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# Analysis of the Effect of MindPlay Usage on Students' Reading Scores in Grades K-6

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## ABSTRACT

This technical report presents analyses and results from a quasi-experimental study of the effect of the MindPlay program on reading achievement scores of students (n=15,881) enrolled in grades K–6 in Dayton (Ohio) Public Schools. Growth trajectory analyses were based on student test scores on the Measures of Academic Progress (MAP) Reading test for six cohorts of students in grades K-6 between the 2016-17 and 2022-23 academic years. The results of the growth-curve analysis confirm a positive effect of MindPlay usage on students' MAP reading score growth over time, even after accounting for a COVID slump evident in national data. We found that growth rates in reading scores of Dayton students during the implementation of MindPlay were significantly higher than the national average (by +0.2 to +0.6 points per year) with even larger increases in reading growth for students who used MindPlay up to 80 or 150 minutes per week. This suggests that implementation of MindPlay may have significantly reduced the COVID slump in Dayton and, instead, allowed many Dayton students to make gains that moved them closer to national average levels of reading achievement.

# INTRODUCTION

The purpose of this study was to examine the effect of MindPlay usage on students' reading achievement scores from the Measures of Academic Progress (MAP) reading test in the Dayton (Ohio) Public Schools (DPS). MindPlay was made available to all students in grades K-10 beginning with the 2018-19 school year, with a particular focus on grades 2 through 6. Implemented as a supplemental resource available for students to use within the school day under faculty supervision and independently outside of the regular classrooms, MindPlay was intended to enhance regular classroom instruction and to work as an integrated strategy embedded in Dayton's existing reading curricula and instructional strategies.

The amount of time spent using MindPlay varied across students, classes, and schools. As such, this study seeks to estimate two impacts: (1) the overall impact of adopting MindPlay, averaged across all K-6 students, regardless of how much the students used it, and (2) the impact of MindPlay under different levels of usage (i.e., 30, 80, and 150 minutes per week).

For this study, CRESP analyzed student test scores on the MAP Reading test for six cohorts of students in grades K-6 administered between fall 2016 and fall 2022. The scores produced by the MAP Reading test are designed to measure reading proficiency and growth (Thum & Kuhfeld, 2020), and differences in national average MAP scores between grades are indicative of expected growth in reading ability for students in US schools. We leverage this aspect of the MAP Reading test to benchmark growth in reading performance of DPS students relative to national averages. Our analyses also examined the total number of minutes of MindPlay usage per academic year for students who attended DPS schools in 2018-19 and later (i.e., those for whom MindPlay was available). These analyses address question # 2 above directly by comparing growth rates at different levels of usage. Based on these two sources of data, along with data on the national average scores on the MAP reading test from 2016 through 2022 (Kuhfeld & Lewis, 2022a; 2022b; Thum & Kuhfeld, 2020), we estimated a multilevel growth curve statistical model to examine students' growth trajectories and whether the usage of MindPlay was associated with additional gains in MAP reading scores.

# METHOD

## DATA PROCESSING AND DESCRIPTIVE STATISTICS

MindPlay delivered to CRESP the two main sources of data for this analysis: outcomes on the MAP reading test and measures of student usage of MindPlay. MAP tests score data was provided to MindPlay by Dayton Public Schools' district office, and student names and IDs were removed from the data before delivery to the research team.  A third source of data was information about national averages of MAP reading scores from two NWEA research reports

(Kuhfeld & Lewis, 2022a; 2022b) along with pre-COVID national norm data for the MAP assessment (Thum & Kuhfeld, 2020). The national average MAP scores for grades K-6 were used to estimate average national growth trajectories by grade level from 2016-2022 as a benchmark comparison for the growth trajectories of Dayton students.

For the students' RIT (Rasch Unit) scores on the MAP reading test, we first computed descriptive statistics, including means, standard deviations, and frequency counts to examine the distributions of test scores (Kuhfield & Lewis, 2022a). For the growth curve analysis, we used the students' grades and test dates to compute a continuous grade variable that indicated at what point in the grade the test was taken. For example, a student in 4th grade who had taken a MAP reading test on September 20th would have a grade value of 4.14 to reflect that 14% of the 4th grade school year had elapsed prior to the test date. This new grade variable was centered at the middle of 3rd grade by subtracting 3.5 in order to center the model intercepts near the middle of the data. A binary indicator for the timing of the COVID pandemic was derived for any test administered after June 1, 2020 to identify test administrations at least three months into the pandemic (i.e., when substantial detrimental effects on student progress are likely to have materialized). Another binary indicator for implementation of MindPlay was derived for any tests after August 1, 2018 (i.e., the date on which access to MindPlay became available to all students in the district).

