Project Report Funded by CYRRC, (2018-2020)

A Culturally Sensitive Intervention for Syrian Refugee Children with Interrupted Schooling: Targeting Math Vocabulary and Associated Number Sense Skills -

Esther Geva[1] & Deborah Benhamu[2]

OISE, University of Toronto

May 2020

Background

For ESL and non-ESL learners, mathematics vocabulary can be a barrier to learning and progressing in mathematics. Indeed, students' ability to communicate mathematically is an important component of their overall mathematical proficiency and academic development (Riccomini et al., 2015). Academic vocabulary is closely bound to their conceptual understanding of mathematics (Capraro, Capraro, and Rupley 2010; Capraro and Joffrion 2006; Kotsopoulos 2007).

The Marzano six- step process is used to support students in a broad range of subject areas in the development of vocabulary. This approach to vocabulary instruction is based on

[1] *Esther Geva, is a Full Professor in the Department of Applied Psychology and Human Development, OISE, University of Toronto.*

[2] *Deboarh Benhamu, initiated this project, and managed all aspects of the program while completing her MA in Child Study and Education Program at OISE, University of Toronto. Deborah's role included recruiting, training and supervision of volunteers and lab students in mathematics curriculum, pedagogy and testing; development of curriculum; teaching and testing students; and overseeing all program logistics. Deborah is currently a math teacher.*

explicit instruction, stimulating prior knowledge, repetition, differentiating instruction, and cooperative learning (Marzano, 2006). Limited research pertaining to the use of this approach in mathematics academic vocabulary development is available. Even less is known about the mathematics skills of vulnerable refugee children who need to learn academic subjects in their second language (L2), and who, as is the case with Syrian refugee children, have suffered from interrupted schooling, not to mention trauma related experiences. Therefore, this project was developed initially (Phase 1) to fill this gap and investigate the extent in which targeted math vocabulary in the L2 (English) can facilitate mathematics learning in a group of Syrian refugee children who had arrived recently in Toronto. With the gain of experience with this initiative, two additional components emerged: 1) the development of a vocabulary measure that is specific to math as the available vocabulary measures that we explored do not include math vocabulary (See Phase 2), and 2) the implementation of the intervention in a school (See Phase 3).

Research and Development

Phase 1: Math intervention pilot study for Syrian refugee children (2016-2018): The objective of Phase 1 was to find out how best we can support Syrian refugee children in addressing gaps in their math knowledge. Intervention was built on individualized and differentiated content instruction, culturally responsive pedagogy, and concreteness fading. 30 Syrian refugee students in grades 1 to 7, 16 boys and 14 girls living in a high-rise, socially supported building in Toronto participated. The complete program took place in the party room of the high-rise, which was converted to a classroom by the volunteers twice a week. The 20 trained volunteer tutors (all university students) delivered the program and administered the assessment instruments. The

3-month intervention consisted of bi-weekly, one-hour sessions, with a 3:1 tutor: student ratio. Since these were refugee children, the groups were determined on the basis of an assessment of their current math skills rather than grade level, to address gaps in learning. Some financial support was obtained through a GoFundMe initiative that raised $5000 to facilitate this initiative..

Students' mathematical knowledge was assessed using the Math Fluency measure (WIAT) and the KTEA Concepts and Applications subtests, administered pre-and post intervention. A paired sample t-test showed significant improvements in students' math fluency and problem solving abilities. Fluency mean change = 2.29, $p<0.05$ and problem solving mean change 6.05, $p<0.00$. See Appendix B for more detailed results.

Phase 1 led to the realization that it is important to focus on the development of math vocabulary, which is often ignored by educators. The implementation of Phase 2 and Phase 3 was supported by a CYRRC grant of $10,000.[3]

Phase 2 - Instrument Development: In order to measure students' knowledge of mathematics academic vocabulary, an experimental measure, the Mathematics Vocabulary Measure (MVM) was developed.

