FR-11-52

Estimation of Students' QualityCore® End-of-Course Exam Grades

Arthur A. Thacker

Prepared for: **Kentucky Department of Education**
Capital Plaza Tower, 17th Floor
500 Mero Street
Frankfort, KY 40601

October 5, 2011

HumRRO
Human Resources Research Organization
66 Canal Center Plaza, Suite 700 • Alexandria, Virginia 22314
www.humrro.org • Phone: (703) 549-3611 - Fax: (703) 519-9661

FR-11-52

Estimation of Students' QualityCore® End-of-Course Exam Grades

Arthur A. Thacker

Prepared for: **Kentucky Department of Education**
Capital Plaza Tower, 17th Floor
500 Mero Street
Frankfort, KY 40601

October 5, 2011

HumRRO
Human Resources Research Organization
66 Canal Center Plaza, Suite 700 • Alexandria, Virginia 22314
www.humrro.org • Phone: (703) 549-3611 - Fax: (703) 519-9661

ESTIMATION OF STUDENTS' QUALITYCORE® END-OF-COURSE EXAM GRADES

Table of Contents

List of Tables

ESTIMATION OF STUDENTS' QUALITYCORE® END-OF-COURSE EXAM GRADES

Introduction

In the 2011-12 academic year Kentucky high school students will take end-of-course (EOC) examinations (ACT's QualityCore®) Exams) in Algebra II, Biology, English II (Sophomore English), and U.S. History. These courses are designed to ascertain if a student has mastered the content sufficiently to move to the next course in the series. Kentucky will also encourage teachers to use the exams as a component of student course grades. This study was designed to provide guidance on how students' grades could be assigned based on EOC exam scores.

Methodology

This study begins by establishing a single "cut score" on the exams. This cut score should coincide with some meaningful categorization or description of students' achievement in the course. We are fortunate in this regard because the Kentucky Council on Postsecondary Education (CPE) has adopted the ACT assessment for determining college readiness and set cut scores on the ACT to indicate that students are ready to take credit bearing college courses. We will begin this study with the ACT cut scores, and link them to scores on the QualityCore® exams. For this study, those cut scores are as follows.

Table 1. ACT College Readiness Cut Scores Set by CPE

Content Area	ACT Score
Reading	20
English	18
Mathematics	19
Science*	19

*CPE did not indicate a science cut score. The average of the other subjects (19) was used for this study.

The next step in our study is to link existing cut scores on ACT to the EOC assessments. For Algebra II and U.S. History, they have already been linked in the QualityCore® technical manual (ACT, 2010). The manual includes, for each QualityCore® score, a range of ACT scores that a student would be predicted to score. For example, a student who scored 150 on the Algebra II EOC exam would be expected to score between 21 and 26 on the ACT Mathematics exam. If we work backwards from the provided tables, we can ascertain that the span of students' Algebra II EOC scores with a predicted score of 19 on ACT mathematics most likely ranges from 141 to 148.

The U.S. History EOC exam does not have a directly comparable ACT exam. The QualityCore® technical manual links it with the ACT Reading assessment. If we use the same procedure we used for Algebra II, we find that the span of U.S. History EOC scores where a predicted score of 20 on ACT Reading most likely ranges from 144 to 152.

Determining our starting range for the remaining two subjects is more complex. The QualityCore® technical manual links them to the PLAN assessments rather than ACT. PLAN is administered earlier and therefore is closer in proximity in time to EOC assessments designed primarily for sophomores. Unfortunately, the CPE did not set college readiness score expectations on the PLAN. So, to determine a similar cut score on PLAN we must first link PLAN to ACT. This is not an unprecedented step. The EXPLORE, PLAN, and ACT assessments are designed to function together and

scores on PLAN are often used to predict scores on ACT. The technical manual links English II to PLAN English and Biology to PLAN Science.

There are several potential methods for generating the PLAN to ACT prediction. The most common would be to generate the regression line between the two using students who had taken both exams. For our purposes, however, we only need a starting range to work with and we can get that without matching students. In 2008-09, Kentucky students had an average PLAN English score of 15.9 and an average PLAN Science score of 17.4. In that same year, Kentucky students had an average ACT English score of 17.5 and an average ACT Science Reasoning score of 18.9. We also know the variance of these scores in standard deviation units. It is a simple step to compute the effect size differences on ACT between the average scores and the CPE-set college ready cut scores. We can then add that same effect size difference to the average PLAN scores to determine roughly equivalent cut scores on the PLAN. Table 2 shows the results of these calculations.

