Impact Evaluation of Imagine Learning Illustrative Mathematics in Cecil County Public Schools

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imagine learning

Contents

Abstract

This retrospective quasi-experimental study evaluated the efficacy of Imagine Learning Illustrative Mathematics (Imagine IM) on student math achievement in Grades K–4 in Cecil County Public Schools during the 2023–2024 school year. To assess the program's impact, multiple outcome measures were analyzed, including Acadience Math, NWEA MAP Growth, and MCAP Math assessments. Propensity score matching and multiple linear regression were used to establish baseline equivalence and isolate treatment effects. Results showed that students who used Imagine IM scored, on average, six points higher on the Spring 2024 Acadience Math assessment and 5.6 points higher on the NWEA MAP Growth assessment than similar peers who did not use the program. While no statistically significant effects were observed on the MCAP Math assessment, Imagine IM demonstrated positive effects on early math performance, particularly in Kindergarten and Grades 3–4. These findings support the use of Imagine IM as a high-quality instructional material that can advance mathematics achievement in elementary grades.

Introduction

While many factors contribute to student learning in mathematics, using instructional materials that are high quality and accompanied by well-developed professional learning may be directly associated with student achievement (Doan et al., 2022; Chingos & Whitehurst, 2012). High-quality instructional materials (HQIM) are educational resources that align closely with educational standards and are designed to be user friendly for both teachers and students. The implementation of HQIM in U.S. classrooms has been found to improve student outcomes without increasing expenditures (Boser, Chingos, & Straus, 2015). Imagine Learning Illustrative Mathematics (Imagine IM) by Imagine Learning is a certified Illustrative Mathematics curriculum optimized by Imagine Learning for engagement, accessibility, and usability. The curriculum offers high-quality K–12 core mathematics instruction that is driven by student discourse and problem-based instructional design (EdReports, 2022).

This study aimed to evaluate the efficacy of Imagine Learning Illustrative Mathematics by addressing the research question: how does participation in Imagine IM impact student achievement in mathematics? To accomplish this, Imagine Learning partnered with Cecil County Public Schools, which implemented Imagine IM across multiple schools with the intent to improve student math performance. Reported study results demonstrate how this program impacted students' state assessment, NWEA MAP Growth, and Acadience mathematics performance by comparing the performance of Imagine IM students to a highly similar group of students who did not use Imagine IM.

Methods

POPULATION

Imagine Learning partnered with Cecil County Public Schools in Maryland to evaluate how Imagine IM had impacted the success of its students. During the 2023–2024 school year, Imagine IM was used in two out of seventeen elementary schools. Since there are not enough treatment units at the school level to complete a sufficiently powered school-level clustered design, a student-level analysis was completed. A limitation of this study is that school-level confounding factors are not controlled for in the analysis and may impact the results. In total, data were collected for 475 treatment students who used Imagine IM and 5,141 control students who did not use Imagine IM.

RESEARCH DESIGN

This study was conducted using data from the 2023–2024 school year. It evaluated the difference in mathematics achievement between treatment and control students. The treatment group was comprised of all students in schools that used the Imagine IM curriculum during the 2023–2024 school year, while the control group included all students from schools that did not. Assignment to the treatment and control groups was not random, so this study is a retrospective quasi-experimental design, and statistical procedures were used to ensure baseline equivalence of the treatment and control samples.

CURRICULUM

Imagine IM is a problem-based math curriculum that supports all learners through a coherent progression of mathematics based on content standards, mathematical practices, and research-based learning trajectories. Each Imagine IM lesson consists of a warm-up, classroom activities, synthesis, and cool-down, with the expectation that students work independently and collaboratively in every lesson. Teachers have access to a variety of print and digital resources through the Imagine Learning Classroom. In the Cecil County Public Schools, teachers at the two elementary schools implementing Imagine IM participated in professional development sessions provided by Imagine Learning at the start of the school year. In addition, teachers in each grade level regularly collaborated to better understand the curriculum and plan lessons. Teachers at the remaining fifteen elementary schools continued using the curriculum that was historically used in the district.

