculate how many seeds will fit across the length and width of your garden or a plot of gardening space. How many seeds will you need to fill the entire space?

Many beans, such as green beans or lima beans, grow very quickly. Try to estimate how many days it will take for the bean sprout to reach 10 centimetres and 20 centimetres. Using a ruler, measure how tall your bean sprout is each day and keep track of its growth using a chart. For an extra challenge, use your chart to create a graph showing your bean sprout's growth over time!

The Fibonacci sequence is a series of numbers where each number is the sum of the two before it. Here is the beginning of the sequence:

1, 1, 2, 3, 5, 8, 13, 21, 34...

The number of petals a flower has is often a number that occurs in this sequence. How many flowers can you find that fit this pattern?

When your tomatoes are ready to harvest, pick three that are different in size. Estimate, then measure the circumference of each tomato. Estimate the number of seeds in the first tomato. Next, cut the tomato in half and count the seeds to find the actual number of seeds. Continue with the other tomatoes. Use the information from the first tomato to help make your estimate for the next one. Does the size of a tomato help you estimate the number of seeds? How many tomato plants could you grow from just one tomato?

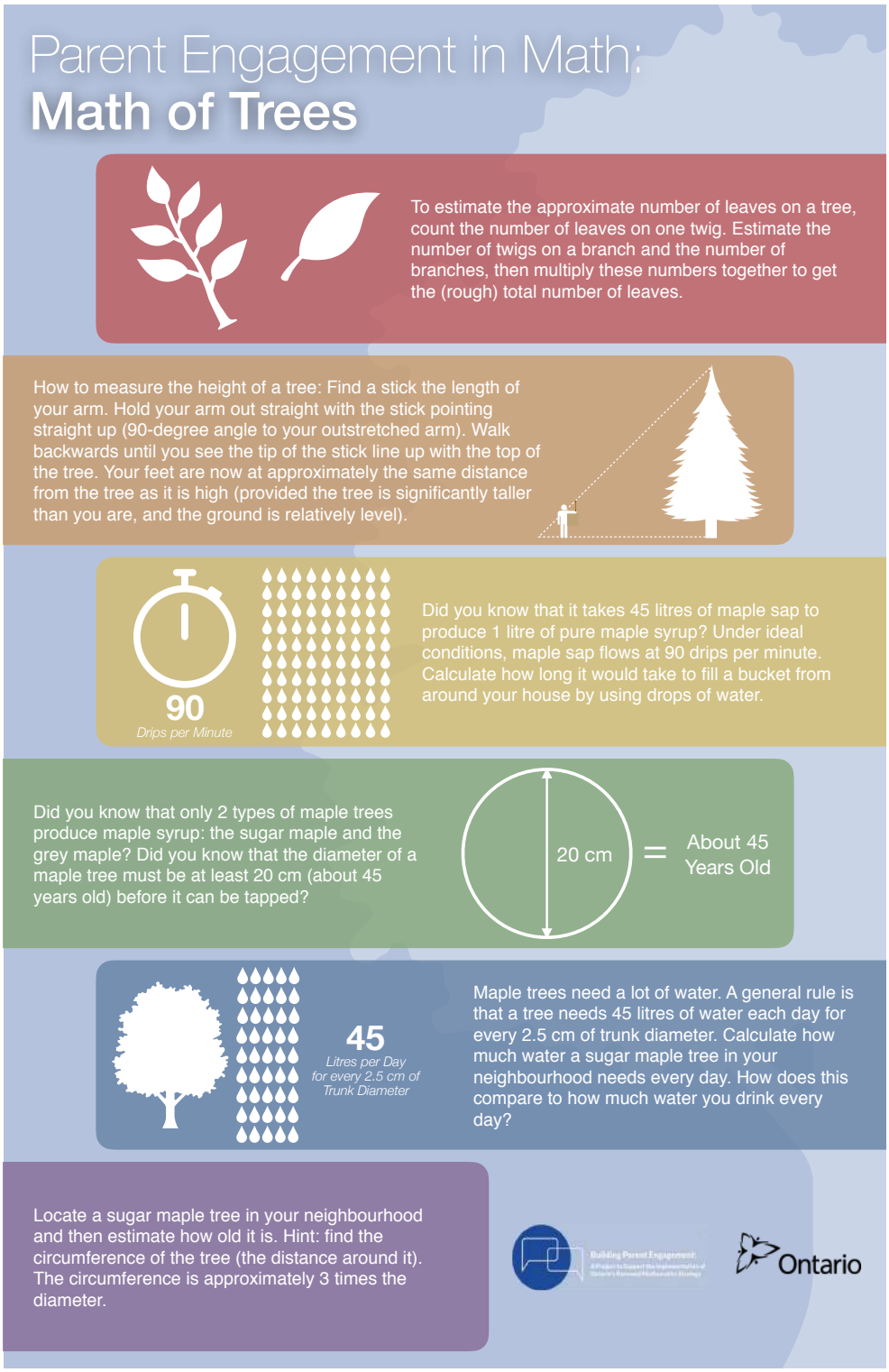
24m²

How many different rectangular-shaped gardens can be designed that have an area of 24m²? Are some shapes better than others? Why? Which garden would require the most fencing? The least fencing?

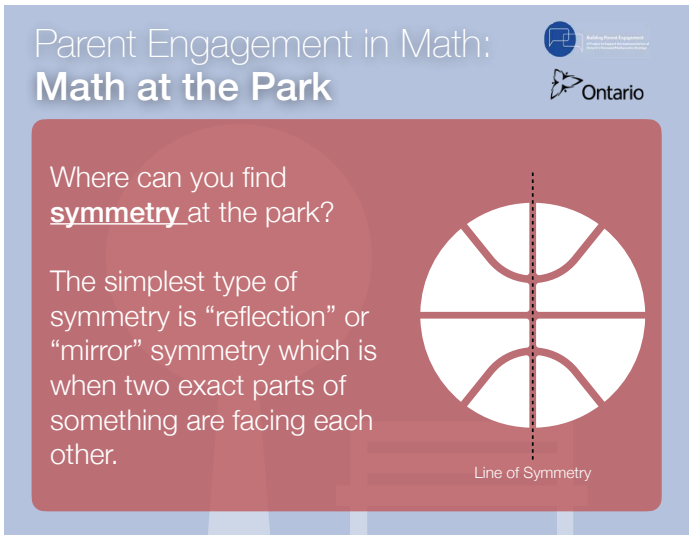
Make a bar graph of the different types of plants in your garden. How many different ways can your sort the plants into categories to create your bar graph? By colour? By number of petals? By type of flower?

