

Struthers City School District: 2018-2019

MATHia Performance & Student Outcomes

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Background

Struthers City School District (Ohio) implements Carnegie Learning's blended Math Solutions and has done so for 3 years across Grades 6-8, Algebra I-II, and Geometry. District officials shared de-identified student data with Carnegie Learning that we use to quantify the association between usage of Carnegie Learning's *MATHia*™ software with outcomes on the mathematics assessment developed by American Institutes of Research (AIR) that are used by schools in Ohio.

Data

Struthers City School District officials shared de-identified data for 95 students who used *MATHia* in the 2018-19 academic year with Carnegie Learning. Data included scores (and achievement levels) for Ohio's end-of-year math exam (developed by the American Institutes for Research or AIR, and often referred to by this acronym) in the 2017-18 and 2018-19 academic years, *MATHia* Adaptive Personalized Learning Score (APLSE) mid-year student categorizations (December 2018), Ohio Section 504 status, special education status, and the mathematics teacher for the class in which students used *MATHia*. Since our focus is on growth in AIR mathematics assessment scores, analyses that follow consider data for 87 of these students, for whom prior year (2017-18) AIR assessment outcomes were available in the data provided.

Analysis Approach

We adopt a predictive modeling approach similar to the approach used in other peer-reviewed, published analyses that associate *MATHia* usage with longer-term standardized test outcomes.^{1,2} However, rather than rely on the granular *MATHia* measures used in the existing modeling work, we primarily rely on APLSE, a workspace-level progress monitoring metric introduced by Carnegie Learning in its *MATHia* reporting analytics, which are based on this work. In each *MATHia* workspace, students are awarded APLSE points based on the extent to which they master skills associated with the workspace, the number of errors made and hints requested in the workspace, and the number of problems required to reach workspace completion. Each of these performance metrics are compared to historical data for each workspace, and a score per workspace is then computed. The overall percentage of points earned by a student compared to the APLSE points available in the student's assigned workspaces provides an overall measure of a student's work in *MATHia* performance and their performance during this work.

Results

We test our ability to predict 2018-19 AIR scores on:

- Prior year (2017-18) end-of-year math exam (AIR) score
- Usage and success in *MATHia* in 2018-19, as measured by APLSE percentage
- Special education status
- Ohio State Section 504 disability status
- Teacher identity

¹ Zheng, G., Fancsali, S.E., Ritter, S., Berman, S. (2019). Using Instruction-Embedded Formative Assessment to Predict State Summative Test Scores and Achievement Levels in Mathematics. *Journal of Learning Analytics*, 6(2), 153–174.

² Ritter, S., Joshi, A., Fancsali, S.E., Nixon, T. (2013). Predicting Standardized Test Scores from Cognitive Tutor Interactions. In *Proceedings of the Sixth International Conference on Educational Data Mining*, 169–176.

Table 1 summarizes the linear regression model to predict 2018-19 AIR score with these variables. We find that *2017-18 AY AIR Score* and *2018-19 AY Final % APLSE* are significant predictors of 2018-19 AIR scores, indicating that a combination of prior performance and performance in *MATHia* in the current academic year predicts AIR outcomes. The resulting model explains approximately 72% of the variation in 2018-19 AIR Score outcomes (i.e., adjusted $R^2 = 0.72$). Holding the other predictors fixed, the results suggest that a 10% increase in APLSE earned is associated with a 4.3 point increase in AIR Score. The insignificance of the remaining predictor variables suggests that *MATHia* performance is just as predictive for students with special education and Section 504 status as for those without such indicators and that classroom implementations of the two teachers represented in the data set are consistent.

We also consider correlation of *MATHia* performance with *growth* in AIR scores from the 2017-18 to 2018-19 and provide a scatter plot in Figure 1. This correlation (0.36) is statistically significant (two-sided Pearson test: $p < 0.001$). There is also no statistically significant correlation between prior year AIR score in 2017-18 and AIR score growth (two-sided Pearson test: $p = 0.54$), indicating that the association between APLSE and AIR score is consistent for students across all prior achievement levels. Figure 2 plots the association of *MATHia* performance with growth in *achievement level* on the AIR (e.g., a growth in achievement level of one might represent moving from “basic” to “proficient” or from “proficient” to “accelerated,” and so on, from the 2017-18 to 2018-19). Figures 1 and 2 illustrate the mid-year APLSE category for each student as a way of determining the extent to which mid-year projections accurately reflect year-end outcomes. Generally, mid-year APLSE category corresponds to end-of-year percent of APLSE earned, with all but a few “approaching” (yellow points in Figure 1) students earning between 50-70% of their final APLSE. However, several students moved from the “approaching” category at mid-year to the “on-track” category ($\geq 70\%$ APLSE in Figure 1) and achieved growth in AIR score.

