RESEARCH BRIEF
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An Early Warning System:
Predicting 10th Grade FCAT Success from 6th Grade FCAT Performance

This Research Brief presents a method for predicting 10th grade FCAT success from 6th grade FCAT performance. A simple equation provides the most probable single score prediction, and give-or-take error margins define high and low probability zones for expected 10th grade scores. In addition, a double-entry table provides estimates of the probability of success on both the Reading and Mathematics tests in 10th grade. The procedures are presented in an extended analogy to weather predictions.

Introduction

We who live in South Florida are familiar with the threat of major wind storms and the kinds of early warnings we receive from the weather services. When the storm is still a considerable distance from landfall, the weathermen present maps indicating possible storm tracks. Their best guesses for the places the storm might hit are couched in terms of high and low probability zones. Knowing these zones and weighing the probabilities helps us take early action and prepare for eventualities.

In this paper, we wish to establish a different kind of early warning system. Students in our district must pass both the Reading and Mathematics FCAT tests to be able to graduate. Having an early indication of the probability of their eventual success would allow us to take timely remedial action and help them toward graduation. Using 6th grade FCAT performance as a basis for predicting 10th grade FCAT success should provide sufficient early warning. Borrowing on the kind of language and techniques of the weather service, we are able to provide specific score predictions while incorporating the ideas of relative assurances of score prediction zones.

The Data

The basis for the predictions is the relationship between 6th grade FCAT scores and 10th grade FCAT scores for the same students. The starting cohort was all M-DCPS students in 6th grade in 2001-02 with a valid FCAT score in Reading or Math or both (n = 21,390). Tracking these students over time, considerable attrition is experienced by the time they reach 10th grade. While the great majority of these students reach 10th grade by the 2005-06 school year, a substantial number take longer. Matching students to their eventual 10th grade status across more than one year resulted in approximately 19,600 students with full data.

For some analyses, the sample of students was partitioned into two parts for purposes of cross-validation. The prediction equations were developed in one half of the sample and applied and assessed in the other half of the sample. This procedure is generally recommended to protect against over-fitting the unique characteristics of the development sample and the subsequent overestimation of prediction success rates. In this research, the results from the cross-validation study showed essentially no differences from the full-sample results and supported full-sample estimates.

The Early-Warning Prediction Model
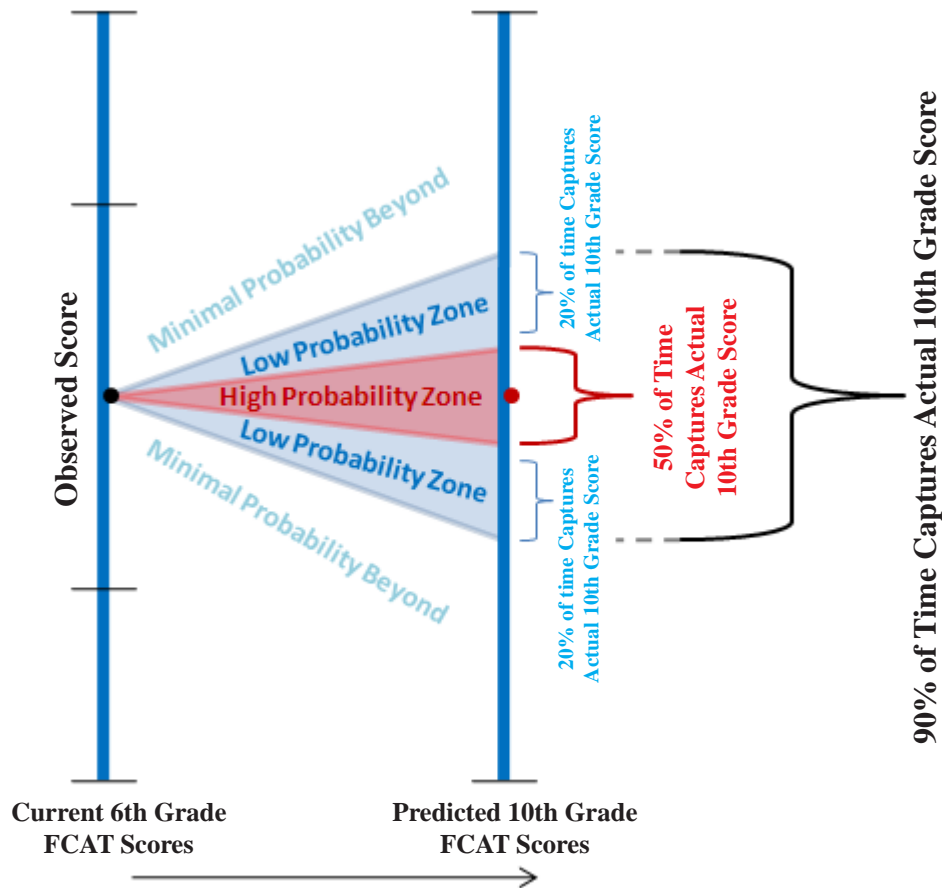
The graphic above illustrates the concept of the early warning prediction. A linear regression analysis provides an equation for predicting the single "most likely" 10th grade score from each observed 6th grade score. Based on the standard error of estimate, three types of prediction zones can be produced. The middle high-probability prediction zone is a relatively narrow band centered on the single predicted score. The boundaries of this zone are defined in terms of plus-or-minus a certain amount of measurement error. For all students who started at the same 6th grade score put into the prediction equation, the actual 10th grade score they received will be represented within this high-probability zone approximately half of the time.

