2026

Assessment of the Early Math Skills Program Grade One

Upper Grand District School Board

UPPER GRAND DISTRICT SCHOOL BOARD

AIM COLLECTIVE

Executive Summary

The Project

In Fall 2024, the Upper Grand District School Board (UGDSB) and researchers from the Carleton AIM Research Centre (ARC) collaborated to evaluate the effectiveness of a 10-week numeracy intervention, Early Math Skills Program, for students in Grade 1. The purpose of the intervention was to improve the numeracy skills of students in Grade 1 who were identified as requiring additional support in mathematics. Identification was based on their performance on a numeracy screener, the Early Math Assessment at School (EMA@School; Douglas & LeFevre, 2023), In this report, we compared the growth in numeracy skills of students who received intervention in the Fall or Winter to that of the non-intervention students. The EMA@School was administered to all students in the Fall, Winter, and Spring.

Results

1. Overall, students who received the intervention in the Fall (Group 1), had greater growth in skills by Spring than students who received the intervention in the Winter (Group 2). One subtest, subtraction, did not show growth, however. End-of-year subtraction fluency scores were not significantly different for Groups 1 and 2.
2. For most subtests, scores of students in intervention Group 1 increased significantly more during the intervention (Fall to Winter) than scores of students who were waiting for intervention.
3. When intervention students were not receiving intervention (Group 1; Winter to Spring, Group 2, Fall to Winter), their change in skills were similar to those of the control group with some subtest exceptions.

Conclusions

1. The Early Math Skills Program was effective in increasing students' foundational numeracy skills.
2. Students' foundational number skills improved in response to the small-group instruction.
3. Intervening at the start of the year benefitted students more than intervening later, although both groups showed benefits of the Early Math Skills instruction.

Acknowledgements

This report describes the results of a collaborative project between the Upper Grand District School Board (UGDSB) and the Carleton AIM Research Centre (ARC) at Carleton University. The research was partially funded by the SSHRC, VSIM Centre and the Office of the Vice-President of Research at Carleton. Ashley Kozak, the K-12 Math Program Lead for the UGDSB, developed the numeracy intervention and supervised the implementation. The intervention was delivered by the Math Support Teachers. Blayne Primeau, Senior Manager – Research, Evidence, and Innovation at the UGDSB was responsible for managing the data. This report is based on de-identified data provided to the ARC team. The report was written by Heather Douglas, Jo-Anne LeFevre, and Ayushi Chitranshi. The final report was reviewed and edited by Ashley Kozak and Blayne Primeau, from the UGDSB.

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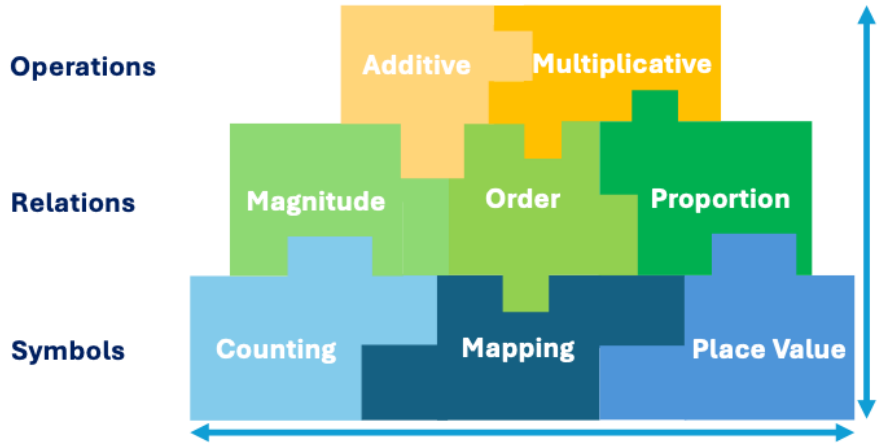
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Background

Foundational numeracy knowledge is hierarchical. One way to conceptualize these hierarchical relations among the foundational skills is shown in Figure 1. Each more advanced skill builds on earlier skills. These interrelations are particularly obvious as children learn to count. As illustrated in Figure 1, counting is the cornerstone of further learning (Aunio & Räsänen, 2016). It requires symbol knowledge, conceptual, and procedural skills. It is often assumed to be an informal numeracy skill in that children seem to acquire it without direct instruction, whereas other skills (such as arithmetic) typically involve/require schooling. However, that assumption is misleading, because counting is complex and requires a long time to master. It is a skill that people continue to use throughout their daily lives but, as adults, we take for granted. Conceptual and procedural counting skills support other skills, such as addition, and thus it is important for children to master counting skills in Kindergarten or Grade 1.