Ontario

Appendix I


Parent Engagement in Math:
Math of Trees
To estimate the approximate number of leaves on a tree, count the number of leaves on one twig. Estimate the number of twigs on a branch and the number of branches, then multiply these numbers together to get the (rough) total number of leaves.
How to measure the height of a tree: Find a stick the length of your arm. Hold your arm out straight with the stick pointing straight up (90-degree angle to your outstretched arm). Walk backwards until you see the tip of the stick line up with the top of the tree. Your feet are now at approximately the same distance from the tree as it is high (provided the tree is significantly taller than you are, and the ground is relatively level).
90
Drips per Minute
Did you know that it takes 45 litres of maple sap to produce 1 litre of pure maple syrup? Under ideal conditions, maple sap flows at 90 drips per minute. Calculate how long it would take to fill a bucket from around your house by using drops of water.
Did you know that only 2 types of maple trees produce maple syrup: the sugar maple and the grey maple? Did you know that the diameter of a maple tree must be at least 20 cm (about 45 years old) before it can be tapped?
20 cm
=
About 45 Years Old
45
Litres per Day for every 2.5 cm of Trunk Diameter
Maple trees need a lot of water. A general rule is that a tree needs 45 litres of water each day for every 2.5 cm of trunk diameter. Calculate how much water a sugar maple tree in your neighbourhood needs every day. How does this compare to how much water you drink every day?
Locate a sugar maple tree in your neighbourhood and then estimate how old it is. Hint: find the circumference of the tree (the distance around it). The circumference is approximately 3 times the diameter.
Ontario

Appendix J


Parent Engagement in Math:
Math at the Park
Ontario
Where can you find symmetry at the park?
The simplest type of symmetry is “reflection” or “mirror” symmetry which is when two exact parts of something are facing each other.
Line of Symmetry

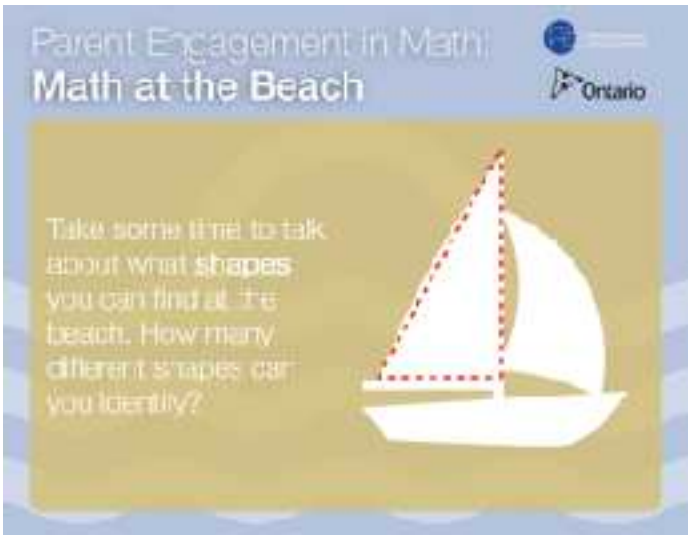

Parent Engagement in Math:
Math at the Park
Ontario
Count each swing you make on a swing set. How high can you count to?


Parent Engagement in Math:
Math at the Park
Ontario
Create a map of your local park using a grid.
Ask questions such as, “What would I find in this?”

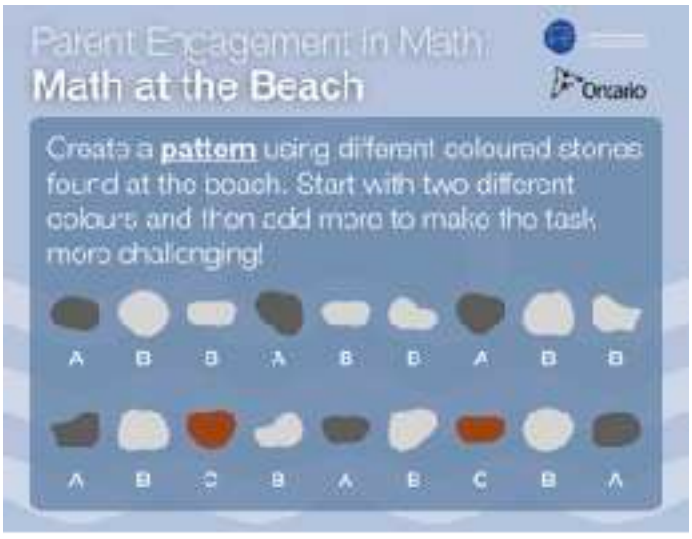

Parent Engagement in Math:
Math at the Park
Ontario
Collect natural materials, such as sticks, leaves, or pinecones, and sort them by size.

Appendix K


Parent Engagement in Math:
Math at the Beach
Ontario
Bring two or more different sizes of buckets to the beach. Estimate how many small buckets it will take to fill a large bucket. Then, use the small bucket to fill the large bucket with sand or water to see how close your estimate was!


Parent Engagement in Math:
Math at the Beach
Ontario
Take some time to talk about what shapes you can find at the beach. How many different shapes can you identify?


Parent Engagement in Math:
Math at the Beach
Ontario
Collect 20 seashells along the shoreline. Create a graph, in the sand or on paper, that shows how many of each type of shell you found.


Parent Engagement in Math:
Math at the Beach
Ontario
Create a pattern using different coloured stones found at the beach. Start with two different colours and then add more to make the task more challenging!
A B B A B B A B B
A B C B A B C B A

Appendix L

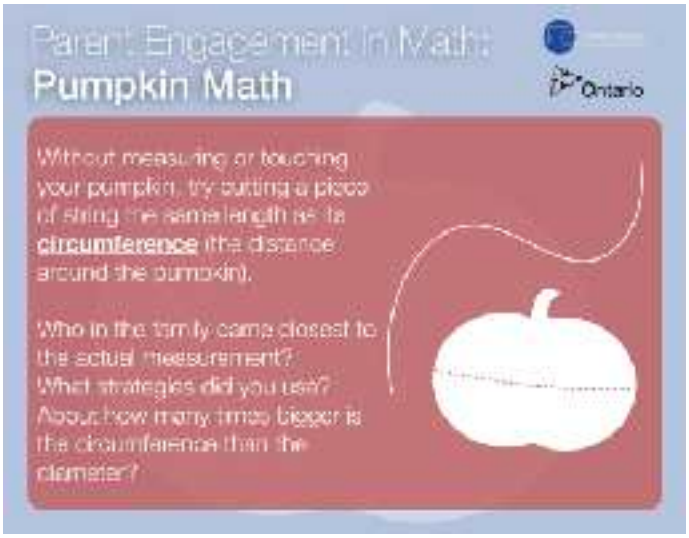

Parent Engagement in Math:
Math in the Fall
Ontario
Trying sorting leaves in a variety of different ways, such as by shape, colour, or size. How many of each type can you find? For an extra challenge, try making a graph of your findings.

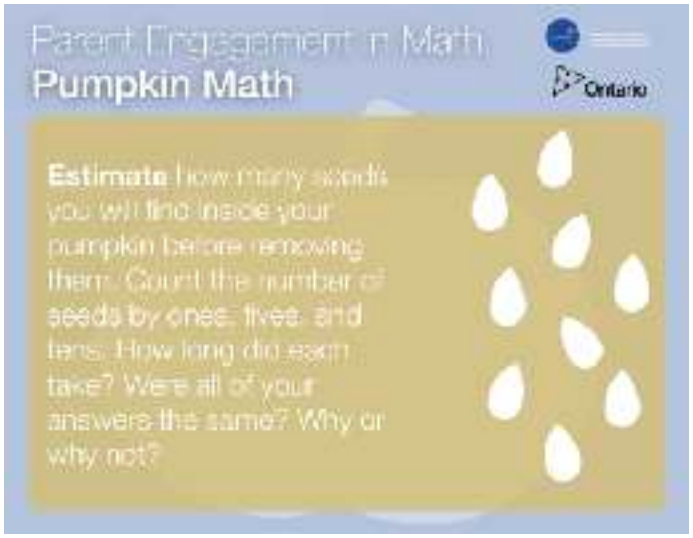

Parent Engagement in Math:
Math in the Fall
Ontario
Bring different sized containers to a local park. Estimate how many acorns will fit in each container and then fill the containers to test your predictions.