On either side of the high-probability zone are two low-probability zones. It is less likely that the true 10th grade score will be this far from the single most likely point estimate. The outer boundaries of these zones will also be defined in terms of plus-or-minus a larger amount of measurement error. The actual 10th grade score received will be represented within each of these low-probability zones approximately 20 percent of the time, respectively.
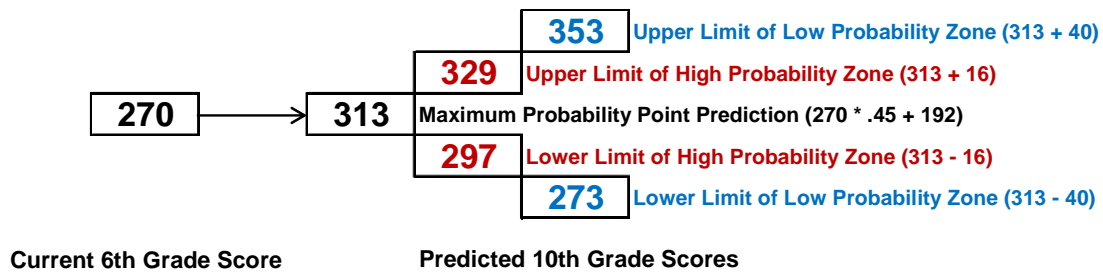
Overall, the high-probability zone and the two low-probability zones will capture the actual 10th grade score corresponding to each 6th grade score approximately 90 percent of the time. This means that there is still a small percentage of the time that the actual 10th grade score will be beyond even the low-probability zones. The true precision of the prediction is reflected in the size of the plus-or-minus measurement error amounts that define the boundaries of the prediction zones.

The Prediction Equations

The relationships between the 6th grade and 10th grade FCAT scores were sufficiently strong (correlations: Mathematics = .74, Reading = .73) that linear regression equations could be used to make meaningful long-range predictions. For the Math FCAT test the relevant information is

((6th grade FCAT Math score) * .45) + 192 = (Predicted 10th grade FCAT Math score)
Boundaries of High-Probability Zone = (Predicted 10th grade FCAT Math score) + or - 16 points
Boundaries of Low-Probability Zones = (Predicted 10th grade FCAT Math score) + or - 40 points

To illustrate how this information can be used, let's assume we wish to predict the 10th grade FCAT Math score for a student who scores 270 on the 6th grade FCAT Math test. The procedure is illustrated below.

353   Upper Limit of Low Probability Zone (313 + 40)

329   Upper Limit of High Probability Zone (313 + 16)

270 → **313**   Maximum Probability Point Prediction (270 * .45 + 192)