The hierarchy of skills includes three sub-domains of knowledge: **Symbols,** which in grade 1 consist primarily of number symbols (e.g., counting, place value, number writing), **relations** (e.g., comparing and ordering numbers, placing numbers on a number line), and **operations** (e.g., arithmetic) (Devlin et al., 2022; Jordan et al., 2010). Skills in each of these areas are related to one another, but each contributes independently to students' mathematical achievement. Math learning is cumulative, meaning that increasingly complex skills build on one another, thus, highlighting the importance of laying a strong foundation in early mathematics (Sarama & Clements, 2009). Math learning is also integrative with the lower-level skills improving as the higher-level skills improve (Xu & LeFevre, 2021).

Figure 1. *Hierarchy of Foundational Number Skills*



Children's numeracy skill proficiency is crucial for future mathematical achievement (Duncan et al., 2007; Gilmore, 2023; Jordan et al., 2009; Romano et al., 2010; Watts et al., 2014) and predicts life outcomes such as high school completion, post-secondary school enrollment, employment, and income (Davis-Kean et al., 2021; Pagani et al., 2010; Parsons & Bynner, 2006). Given the importance of foundational numeracy skills for academic and life achievement,

it is essential to use evidence-based, valid, and reliable assessment tools to evaluate and track students' progress in numeracy.

The Assessment Tool

The EMA@School is a universal numeracy screener developed by math cognition researchers at Carleton University (Douglas & LeFevre, 2023). The screener includes a battery of subtests that measure students' foundational numeracy skills. In grade 1, these skills include students' understanding of number format and structure (e.g., counting, number writing), number relations (i.e., magnitude comparison and number line estimation) and operations (e.g., addition, subtraction). The screener is a pencil-paper assessment that has two parts in Grade 1 -- a brief one-on-one assessment and a group (full class) assessment. It takes approximately 20 minutes to administer. Students who score below the normed cut score may need extra support in mathematics.

The Intervention

The Upper Grand District School Board's Tier 2 Early Math Skills Program is a 10-week intervention for students in Grade 1 who require additional support in mathematics. The focus of the intervention is on improving foundational numeracy skills (e.g., counting, number line estimation, place value, number relations, and arithmetic). The intervention was delivered by eight Math Support Teachers (MSTs) who worked with small groups of 3-4 students for 30 minutes per day, 4-5 times per week. This intervention was in addition to students' regular math time. MSTs were assigned to different schools for each intervention cycle, thus participating students were those needing support from the assigned schools. For Cycle 1, Fall data was used to choose participating schools based on the highest number of students who scored in the Tier 2 scoring range. For Cycle 2, Winter EMA data was used to choose schools that had the highest number of students who scored in the Tier 2 scoring range, and had the highest number of students in the developing proficiency range. A breakdown of the intervention activities by week can be found in Appendix A, Table A.1.

Research Questions

1. Did the intervention affect students' foundational numeracy skills?

2. At Time 3 (Spring), how many intervention students were still classified as needing additional support in mathematics?

3. Did the intervention affect students' scores on each of the EMA subtests?

Method

Participants

In the Fall of 2024, educators in the UGDSB tested all Grade 1 (N = 2389) students with the EMA. Based on the Fall EMA scores, students who were deemed at-risk or close to at-risk at Cycle 1 designated schools were placed in Group 1 (n = 155). These students participated in the first round of the Early Math Skills Program (EMP), a Tier 2 intervention led by a trained group of Math Support Teachers (MSTs). All students were re-tested in the Winter. Students at Cycle 2 designated school who were deemed at risk or close to risk at Time 2 and had not participated in the first round of interventions, were placed in Group 2 (n =158) and participated in the MSP. A third group of students (n = 144) received intervention shortly before Spring testing and are not included in the analyses as the pre-post testing did not align with their intervention timing. Students who did not receive intervention were the Control group (n = 1932). All students were retested in the Spring.