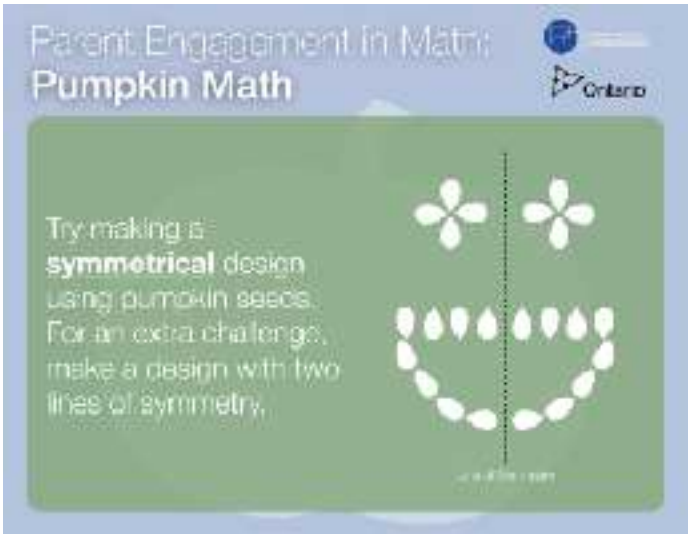

Parent Engagement in Math:
Math in the Fall
Ontario
Cut apples evenly into halves, thirds, and fourths to learn about the relationship between fractions and whole numbers while enjoying a healthy snack.

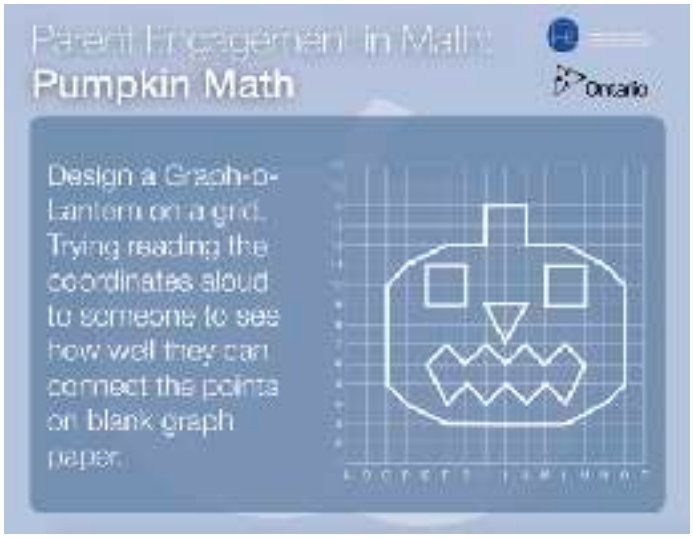

Parent Engagement in Math:
Math in the Fall
Ontario

Appendix M

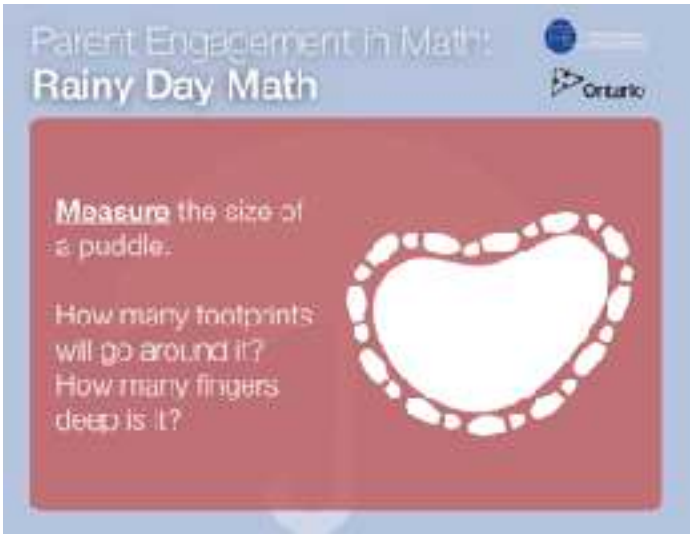

Parent Engagement in Math:
Pumpkin Math
Ontario
Without measuring or touching your pumpkin, try cutting a piece of string the same length as its circumference (the distance around the pumpkin).
Who in the family came closest to the actual measurement? What strategies did you use? About how many times bigger is the circumference than the diameter?


Parent Engagement in Math:
Pumpkin Math
Ontario
Estimate how many seeds you will find inside your pumpkin before removing them. Count the number of seeds by ones, fives, and tens. How long did each take? Were all of your answers the same? Why or why not?


Parent Engagement in Math:
Pumpkin Math
Ontario
Try making a symmetrical design using pumpkin seeds. For an extra challenge, make a design with two lines of symmetry.


Parent Engagement in Math:
Pumpkin Math
Ontario
Design a Graph-o-Lantern on a grid. Trying reading the coordinates aloud to someone to see how well they can connect the points on blank graph paper.

Appendix N

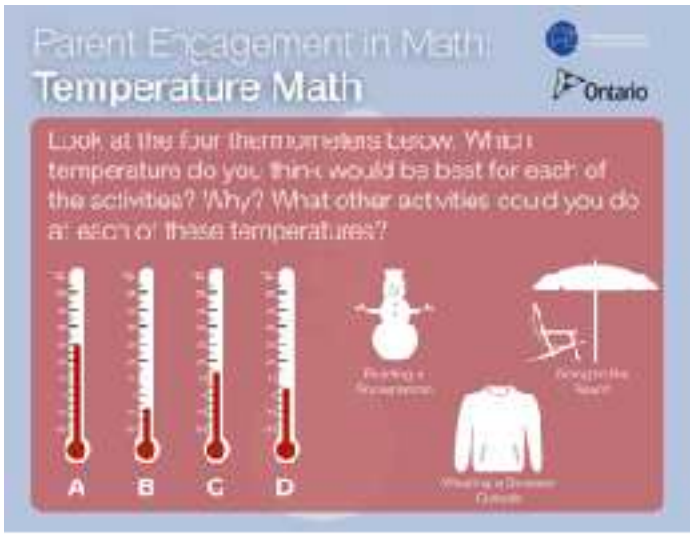

Parent Engagement in Math:
Rainy Day Math
Ontario
Measure the size of a puddle.
How many footprints will go around it? How many fingers deep is it?

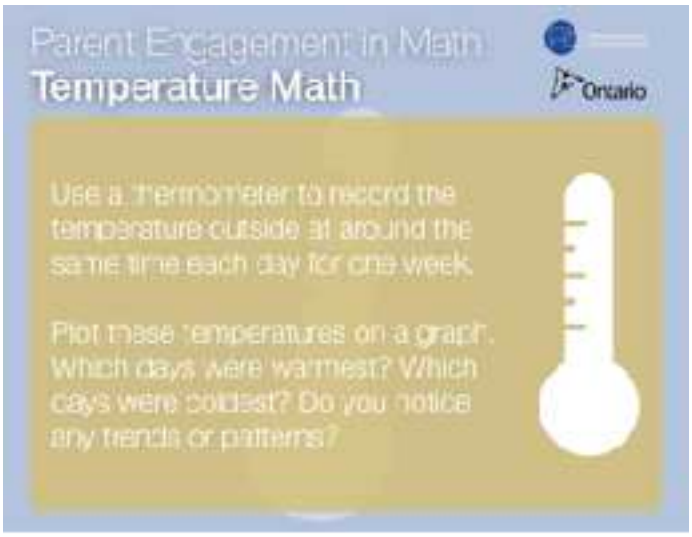

Parent Engagement in Math:
Rainy Day Math
Ontario
Calculate how much rain falls in one hour.
Collect rainwater in a container and measure using teaspoons.