The MVM assesses students' mathematics academic vocabulary which was used as a progress measure (see Appendix A for some item examples). 104 items were initially developed by examining the vocabulary needed to master learning expectations as outlined on the Mathematics Ontario Curriculum; 74 items were selected for the measure tested during this intervention. The

[3] It should be noted that the CYRCC funding was complemented by relying on 1 UofT ROP undergraduate student, 2 OISE MA students with a Graduate Assistantship, and 5 M.Ed students who participated in this project as part of ADP 1210 - which is a research internship course.Two teacher candidates from OISE were hired for curriculum development and to teach part of the intervention using CYRCC funding.

MVM was tested against the Peabody Vocabulary Vocabulary Test (PPVT), which is a receptive vocabulary test that is often used to assess general vocabulary in English, to determine validity. The two measures are positively correlated $r=.49$, $p= 0.01$ (2-tailed). Non-parametric analysis confirmed assumptions, suggesting that the MVM is a valid measure of vocabulary $r=.36$, $p=0.023$ (2-tailed), but also that it is not identical to the PPVT in terms of the kind of vocabulary assessed. See Appendix C for result tables.

Phase 3: Implementation of a systematic math program with a focus on math concepts and math vocabulary: The language of mathematics is necessary in order to communicate higher order mathematics reasoning (Sloyer, 2003); yet, mathematical language poses many challenges for students. Language is needed in order to understand new concepts, communicate ideas and to extract information from written word problems and assessments. Mathematic academic vocabulary is precise, technical and dense in nature and as such, it is more demanding than general vocabulary (Forsyth & Powell, 2017). As such, language can be a significant barrier for learning mathematics, for ESL and non-ESL students alike.

The focus of this after-school math skills oriented program was on math related vocabulary. Students were taught grade appropriate math concepts and corresponding vocabulary of increasing difficulty that captured concepts taught across grades in the Ontario math curriculum (e.g., *bigger than, cost, dime, heavy, pattern, temperature, numerator, hexagon*). Instruction during the intervention was based on evidence based pedagogical approaches including explicit instruction of math concepts and the associated vocabulary, activating prior knowledge, repetition, differentiated instruction, and cooperative learning.

The approach to vocabulary instruction was founded on Marzano's six-step process which maximizes student learning of essential vocabulary (Marzano, 2004). The six steps are as follows: (1) Provide informal description, explanation or example of the new term of phrase. (2) Give students opportunity to restate the teacher-provided explanations or examples in their own words (3) Construct a picture, symbol or graphic representation of the term or phrase (4) Provide students with periodic opportunities to re-engage with the terms (5) Create opportunities for small group and/or peer-to-peer discussions on specific terms (6) Provide opportunities for students to revisit terms through game like activities (Marzano, 2004).

Altogether there were 48 grade 3 elementary school participants. Participants were selected by teachers from 12 grade 3 classrooms from the same public school. The teachers nominated children who they perceived as vulnerable and believed that they could benefit from the math intervention. Randomization into the immediate and waitlisted control groups (see below) was done at the classroom level. Six classrooms were designated as immediate intervention, and 6 classrooms were designated as waitlisted control classes. Two students did not complete the intervention, and complete data was available for 39. Of these 39 students, 17 were ESL and 22 spoke English as their first language. The participating school was located in the neighbourhood school that was also attended by participants in Phase 1.

The design was a pretest- intervention-posttest with a wait-listed control group. (See Appendix F for a diagram illustrating the research design). In the Fall semester 24 students received the math skills intervention while the remainder 24 were in the "business as usual" group. In the 2nd semester 24 children who were in the wait-listed group received the same intervention. The participants in both groups attended the after-school program twice a week for

12 weeks. Results indicated that all students who received the intervention showed an increase in their knowledge of mathematics academic vocabulary.