297   Lower Limit of High Probability Zone (313 - 16)

273   Lower Limit of Low Probability Zone (313 - 40)

Current 6th Grade Score   **Predicted 10th Grade Scores**
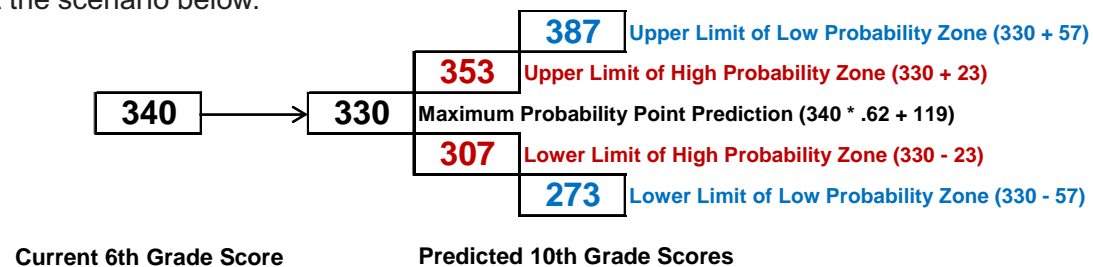
Using this model, our best guess for the 10th grade FCAT Math score for this student is a score of 313. About 50 percent of the time the actual 10th grade score will be between 297 and 329. Around 20 percent of the time it will be between 273 and 297, and another 20 percent of the time it will be between 329 and 353. This leaves about 10 percent of the time that the actual observed 10th grade FCAT Math score will be beyond even the limits of the low-probability zones.

The same kind of prediction model can be applied to the FCAT Reading tests.

((6th grade FCAT Reading score) * .62) + 119 = (Predicted 10th grade FCAT Reading score)
Boundaries of High-Probability Zone = (Predicted 10th grade FCAT Reading score) + or - 23 points
Boundaries of Low-Probability Zones = (Predicted 10th grade FCAT Reading score) + or - 57 points

For the Reading tests, the numbers in the equation and zone limits are slightly different. The zones are slightly wider, reflecting the slightly weaker relationship between the Reading tests than between the Math tests. As an example, if we are predicting for a student with a 6th grade Reading FCAT score of 340, we would get the scenario below.

387   Upper Limit of Low Probability Zone (330 + 57)

353   Upper Limit of High Probability Zone (330 + 23)

340 → **330**   Maximum Probability Point Prediction (340 * .62 + 119)

307   Lower Limit of High Probability Zone (330 - 23)

273   Lower Limit of Low Probability Zone (330 - 57)

Current 6th Grade Score   **Predicted 10th Grade Scores**

Joint Probabilities

While the previous equations and zones help predict each the Reading and Math tests separately, students must pass (score higher than 300) both tests in order to be eligible to graduate. It is possible to incorporate both the 6th grade Reading and Math score into one prediction of passing both the 10th grade Reading and Math tests. The statistical technique involves a binary logistic regression procedure that can become somewhat mathematically involved. Fortunately, by appropriate statistical manipulation, the results can be expressed in an easy to understand probability of passing both tests.

On the following page we present a table that can be used to look up the probability that a student will pass both the Reading and Math 10th grade tests. We simply enter the column headed by the closest value to the student's observed 6th grade Reading test score and the row headed by the closest value to the student's observed 6th grade Math test score. The intersection of this row and column contains the probability that the student will pass both the Reading and Math tests in 10th grade.

As an example, suppose the student we are interested in has scored 320 on the 6th grade Reading test and 280 on the 6th grade Math test. At the intersection of this column and row, as highlighted in the table, we see that the student would have a 60 percent probability of passing both tests in 10th grade.

As a test of the accuracy of this type of prediction, we categorized every student in the sample into predicted passing both tests if the joint probability was greater than 50%, and predicted not passing both tests otherwise. With this simple test we successfully classified over 80 percent of the students in the sample.

Caveats

Because we had to use data that spanned several years, the 6th grade class that these predictions are based on is several years before the current 6th grade class. In that intervening time period, some conditions may have changed that could effect the accuracy of the predictions. For example, the requirement of passing FCAT Reading for promotion in 3rd grade was not yet in effect for the 6th grade upon whom the prediction models were based. For these and other reasons, the user of these prediction models should exercise caution when applying them to current M-DCPS students.

Summary

A method of predicting the potential for success on 10th grade FCAT tests early in a student's career should prove valuable to the District. Of course, all long-range predictions are subject to imprecision. Despite the inherent limitations, meaningful predictions can be made from as early as 6th grade. This Research Brief has presented methods for score predictions with their associated margins of error. The Office of Assessment, Research, and Data Analysis is preparing to provide schools with lists of students who, based on these predictions from 6th grade, are projected to be in jeopardy on the 10th grade tests. It is hoped that student's found off track for 10th grade success can be helped and redirected if identified early enough. As with early warning systems for tropical storms, the best advice is to hope for the best, but prepare for the worst.

