An Attempt to Refine the High School RTI^2 Early Warning Detection System

Technical Report

Clint Sattler
Supervisor, Research and Evaluation
Knox County Schools
Department of Research, Evaluation, and Assessment

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Overview

Tennessee's Response to Instruction and Intervention (RTI^2) is a framework designed to better meet students' learning needs through tiers of academic support. Under this framework, all students receive Tier I supports and at-risk students receive increasingly intensive supports in Tiers II and III. Students are identified for Tier II and Tier III supports through a screening process and follow-up diagnostic assessments. In grades K through 8 RTI^2 screening requires nationally normed skills-based assessments. High school students can be screened by a multi-facetted early warning system (EWS) that incorporates a variety of student data (TDOE, 2017).

RTI^2 was implemented at the high school level in the 2016-2017 school year (SY1617). The Tennessee Department of Education (TDOE) provided a sample template for the types of student data to be included in an early warning system (TDOE, 2016). These characteristics included academic indicators, behavioral indicators, attendance, and other at-risk indicators (such as prior intervention enrollment, grade-level retention, special education status, English Language Learner status, and migrant youth status).

In the winter of 2016, the Knox County Schools (KCS) modified the template to better align with district priorities and needs (see Appendix A). The Knox County EWS included student attendance, performance on state exams, separate indicators for in-school and out-of-school suspension, remandment actions, and quarterly grades in the four cores subject areas (ELA, Math, Science, and Social Studies). After the initial year of implementation, the department of Research, Evaluation, and Assessment (REA) completed a preliminary study regarding the ability of the EWS to correctly classify Tier II and Tier III high school RTI^2 students (see Appendix B). The results of this study indicated that the EWS was a relatively poor classifier of enrollment in Tiers II and III. Feedback from a sample of high school principals confirmed the poor sensitivity of the EWS.

This study attempts to determine if the current EWS could be refined through a machine learning approach (specifically a regression tree) in order to more accurately identify the students that KCS high schools are actually placing in Tier II and III. A regression tree was constructed such that decision nodes were based on the existing criteria and cut-point in the existing EWS. Results indicate that a regression tree can increase the accuracy of overall student classification, but the model is less likely than the existing EWS to correctly classify student enrollment in Tiers II or III.

Methodology

RTI^2 tier enrollment, student behavior, scheduling, attendance, and grade data were extracted from the KCS student information system (ASPEN). Students were considered to be enrolled in Tier II or Tier III interventions if they had an active RTI^2 plan or if they were scheduled in any intervention course. The dataset for the analysis included all students in grades 10 through 12. Ninth grade students were omitted from this analysis because those students used a different set of state assessment data for their EWS. Students with individualized education plans (IEPs) were removed from the dataset because these students may have been scheduled in intervention classes in order to meet their IEP requirements. The final dataset included 11,256 students. Two hundred and sixty (260) students had either an active RTI^2 plan or were scheduled for an intervention class.

The classification algorithm chosen for this study was a regression tree model. The variables used in the algorithm were current-year (SY1718) attendance (100*days attended/days enrolled), the number of current-year in-school suspension actions, the number of current-year out-of-school actions, current-year remandment actions, the last 4 quarterly grades in Math, ELA, Science, and Social Studies classes (spanning the 2nd semester of SY1617 and the 1st semester of SY1718), and each student's entire history of performance on end-of-course state assessments. The data was organized to use the existing EWS criteria (i.e. classroom grades in the most recent 4 quarters, student performance less than the 25th percentile on state assessments, etc.) because these criteria align with current district goals. This analysis assumes that an ideal EWS system only identifies students who would be enrolled in Tier II or Tier III academic interventions.

The regression tree was run using the class method. Minimum node splits were set to 20 and minimum bucket sizes were set to 10 in order to avoid over-fit of the data. The complexity parameter tolerance for branch pruning was set to 0.0001. The regression tree was generated using R version 3.4.3 running on RStudio version 1.0.143. The required R packages for this analysis included rpart, rattle, and rpart.plot.

