Date	Time/Duration	Event	Title	Organizer
Thursday, January 28	11am EST/2hr	Workshop	Writing Workshop with Barbara Sarnecka	MCLS Training Board
Tuesday, February 2	9am EST/1hr	Symposium	The nature of mathematical difficulties: Implications for education and intervention	Ann Dowker
Thursday, February 11	11am EST/1hr	Symposium	Understanding of mathematical equivalence in elementary and middle school: Predictors and implications	Caroline Hornburg
Tuesday, February 16	6pm EST/1hr	Symposium	Longitudinal relations between executive functioning and math learning	Nancy Jordan
Thursday, February 25	11am EST/2hr	Workshop	Online Experiments with Children	MCLS Training Board
Tuesday, March 2	9am EST/1hr	Symposium	Children's math engagement: Exploring cognitive, contextual, and family influences	Mary DePascale
Thursday, March 11	11am EST/1hr	Symposium	Insights into predictors and correlates of proportional reasoning	Elien Vanluydt
Tuesday, March 16	9am EST/1hr	Symposium	Cross-representational knowledge: Connecting fractions and decimals	David Braithwaite
Thursday, March 25	6pm EST/1hr	Symposium	Principle knowledge in mathematics: Its development, cognitive predictors, and potential interventions	Terry Wong
Tuesday, March 30	9am EST/2hr	Workshop	Panel Discussion on the Academic Job Market	MCLS Training Board
Tuesday, April 13	9am EST/1hr	Symposium	Spontaneous mathematical focusing tendencies and the development of early mathematical skills	Jake McMullen
Thursday, April 22	11am EST/1hr	Symposium	Alternative models of the Approximate Number System	Attila Krajcsi
Tuesday, April 27	9am EST/2hr	Workshop	TBA	MCLS Training Board

Thursday, January 28
11am EST / 2hr
Writing Workshop with Barbara Sarnecka

Tuesday, February 2
9am EST/1hr
The nature of mathematical difficulties: Implications for education and intervention

Presenters
Ann Dowker, Oxford University, England
Elien Bellon, KU Leuven, Belgium
Flavia Santos, Dublin University, Ireland
Tuire Koponen, University of Jyväskylä, Finland

Mathematical difficulties are common. Severe specific difficulties with number and arithmetic, which are sometimes described as 'developmental dyscalculia', are estimated to occur in about 6% of the population. A far larger number have less severe or less specific difficulties, which nevertheless have serious impacts on them. It is important to understand mathematical difficulties if we are to gain a better knowledge of how to prevent or ameliorate them.

In this symposium, two talks will focus on the nature, characteristics and predictors of mathematical ability and difficulties; one will focus on intervention and one will focus on both.

Ann Dowker compared children classed by their teachers with mathematical difficulties with unselected children. They were given two standardized arithmetic tests, and also a test of both addition calculation and use of derived fact strategies. Performance on addition calculation and selection for mathematical difficulties had independent effects on the standardized arithmetic tests. Addition performance level influenced derived fact strategy use, but there was no independent effect of selection for mathematical difficulties. This may mean either that derived fact strategy use is dependent on arithmetical ability but not a specific feature of mathematical difficulties, or that it is insufficiently considered when teachers and others assess children as having mathematical difficulties.

Elien Bellon and colleagues. used a panel longitudinal design to investigate arithmetic achievement, mathematics anxiety and metacognitive monitoring skills in 127 second graders (7-8-year-olds) and followed them up one year later (in third grade). This enabled a fine-grained analysis of the concurrent and longitudinal relationships between arithmetic, mathematics anxiety and metacognitive monitoring, giving some insights into the origins of mathematical abilities and difficulties.

Flavia Santos and colleagues will talk about one intervention that has been used with both typically developing and dyscalculic children: the Calcularis adaptive software., devised by Karin Kucian and colleagues. It has been previously found to improve aspects of mathematics after 24 sessions. A Randomised Controlled Trial allocated 66 children between 8 and 10, with a diagnosis of developmental dyscalculia, to three groups: a Calcularis group; a group with similar but non-adaptive software and a business-as-usual group. The intervention groups attended 20 training sessions in small groups at schools. Seven weeks after training, the Calcularis group performed better than the controls on a variety of number tasks, indicating that a shorter protocol than the original one boosted math's performance in children with developmental dyscalculia.