Analyses

To determine the effectiveness of the intervention, we compared pre- and post-intervention EMA@School scores for the intervention and control groups. The total EMA@School scores were weighted according to the standard test administration guidelines. Scores were analyzed in a series of 3(Intervention Group: Control, Intervention Group 1, Intervention Group 2) by 3(Time: Fall, Winter, Spring) mixed ANOVAs. We expected to find interactions between time and intervention group on all EMA tasks, indicating that scores of students participating in the

intervention groups changed more on the EMA from pre- to post-intervention than students who were not currently participating in the intervention.

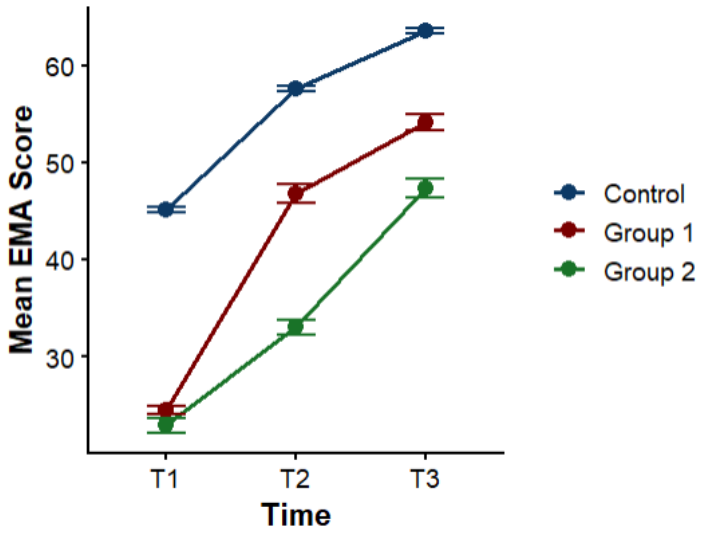
Results

1 Did the intervention affect students' foundational numeracy skills?

As shown in Figure 2, Groups 1 and 2 started the year with similar EMA scores ($p = .300$) whereas the Control group scores were significantly higher ($ps < .001$). Scores increased significantly for all groups across all time points ($p < .001$). The scores of students in the control group scores were significantly higher than those of students in the intervention groups at all time points ($ps < .001$). At Times 2 and 3, the scores of students in Group 1 were significantly higher than those of students in Group 2 ($ps < .001$). This pattern shows that the intervention group made more progress than students who did not receive the intervention.

Notably, the gap in scores between the two groups decreased from 13.65 in Fall to 7.18 in Spring. This finding suggests that receiving the intervention in the Fall (T1 to T2) led to greater growth in skills by the end of the year compared to receiving the intervention in the Winter (T2 to T3). Details of the statistics are shown in Appendix B, Table B1.

Figure 2
Total EMA Score from Time 1 (Fall) to Time 3(Spring)



2 At Time 3 (Spring), how many intervention students were still classified as needing additional support in mathematics?

Seventy-six percent of the students who received the intervention scored in the bottom quartile (classified as needs support) at the first assessment (Fall). By the Spring, however, the proportion shifted, with 56% of intervention students classified as needing support. Thus, 20% of the students who received an intervention were no longer classified as needing additional support by the end of the school year.

EMA Subtest Analyses

3 Did the intervention affect students' scores on each of the EMA subtests?

The analyses of overall EMA scores provide clear evidence that students' skills improved in response to the intervention. To evaluate the effectiveness of the intervention on specific numeracy skills, we examined changes the students' scores in each EMA subtest. All the interactions between time and group were statistically significant, consistent with the overall analysis (see Appendix B, Table B2). Thus, all of their specific numeracy skills improved, although there were nuances across the two groups.