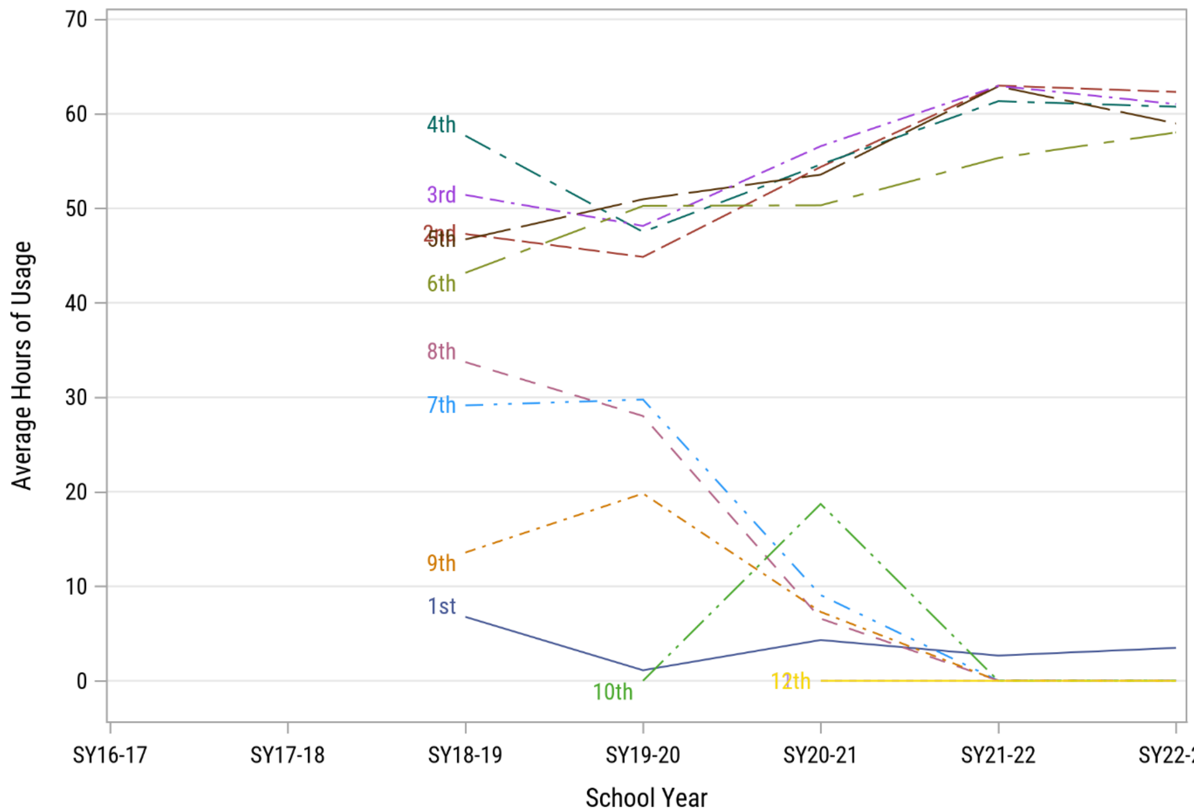
To incorporate a dosage effect of MindPlay into the growth curve analysis, we used the total number of minutes that each student used MindPlay in each academic year. After conducting descriptive analyses of the minutes used, we found that there were students for whom test-scores after fall 2019 were available, but there was no corresponding record in the MindPlay usage data set. These students are assumed to have not used MindPlay at all that year. For example, if a student in the test-score dataset had MAP reading scores in 5th and 6th grade in 2019 and 2020, but no record of minutes used in the corresponding academic years in the MindPlay usage data, that student was assigned a value of 0 for minutes used. In this way, we seek to produce an unbiased estimate of the effect of usage on MAP reading scores. Our analysis showed that very few students in grades 2-6 were missing usage data, but many students in grades K-1 and 7-12 did not use MindPlay (see Table 1). This aligns well with the focused implementation of MindPlay in grades 2-6 in Dayton.