Even highly effective interventions are usually found to be more effective with some children than others. Tuire Koponen has investigated the factors involved in dysfluency in arithmetic and responsiveness to fluency interventions. She here reviews findings from findings of several longitudinal studies examining numerical and non-numerical cognitive predictors of arithmetic fluency/dysfluency, and of responsiveness to interventions to improve fluency.

Thus, the symposium addresses the factors involved in arithmetical difficulties, and how this knowledge may be used to develop interventions that will be maximally effective.

Thursday, February 11
11am EST / 1hr
Understanding of mathematical equivalence in elementary and middle school: Predictors and implications

Presenters
Emine Simsek, Loughborough University, England
Elizabeth Wakefield, Loyola University Chicago, USA
Caroline Hornburg, Virginia Tech, USA

Mathematical equivalence, or the relation between two quantities that are equal and interchangeable, is considered a foundational concept in mathematics (Charles, 2005; Kieran, 1981). Unfortunately, many elementary school children struggle to understand this concept. Children's understanding of mathematical equivalence in symbolic form (e.g., 3 + 4 =__+ 2) has been identified as a key predictor of later mathematics achievement (McNeil, Hornburg, Devlin, Carrazza, & McKeever, 2019) and algebra readiness (Devlin, Hornburg, & McNeil, 2019; Matthews & Fuchs, 2020). The field has made substantial progress in understanding why children struggle to understand mathematical equivalence, specifically, that it is due in part to the way arithmetic is traditionally taught (e.g., a + b = __). However, many questions remain unanswered. This symposium takes a broad approach, examining avenues spanning from predictors of children's understanding of equivalence to the consequences of having a conceptual understanding. Four talks are presented by scholars from across the globe.

In the first presentation, Emine Simsek (Postdoctoral Researcher, Loughborough University) will report results from a large cross-cultural study investigating the role of classroom-level factors (teacher knowledge and textbooks) on children's understanding of equivalence. Simsek and colleagues found that teachers' knowledge of relational strategies related to students' understanding of equivalence, but knowledge of operational strategies and textbooks did not, challenging previous theories.

The second and third presentations will focus on interventions to improve children's understanding of equivalence. In the second presentation, Elizabeth Wakefield (Assistant Professor, Loyola University Chicago) will describe two studies conducted with third and fourth graders aimed at understanding the role of individual differences in how children benefit from instruction that incorporates action on manipulatives or co-speech gestures. Wakefield and colleagues found that children with higher prior knowledge benefitted similarly from any instruction; however, children with lower prior knowledge benefitted more from concrete instruction using actions on manipulatives than gesture instruction. In the third presentation, Erin Ottmar (Assistant Professor, Worcester Polytechnic Institute) will present results from a randomized control trial in which middle school students solved equations either using the digital game "From Here to There!" in which they could dynamically transform expressions, or an online problem set control with hints and immediate feedback. Ottmar and colleagues found that students in the dynamic game condition demonstrated better conceptual understanding of equivalence than those in the control condition.

In the final presentation, Caroline Hornburg (Assistant Professor, Virginia Tech) will discuss findings from a study examining children's understanding of equivalence in concrete form (e.g., story problems, block problems) as well as in symbolic form. Hornburg and colleagues found that second graders' concrete understanding of equivalence uniquely predicted both algebra readiness in middle school and mathematics achievement in fifth grade. Furthermore, models including symbolic understanding of equivalence as another predictor revealed that both concrete and symbolic understanding contributed unique variance. Overall, this symposium furthers our understanding of the factors related to children's understanding of mathematical equivalence and has potential implications for teachers' incorporation of equivalence content into elementary mathematics lessons.

