Missouri Classroom Diagnostic Tool Predictive Study Plan

Version 1.0

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Introduction

This document presents a plan for a study that will be conducted to examine the predictive relationship between the Missouri Classroom Diagnostic Tool (CDT) assessment and the associated Missouri Assessment Program (MAP) in grades 3 through 8 in English Language Arts (ELA) and Mathematics. The MAP is an assessment system designed to measure student learning as directed by the Missouri Department of Elementary and Secondary Education (DESE). Each content area of MAP is assessed through multiple-choice and constructed response items (including technology-enhanced items) and there are four performance levels associated with each content area. The MAP assessments are administered on-line.

The CDT assessments are computer-adaptive assessments in Reading and Mathematics. Most of the items in the CDT assessments are aligned with Missouri Learning Standards. The CDT benchmarks are not Missouri-specific and currently reflect the content structure of the Pennsylvania state assessment in the associated grades and content area. CDT assessments were administered for the first time to Missouri students in the 2015-16 school year. CDT can be administered multiple times over the course of the academic year.

The CDT assessments are on content-specific vertical scales and increase in difficulty within and across grade levels because student ability increases over the course of the year and across grades. Assessment difficulty and student ability are matched by grade in order to have the desired result of minimizing the standard error of measurement. While the CDT was originally designed to provide diagnostic information about student performance to teachers throughout the school year, this study will focus on using the CDT assessment scores to provide teachers, students, and parents with an early indication of students' expected performance on the subsequent MAP assessment. This assumes an appropriate, positive relationship exists between the CDT scores and the associated MAP assessment scores. This study will be conducted in an attempt to validate this assumption.

Data Source

The study will be based on Missouri student data from 2015-2016 CDT and 2016 Spring MAP administrations in grades 3 through 8 in English Language Arts and Mathematics. If supported by the number of students tested throughout the year and CDT results, the CDT student scores will be analyzed by administration sub-windows: Fall/Winter window and Spring window.

The CDT data will be merged with MAP data in order to conduct the data analysis. Descriptive statistics including N counts, scale score means, and scale score standard deviations will be computed for CDT assessment per administration sub-window for each grade and content area to evaluate student performance progression across year. The corresponding MAP student scale score summaries will also be computed. In addition Pearson correlations between each set of CDT scores and the associated MAP scale scores will be computed to evaluate the direction and

magnitude of the relationship between CDT and MAP. A positive, moderate-to-strong relationship between the CDT and MAP scores is expected.

Method

Isotonic regression approach for prediction

The prediction of a MAP score will be derived using isotonic regression (Robertson, Wright, and Dykstra, 1988) of the MAP test conditional mean score given a CDT score. The MAP test conditional mean score $\bar{Y}_i$ will be calculated as follows:

$$\bar{Y}_i = E(Y \mid X = x_i), \quad (1)$$

where x_i is the CDT score and Y is the MAP score.

The isotonic regression finds the fitted value $\hat{z}_i$ that minimizes the sum $\Sigma_i(Y_i - \hat{z}_i)^2$ under the order constraints: if $x_i >= x_j$, then $\hat{z}_i >= \hat{z}_j$. To reduce the variation at the higher or lower ends of the ability range where the observations are often sparse with very few MAP test scores associated with a given CDT score, the ends of the regression line may be adjusted if necessary. For example, the isotonic regression will be calculated up to the highest CDT score that has at least 5 state test scores associated with it. Then, the isotonic regression line may be extrapolated out horizontally to the CDT highest obtainable score.

The standard error of prediction (SEP) will be calculated as follows:

$$SEP = \frac{\sqrt{\sum_i \sum_{k_j} \left(Y_{ik_j} - \hat{z}_i\right)^2}}{N}, \quad (2)$$

where N is the total number of students, index i runs through all the unique CDT scores, index ki runs through all the state summative MAP scores that are associated with the *i-th* unique CDT score. $Y\ ik\ i$ is a state MAP test score associated with the *i-th* unique CDT score, and $\hat{z}_i$ is the predicted MAP score for the *i-th* unique CDT score.

Computation of performance level probability

To estimate a student's probability of falling into *Proficient* or *Advanced* levels of the MAP test, an assumption will be made that the predicted MAP test score Z follows a normal distribution with mean = z and standard deviation = SEP, where z is the predicted score as calculated above. Although there are three MAP cut scores and we propose to use the *Proficient* cut only for greater accuracy of prediction. The probability of a student being classified as *Proficient* or *Above* based on his or her CDT scale score will be calculated.

Results
The following results will be presented as part of the study:

1) Scatter plots with the isotonic regression line showing the predictive relationship between the scale scores of a CDT scores (X-axis) and the scale scores of the associated MAP assessment (Y-axis) will be produced.

2) Using the Proficient cut score on MAP tests, contingency tables will be generated that compare observed and predicted performance level placement on the MAP tests. The "observed" means the classification based on the students' observed MAP results, and "predicted" indicates the classification based on the predicted scores resulting from the isotonic regression analyses conducted for the study.

3) The classification consistency (CC) rates will be generated. The sum of diagonal values in the contingency tables is the percent of classification consistency. This represents the percent of students whose observed and predicted performance levels classification matched with perfect agreement.

4) Tables with CDT scale score-to-expected MAP scale score-to-standard error of prediction for each grade and content area will be generated.

5) Lookup tables including CDT scores and the probability of being classified as *Proficient* or *Above* on the MAP test based on the isotonic regression analyses conducted for the study will be created. These tables can be provided in excel format (see an example below) and will also be included in a technical memo.

Subject	Grade	CDT Scale Score	Probability of '*Proficient* or *Above*' on MAP
Math	8	750	.15
Math	8	751	.16
Math	8	752	.16
Math	8	….	…..
Math	8	1050	.32
Math	8	1051	.34
Math	8	1052	.35.
Math	8	1053	.37
Math	8	…..	----
Math	8	1350	.68
Math	8	1351	.69
Math	8	1352	.70
Math	8	1353	.71
Math	8	…..	----

Summary

The results can be used by teachers as early indicators of students' expected performance on the Summative assessment assuming that there is a positive relationship between CDT and Summative. Diagnostic information coming from CDT can be used to adjust classroom instruction in order to target the areas of lower performance and increase the likelihood of success on the Summative assessment. The teacher can also compare the scale score growth (and associated probability of success) of each student across multiple administrations of the CDT.

Reference

Robertson, T., Wright, F.T., & Dykstra, R.L. (1988). *Order restricted statistical inference.* New York, Wiley.