Table 2. Setting PLAN College Ready Cut Scores

Subject	ACT Mean (SD)	CPE ACT Cut	Effect Size	PLAN Mean (SD)	PLAN Mean Adjusted by Effect Size
Biology	18.9 (4.6)	19	0.02	17.4 (3.5)	**17.5**
English II	17.5 (6.1)	18	0.08	15.9 (4.3)	**16.3**

If we round both the final results of our PLAN to ACT calculations to the nearest whole number, the PLAN cut score for Biology is 18 and the plan cut score for English is 16. From there we can generate our ranges from the QualityCore® technical manual in the same manner we used previously. We find that the span of Biology EOC scores where a predicted score of 18 on PLAN Science most likely ranges from 144 to 152. The EOC span for English II to predicted score of 16 on PLAN English ranges from 144 to 157. It should be noted that the English II range is greater than the range for other subjects. This is due to the variance on the English ACT and PLAN assessments being larger than the variance for other subjects, not because of the method of extrapolating between PLAN and ACT. Table 3 summarizes the results for determining the beginning ranges for setting an initial grade cut score.

Table 3. Ranges for Setting Initial EOC Cut Scores

EOC Exam	Linked ACT Content Area	ACT Cut Score	Lower Bound	Center Range**	Upper Bound
U.S. History	Reading	20	144	148	152
English II	English	18	144	150	157
Algebra II	Mathematics	19	141	144	148
Biology	Science*	19	144	148	152

**Rounded down to generate whole number cut point.

The next step in our process is one requiring judgment. We must determine what our calculated cut score ranges should equate to in terms of grades. Typically, using an A-F grading system, we begin with the assumption that a C is equivalent to "average performance." Then a B is defined as "above average" and an A is "far above average." A grade of D represents "below average" performance and an F indicates failure to meet the minimum requirements. Using this logic, Kentucky would assert that average performance in high school should indicate that students are prepared for college or career. However, not every student will attend college and certainly the students who do so will select various majors, each with specific pre-college preparation requirements. We reason that students who receive letter grades of B or higher in a subject should be able to take and pass credit bearing college courses in

that subject. For that reason, we will begin all further calculations from the standpoint that the CPE Benchmarks should distinguish B from C students.

Now we must assign scores from the indicated ranges to become the actual cut scores distinguishing students receiving grades of "B or higher" from those receiving "C or lower." Our best estimate of the score dividing students between those meeting the CPE benchmark and those not meeting it would be the midpoint of the range of student scores for which the CPE benchmark is likely. We therefore selected the center of the range as the first cut score on our grading scale. Students scoring at or above this first cut score (the Center Range from Table 3) will receive an A or B, those scoring below the cut score will receive a C, D, or F. Using this reasoning, some students who receive As and Bs will not meet the CPE benchmark. Similarly, some students who receive Cs, Ds or Fs will meet the benchmark. Approximately half of the students who score exactly at the subject-specific cut score should also meet the CPE benchmark.

ACT provided percentile rank tables for a national sample of students taking each of the QualityCore® EOC assessments. Using the center range included in Table 3, we can predict the percentage of students scoring above and below each of our initial cut scores. It should be noted that these predictions are based on a national sample and Kentucky's distribution of scores may be somewhat different. Table 4 contains the results.

Table 4. Percentages of Students Scoring Above Each Potential B-C Cut Score

EOC Assessment	Percentage B or Above
U.S. History	41%
English II	73%
Algebra II	68%
Biology	54%

The results are not as consistent as we might wish for setting cut scores across subjects. There are several potential reasons for this phenomenon. First, the CPE Benchmarks are not set at exactly the same score across subjects and range from 18-20 on the ACT. Second, two of the subjects were linked to PLAN and then to ACT rather than to ACT directly. This explanation is unlikely the cause of our concerns, however, because the magnitude of percentiles is not consistent based on the type of link. Third, the EOC benchmark assessments have a fairly "chunky" scale. It ranges from 125-175, but we don't get past a percentile ranking of 1 until we pass a score of about 136 and we reach a percentile ranking of 100 at between 160 and 165 (depending on subject). This reduces our potential range from 50 points to about 30 scores with percentiles that can be differentiated. Still, the scale limits on percentile are fairly consistent and are unlikely culprits for the differences in percentiles at our initial cut scores. The fourth potential rationale seems much more likely. The distribution of scores for the EOC exams differs considerably by assessment. For example, only 27% of students in the national sample scored below 150 on the English II exam while 77% of students scored below 150 in Algebra II. Differences in the shape of the distribution can cause substantial variability in the percentages of students scoring at a particular point along the scale. This phenomenon may be attributable to genuine differences in students' performance by course. The remainder of this report is based on that assumption.