Discussion & Recommendations

The statistical significance of APLSE over and above prior-year AIR scores in predicting year-end AIR scores demonstrates the value of APLSE as a metric for progress monitoring and performance targeting end-of-year AIR scores; APLSE is *not* merely a measure of prior knowledge and ability. Our analysis of student growth also supports this conclusion. Students who showed greater success in *MATHia* tended to demonstrate more growth in knowledge, as measured by AIR scores, suggesting that such growth may be driven by *MATHia* usage, not just prior student ability, which, as measured by prior year AIR scores, we found to be uncorrelated with AIR score growth.

Findings of the present analysis are consistent with previous, published research on *MATHia* usage in states including Florida, Virginia, and West Virginia. The general consistency of mid-year APLSE categories with year-end findings suggests relatively consistent usage and performance throughout the academic year, but the fact that students moved “out” of the “approaching” category to be “on-track” also represents an opportunity for future progress monitoring and potential interventions to improve learner performance.

Predictor Variable	Parameter Estimate	P-value
<i>Intercept</i>	146.5	0.01*
<i>2017-18 AY AIR Score</i>	0.77	< 0.001***
<i>2018-19 AY Final % APLSE</i>	0.43	< 0.001***
<i>Teacher (Binary)</i>	-1.01	0.76
<i>Special Education Status (Binary)</i>	5.61	0.27
<i>Section 504 Status (Binary)</i>	2.28	0.75

Table 1. Summary of least squares linear regression model predicting 2018-19 AIR scores with five predictor variables (n = 86; adjusted $R^2 = 0.72$; * = significant @ $\alpha = 0.05$ level; * = significant @ $\alpha = 0.001$ level)**