We compared changes in MVM scores between Time1 and Time2 when only Group 1 ("Immediate") received the intervention and Group 2 ("Delayed") acted as a "business as usual". An independent sample t-test using the difference in MVM scores between Time1 (pretest) and Time1 (immediate posttest). There was a significant difference in the pre-post improvement between the treatment and "Delayed" group. An independent sample t-test was conducted using the difference in MVM scores from time2 and time1. The immediate group improved significantly more (M= 4.75, SD= 6.7) than the business as usual group (M=0.05, SD=4.8); t(34)=2.4, p=0.02). Effect size= 0.14.; normality assumptions were satisfied. In fact, children in the business as usual group did not improve at all during the semester on their familiarity with math vocabulary.

In addition, student's scores at the three time points (see Appendix F for illustration) were analyzed using two-way, repeated measures ANOVA (with time and group as the two independent variables).. The analysis revealed that there was a significant effect of time ($F(2, 52) = 26.42$, $p < .001$, η p2 = 0.504) showing that participants increased their knowledge of math academic vocabulary during the entire study (See Appendix E).

As a follow to demonstrating the impact of the program on MVM, the teaching resources developed during the intervention phase were compiled and used to develop a set of lesson plans that will be distributed to teachers for use in their classrooms. A first full draft of these teaching resources is now complete.

Results indicate that the intervention program can support the development of mathematics vocabulary and the underlying math concepts regardless of their home language in classrooms that include a range of immigrant and refugee children.

Implications and Future Directions

A focus on mathematics vocabulary can support a wide range of learners. Further research should be conducted to determine the effectiveness of this approach. This should involve larger samples, the collection of background information, and careful assessment of cognitive and language skills as well as math achievement tests. The lesson plans developed should be tested in several classrooms and feedback should be gathered from teachers to make these resources easily accessible. Furthermore, throughout this intervention, a new way of assessing students' knowledge of mathematics vocabulary (MVM) was developed. In order to ensure that the MVM is valid and has the same results in different different populations, sex, grade levels, the assessment tool should be tested on students from a wider population and span across grade levels.

Knowledge Mobilization To Date

Academic Conferences:

-Benhanu D., & Geva, E. The Effectiveness of a Culturally Sensitive Curriculum in Mathematics Education: A Mathematics Intervention Program for Syrian Refugees. Presented as part of the Canaidan Psychological Association (CPA) 2017 symposium: “Culturally Sensitive

Interventions for the Multicultural Classroom: Complementary Instructional, Cultural and Social-Emotional Considerations" (Geva, E. Symposium Organizer).

-Benhamu, D. & Geva , E . (2019). The Role of Academic Vocabulary in Supporting Students' Mathematical Proficiency. CAN-Germany Workshop on the Integration of Refugees. Toronto, OISE. April 9-11, 2019

Media

Benhamu, Deborah; Geva, Esther. *Number Buddies: Providing Math Support for Syrian Refugee Children*. Robertson Program Blog. April 16, 2016. Url: https://wordpress.oise.utoronto.ca/robertson/2018/04/16/number-buddies-providing-math-support-for-syrian-refugee-children/

Benhamu, Deborah. Gift to Canada Contest Finalist. Globe and Mail. July 17, 2017. url= https://www.theglobeandmail.com/news/national/the-globe-and-mail-teams-with-we-charity-to-showcase-young-people-making-canada-a-betterplace/article35533607/

Workshops:

Canada-Swedish Exchange. September 2018. *Learning Math in the Presence of Language Barriers*

Canada Germany Exchange. April 2019. Learning Math in the Presence of Language Barriers

Guest Lectures in Graduate Level Courses

OISE APD1285-Learning Disabilities. Interventions for students with Mathematical Disabilities, November 24th, 2019

OISE ADP1285- Learning Disabilities. Interventions for students with Mathematical Disabilities, February 25th, 2020

OISE ADP5284- Assessment and Intervention in Multicultural/Bilingual Context October 29, 2019.

Student Posters:

-University of Toronto Annual Research Opportunities Program (ROP Fair March, 2019)

An Investigation on Whether Strong English Vocabulary Confers Strong Mathematical Vocabulary in Elementary School Children.