Tuesday, February 16
6pm EST / 1hr
Longitudinal relations between executive functioning and math learning

Presenters
Haobai Zhang, University of Delaware, USA
Dana Miller-Cotto, University of Delaware, USA
Andrew Ribner, University of Pittsburgh, USA
Ee Lynn NG, National Institute of Education, Singapore

Symposium Organizer: Nancy C. Jordan, University of Delaware

This symposium brings together researchers who are examining longitudinal relations between cognitive and mathematical abilities, with a particular emphasis on executive functions (EF). Many studies suggest EF and mathematical abilities are strongly associated during the school years, yet the direction and pattern of these relations at various stages of development are not always clear. Longitudinal research is necessary to uncover potential unidirectional and bidirectional relations and patterns of development over multiple years (Peng & Kievet, 2020)

All of the presentations make use of large nationally representative data sets with multiple time points: the publicly available Early Childhood Longitudinal Study (ECLS-K:2011) in the U.S. and Singapore Kindergarten Impact Project (SKIP). Such data sets provide unique opportunities to examine directional relationships during the elementary school years and to examine the influence of individual and group differences.

The first three presentations use the ECLS-K data set. Over 18,000 children participated starting in kindergarten and to date data have been followed through 5th grade. EF was directly assessed through measures of cognitive flexibility (K- 5th grade), working memory (WM; K-5th grade), and inhibitory control (4th-5th grade). Math achievement, assessed in the fall and spring of each grade, measured concepts, procedures, and problem solving. Using cross-lagged models, Zhang examined the bidirectional relation between cognitive flexibility/WM and math achievement from K through 5th grade, suggesting that EF influences math learning but math learning also influences EF. Cotto-Miller Miller-Cotto employed latent change score analyses to test the relationship between working memory and mathematics skills in kindergarten, first grade, and second grade, attending to the within and between effects. Ribner used latent class analyses to examine co-occurring growth patterns in EF and math and found six unique classes characterizing parallel growth in EF and math. Comparing these with cross-lagged models of EF and math development, Ribner will discuss implications for educational practice.

The fourth presentation presents data from the SKIP longitudinal data set, which followed 1,500 children from the start of kindergarten to their first year of primary school (ages 5-7). Drawing on data from SKIP and new data collected from a subsample of SKIP participants at age 9, Ng examined later math outcomes of children with different self-regulation profiles at primary school entry. Moderators include factors associated with the child (e.g., growth mindset) and home/parents (e.g., parents' failure mindset, home numeracy environment).

As a whole, the presentations elucidate key longitudinal relations between aspects of EF and mathematical learning. Implications for intervention design will be addressed.

Thursday, February 25
11am EST / 2hr
Online Experiments with Children

Presenters TBA!

Tuesday, March 2
9am EST / 1hr
Children's math engagement: Exploring cognitive, contextual, and family influences

Presenters
Mary DePascale University of Maryland, College Park, USA
Marjorie Schaeffer, St. Mary's College, USA
Dawn Short, Abertay University, Scotland
Andrew Ribner, University of Pittsburgh, USA

Math knowledge in early childhood is predictive of academic and mathematical achievement through adolescence (Watts et al, 2014. From a young age, children's engagement in math relates to their math learning (Bodovski & Farkas, 2007; Hofer, Farran, & Cummings, 2013). Many factors including parent input and teacher's beliefs are known to relate to children's learning, and it is likely that these factors also impact children's engagement in math. Understanding the influences on children's math engagement, and subsequent impacts on their math ability, is important for promoting children's math development in early childhood. This symposium will examine multiple factors influencing children's engagement in math (DePascale, Schaeffer) as well as the impact of engagement in math at home and school on children's math abilities (Ribner, Short).

First, Mary DePascale (Doctoral Student, University of Maryland, College Park, USA) explores the role of children's Spontaneous Focus on Number (SFON) and math ability on children's math talk during play with a parent. Results indicate that children's SFON relates to their math ability, but only math ability relates to children's use of number words during play. This suggests that children's own cognitive abilities influence the way they engage in math play.

Second, Marjorie Schaeffer (Assistant Professor, St. Mary's College, USA) will present a study on how pressure and math anxiety impact family math engagement for families of first grade children. Results show that math anxiety and pressure both impacted performance on a math homework assignment. This suggests that both contextual and socioemotional factors influence children's engagement and performance in math.

Third, Dawn Short (Doctoral Student, Abertay University, Scotland) will present on the impact of math attitudes on children's math attainment. Math attitudes were measured in children as well as in children's teachers and caregivers at two time points. Findings show that children's attainment in math did not relate to their own or adults' math attitudes at time 1, even when attitudes towards math were negative. This suggests that the influence of adult attitudes on children's math attitudes and performance may vary over time.