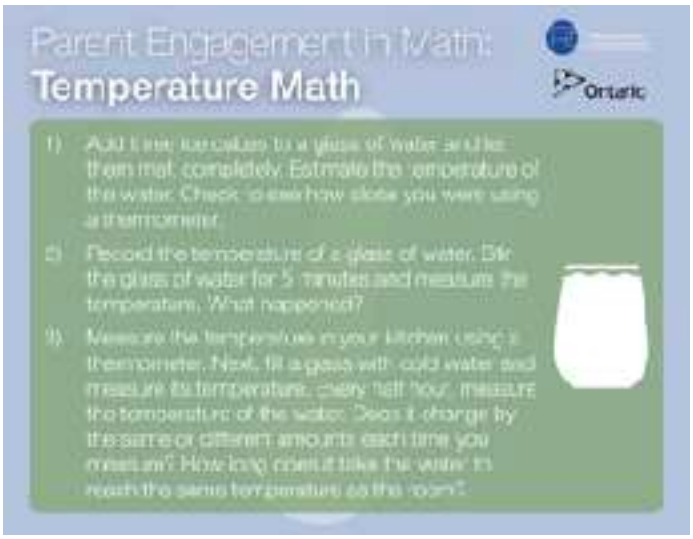

Parent Engagement in Math:
Rainy Day Math
Ontario
Use an eyedropper to count how many drops of water you can fit on different coins.

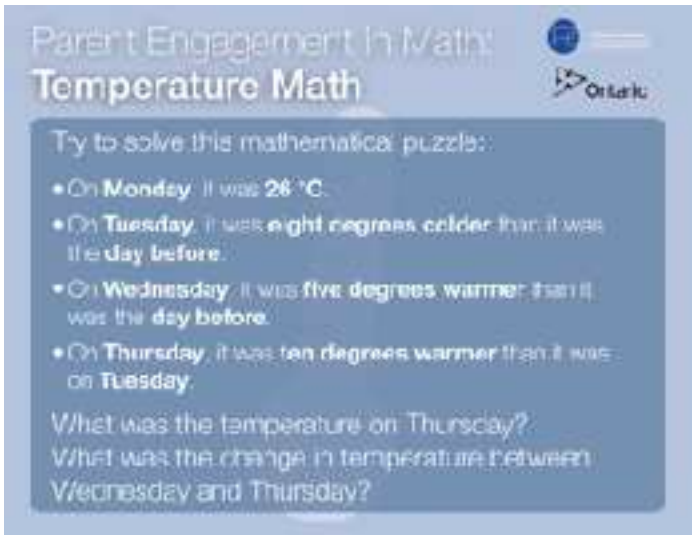

Parent Engagement in Math:
Rainy Day Math
Ontario
Calculate your distance from a lightning strike. Every three seconds between lightning and thunder means the lightning is approximately one kilometre away. Use a timer, or do your best to count accurately!
6 seconds
÷ 3 =
2 kilometres

Appendix O

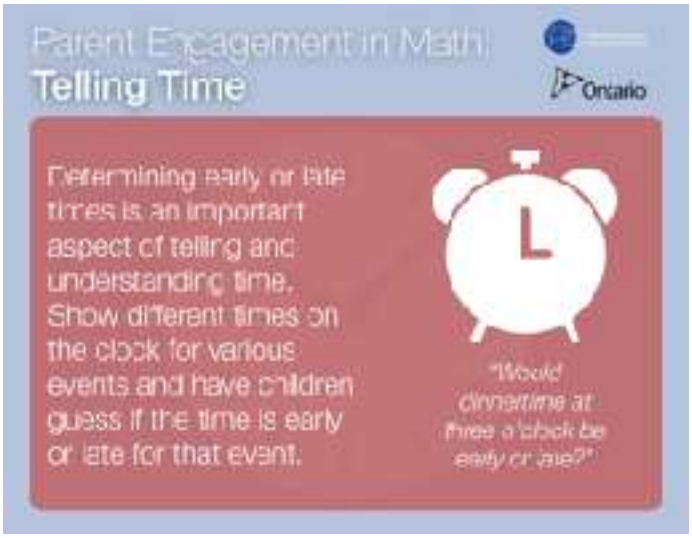

Parent Engagement in Math:
Temperature Math
Ontario
Look at the four thermometers below. Which temperature do you think would be best for each of the activities? Why? What other activities could you do at each of these temperatures?
A
B
C
D

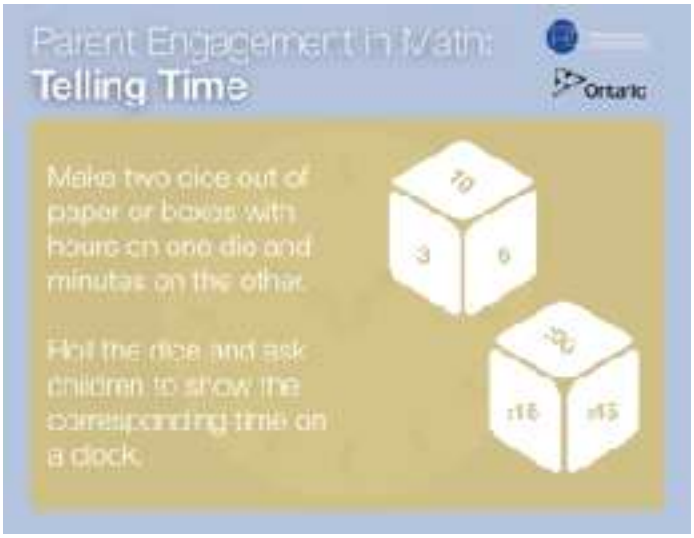

Parent Engagement in Math:
Temperature Math
Ontario
Use a thermometer to record the temperature outside at around the same time each day for one week.
Plot these temperatures on a graph. Which days were warmest? Which days were coldest? Do you notice any trends or patterns?


Parent Engagement in Math:
Temperature Math
Ontario

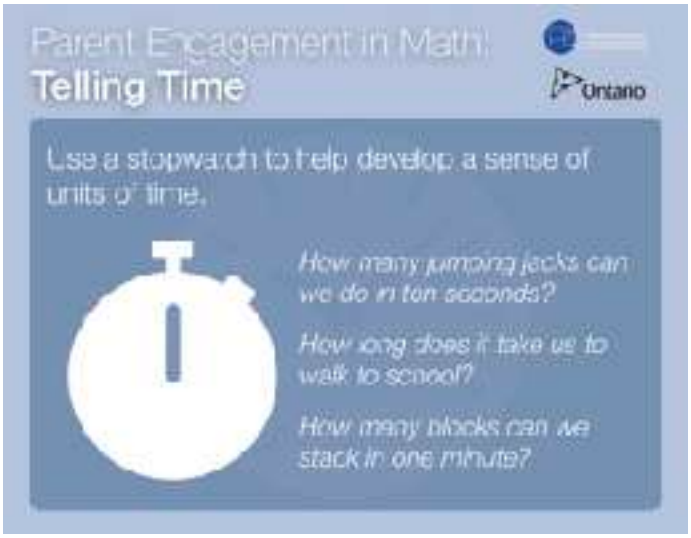

Parent Engagement in Math:
Temperature Math
Ontario
Try to solve this mathematical puzzle:
• On Monday, it was 26 °C.
• On Tuesday, it was eight degrees colder than it was the day before.
• On Wednesday, it was five degrees warmer than it was the day before.
• On Thursday, it was ten degrees warmer than it was on Tuesday.
What was the temperature on Thursday?
What was the change in temperature between Wednesday and Thursday?