Symbolic Number Skills

As shown in Figures 4 to 7, the overall pattern of scores and change in scores for students' symbolic number skills (***verbal counting, next numbers***, ***number naming, and number writing***) are similar to the change in total EMA scores. From Fall to Winter, Group 1 scores changed more than Group 2 scores, and from Winter to Spring, Group 2 began to catch up but still ended the year with lower scores than Group 1. These findings show that the intervention groups closed the gap between themselves and the Control group, although the early intervention group, Group 1, finished the year with higher scores than Group 2.

Figure 4. *Change in Verbal Counting by Group*

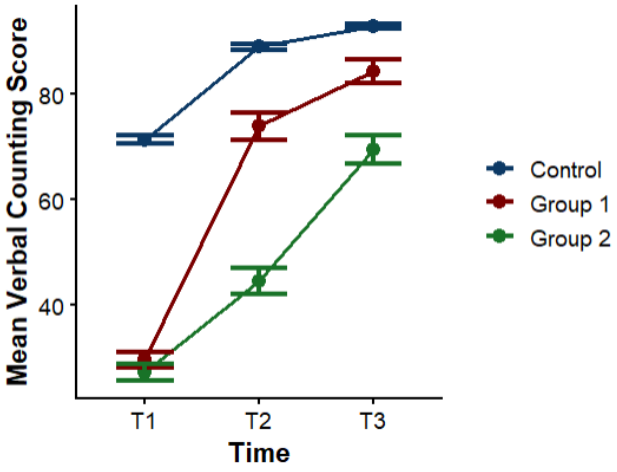


Figure 5. *Change in Next Numbers by Group*

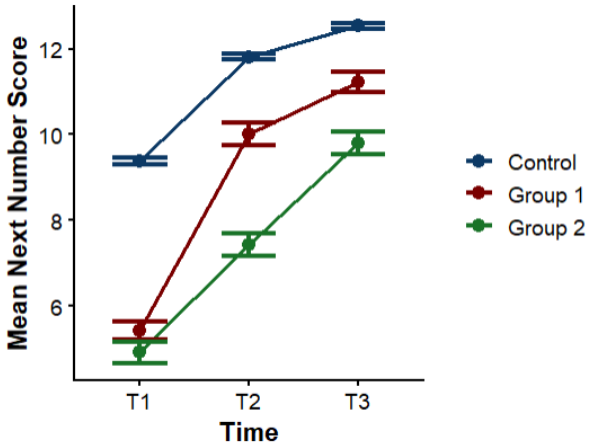


Figure 6. *Change in Number Naming by Group*

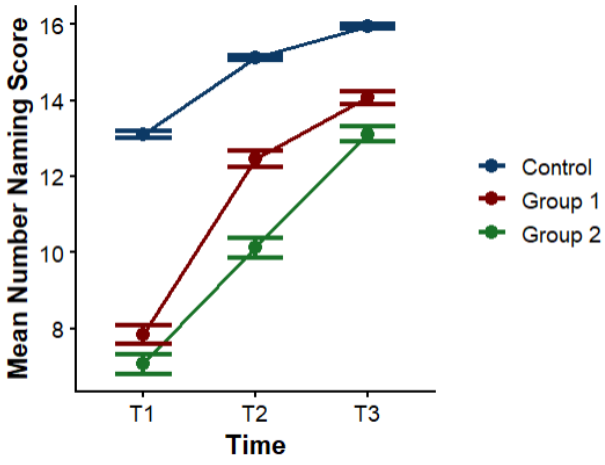
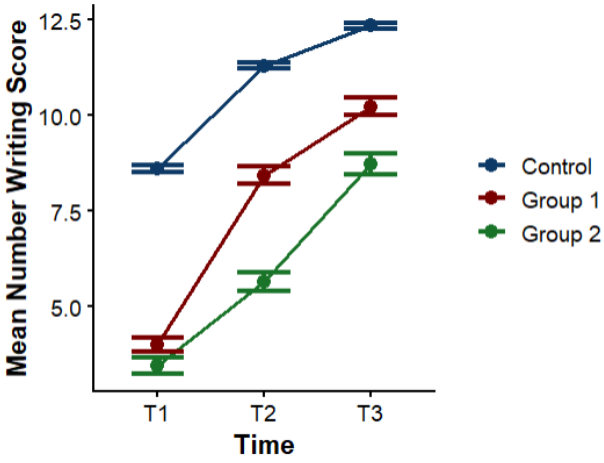