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Probability of Passing Both Reading and Math FCAT in 10th Grade

Reading FCAT Score 6th Grade

Math FCAT Score 6th Grade (rows) × Reading FCAT Score 6th Grade (columns)

Math \ Reading	200	210	220	230	240	250	260	270	280	290	300	310	320	330	340	350	360	370	380	390	400	410	420	430	440	450
200					5%	7%	8%	10%	13%	16%	20%	24%	28%	34%	39%	45%	51%	58%	63%	69%	74%	78%	82%	86%	88%	91%
210					6%	8%	10%	12%	15%	18%	22%	27%	32%	38%	43%	50%	56%	62%	67%	72%	77%	81%	85%	87%	90%	92%
220				6%	7%	9%	11%	14%	17%	21%	25%	30%	36%	42%	48%	54%	60%	65%	71%	76%	80%	83%	87%	89%	91%	93%
230			5%	7%	8%	11%	13%	16%	20%	24%	29%	34%	40%	46%	52%	58%	64%	69%	74%	79%	82%	86%	88%	91%	93%	94%
240		5%	6%	8%	10%	12%	15%	19%	23%	27%	32%	38%	44%	50%	56%	62%	67%	73%	77%	81%	85%	88%	90%	92%	94%	95%
250	5%	6%	7%	9%	11%	14%	17%	21%	26%	31%	36%	42%	48%	54%	60%	66%	71%	76%	80%	84%	87%	89%	91%	93%	95%	
260	6%	7%	9%	11%	13%	16%	20%	24%	29%	34%	40%	46%	52%	58%	64%	69%	74%	79%	83%	86%	89%	91%	93%	94%		
270	7%	9%	11%	14%	16%	19%	23%	27%	33%	38%	44%	50%	56%	62%	68%	73%	78%	82%	85%	88%	90%	92%	94%	95%		
280	7%	9%	12%	14%	18%	22%	26%	31%	36%	42%	48%	54%	60%	66%	71%	76%	80%	84%	87%	90%	92%	94%	95%			
290	9%	11%	13%	17%	20%	24%	29%	35%	40%	46%	52%	59%	64%	70%	75%	79%	83%	86%	89%	91%	93%	94%				
300	10%	13%	16%	19%	23%	28%	33%	38%	44%	51%	57%	63%	68%	73%	78%	82%	85%	88%	90%	92%	94%	95%				
310	12%	15%	18%	22%	26%	31%	37%	43%	49%	55%	61%	66%	72%	76%	80%	84%	87%	90%	92%	93%	95%					
320	14%	17%	20%	25%	30%	35%	41%	47%	53%	59%	65%	70%	75%	79%	83%	86%	89%	91%	93%	94%						
330	16%	19%	23%	28%	33%	39%	45%	51%	57%	63%	68%	73%	78%	82%	85%	88%	90%	92%	94%							
340	18%	22%	26%	31%	37%	43%	49%	55%	61%	67%	72%	77%	81%	84%	87%	90%	92%	93%	95%							
350	21%	25%	30%	35%	41%	47%	53%	59%	65%	70%	75%	79%	83%	86%	89%	91%	93%	94%								
360	24%	28%	33%	39%	45%	51%	57%	63%	69%	74%	78%	82%	85%	88%	90%	92%	94%	95%								
370	27%	32%	37%	43%	49%	55%	61%	67%	72%	77%	81%	84%	87%	90%	92%	93%	95%									
380	30%	34%	41%	49%	55%	59%	65%	71%	75%	80%	83%	86%	89%	91%	93%											
390	34%	39%	45%	52%	59%	65%	71%	74%	78%	82%	86%	88%	91%	92%	94%											
400	38%	43%	50%	56%	62%	67%	72%	77%	80%	84%	86%	89%	90%	92%	94%	95%										
410	42%	48%	54%	60%	65%	71%	76%	80%	83%	86%	88%	89%	91%	93%	94%											
420	46%	52%	58%	64%	69%	74%	79%	83%	86%	88%	90%	92%	93%	95%												
430	50%	56%	62%	68%	73%	77%	81%	85%	88%	90%	92%	94%	95%													
440	54%	60%	66%	71%	76%	80%	84%	87%	90%	91%	93%	94%	95%													
450	58%	64%	69%	74%	79%	83%	86%	89%	91%	93%	94%															

(blue cells) = less than 5% probability of passing both tests in 10th grade.

(green cells) = greater than 95% probability of passing both tests in 10th grade.