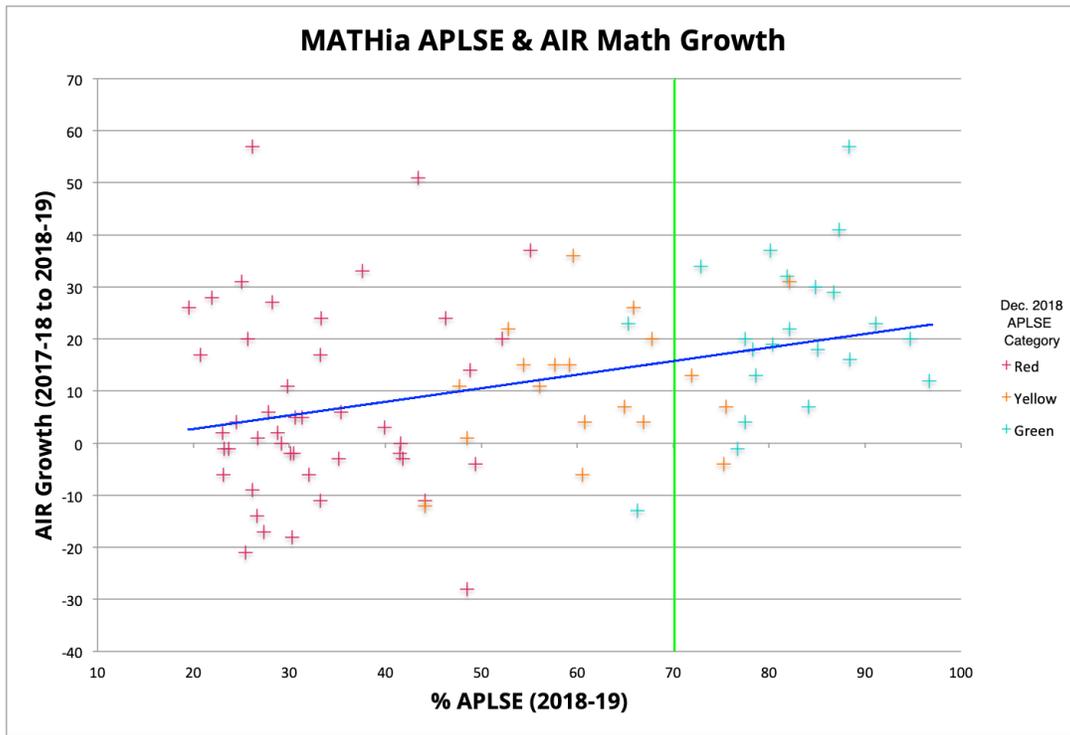


Figure 1. Scatterplot of % APLSE earned in the 2018-19 academic year by 86 Struthers City students against AIR growth between the 2017-18 and 2018-19 academic years. The line of best fit is displayed in blue and a green line at % APLSE = 70% represents Carnegie Learning’s “on-track” criteria for APLSE. Point colors represent the APLSE “category” of each student roughly at mid-year (in December 2018; Red = “Needs Remediation”; Yellow = “Approaching”; Green = “On-Track”).

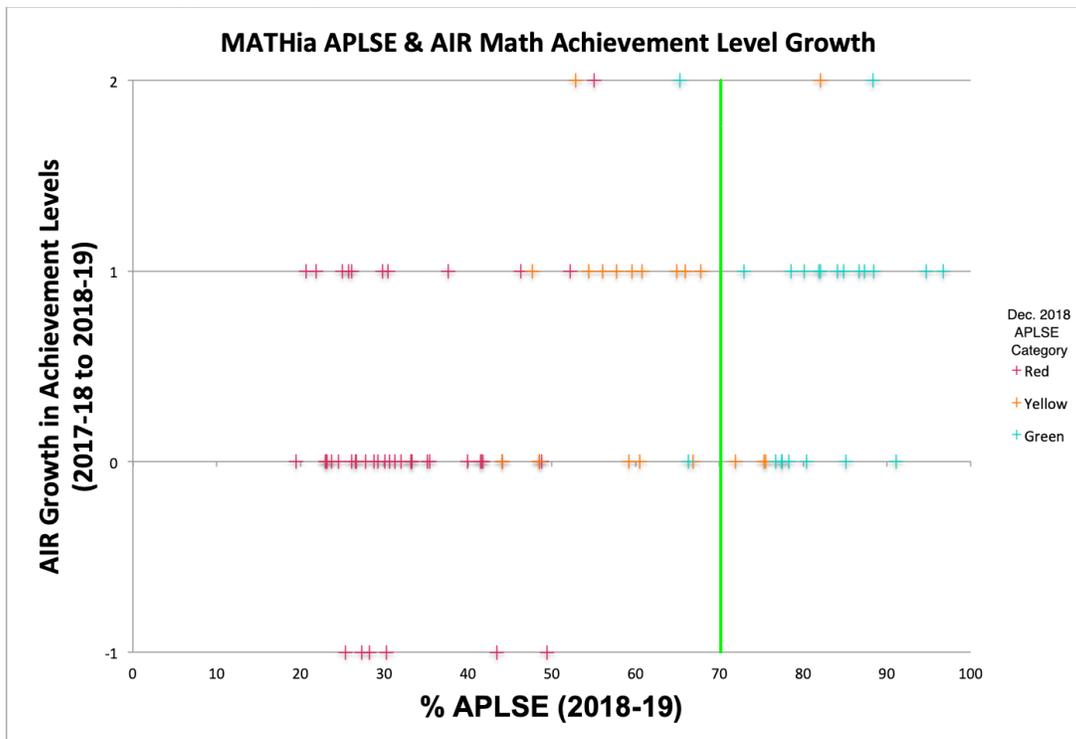


Figure 2. Scatterplot of % APLSE earned in the 2018-19 academic year by 86 Struthers City students against AIR achievement level growth between the 2017-18 and 2018-19 academic years. The green line at % APLSE = 70% represents Carnegie Learning’s “on-track” criteria for APLSE. Point colors represent the APLSE “category” of each student roughly at mid-year (in December 2018; Red = “Needs Remediation”; Yellow = “Approaching”; Green = “On-Track”).