MEASURES

Multiple data sources were compiled to describe students and their mathematics achievement. Student math proficiency outcomes were determined using a standardized progress monitoring assessment. Student demographic data were collected to provide additional information on student characteristics that may impact measures of learning outcomes. These data sources are reviewed in more detail below.

Math Proficiency: Students' math proficiency was determined using several assessments: the Acadience math assessment was administered in both the fall and spring to all students in Grades K–4. Additionally, NWEA MAP Growth was administered in the fall and spring with students in Grade 2. Finally, the Maryland Comprehensive Assessment Program (MCAP) math test was administered to students in Grades 4 in both Spring 2023 and Spring 2024. For each assessment, Spring or Fall 2023 scores were used to establish baseline equivalence between study groups, and Spring 2024 scores were used to estimate the effect of Imagine IM on math proficiency.

Student Demographics: Information was collected on individual student demographic characteristics including grade level, gender, disability status, English language learner status, economic disadvantage status, and ethnicity.

Acadience Analysis

To ensure that the baseline characteristics of treatment and control students used in analyses were comparable, 1:1 nearest neighbor propensity score matching without replacement was used to create a statistically equivalent analytical sample.[1] Control students were matched to treatment students based on their Fall 2023 Acadience composite score and all demographic factors. This matching process matched students with each of Grades K through 4 before combining the matched samples into an overall matched analytical sample. The resulting analytical sample included 251 users of Imagine IM and 251 non-users. Table 1 below describes the characteristics of the sample.

[1]Propensity score matching was executed using the matchit function in R's MatchIt package. The caliper was set to 0.1 to ensure adequate baseline equivalence was achieved.

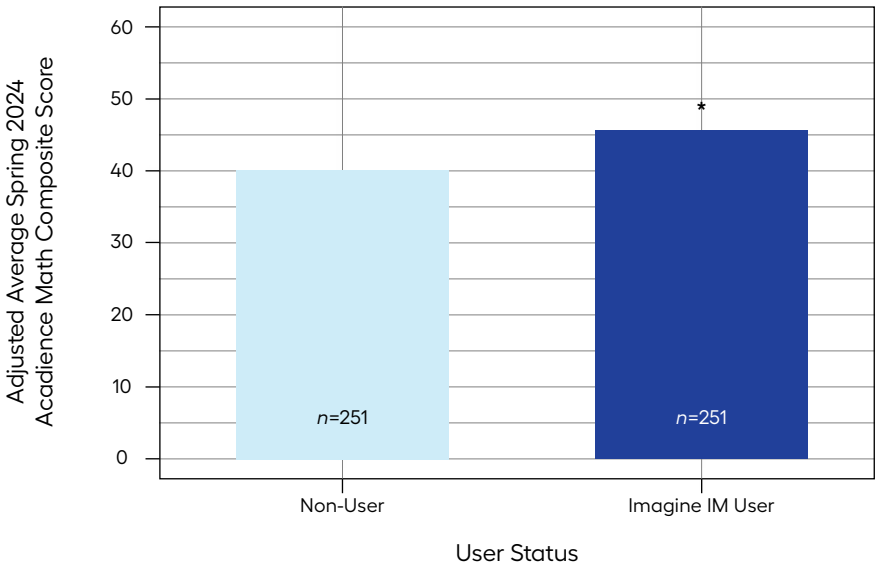
Table 1: Student Characteristics of the Analytical Sample