Figure 7. *Change in Number Writing by Group*



Relation Skills

The pattern of change in **comparing numbers** was the same as that seen for number skills (see Figure 8). The Spring scores of students in Group 1 were higher than those of students in Group 2, $p = .012$. The pattern of change however was different for **number line** performance (see Figure 9). Group 2 students did not show any significant change in their number line skills from Fall to Winter ($p = .569$). Although, as expected, they did show growth from Winter to Spring ($p < .001$), however, they did not catch up to students in Group 1. Group 1 students' Spring scores were higher than those of Group 2 students ($p = .031$).

Figure 8. *Change in Comparing by Group*

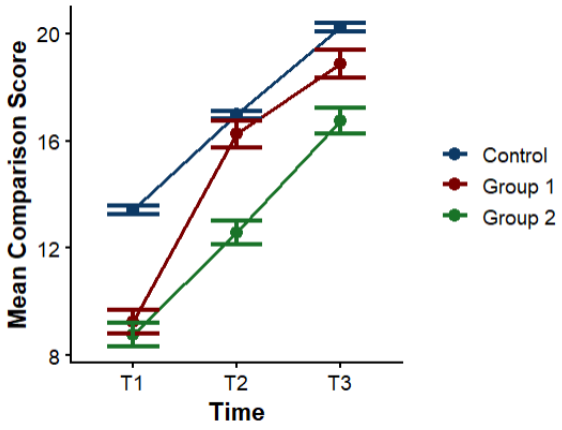
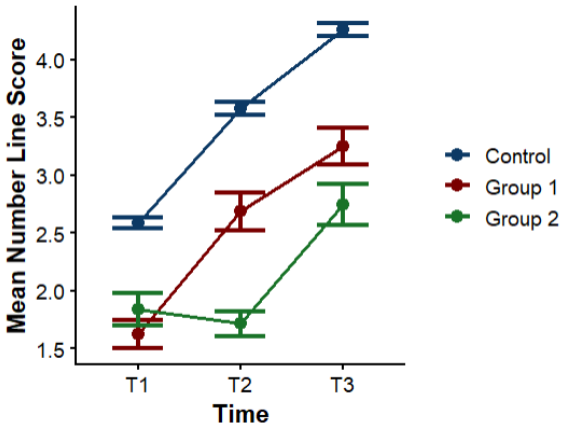


Figure 9. *Change in Number Line by Group*



Operation Skills

Operation skills for all groups grew significantly across all time points (see Figures 10 and 11). For both **addition** and **subtraction fluency**, scores of students in Group 1 changed more from Fall to Winter than did those in Group 2. For subtraction, Group 2 students caught up to Group 1 students by Spring (p = .052). Notably, the intervention had a stronger emphasis on number and relation skills than on arithmetic.