To simplify the interpretation of the growth curve estimates, we centered the value of minutes used within each grade. This grade-centering produces a value for each students' minutes used relative to the average usage of all students in that grade. For example, the average usage of 4th graders was approximately 3,387 minutes across an entire school year. Thus, if a 4th grader had 4,000 minutes of usage, their grade-centered value of usage in our statistical model would be +613 minutes. Centering usage at the grade level is further justified because the average amount of usage by K-6 students was fairly stable within each grade level across the different academic years (see Figure 1). Centering was helpful for the growth curve model because it enables us to estimate the average effect of MindPlay (i.e., impacts for the average student) along with impact estimates by level of usage, all within a single statistical model. In order to improve interpretation, this centered value of annual minutes was then divided by 36 to convert it to a weekly value of usage (assuming students would be using MindPlay in an academic year consisting of 36 weeks). We then divided that value by 10 so that a 1-unit change in the MindPlay usage variable was the effect of an increase of 10 additional minutes of MindPlay usage per week.

**Table 1. Percent of Students Missing MindPlay Usage Data**

| Grade | Students Missing Usage | Total Students | Percent |
|---|---|---|---|
| ~ | 378 | 802 | 47.13% |
| K | 2,249 | 2,265 | 99.29% |
| 1 | 3,204 | 3,746 | 85.53% |
| 2 | 166 | 4,406 | 3.77% |
| 3 | 124 | 4,644 | 2.67% |
| 4 | 119 | 4.314 | 1.89% |
| 5 | 107 | 4,378 | 2.44% |
| 6 | 108 | 4,301 | 2.51% |
| 7 | 2,166 | 3,928 | 55.14% |
| 8 | 2,313 | 3,799 | 60.88% |
| 9 | 3,308 | 4,270 | 77.47% |
| 10 | 1,759 | 1,789 | 98.32% |
| 11 | 1,343 | 1,343 | 100% |
| 12 | 577 | 577 | 100% |

**Figure 1. Average MindPlay Usage by Year (For Each Grade)**




To draw comparisons with the national trend of students' MAP score trajectories, we estimated a linear model of the national growth trajectory using national norms from years 2016-2022 from Kuhfeld and Lewis (2022a). The estimated trajectory reflects the average growth trajectory of the real-world counterpart population during the years MAP scores are available for Dayton students (i.e., 2016-2022). These national average scores come from Table 3 in Kuhfeld and Lewis (2022a), Table 3 in Kuhfeld and Lewis (2022b), and Table A.1 in Thum and Kuhfeld (2020). The data for the prototypical national average students included the same binary COVID identifier as the Dayton students, but all values of the binary MindPlay variable were coded 0 to reflect students who never had access to MindPlay.

### GROWTH CURVE ANALYSIS

We used the PROC HPMIXED procedure in SAS 9.4 to fit a multilevel growth curve model with the following form:

$$
\begin{aligned}
RITscore_{it} = {} & \gamma_{00} + \gamma_{10}(Grd) + \gamma_{20}(Grd^2) + \\
& \gamma_{01}(COVID) + \gamma_{02}(MindPlay) + \gamma_{03}(MindPlay \times Usage) + \\
& \gamma_{11}(COVID \times Grd) + \gamma_{12}(MindPlay \times Grd) + \gamma_{13}(MindPlay \times Usage \times Grd) + \\
& \gamma_{21}(COVID \times Grd^2) + \gamma_{22}(MindPlay \times Grd^2) + \gamma_{23}(MindPlay \times Usage \times Grd^2) + \\
& + e_{0i} + e_{1i}(Grd) + e_{2i}(Grd^2) + r_{it}
\end{aligned}
$$

The first line of the model includes the main growth trajectory intercept ($\gamma_{00}$) and slope terms (linear: $\gamma_{10}$; quadratic: $\gamma_{20}$) for each student. The parameters for COVID and MindPlay were included as time-varying predictors to estimate the effect on the growth rates for the onset of COVID and access to MindPlay, including their effects on growth rates (i.e., as two- and three-way interaction terms). The usage term was included only through interactions with the MindPlay indicator so that the amount of usage would be included in the model only when MindPlay=1 (the period in which MindPlay was available to Dayton students).

The model also included random effects terms (the $e$ and $r$ parameters shown in the last line of the model) to estimate the variance of baseline achievement and growth rates for the Dayton school children. Our primary interests were to estimate (A) the overall effect of MindPlay (averaged across all students with access, regardless of usage) evident in the $\gamma_{02}$, $\gamma_{12}$ and $\gamma_{22}$ model parameters above, and (B) the additional effect additional minutes of MindPlay usage for those who had access to MindPlay, evident in the $\gamma_{03}$, $\gamma_{13}$ and $\gamma_{23}$ model parameters above.