	Comparison Students (*n* = 251)	Imagine IM Students (*n* = 251)	*p*-value	Standardized Mean Difference (SMD)
Average (SD) Fall 2023 Acadience Composite Score	44.13 (39.20)	44.13 (39.20)	>.999	<.001
Grade Level			>.999	<.001
Grade K	48	48		
Grade 1	28	28		
Grade 2	65	65		
Grade 3	52	52		
Grade 4	58	58		
Gender			.858	.024
Female	134	131		
Male	117	120		
Students with Disabilities			.260	.113
No	227	218		
Yes	24	33		
English Language Learner			>.999	<.001
No	246	246		
Yes	5	5		
Economically Disadvantaged			.721	.040
No	126	121		
Yes	125	130		
Ethnicity			.982	.076
African American	6	5		
American Indian	1	1		
Asian	1	1		
Caucasian	224	222		
Hispanic	6	5		
Multi-Racial	13	17		

Descriptive tables of unadjusted average Fall 2023 and Spring 2024 Acadience composite scores can be found in **Appendix A**. Multiple linear regression was used to evaluate the differences in Spring 2024 Acadience math achievement between Imagine IM users and non-users, controlling for Fall 2023 Acadience math achievement and other covariates. An indicator of whether a student was a control or treatment student was included in the regression as the primary predictor variable.

Overall, use of Imagine IM was found to be positively and statistically significantly associated with students' Acadience mathematics performance. Imagine IM users scored an average of 6.07 points higher than students that did not use Imagine IM; $B = 6.07$, $t(486) = 2.40$, $p = .017$ (see **Figure 1**). Program usage and the other covariates in the model accounted for 60% of the variance found in Spring 2024 scores, $R^2 = .604$, $F(15,486) = 49.4$, $p < .001$. **Table 2** summarizes the results of the multiple linear regression.

Figure 1. Overall Impact of Imagine IM on Spring 2024 Acadience Math Composite Scores



*$p < .05$

Table 2: Overall Impact of Imagine IM on Spring 2024 Acadience Math Composite Scores

Coefficients	Estimate	Standard Error	*p*-value
Imagine IM User Indicator	6.07	2.53	.017
Intercept	72.24	9.59	<.001
Fall 2023 Acadience Math Composite Score	0.72	0.06	<.001
Grade Level			
Grade 1	-114.48	7.18	<.001
Grade 2	-45.75	3.91	<.001
Grade 3	-15.08	4.13	<.001
Grade 4	-13.65	4.33	.002
English Language Learner Indicator	-43.32	13.87	.002
Male Indicator	2.39	2.69	.374
Student with Disability Indicator	-28.04	4.39	<.001
Economically Disadvantaged Indicator	-10.80	2.65	<.001
Ethnicity			
American Indian	40.46	26.00	.120
Asian	-22.18	23.10	.337
Caucasian	16.03	8.81	.070
Hispanic	37.97	14.32	.008
Multi-Racial	9.15	10.05	.363

DIFFERENTIAL IMPACT BY GRADE LEVEL

A series of analyses were further conducted to examine whether the effects of Imagine IM varied across grade bands. Descriptive tables of unadjusted average Acadience math composite scores by grade bands can be found in **Appendix A** and tables demonstrating baseline equivalence by grade can be found in **Appendix B**. Imagine IM users had statistically significantly higher Spring 2023 Acadience math composite scores than comparable nonusers for Kindergarten and Grade 3–4 students. Results were non-significant for students in Grades 1–2 (Table 3). Complete regression results can be found in **Appendix C**.

Table 3: Impact of Imagine IM on Spring 2024 Acadience Math Composite Scores by Grade Band

Grade Level	Imagine IM Indicator Estimate	Standard Error	*p*-value
Kindergarten	14.12	6.42	.031
Grade 1–2	-2.11	2.88	.466
Grade 3–4	8.86	3.88	.024

NWEA MAP Growth Analysis

To ensure that the baseline characteristics of treatment and control students used in analyses were comparable, 1:1 nearest neighbor propensity score matching without replacement was used to create a statistically equivalent analytical sample.[2] Control students were matched to treatment students based on their Fall 2023 NWEA MAP Growth RIT score and all demographic factors. This matching process included only Grade 2 students because only students in Grade 2 took the NWEA MAP Growth math assessment in both the Fall and Spring. The resulting analytical sample included 58 users of Imagine IM and 58 non-users. Table 4 below describes the characteristics of the sample.