-ADP1210 Research Practicum Poster Presentation April 2nd, 2019:

1)Gender Differences in Motivation, Classroom Engagement and Math Achievement among Early Learners

2)The Relationship Between Parental Education Level and Children's Mathematical Performance

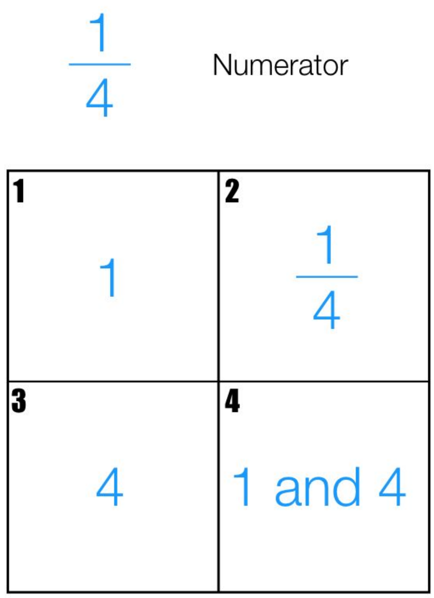
3)Are Grade Three Students' Attitudes Toward Math Related to Their Math Performance?

4)Exploring the Grade 3 Immigrant Students' Development of Numerical Magnitude Processing, General Vocabulary, and their Improvement of Math Achievement in a Math Intervention Program

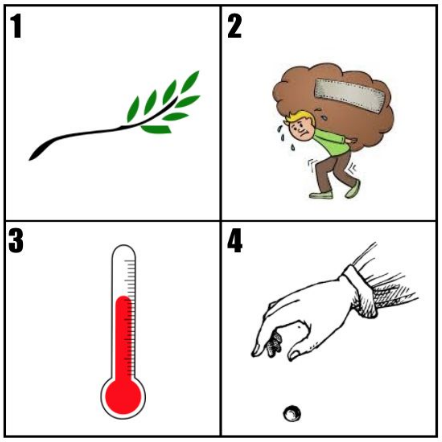
5)An Investigation on Whether Parent Educational Level Affects on Children's Math Ability in Elementary School

Appendix A- Examples of MVM items developed in this project

The current version includes 72 math related vocabulary items which represent the Ontario math curriculum Grades 1-12.



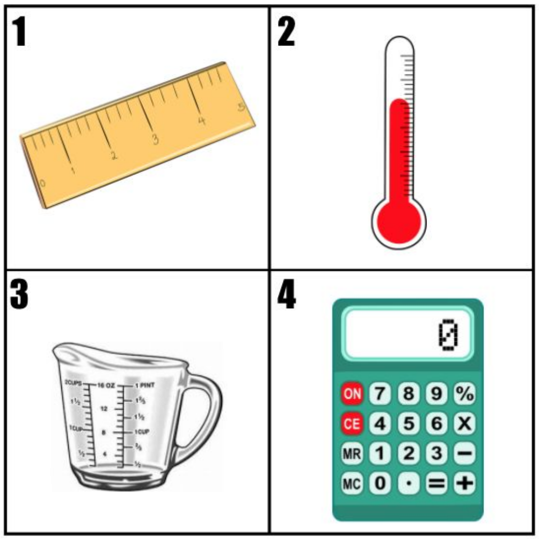
Heavy



Dime

1 25 cents	2 15 cents
3 10 cents	4 1 cent

Temperature



Appendix B Phase 1: - t-test results

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Change in Math Fluency	2.28571	3.19598	.69742	.83092	3.74051	3.277	20	.004
Pair 2	Change in Problem Solving	6.04762	5.66106	1.23534	3.47073	8.62450	4.895	20	.000

*Normality assumptions were satisfied.