Results

The current high school EWS uses point totals in order to identify students as likely candidates for Tier II or Tier III intervention. Students earning 10 or more points in the system are denoted by icons in ASPEN for Tier II or III consideration. Application of the points-based EWS yields the classification matrix in Table 1.

Table 1: Existing EWS Classification Matrix

	EWS Points < 10	EWS Points ≥ 10
Tier I (only) student	9666	1330
Tier II or III student	137	123

The points-based EWS identified 1,453 students for Tier II or III consideration. Eighty-seven percent ([9,669+123]/[9,669+1,330+137+123] = 87%) of all students were correctly classified by this system and among the students served by Tier II and III supports, 47.3% of the students were correctly identified (123/[123+137] = 47.3%).

The regression tree generated by the analysis is contained in Figure 1.

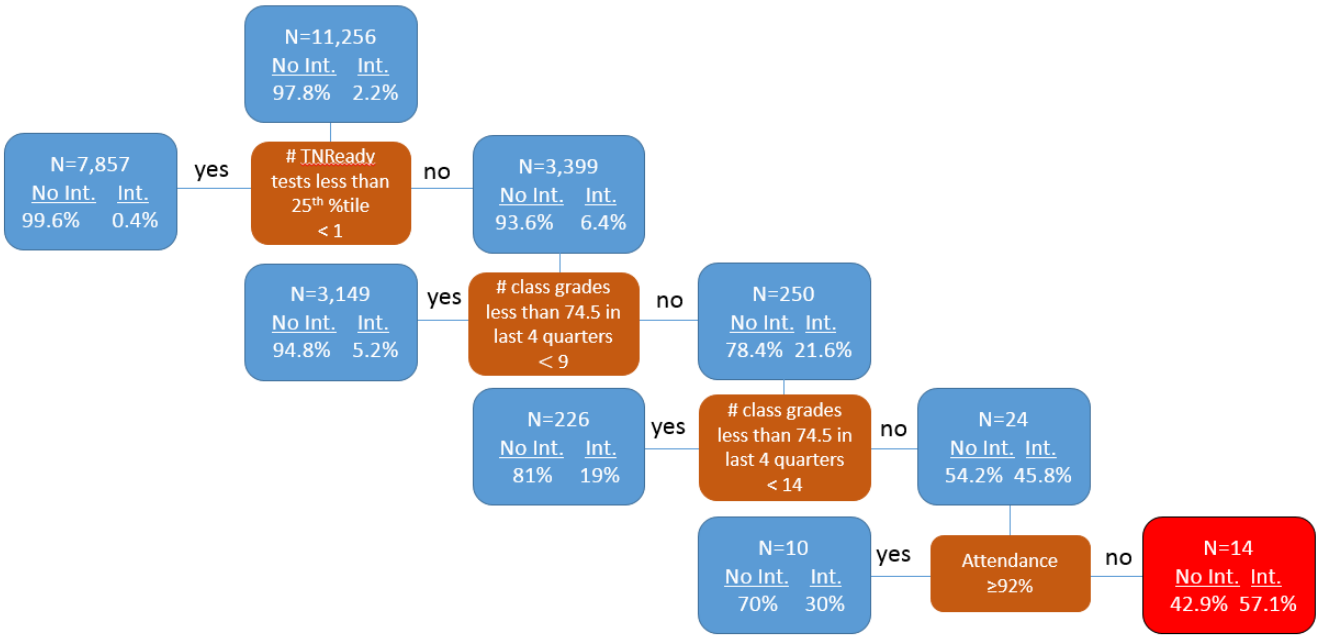

Figure 1: EWS Regression Tree

This regression tree identified only 14 students as probable Tier II or III enrollees, and of the 14 students identified, only 8 of those students were served in Tier II or III in SY1718. The full regression tree generated from the analysis is therefore poorly suited for identifying Tier II or III enrollment from the data. However, the model can be pruned to the second branch in the tree. This would result in 250 students identified for participation in Tier II or III

intervention (Figure 2). The classification matrix for the pruned regression tree is contained in Table 2.