Table 4: Student Characteristics of the NWEA MAP Growth Analytical Sample

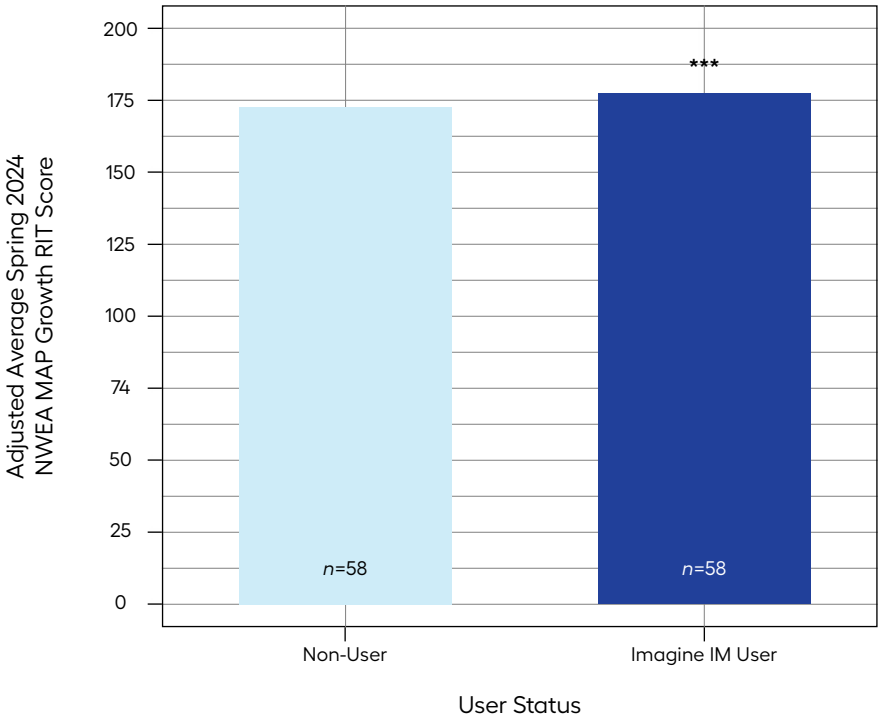
	Comparison Students (*n* = 58)	Imagine IM Students (*n* = 58)	*p*-value	Standardized Mean Difference (SMD)
Average (SD) Fall 2023 NWEA MAP Growth RIT Score	167.48 (11.10)	167.48 (11.10)	>.999	<.001
Grade Level			>.999	<.001
Grade 2	58	58		
Gender			>.999	<.001
Female	35	35		
Male	23	23		
Students with Disabilities			>.999	.055
No	52	51		
Yes	6	7		
English Language Learner			>.999	<.001
No	57	57		
Yes	1	1		
Economically Disadvantaged			>.999	<.001
No	24	24		
Yes	34	34		
Ethnicity			>.999	<.001
African American	1	1		
Caucasian	52	52		
Hispanic	2	2		
Multi-Racial	3	3		

[2]Propensity score matching was executed using the matchit function in R's MatchIt package. The caliper was set to 0.05 to ensure adequate baseline equivalence was achieved.

Descriptive tables of unadjusted average Fall 2023 and Spring 2024 NWEA MAP Growth scores can be found in **Appendix A**. Multiple linear regression was used to evaluate the differences in Spring 2024 NWEA MAP Growth Math achievement between Imagine IM users and nonusers, controlling for Fall 2023 NWEA MAP Growth math achievement and other covariates. An indicator of whether a student was a control or treatment student was included in the regression as the primary predictor variable.