Finally, Andrew Ribner (Postdoctoral Associate, University of Pittsburgh, USA) examines the impact of a longitudinal, home-based training study on 4-year-old children's math performance. Findings highlight the importance of parent-child engagement in math activities, as parent-child math board game play increased children's math performance, whereas children with parents in the parent-only math training condition showed negative effects, resulting from decreases in parent math engagement with children.

Together, the studies presented demonstrate the influence of individual, home, and school factors on young children's math engagement, with implications for increasing children's engagement and performance in math.

Thursday, March 11
11am EST / 1hr
Insights into predictors and correlates of proportional reasoning

Presenters
Elien Vanluydt, KU Leuven, Belgium
Jake McMullen, University of Turku, Finland
Tine Degrande, KU Leuven, Belgium

Discussant: Matthew Inglis, Loughborough University, England

Proportional reasoning is a central topic in primary education and is considered crucial for a variety of topics across primary, secondary, and higher mathematics (e.g., fractions, probability, algebra, statistics) and other study domains (e.g., economics, technology, physics). An abundance of studies however shows that many children encounter difficulties when dealing with proportions. Given its crucial role in children's development, more research is needed to further our theoretical understanding of proportional reasoning, and to guide interventions.

The present symposium adds to the current research, by not merely looking at proportional reasoning as such, but by relating it to other research domains: patterning, probability, rational numbers, and spontaneous focusing tendencies. The latter research domains have mainly developed separately, but constitute important predictors and correlates of proportional reasoning, and therefore are pivotal to investigate in parallel. The studies in this symposium, moreover, use a variety of research methods including both cross-sectional and longitudinal data, and expand the age range of traditional research on proportional reasoning by covering the range from kindergarten, to primary and middle school. Together, the talks in this symposium, investigate (1) patterning as a potential precursor for early proportional reasoning, (2) the relation between Spontaneous Focusing On multiplicative Relations (SFOR) and (in)appropriate reasoning in the domain of proportionality, and (3) parallels between (in)appropriate reasoning in the domain of proportionality and other mathematical domains.

More specifically, Vanluydt (PhD student at KU Leuven, Belgium), Wijns, Torbeyns, and Van Dooren longitudinally investigated patterning as a potential precursor of proportional reasoning. Although patterning has been put forward as a potential precursor of early proportional reasoning in the literature, this has not been empirically investigated yet. If proficiency in patterning in kindergarten explains individual differences in performance on proportional reasoning problems in early primary school, more attention to patterns in young children may be a fruitful way to support early proportional reasoning.

Besides appropriate reasoning, it is also worthwhile to investigate inappropriate reasoning in the domain of proportionality, as well potential explanations for this inappropriate reasoning. To this end, McMullen (Postdoctoral Researcher and Adjunct Professor at the University of Turku, Finland) and Degrande did not examine typical mathematical skills, but rather investigated students' spontaneous mathematical focusing in non-explicitly mathematical situations. Their study was targeted at unraveling the relation between SFOR on the one hand, and additive and proportional word problem solving on the other, in middle school.

Finally, the study of Degrande (Postdoctoral Researcher at KU Leuven, Belgium), Supply, Van Dooren, and Van Hoof cross-sectionally investigated parallels between primary school children's appropriate and inappropriate reasoning in the domain of proportionality and in distinct but related domains, namely fractions and probability. This study has implications for the design of interventions to prevent and remedy inappropriate reasoning across these domains.

As discussant, Inglis (Professor of Mathematical Cognition at Loughborough University, United Kingdom), who's main research focus is mathematical thinking and learning, will provide a general commentary on the individual papers and integrate the contributions of the various studies.