Figure 10. *Growth in Addition by Group*

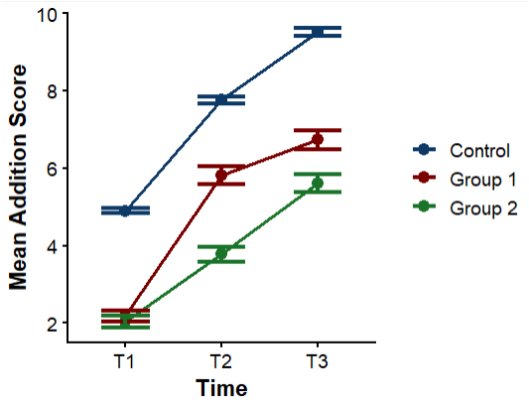
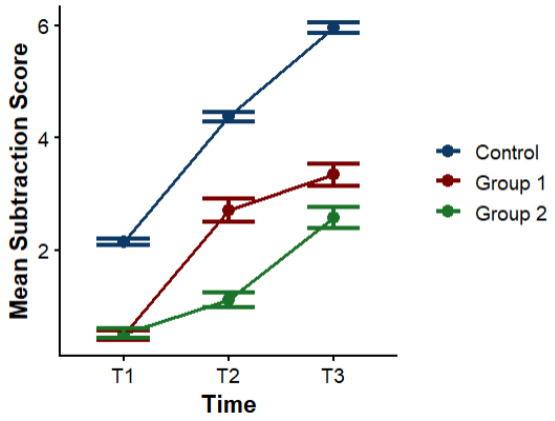


Figure 11. *Growth in Subtraction by Group*



Discussion

The goal of this project was to evaluate the Early Math Skills Program designed by the Upper Grand District School Board. As described above, the EMP intervention led to greater gains in foundational numeracy skills for students in Grade 1 compared to their peers who had not received the intervention. When students were receiving the intervention, they showed similar gains as students in the control group (i.e., those who did not receive any intervention but also had higher skills to start). However, when the intervention finished, their rate of growth slowed compared to their peers currently receiving the intervention (Group 2) or the students in the control group. These findings support the view that students whose core skills are weak in Grade 1 need more intensive or focused instruction to show growth. In this present project, this was

achieved through a Tier 2 intervention. The results also suggest that students who start Grade 1 with weak skills will improve if they receive appropriate instruction, raising the important question of how to ensure that all students benefit as much as possible from the instruction they receive in grade 1 mathematics.

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Appendix A

Table A1. *Breakdown of the Intervention Program by Week*

WEEK	Early Math Skills Program for Grade 1
Week 1	Diagnostics (arithmetic running records, Grade 1 board-designed diagnostic assessment, attitude survey) and relationship building
Week 2	Number sense and counting (10 days) [based on Gr 1 Diagnostic & screener] a. Estimating b. Composing and decomposing numbers c. 1 or 2 more/less d. Spatial sense activities
Week 3	Number sense and Counting (con't)
Week 4	Number Relationships (10 days) a. Anchor to 5 and 10 b. Ordering and comparing numbers (place value, more/less/equal) c. 1 and 2 more/less
Week 5	Number Relationships (con't)
Week 6	Number Lines (5 days) a. Number paths b. Half and benchmark numbers (0-20, maybe 0-50) c. Counting to 50 by 1s, 2s, 5s, 10s concretely and using number path/line
Week 7	Whole Number Operations a. Part-whole: using cubes, counters, number balances, number lines/paths b. Addition c. Subtraction d. Counting to 50 by 1s, 2s, 5s, 10s
Week 8	Equations a. Equal symbol meaning b. Inequality c. Composing and decomposing numbers d. Properties of operations (explicit teaching) e. Determining pairs of addition and subtraction expressions are equivalent or not
Week 9	Operations and Number Relations (using number lines/paths; other concrete tools)
Week 10	Math Running Records, Gr 1 Diagnostic, attitudinal survey

Appendix B

Table B1. *Summary of Main and Interaction Effects for Total Weighted EMA Score*.

Effect	*df*	*F*	*p*	η_p^2
Weighted PNSA				
Time	1.73[a], 1809	2378.47	<.001	.568
Group				
Time x Group	4, 3620	89.69	<.001	.090

Note. *df* = degrees of freedom, *F* = F ratio, *p* = level of significance, η_p^2 = partial eta squared effect size

Table B2. *Summary of ANOVA Time x Group Interaction Results for Each EMA Subtest*

Tasks	*df*	*F*	*p*	η_p^2
Verbal count		82.66	<.001	.080
Next numbers		59.30	<.001	.059
Number naming		120.28	<.001	.114
Number writing		40.15	<.001	.040
Number comparison		11.08	<.001	.011
Number line		7.24	<.001	.008
Addition fluency		8.05	<.001	.008
Subtraction fluency		19.17	<.001	.020