Overall, use of Imagine IM was found to generate a positive and statistically significant impact on students' NWEA MAP Growth mathematics performance. Imagine IM users scored an average of 5.62 points higher than students that did not use Imagine IM; $B = 5.62$, $t(107) = 4.15$, $p < .001$ (**Figure 2**). Program usage and the other covariates in the model accounted for 67% of the variance found in Spring 2024 scores, $R^2 = .668$, $F(8,107) = 26.93$, $p < .001$. **Table 5** summarizes the results of the multiple linear regression.

Figure 2. Overall Impact of Imagine IM on Spring 2024 NWEA MAP Growth RIT



*** $p < .001$

Table 5: Overall Impact of Imagine IM on Spring 2024 NWEA MAP Growth Math RIT Scores

Coefficients	Estimate	Standard Error	*p*-value
Imagine IM User Indicator	5.62	1.35	<.001
Intercept	55.53	12.81	<.001
Fall 2023 NWEA MAP Growth RIT Score	0.75	0.07	<.001
Male Indicator	-0.44	1.46	.765
Student with Disability Indicator	-3.00	2.34	.203
Economically Disadvantaged Indicator	-1.80	1.49	.230
Ethnicity			
Caucasian	2.67	5.29	.614
Hispanic	-4.92	6.36	.441
Multi-Racial	-7.58	5.96	.206

MCAP Analysis

To ensure that the baseline characteristics of treatment and control students used in analyses were comparable, 1:1 nearest neighbor propensity score matching without replacement was used to create a statistically equivalent analytical sample.[3] Control students were matched to treatment students based on their Spring 2023 MCAP scaled score and all demographic factors. This matching process included only Grade 4 students; Grade 3 students participated in the MCAP assessment in Spring 2024 but did not have a baseline score from Spring 2023 and therefore are not included in the analysis. The resulting analytical sample included 46 users of Imagine IM and 46 non-users. Table 6 below describes the characteristics of the sample.

[3]Propensity score matching was executed using the matchit function in R's MatchIt package. The caliper was set to 0.02 to ensure adequate baseline equivalence was achieved.

Table 6: Student Characteristics of the MCAP Analytical Sample

	Comparison Students (*n* = 46)	Imagine IM Students (*n* = 46)	*p*-value	Standardized Mean Difference (SMD)
Average (SD) Spring 2023 MCAP Math Scaled Score	748.61 (14.34)	748.61 (14.34)	>.999	<.001
Grade Level			>.999	<.001
Grade 4	46	46		
Gender			>.999	<.001
Female	28	28		
Male	18	18		
Students with Disabilities			>.999	<.001
No	44	44		
Yes	2	2		
English Language Learner			>.999	<.001
No	46	46		
Economically Disadvantaged			>.999	<.001
No	25	25		
Yes	21	21		
Ethnicity			>.999	<.001
Caucasian	44	44		
Multi-Racial	2	2		

Descriptive tables of unadjusted average Spring 2023 and Spring 2024 MCAP scores can be found in **Appendix A**. Multiple linear regression was used to evaluate the differences in Spring 2024 MCAP math achievement between Imagine IM users and non-users, controlling for Spring 2023 MCAP math achievement and other covariates. An indicator of whether a student was a control or treatment student was included in the regression as the primary predictor variable. Using multiple linear regressions after propensity score matching ensured that any remaining differences in the underlying treatment and control samples were controlled for by the regression model, effectively isolating the impact of Imagine IM.

Overall, use of Imagine IM was found to generate a non-significant impact on students' MCAP mathematics performance, B = -0.70, $t(85)$ = -0.477, p = .635 (**Figure 3**). Program usage and the other covariates in the model accounted for 70% of the variance found in Spring 2021 scores, R^2 = .704, $F(6,85)$ = 33.73, p < .001. **Table 7** summarizes the results of the multiple linear regression.