The next step in our process is to determine the remaining cut scores to differentiate the remaining letter grades. We began with the reasoning that students who receive an A versus a B should be very likely to score at or above the CPE benchmark. To determine the A versus B cut score, we chose the point on the ACT-provided score range tables where the students most likely score was beyond the range

for the CPE benchmark. The vast majority of students receiving letter grades of A can be expected to score at or above the CPE benchmark using this logic.

Similarly, we can set the C versus D cut score at the point on the ACT tables where the range of scores is entirely below the CPE benchmark. This would mean that very few students scoring below letter grade C would be expected to meet the CPE benchmark. It would also mean that the majority of Kentucky students would receive an A, B, or C on all of the end-of-course exams. This method was not designed to generate a "bell-shaped" curve (with equal numbers of As and Fs) but looks more like the typical grade distribution in the state[1].

The final cut score we need is the D versus F cut score. The end-of-course exams in Kentucky are designed to give Kentucky educators a common metric by which to compare performance across schools and districts. The exams were not implemented as a "passing requirement" for the courses. Students' scores are expected to count toward their final grades, but a poor score on the end-of-course assessment was not intended to disqualify many students from passing the course. On the advice of Kentucky educators, we set a common D versus F cut score of 136 for all end-of-course exams. This means, assuming Kentucky students are similar to the national sample, that only about 1% of all students are expected to receive failing grades on the assessment.

The results of these methods are presented in Table 5. Table 5 also includes the approximate expected proportion of students scoring at each grade level and a "cumulative percentage" in reverse to indicate the expected proportion of student scoring at-or-above any letter grade. At least 70% of students are expected to score at or above a C for all end-of-course exams using this guidance.

Table 5. Cut Score Solutions for All EOC Exams

		Grade F	Grade D	Grade C	Grade B	Grade A
US History	Minimum EOC Score		136	144	148	153
	Percentage	1%	22%	36%	26%	15%
	Cumulative Percentage		99%	77%	41%	15%
English II	Minimum EOC Score		136	144	150	158
	Percentage	1%	11%	11%	48%	29%
	Cumulative Percentage		99%	88%	77%	29%
Algebra II	Minimum EOC Score		136	141	144	149
	Percentage	1%	13%	18%	42%	26%
	Cumulative Percentage		99%	86%	68%	26%
Biology	Minimum EOC Score		136	145	148	153
	Percentage	1%	28%	15%	25%	31%
	Cumulative Percentage		99%	71%	56%	31%

There is considerable variability in the grade cut scores based on beginning B-C cut scores from the range of scores linked to ACT benchmarks, and by subject area. For example, the cut scores for English II are much higher than cut scores for the other subjects. This is true despite our linking the English II cut score to the ACT English benchmark score of 18 (the lowest benchmark score used for this study). This is likely due to differences in the EOC means and variances. Table 6 contains the means and standard deviations for each of the EOC assessments. English II had the highest mean and variance.

[1] According to district-level educators who consulted during the selection of the final process.

Table 6. QualityCore® EOC Assessment Means and Standard Deviations[2]

	Mean	SD
English 10	154.07	7.10
Algebra II	146.69	4.86
Biology	149.81	6.79
US History	147.40	5.69

Obviously, this represents only one of the multitude of solutions that could be applied to setting cut scores for grading the EOC exams. We might assign different percentages or effect sizes to separate one grade from another. We might choose a different part of the ACT benchmark linked range as our starting point. This solution has the following advantages:

- EOC scores are linked to an important college readiness indicator.
- The procedure was applied in the same manner across all subjects.
- The solutions are relatively easy to explain to the field.
- Kentucky educators provided input and guidance during the process.

Final Recommended Scoring Table

Subject	A	B	C	D	F	CPE-linked College Readiness Benchmark
US History	153-above	148-152	144-147	136-143	135-below	148
English II	158-above	150-157	144-149	136-143	135-below	150
Algebra II	149-above	144-148	141-143	136-140	135-below	144
Biology	153-above	148-152	145-147	136-144	135-below	148

[2] Table provided by ACT via personal email communication August 19, 2011.

References

ACT (2010). QualityCore®: technical manual. Iowa City, IA (Author).