Appendix P

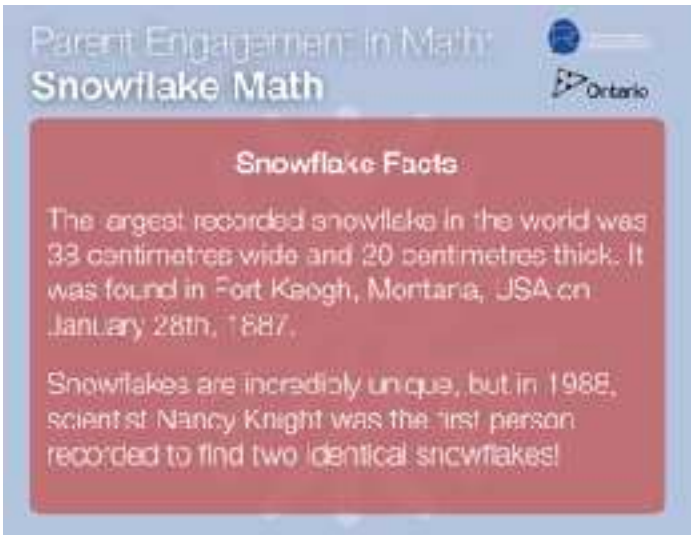

Parent Engagement in Math:
Telling Time
Ontario
Determining early or late times is an important aspect of telling and understanding time. Show different times on the clock for various events and have children guess if the time is early or late for that event.
"Would dinnertime at three o'clock be early or late?"


Parent Engagement in Math:
Telling Time
Ontario
Make two dice out of paper or boxes with hours on one die and minutes on the other.
Roll the dice and ask children to show the corresponding time on a clock.


Parent Engagement in Math:
Telling Time
Ontario
Ask children what time it would be when the hour hand and minute hand are in certain locations.
The hour hand is on three. The minute hand is on six. What time is it?

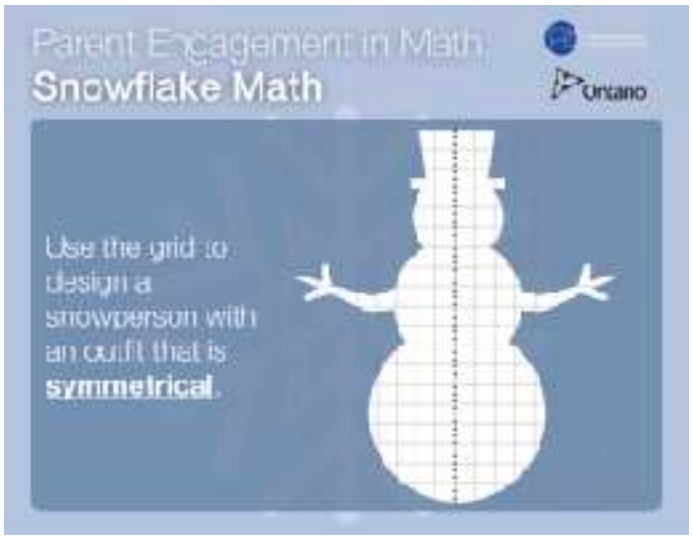

Parent Engagement in Math:
Telling Time
Ontario
Use a stopwatch to help develop a sense of units of time.
How many jumping jacks can we do in ten seconds?
How long does it take us to walk to school?
How many blocks can we stack in one minute?

Appendix Q

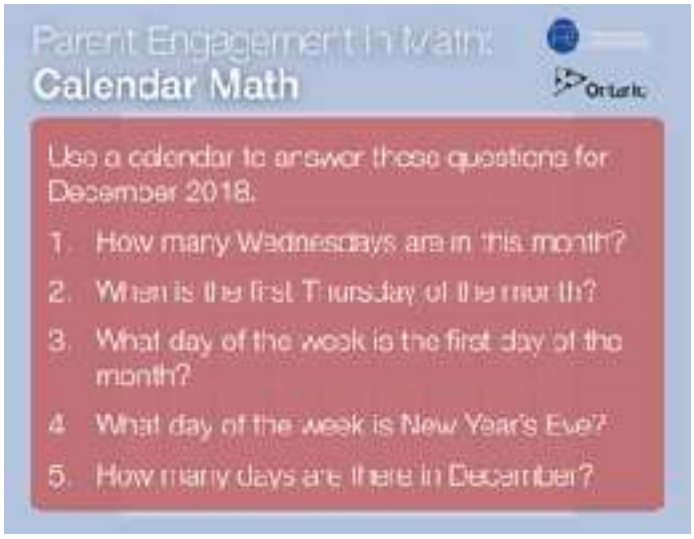

Parent Engagement in Math:
Snowflake Math
Ontario
Snowflake Facts
The largest recorded snowflake in the world was 38 centimetres wide and 20 centimetres thick. It was found in Fort Keogh, Montana, USA on January 28th, 1887.
Snowflakes are incredibly unique, but in 1988, scientist Nancy Knight was the first person recorded to find two identical snowflakes!

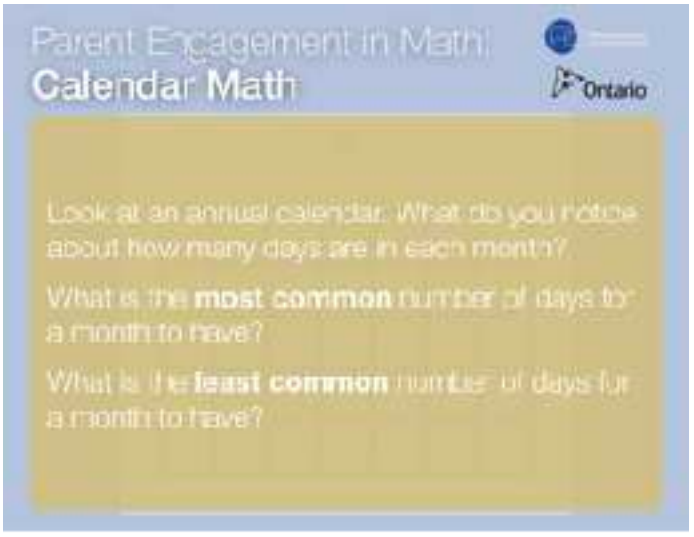

Parent Engagement in Math:
Snowflake Math
Ontario
Try to identify lines of symmetry on paper snowflakes (or real snowflakes using a magnifying glass outside!). How many lines of symmetry do you notice?

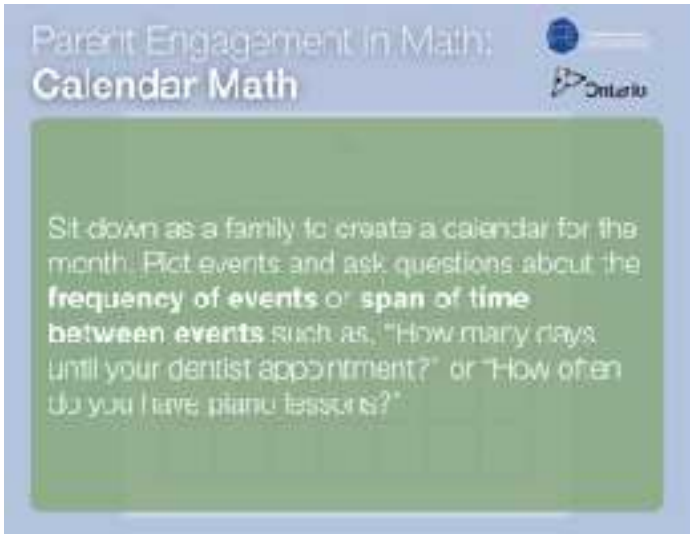

Parent Engagement in Math:
Snowflake Math
Ontario
Place an empty bucket outside to collect snow. Use a ruler to track how much snow falls in one day. Empty the bucket and repeat! How can you track and display this information?