Appendix C (Phase 2): Analyses involving the math vocabulary test (MVM)

Pearson Correlation

Correlations			
		MVM	PPVT
MVM	Pearson Correlation	1	.494**
	Sig. (2-tailed)		.001
	N		39

Non-Parametric Analyses- Spearman's rho

Correlations			
		MVM	PPVT
MVM	Correlation Coefficient	1.000	.364*
	Sig. (2-tailed)	.	.023
	N		39

Appendix D: Phase 3 Results

Time 1 and Time 2 Descriptive Statistics

Comparison of Post-test - Pre-test differences in the "Immediate" and "business as usual" groups (Time 2- Time 1:

Group Statistics					
	Group	N	Mean	Std. Deviation	Std. Error Mean
MVMT2 - MVMT1	Treatment	16	4.7500	6.70820	1.67705
	Business as Usual	20	.0500	4.82837	1.07966

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
MVM2-MVM1	**Equal variances assumed**	3.156	.085	2.444	34	.020	4.70000	1.92330	.79138	8.60862
	Equal variances not assumed			2.356	26.427	.026	4.70000	1.99453	.60340	8.79660

*Normality assumptions were satisfied.

Appendix E: Comparison of Student Progress across Time 1, Time 2 and Tim 3: 2-Way Repeated Measures ANOVA

Descriptive Statistics

	Group	Mean	Std. Deviation	N
MVM Time1	Immediate	43.00	7.173	12
	Delayed	42.88	5.252	16
	Total	42.93	6.024	28
MVM Time2	Immediate	47.67	10.586	12
	Delayed	44.00	6.643	16
	Total	45.57	8.578	28
MVM Time3	Immediate	51.75	6.969	12
	Delayed	49.88	6.879	16
	Total	50.68	6.853	28

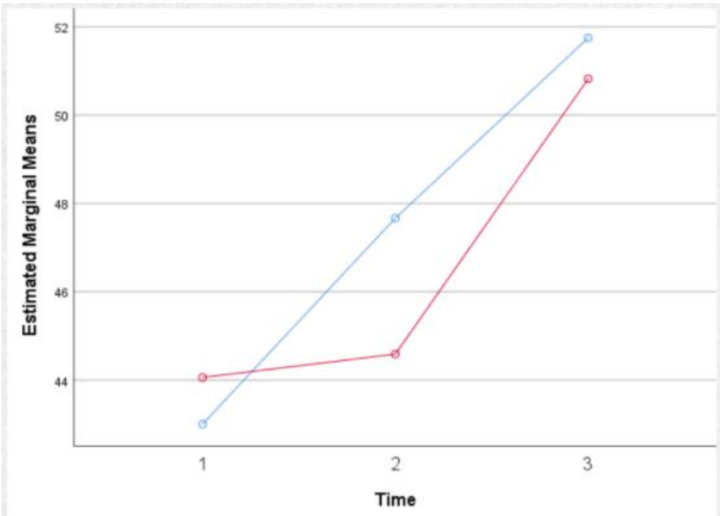
Tests of Within-Subjects Effects

Measure: MVM

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	870.341	2	435.171	26.422	.000	.504
	Greenhouse-Geisser	870.341	1.956	444.997	26.422	.000	.504
	Huynh-Feldt	870.341	2.000	435.171	26.422	.000	.504
	Lower-bound	870.341	1.000	870.341	26.422	.000	.504
Time*Group	Sphericity Assumed	43.008	2	21.504	1.306	.280	.048
	Greenhouse-Geisser	43.008	1.956	21.990	1.306	.280	.048
	Huynh-Feldt	43.008	2.000	21.504	1.306	.280	.048
	Lower-bound	43.008	1.000	43.008	1.306	.264	.048
Error(time)	Sphericity Assumed	856.444	52	16.470			
	Greenhouse-Geisser	856.444	50.852	16.842			
	Huynh-Feldt	856.444	52.000	16.470			
	Lower-bound	856.444	26.000	32.940			

*Sphericity assumption was met, p>0.05

Estimated Marginal Means of Vocabulary Measure



Group 1(Immediate)
Group 2 (Delayed)

Appendix F Research Design