Tuesday, March 16
9am EST / 1hr
Cross-representational knowledge: Connecting fractions and decimals

Presenters
Hilma Halme, University of Turku, Finland
David Braithwaite, Florida State University, USA
Ilyse Resnick, University of Canberra, Australia
Jo Van Hoof, KU Leuven, Belgium

Fractions and decimals are uniquely important and uniquely difficult in children's mathematical development. Much previous research has investigated children's understanding of fractions and decimals separately—that is, within-representational knowledge. This symposium will investigate individual differences in children's cross-representational knowledge—that is, knowledge of relations between fractions and decimals. The four talks comprising the symposium will discuss children's ability to switch between fraction and decimal representations (Halme), fraction versus decimal comparison and its relations to rational number arithmetic skill (Braithwaite), the parallel development of fraction and decimal magnitude knowledge and its relations to math achievement (Resnick), and the development of learners' understanding of the dense structure of fractions and decimals (van Hoof). The findings indicate that cross-representational knowledge predicts various outcomes above and beyond the contribution of within-representational knowledge and that some aspects of rational number understanding may develop with decimals earlier than with fractions.

Thursday, March 25
6pm EST / 1hr
Principle knowledge in mathematics: its development, cognitive predictors, and potential interventions

Presenters
Katherine Robinson, Campion College, the University of Regina, Canada
Terry Wong, University of Hong Kong, Hong Kong
Richard Prather, University of Maryland, College Park, USA
Martha Alibali, University of Wisconsin-Madison, USA

This symposium will focus on principle knowledge in mathematics. Principles are defined as the fundamental laws or regularities that apply within a problem domain (Prather & Alibali, 2009). Examples of such principles include inversion (e.g., a + b – b = a) and relation to operands (e.g., for any positive b, if a + b = c, then c > a). The current symposium will discuss various issues related to principle knowledge understanding, including the development of such knowledge, the cognitive predictors of such knowledge, as well as some interventions that are designed to improve students' principle knowledge.

In the first talk, Prof. Katherine Robinson will share the results of a three-year longitudinal study that tracked fourth graders' understanding of three arithmetic principles, namely inversion, associativity, and equivalence. In the second talk, Dr. Terry Wong will present the findings of a study that examined the roles of different cognitive capacities (e.g., intelligence, working memory, spatial skills, processing speed, and inhibition) in the understanding of four arithmetic principles (commutativity, inversion, relation to operands, and direction of effect) among fourth graders.

The last two talks are about the potential interventions. In the third talk, Dr. Richard Prather will share the findings of a study that examined the relation between participant's knowledge of the relation to operands principle in both positive and negative numbers and their spontaneous focus on numerical relations. He also tested whether feedback directing attention to relations affected participants' attention to relation and their arithmetic principle knowledge. Finally, Prof. Martha Alibali will present a study that tested the effectiveness of a software-based intelligent tutoring system in improving middle-school students' principle knowledge related to algebra (e.g., equality, inverse operations, isolating the variable, doing the same thing to both sides, and preserving the unknown value across steps).

The symposium aims to stimulate discussions on the topic of principle knowledge in mathematics. We hope that such discussion will generate new insights for future research on this topic.

Tuesday, March 30
9am EST / 2hr
Panel Discussion on the Academic Job Market

Panelists TBA!

Tuesday, April 13
9am EST / 1hr
Spontaneous mathematical focusing tendencies and the development of early mathematical skills

Presenters
Nore Wijns, KU Leuven, Belgium
Michèle Mazzocco, University of Minnesota, USA
Alex Silver, University of Pittsburgh, USA
Minna Hannula-Sormunen, University of Turku, Finland

Until recently, individual differences in the development of mathematical skills have almost exclusively been studied using overtly mathematical tasks. However, a novel approach using non-explicitly mathematical tasks has revealed that not all children equally focus on mathematical aspects when not guided to do so. Children's tendency of Spontaneous Focusing On Numerosity (SFON) has been found to predict individual differences in early numeracy and mathematical development throughout primary school. A higher SFON tendency is thought to trigger more self-initiated practice with numerical skills in children's everyday lives, which leads to advantages in learning mathematics. This symposium includes four empirical studies which build on the previous findings of SFON studies by extending this work to examine children's spontaneous mathematical behavior with other mathematical aspects and by examining how both perceptual and educational contexts effect spontaneous mathematical focusing.

Representing one of the newest faces on the spontaneous mathematical focusing tendencies scene is the work by Wijns (PhD candidate, KU Leuven, Belgium) and colleagues examining the role of spontaneous focusing on patterns (SFOP) in the early development of mathematical skills. In this study, they present a longitudinal investigation of the development of SFOP in relation to patterning and numerical abilities.