Figure 3. Overall Impact of Imagine IM on Spring 2024 MCAP Math Scaled Scores

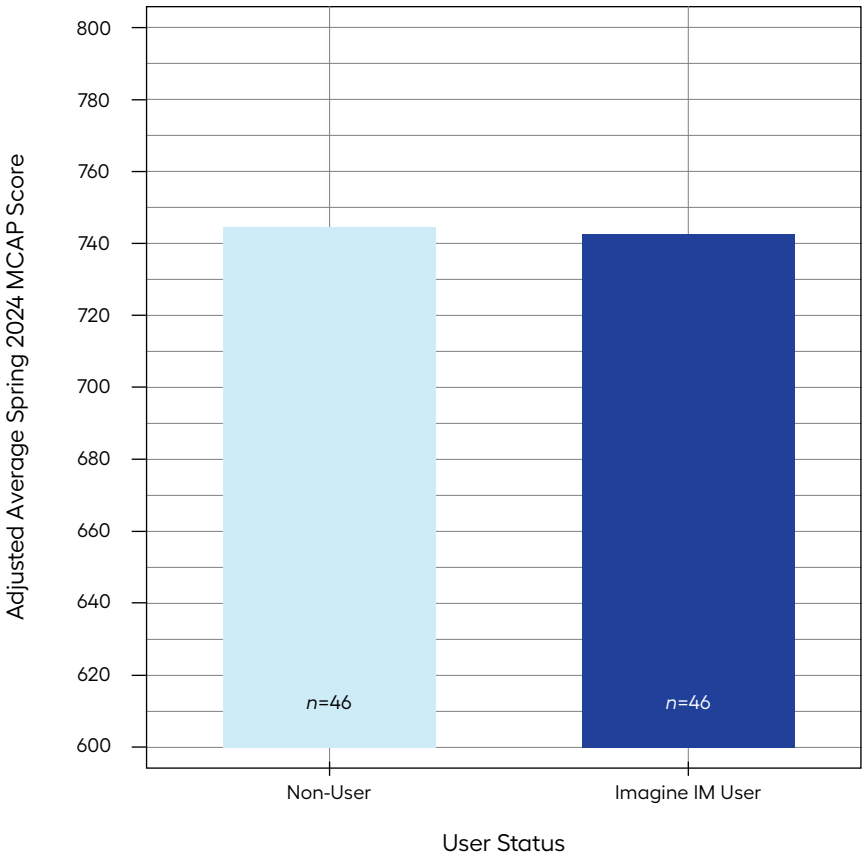


Table 7: Overall Impact of Imagine IM on Spring 2024 MCAP Math Scaled Scores

Coefficients	Estimate	Standard Error	*p*-value
Imagine IM User Indicator	-0.70	1.46	.635
Intercept	200.22	40.70	<.001
Spring 2023 MCAP Scaled Score	0.73	0.05	<.001
Male Indicator	0.11	1.60	.945
Student with Disability Indicator	-0.42	3.86	.913
Economically Disadvantaged Indicator	-0.40	1.61	.806
Multi-Racial Indicator	-0.42	3.80	.912

Conclusion

This study provides evidence of the efficacy of Imagine IM on student math achievement for students in Grades K–4 by comparing students who participated in Imagine IM with those who did not during the 2023–2024 school year. A limitation of this study is that schoollevel confounding factors are not controlled for in the analysis and may impact the results since there are not enough user schools for a sufficiently-powered analysis. This study is, however, a retrospective quasi-experimental design and uses propensity score matching, multiple linear regression, and multiple outcome measures to analyze the impact of Imagine IM. Results show that students who participated in Imagine IM scored six points higher on the Spring 2024 administration of the Acadience math test and five points higher on the NWEA MAP Growth math assessment than did similar comparison students. There was not a statistically significant difference in performance on the MCAP math assessment between Imagine IM users and non-users. Thus, this study provides evidence that the use of Imagine IM supports students' mathematics achievement.