## RESULTS

The results of the growth-curve analysis indicate that there was, on average overall, a positive effect of MindPlay usage on students' RIT scores. Dayton students' baseline achievement prior to the implementation of MindPlay was significantly lower than the national average (by -1.8 points), and negative impacts of the COVID pandemic on achievement are significant in both the Dayton and national average trajectories (see Figure 2). However, the growth in RIT scores of Dayton students during the implementation of MindPlay was significantly higher than the national average (by +0.2 to +0.6 points per year). This suggests that implementation of MindPlay may have significantly reduced the COVID slump in Dayton and, instead, allowed many Dayton students to make gains that moved them closer to national average levels of reading achievement.

We also found that an increase of 10 minutes of MindPlay usage per week was associated with an additional gain of +0.29 points on the RIT score. In addition, an increase of 10 minutes of

MindPlay usage per week was associated with an increase of +0.14 points for a students' growth rate.

To illustrate the effect of MindPlay usage we calculated model-based estimates of RIT score trajectories for students with average weekly usage of 30, 80, and 150 minutes. These three separate growth trajectories (along with the trajectory of the national average) are included in the panel plot in Figure 2. The trajectories shown represent the expected trajectory averaged across the students with each level of usage, based on the parameter estimates from the growth model. Each panel reflects the growth for a separate cohort (one for each grade level starting in 2016). Results show that for the 2nd through 5th grade cohorts, the growth rates of Dayton students prior to the introduction of MindPlay are clearly slower than the national average; but after the introduction of MindPlay, the growth rates in Dayton match or exceed the national average. In all cohorts, those students who used MindPlay for more minutes per week had RIT scores that were closer to the national average.

**Figure 2. Model-Based Estimates of Average RIT Scores**

## REFERENCES

Kuhfeld, M. & Lewis, K. (2022a). *Technical appendix for: Student achievement in 2021-22: Cause for hope and continued urgency.* NWEA. Retrieved from https://www.nwea.org/uploads/2022/07/Technical-appendix-for-Student-achievement-in-2021-22-Cause-for-hope-and-continued-urgency.pdf

Kuhfeld, M. & Lewis, K. (2022b). *Technical appendix for: Progress towards pandemic recovery: Continued signs of rebounding achievement at the start of the 2022-23 school year*. NWEA. https://www.nwea.org/uploads/2022/12/Tech-Appendix-for-progress-towards-pandemic-recovery.pdf

Thum, Y. M., & Kuhfeld, M. (2020). *NWEA 2020 MAP growth achievement status and growth norms for students and schools*. NWEA Research Report. Portland, OR: NWEA

# APPENDIX A:
# STATISTICAL ESTIMATES FROM MULTILEVEL GROWTH CURVE MODEL

Table A1 includes the parameter estimates and standard errors for the fixed effects in the growth curve model that was fit in the PROC HPMIXED procedure in SAS 9.4.

| Effect | Model Parameter | | Estimate | Standard Error |
|---|---|---|---|---|
| Expected Baseline RIT Score | $\gamma_{00}$ | Intercept | 182.81*** | 0.02 |
| Expected Baseline Growth Rate | $\gamma_{10}$ | Grd | 9.59*** | 0.06 |
| Expected Growth Trajectory Curve | $\gamma_{20}$ | Grd*Grd | -0.88*** | 0.02 |
| Baseline Impact of COVID | $\gamma_{01}$ | COVID | -3.81*** | 0.02 |
| Impact of COVID on Baseline Growth Rate | $\gamma_{11}$ | Grd*COVID | -0.84*** | 0.06 |
| Impact of COVID on Trajectory Curve | $\gamma_{21}$ | Grd*Grd*COVID | 0.28*** | 0.03 |
| Baseline Difference at Start of MindPlay | $\gamma_{02}$ | MindPlay | -1.76*** | 0.15 |
| Impact of MindPlay on Baseline Growth Rate | $\gamma_{12}$ | Grd*MindPlay | 0.09 | 0.05 |
| Impact of MindPlay on Trajectory Curve | $\gamma_{22}$ | Grd*Grd*MindPlay | 0.10** | 0.03 |
| Difference in Baseline Achievement per 10 additional minutes of MindPlay each Week | $\gamma_{04}$ | MindPlay*Usage | 0.29*** | 0.02 |
| Impact on Baseline Growth Rate per 10 additional minutes of MindPlay each Week | $\gamma_{14}$ | Grd*MindPlay*Usage | 0.14*** | 0.01 |
| Impact on Trajectory Curve per 10 additional minutes of MindPlay each Week | $\gamma_{24}$ | Grd*Grd*MindPlay*Usage | -0.03*** | 0.01 |

Note. $N_{datapoints}$= 109,453 , $N_{DaytonStudents}$ = 15,701, $^{***}p < .0001$, $^{**}p<.01$