The middle half of the symposium will cover issues pertaining to stimulus and response effects on the elicitation of SFON instances. First, Mazzocco (Professor, University of Minnesota, USA) and colleagues continue to probe the effects of perceptual salience on SFON based responses. For the first time, they are able to examine the relation between performance on the Attention to Number tasks and mathematical skills, including investigating how Attention to Number predicts mathematical abilities one year later.

Examining these situational effects on SFON from the perspective of task demands, Silver (PhD student, University of Pittsburgh, USA) and colleagues examine the relation between four-year olds' SFON in behavioral tasks, SFON in verbal tasks, and mathematical ability in young children. This study will provide a valuable contribution into the ongoing discussion of the relation between SFON performance in different task designs and how these may be differently related to early mathematical development.

Providing us a look at how SFON tendency may contribute to early mathematical development, Hannula-Sormunen (Professor, University of Turku, Finland) and colleagues present results from two interventions aimed at improving SFON tendency and early numeracy in young children. Results reveal an immediate positive impact on SFON tendency, with positive transfer effects to early numeracy skills over an extended period of time. These results provide important verification of the causal and educational impact of SFON tendency on early numeracy.

Thursday, April 22
11am EST / 1hr
Alternative models of the Approximate Number System

Presenters
Tali Leibovich-Raveh, University of Haifa, Israel
Bert Reynvoet, KU Leuven, Belgium
Nathan Lau, University of Western Ontario, Canada
Attila Krajcsi, ELTE Eötvös Loránd University, Hungary; Central European University, Hungary

In the last three decades, the Approximate Number System (ANS) model has been the dominant account for many phenomena in numerical cognition. This system is believed to generate many effects related to basic number processing, and its sensitivity is also believed to be related to higher level mathematics performance. While the last decades have witnessed the flourish of this model, recently many details of this model has been questioned. The present symposium discusses some of the key issues related to the ANS model.

Since the beginning of utilizing non-symbolic numerical stimuli, it is a key question whether non-numerical features of the stimuli are controlled correctly, whether it is possible at all to control for all non-numerical properties, and how analysis methods can disentangle the effects of the numerical and the non-numerical features. To get a new insight, the first talk (Ezra & Leibovich-Raveh) reverses the question and asks whether numerical features influence the non-numerical feature-based decisions. It was found that participants could consider the relevant continuous magnitude, and that the automaticity in quantity processing is affected by both bottom-up and top-down factors.

Many works reported that the sensitivity of the ANS is related to the school math achievement or to the everyday math performance or to some high-level math problem solving. Frequently, the validity of those works are questioned, for example, whether symbolic and non-symbolic numbers are processed in a similar way, whether inhibition in non-symbolic tasks may play a role in the observed correlations, or whether the relation may apply to the whole population. The second talk (Reynvoet, Ribner, Elliott, Van Steenkinste, Sasanguie, Libertus) investigates the role of the stimulus generation protocol in these relations and finds that the protocol one chooses has an effect on the relation between numerosity comparison performance, inhibition and different math measures. The third talk (Lau, Zheng, De Jesus, Ansari) explores the possibility that the observed relations apply only to some subgroups of the population, and a latent transition analysis is used in a longitudinal large sample study.

From time to time, alternative models are proposed to account for the basic phenomena that are usually attributed to the ANS. Some of these models are considered as a refinement or fine-tune of the ANS model, while some others propose entirely different architecture and data processing. In the fourth talk (Krajcsi, Lengyel, Kojouharova) an alternative model is proposed for the symbolic number processing. According to the Discrete Semantic System (DSS) model, symbolic numbers are stored in a conceptual network-like representation, and this architecture accounts for all the known elementary symbolic number processing phenomena formerly attributed to the ANS. Additionally, the DSS model can explain recently described phenomena that the ANS model cannot account for.

The four talks of the symposium designate new possibilities how modified version of the ANS model or how alternative models with entirely new mechanisms could provide a more coherent and more parsimonious account for the ever-growing set of phenomena in numerical cognition.

Tuesday, April 27
9am EST / 2hr
Workshop TBA