References

Boser, U., Chingos, M., and Straus, C. (2015). The Hidden Value of Curriculum Reform: Do States and Districts Receive the Most Bang for Their Curriculum Buck? Retrieved from Center for American Progress: https://cdn.americanprogress.org/wp-content/uploads/2015/10/06111518/CurriculumMatters-report.pdf

Chingos, M., Whitehurst, G. (2012). Choosing Blindly: Instructional Materials, Teacher Effectiveness, and the Common Core. Retrieved from Brown Center on Education Policy at Brookings: https://www.brookings.edu/wp-content/uploads/2016/06/0410_curriculum_chingos_whitehurst.pdf

Doan, S., Kaufman, J. H., Woo, A., Tuma, A. P., Diliberti, M. K., and Lee, S. (2022). How States are Creating Conditions for Use of High-Quality Instructional Materials in K-12 Classrooms: Findings from the 2021 American Instructional Resources Survey. Retried from RAND Corporation: https://www.rand.org/pubs/research_reports/RRA134-13.html

EdReports. (2021). Imagine IM K–5 Math. Retrieved from: https://edreports.org/reports/detail/imagine-learning-illustrative-mathematics-k-5-math-2021/first-grade

What Works Clearinghouse. (2022). What Works Clearinghouse procedures and standards handbook, version 5.0. U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance (NCEE).

Appendix A

Table A1: Unadjusted Mean Acadience Math Composite Scores by Grade Band

	Fall 2023 (SD)	Spring 2024 (SD)	Mean Change
Grade K			
Imagine IM (*n* = 48)	24.65 (18.45)	104.21 (50.29)	79.56
Comparison (*n* = 48)	24.65 (18.45)	93.23 (45.34)	68.58
Grade 1–2			
Imagine IM (*n* = 93)	51.70 (55.45)	52.77 (23.97)	1.08
Comparison (*n* = 93)	51.70 (55.45)	55.29 (28.48)	2.59
Grade 3–4			
Imagine IM (*n* = 110)	46.23 (23.72)	105.85 (41.65)	59.62
Comparison (*n* = 110)	46.23 (23.72)	97.68 (41.25)	51.45
All Grades			
Imagine IM (*n* = 251)	44.13 (39.20)	85.87 (45.73)	41.74
Comparison (*n* = 251)	44.13 (39.20)	81.12 (42.71)	37.00

Table A2: Unadjusted Mean NWEA MAP Growth Scores

	Fall 2023 (SD)	Spring 2024 (SD)	Mean Change
Grade 2			
Imagine IM (*n* = 58)	167.48 (11.10)	187.22 (10.41)	19.74
Comparison (*n* = 58)	167.48 (11.10)	181.66 (13.27)	14.17

Table A3: Unadjusted Mean MCAP Math Scaled Scores

	Fall 2023 (SD)	Spring 2024 (SD)	Mean Change
Grade 2			
Imagine IM (n = 46)	748.61 (14.34)	743.70 (11.86)	-4.91
Comparison (n = 46)	748.61 (14.34)	744.39 (13.12)	-4.22

Appendix B

Table B1: Kindergarten Baseline Equivalence

	Comparison Students (*n* = 48)	Imagine IM Students (*n* = 48)	*p*-value	Standardized Mean Difference (SMD)
Average (SD) Fall 2023 Acadience Composite Score	24.65 (18.45)	24.65 (18.45)	>.999	<.001
Grade Level			>.999	<.001
Grade K	48	48		
Gender			>.999	.042
Female	27	26		
Male	21	22		
Students with Disabilities			.551	.183
No	43	40		
Yes	5	8		
English Language Learner			>.999	<.001
No	46	46		
Yes	2	2		
Economically Disadvantaged			>.999	<.001
No	24	24		
Yes	24	24		
Ethnicity			>.999	<.001
American Indian	1	1		
Asian	1	1		
Caucasian	45	45		
Multi-Racial	1	1		