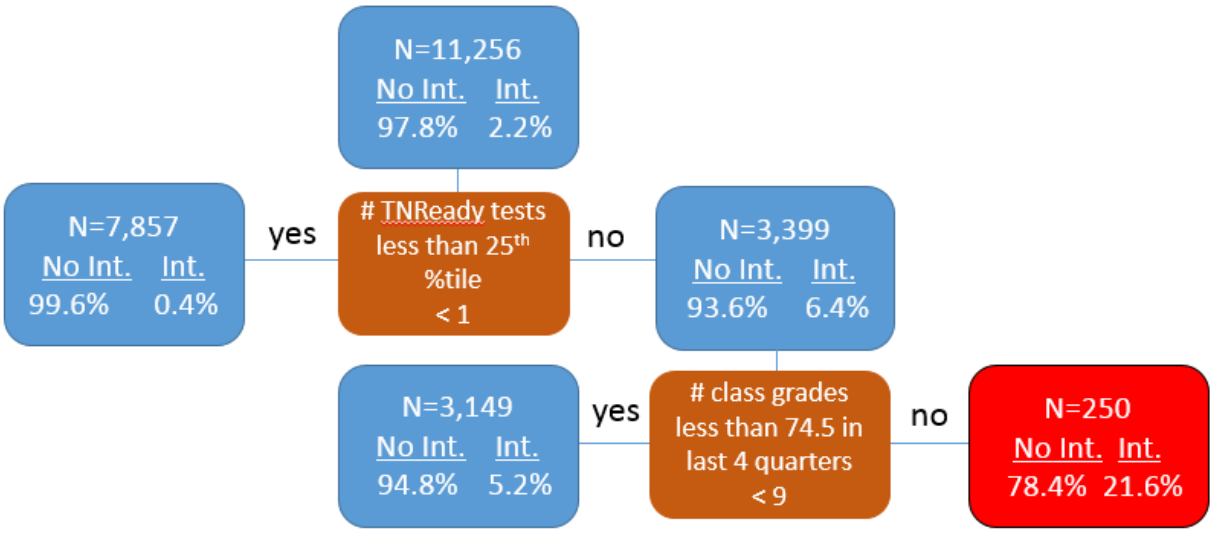

Figure 2: Pruned EWS Regression Tree

Table 2: Pruned Regression Tree EWS Classification Matrix

	Pruned Tree: Tier II/III=No	Pruned Tree: Tier II/III=Yes
Tier I (only) student	10801	195
Tier II or III student	205	55

The pruned regression tree identifies a much more manageable number of students for further screening and correctly classifies a higher percentage of students (96.4%) than the current EWS. However, among the students served by Tier II or III, the pruned tree only correctly identified approximately 20% of these students.

Conclusions & Considerations

The results of this analysis indicate that the classification of participation in Tier II and Tier III with both accuracy and precision is difficult. These results are similar to published findings regarding other early warning systems used in secondary education (Allensworth, Bowers). This analysis found three reasons for the relative poor predictive performance of each EWS.

The percentage of high school students receiving academic supports in Tier II or III interventions is relatively low. Only 2.3% of the active Knox County students in grades 10 through 12 were receiving support in Tiers II or III as of February 2018. The regression tree under-identified Tier II or III students in order to maximize the overall classification rate. The current points-based EWS was more accurate in correctly identifying students enrolled in Tier II or III, but it does so at the expense of the overall classification accuracy. For every 6 students identified by the points-based EWS, only 1 was actually supported by Tier II or III intervention.

School-based priorities add another layer of unpredictability to the data. Informal conversation with high school principals indicated that student participation in Tiers II or III were based on school-specific goals rather than the EWS point totals. One school may prioritize Tier II or III supports for students with poor grades whereas another school may prioritize performance on state examinations. The school-to-school variation in selection criteria for Tier II or III may indicate that a district-wide EWS will always be a poor classifier.

Finally, each EWS ignores some imbalances in the data. The EWS system considers classroom grades in the latest 4 quarters in core subjects (science, math, ELA, and social studies). However, not all students are scheduled in the same number of classes in these subjects. Similarly, the state assessment data is based on the number of state end-of-course exams in which a student scores in the bottom quartile. Under the existing EWS structure, which was the basis for the regression tree, students who are enrolled in a greater number of core classes or who have taken a greater number of end-of-course exams have a greater potential for identification.