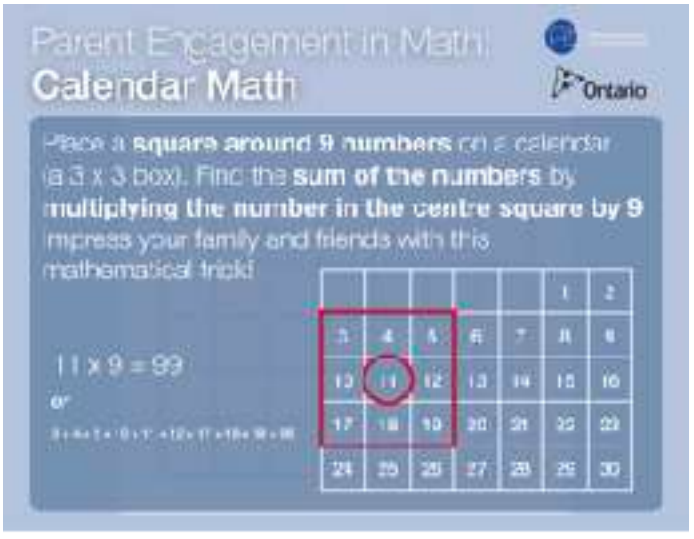

Parent Engagement in Math:
Snowflake Math
Ontario
Use the grid to design a snowperson with an outfit that is symmetrical.

Appendix R


Parent Engagement in Math:
Calendar Math
Ontario
Use a calendar to answer these questions for December 2018.
1. How many Wednesdays are in this month?
2. When is the first Thursday of the month?
3. What day of the week is the first day of the month?
4. What day of the week is New Year's Eve?
5. How many days are there in December?

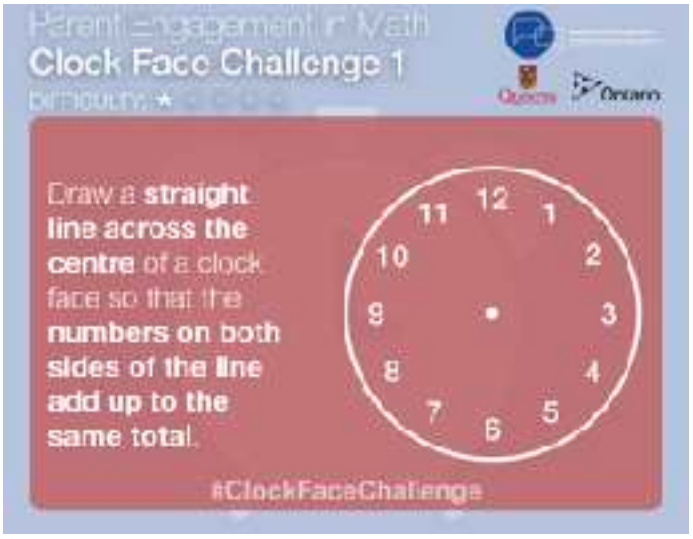

Parent Engagement in Math:
Calendar Math
Ontario
Look at an annual calendar. What do you notice about how many days are in each month?
What is the most common number of days for a month to have?
What is the least common number of days for a month to have?


Parent Engagement in Math:
Calendar Math
Ontario
Sit down as a family to create a calendar for the month. Plot events and ask questions about the frequency of events or span of time between events such as, "How many days until your dentist appointment?" or "How often do you have piano lessons?"


Parent Engagement in Math:
Calendar Math
Ontario
Place a square around 9 numbers on a calendar (a 3 x 3 box). Find the sum of the numbers by multiplying the number in the centre square by 9
Impress your family and friends with this mathematical trick!
11 x 9 = 99
or

Appendix S


Parent Engagement in Math
Clock Face Challenge
Queens
Ontario


Parent Engagement in Math
Clock Face Challenge 1
Queens
Ontario
Draw a straight line across the centre of a clock face so that the numbers on both sides of the line add up to the same total.
#ClockFaceChallenge

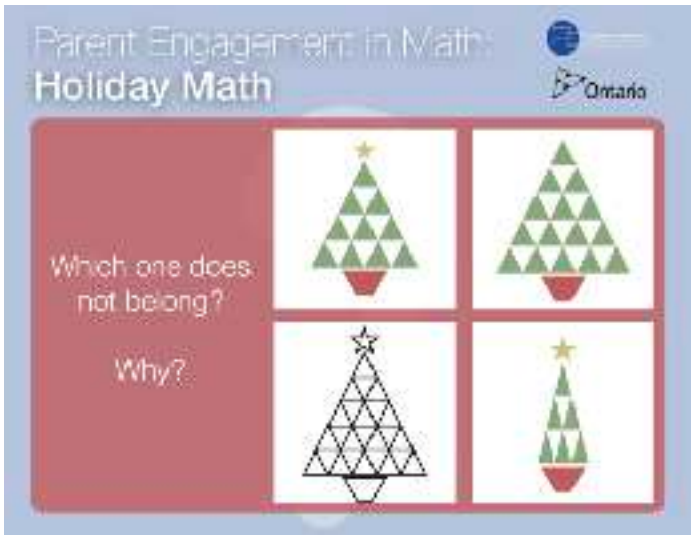

Parent Engagement in Math
Clock Face Challenge 2
Queens
Ontario
Draw two lines like the hands of the clock to divide the clock face so that the total of the numbers on one side of the lines is twice the total on the other side. Can you do this in another way?
#ClockFaceChallenge

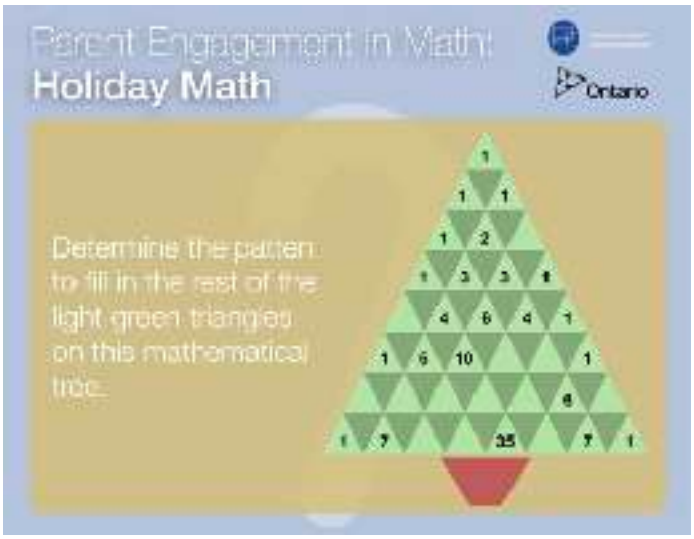

Parent Engagement in Math
Clock Face Challenge 3
Queens
Ontario
Draw two straight lines anywhere on the clock face to split it into three parts so that the sums of the numbers in each of the parts are equal.
#ClockFaceChallenge


Parent Engagement in Math
Clock Face Challenge 4
Queens
Ontario
Draw five straight or curved lines anywhere on the clock face to divide it into six parts so that in each part there are two numbers that add up to the same number.
#ClockFaceChallenge

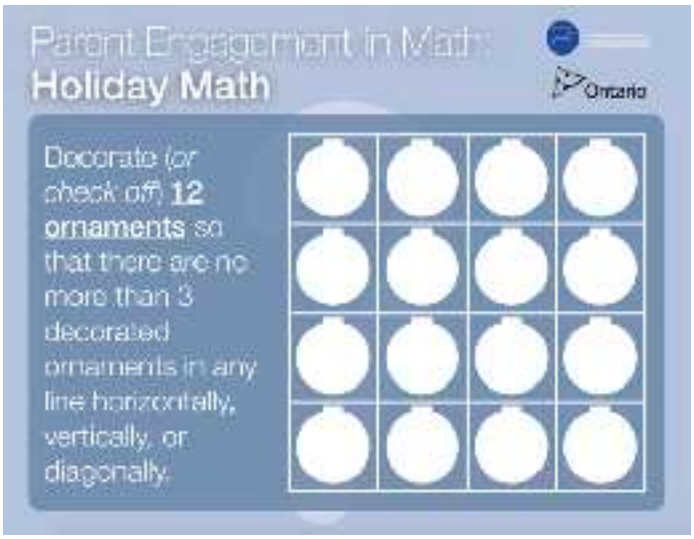

Answer Key

Appendix T


Parent Engagement in Math:
Holiday Math
Ontario
Which one does not belong?
Why?