Table B2: Grade 1-2 Baseline Equivalence

	Comparison Students (*n* = 93)	Imagine IM Students (*n* = 93)	*p*-value	Standardized Mean Difference (SMD)
Average (SD) Fall 2023 Acadience Composite Score	51.70 (55.45)	51.70 (55.45)	>.999	<.001
Grade Level			>.999	<.001
Grade 1	28	28		
Grade 2	65	65		
Gender			.883	.043
Female	53	51		
Male	40	42		
Students with Disabilities			>.999	.037
No	85	84		
Yes	8	9		
English Language Learner			>.999	.147
No	92	93		
Yes	1	0		
Economically Disadvantaged			.768	.065
No	43	40		
Yes	50	53		
Ethnicity			.547	.215
African American	3	2		
Caucasian	82	79		
Hispanic	3	2		
Multi-Racial	5	10		

Table B3: Grade 3-4 Baseline Equivalence

	Comparison Students (*n* = 110)	Imagine IM Students (*n* = 110)	*p*-value	Standardized Mean Difference (SMD)
Average (SD) Fall 2023 Acadience Composite Score	46.23 (23.72)	46.23 (23.72)	>.999	<.001
Grade Level			>.999	<.001
Grade 3	52	52		
Grade 4	58	58		
Gender			>.999	<.001
Female	54	54		
Male	56	56		
Students with Disabilities			.411	.139
No	99	94		
Yes	11	16		
English Language Learner			>.999	.061
No	108	107		
Yes	2	3		
Economically Disadvantaged			.893	.036
No	59	57		
Yes	51	53		
Ethnicity			.994	.039
African American	3	3		
Caucasian	97	98		
Hispanic	3	3		
Multi-Racial	7	6		

Appendix C

Table C1: Kindergarten Baseline Equivalence

Coefficients	Estimate	Standard Error	*p*-value
Imagine IM User Indicator	14.12	6.42	.031
Intercept	75.50	34.91	.033
Fall 2023 Acadience Math Composite Score	1.28	0.20	<.001
English Language Learner Indicator	-26.49	26.01	.311
Male Indicator	16.71	7.43	.027
Student with Disability Indicator	-55.86	11.52	<.001
Economically Disadvantaged Indicator	-8.79	6.69	.193
Ethnicity			
Asian	-40.31	34.39	.244
Caucasian	-8.83	34.35	.798
Multi-Racial	-34.72	40.77	.397

Table C2: Grade 1–2 Regression Results

Coefficients	Estimate	Standard Error	*p*-value
Imagine IM User Indicator	-2.11	2.88	.466
Intercept	-11.63	11.17	.300
Fall 2023 Acadience Math Composite Score	0.40	0.05	<.001
Grade Level			
Grade 2	36.07	5.96	<.001
English Language Learner Indicator	-34.45	22.46	.127
Male Indicator	-0.74	3.20	.817
Student with Disability Indicator	-21.32	5.54	<.001
Economically Disadvantaged Indicator	-11.17	3.01	<.001
Ethnicity			
Caucasian	30.42	9.07	.001
Hispanic	41.93	13.64	.002
Multi-Racial	23.38	10.19	.023

Table C3: Grade 3–4 Regression Results

Coefficients	Estimate	Standard Error	*p*-value
Imagine IM User Indicator	8.86	3.88	.024
Intercept	47.40	13.40	<.001
Fall 2023 Acadience Math Composite Score	1.18	0.10	<.001
Grade Level			
Grade 4	-7.49	4.39	.090
English Language Learner Indicator	9.10	31.84	.775
Male Indicator	5.33	3.99	.183
Student with Disability Indicator	-14.72	6.42	.023
Economically Disadvantaged Indicator	-8.32	4.15	.046
Ethnicity			
Caucasian	3.26	12.21	.790
Hispanic	-22.67	31.29	.470
Multi-Racial	-1.67	14.51	.909