It is likely that the best near-term solution is to continue the deployment of the points-based EWS. The Knox County schools would rather over-identify students for enrollment in Tier II or III than risk not identifying students who are truly at risk. Additionally, the district RTI^2 system is expected to shift from a (mostly) academic focus to an integrated multi-tiered support system that provides additional interventions tailored to behavioral and attendance issues. The current (points-based) early warning system will likely provide a better framework to identify at-risk students under this multi-tiered approach (Duffy).

References

Allensworth, E. The use of ninth-grade early warning indicators to improve Chicago schools. Journal of Education for Students Placed at Risk (JESPAR) 18.1 (2013): 68-83.

Bowers, A., Sprott, R., Taff, S. Do we know who will drop out? A review of the predictors of dropping out of high school: Precision, sensitivity, and specificity. *The High School Journal* (2012): 77-100.

Duffy, H. Meeting the Needs of Significantly Struggling Learners in High School: A Look at Approaches to Tiered Intervention. *National High School Center (2007)*.

TDOE, Accessing Progress: Four Years of Learnings from RTI² Implementation in Tennessee, Tennessee Department of Education (2018).

TODE, HS EWS Example, HW EWS Example, Tennessee Department of Education: Instructional Resources (2016), Microsoft Excel File.

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Appendix

Appendix A: Knox County Schools' Points-Based Early Warning Detection System

	At Risk Points						
	1	2	3	4	5	6	7
Attendance	Attendance at or below 95%	Attendance at or below 90%	Attendance at or below 85%	Attendance at or below 80%	-	-	-
Assessments	1 EOC (TCAP for 9th grade) result less than 25th percentile	2 EOC (TCAP for 9th grade) results less than 25th percentile	3 EOC (TCAP for 9th grade) results less than 25th percentile	4 EOC (TCAP for 9th grade) results less than 25th percentile	5 EOC (TCAP for 9th grade) results less than 25th percentile	6 EOC results less than 25th percentile	7 EOC results less than 25th percentile
Conduct: ISS	ISS action (each action from 1 to 3 actions)	ISS action (each action from 4 to 6 actions)	ISS action (each action from 7+ actions)	-	-	-	-
Conduct: OSS	-	OSS action (each action from 1 to 3 actions)	-	OSS action (each action from 4 to 6 actions)	-	OSS action (each action from 7+ actions)	-
Conduct: Remandment	-	-	Remandment Action	-	-	-	-
Grades	Quarter grade less than 74.5 (each grade in each quarter in English, Math, Science, or Social Studies)	-	-	-	-	-	-

Appendix B: Early Warning Detection System Memo

To: Paula Sarver

From: Clint Sattler

Subject: Validation of the Early Warning Detection System

Date: June 22, 2017

Data was pulled from ASPEN on May 15th to monitor the accuracy of the Knox County Schools' 9th grade and 10th-12th grade RTI^2 early warning detection systems (EWDS; methodology provided at the end of this document). The current methodology provides the first visual warning related to student performance after meeting a 10 point threshold. Of the 862 students in intervention (on May 15th), 466 (54%) had a point total less than 10.

Sensitivity analysis indicates that lowering the threshold to 5 points would maximize the difference between the true positive rate (providing a warning for a student who was receiving intervention supports) and the false positive rate (providing a warning for a student who was not receiving intervention supports). Only 16.8% of high school students enrolled in intervention had fewer than 5 points. However, lowering the threshold to 5 points would add a warning indicator to roughly 6,000 students who were never enrolled in intervention. Lowering the threshold to 5 points does not seem like a practical solution.

The percentage of students who were enrolled in intervention by EWDS point total is plotted below. There appears to be no better threshold than 10 points for practical application of the existing system. However, the EWDS does not appear to reflect the current rationale used to place students in high school RTI^2. Feedback may be solicited from the KCS high school RTI^2 committee to better reflect the current rationale for student placement in RT