Parent Engagement in Math:
Holiday Math
Ontario
Determine the pattern to fill in the rest of the light green triangles on this mathematical tree.


Parent Engagement in Math:
Holiday Math
Ontario
An elf wears a hat, sweater, pants, and matching pair of boots each day. If an elf wants to wear a different combination of items for as many days as possible, how many days could this fun last?


Parent Engagement in Math:
Holiday Math
Ontario
Decorate (or check off) 12 ornaments so that there are no more than 3 decorated ornaments in any line horizontally, vertically, or diagonally.

Appendix U


Math Games
Ontario
Addition Mind Reader
Players:
Materials:
Instructions:
Notes:


Math Games
Ontario


Math Games
Ontario
Let's Roll to 100!
Players:
Materials:
Instructions:
Notes:

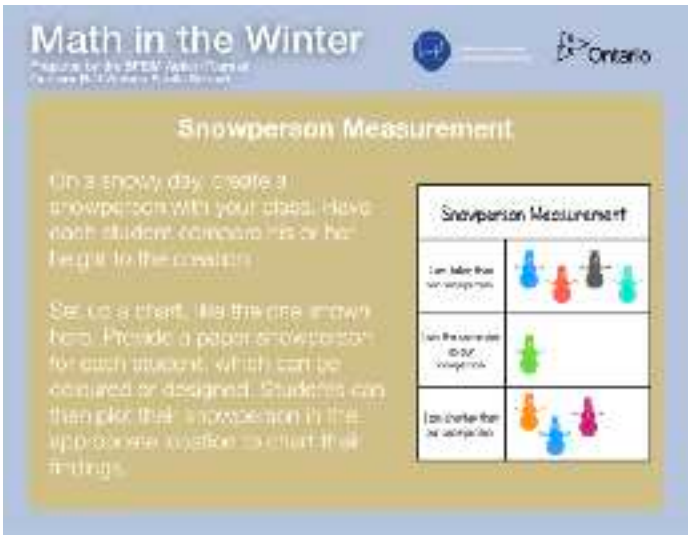

Math Games
Ontario


Math Games
Ontario
Make 12
Players:
Materials:
Instructions:

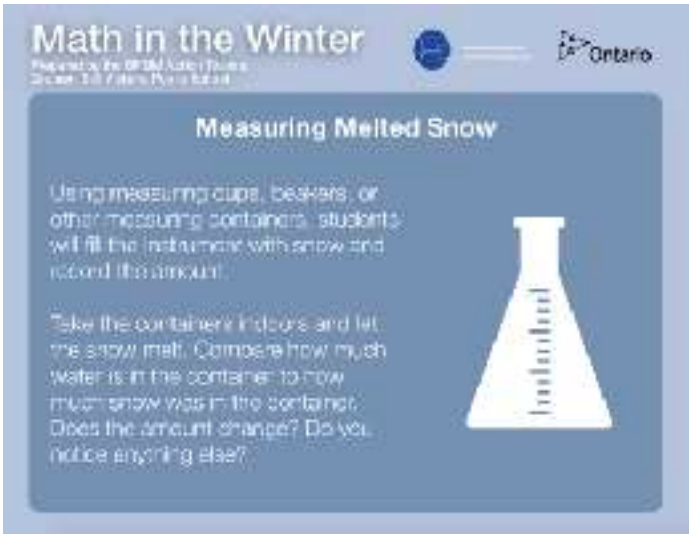

Math Games
Ontario

Appendix V

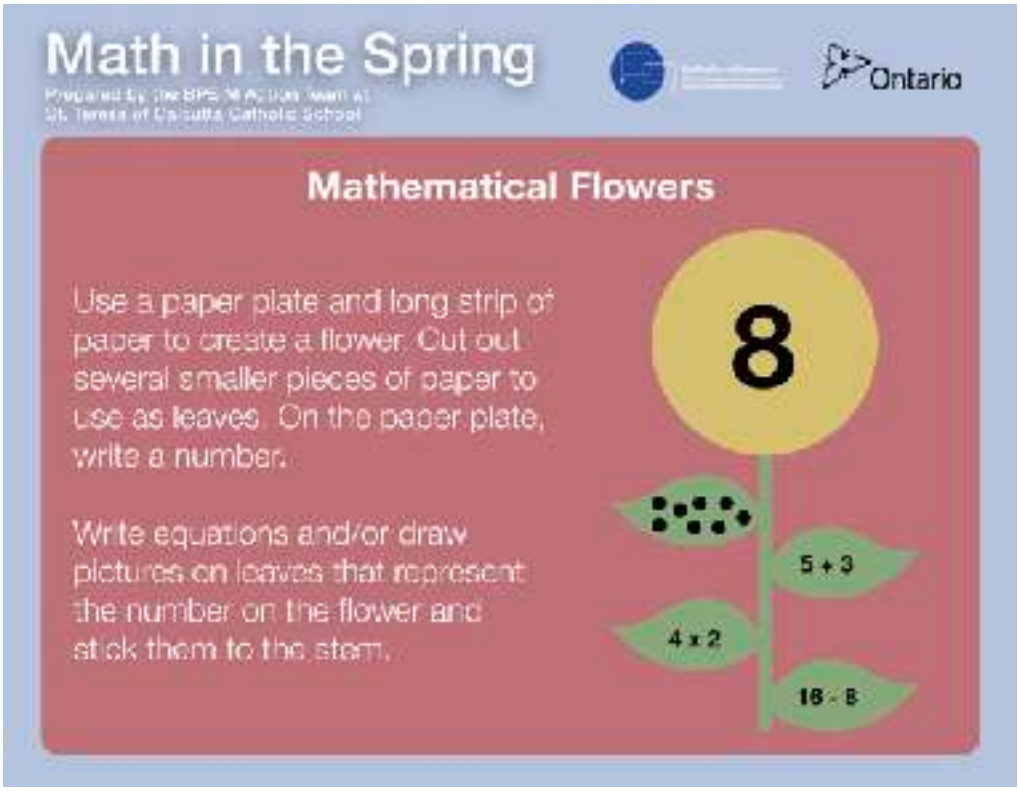

Math in the Winter
Ontario
Snowflakes on Mittens
Cut out 10 or more mittens from different coloured construction paper, and a large number of smaller snowflakes from plain white paper. Label each mitten a different number from one to the number of mittens you have.
Have students match the correct number of snowflakes to each mitten, or vice versa.
3
1

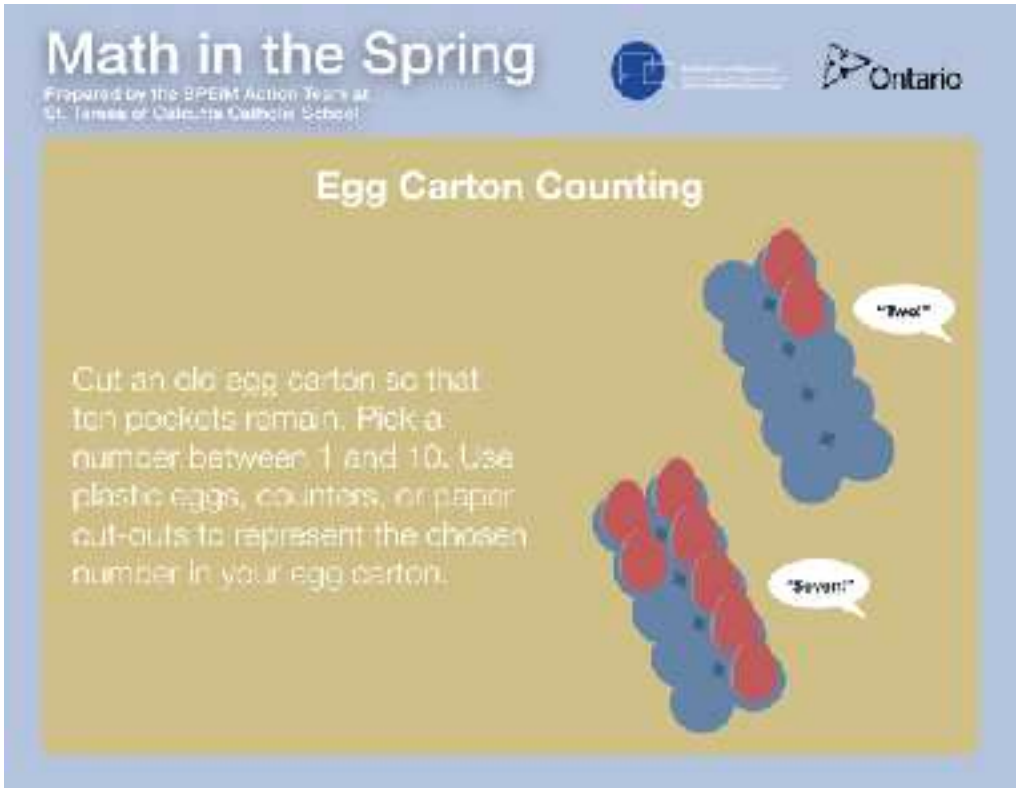

Math in the Winter
Ontario
Snowperson Measurement
On a snowy day, create a snowperson with your class. Have each student contribute his or her legs to the creation.
Set up a chart, like the one shown here. Provide a paper snowperson for each student, which can be coloured or designed. Students can then plot their snowperson in the appropriate location to chart their findings.
Snowperson Measurement


Math in the Winter
Ontario
Help Build Frosty
Have a number of paper snowpeople created with each one being built from four circles. The circles can represent the following:
• The head
• A number in percentage form
• The same number in decimal form
• The same number in fractional form
Students will build snowpeople using the circles with all pieces used in the body representing the same amount.
75%
0.75
3/4

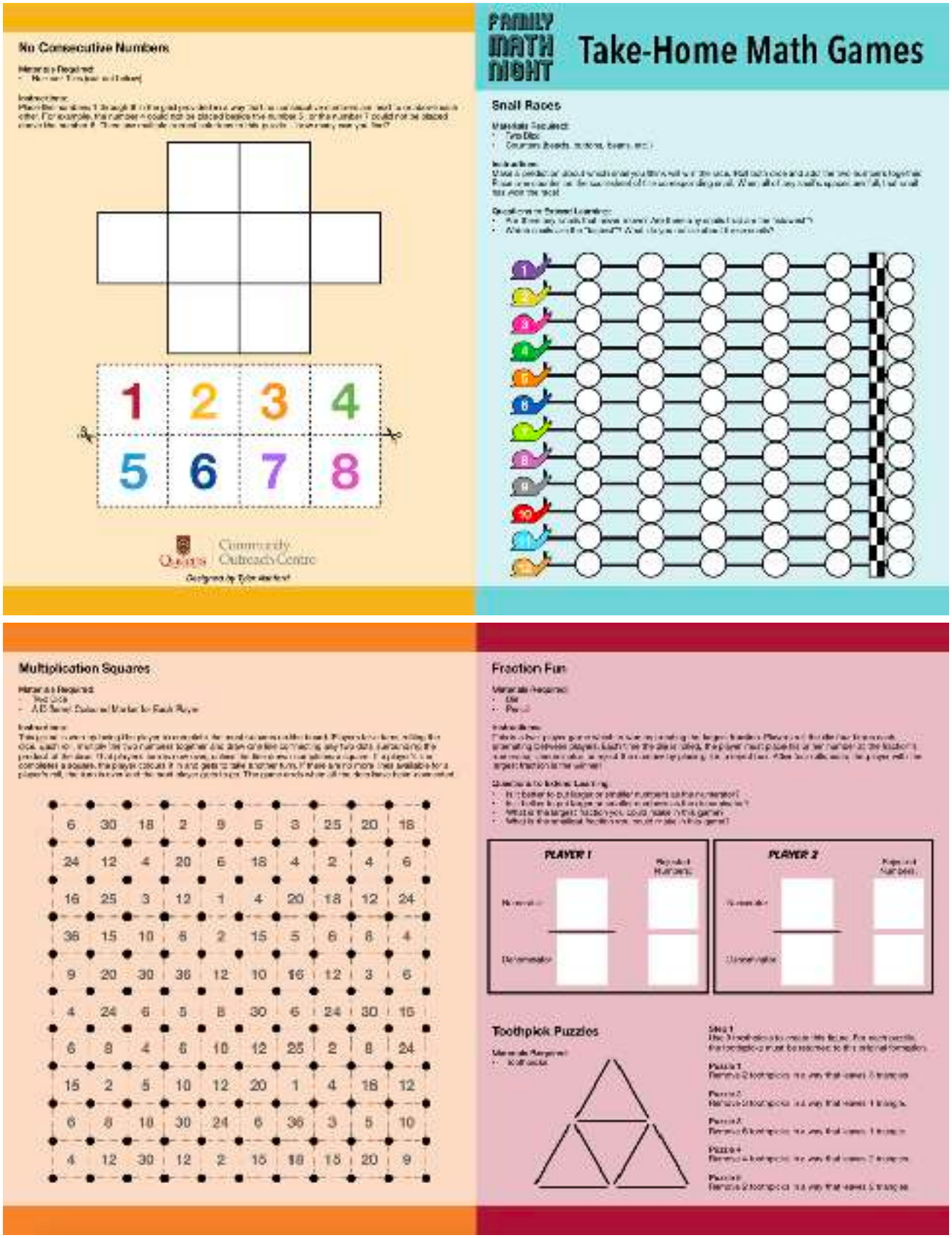

Math in the Winter
Ontario
Measuring Melted Snow
Using measuring cups, beakers, or other measuring containers, students will fill the instrument with snow and record the amount.
Take the containers indoors and let the snow melt. Compare how much water is in the container to how much snow was in the container. Does the amount change? Do you notice anything else?

Appendix W


Math in the Spring
Ontario
Mathematical Flowers
Use a paper plate and long strip of paper to create a flower. Cut out several smaller pieces of paper to use as leaves. On the paper plate, write a number.
Write equations and/or draw pictures on leaves that represent the number on the flower and stick them to the stem.
8
5 + 3
4 x 2
18 - 8


Math in the Spring
Ontario
Egg Carton Counting
Cut an old egg carton so that ten pockets remain. Pick a number between 1 and 10. Use plastic eggs, counters, or paper cut-outs to represent the chosen number in your egg carton.
"Seven!"

Appendix X


No Consecutive Numbers
1 2 3 4
5 6 7 8
Queen's Community Outreach Centre
FAMILY MATH NIGHT
Take-Home Math Games
Snail Races
Multiplication Squares
6 30 18 2 9 5 3 25 20 18
24 12 4 20 6 18 4 2 4 6
16 25 3 12 1 4 20 18 12 24
36 15 10 6 2 15 5 6 8 4
9 20 30 36 12 10 16 12 3 6
4 24 6 5 8 30 6 24 30 15
6 8 4 6 10 12 25 2 8 24
15 2 5 10 12 20 1 4 18 12
6 8 10 30 24 6 36 3 5 10
4 12 30 12 2 15 18 15 20 9
Fraction Fun
PLAYER 1
PLAYER 2
Toothpick Puzzles