

Accountability Brief



Public Schools of North Carolina

State Board of Education • North Carolina Department of Public Instruction • Michael E. Ward, Superintendent

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Setting Annual Growth Standards: “The Formula”

Background

The ABCs of Public Education is a comprehensive plan to reorganize public schools in North Carolina. This plan focuses on: (1) strong accountability, (2) emphasis on the basics and on high educational standards, and (3) maximum local control. A key component of the ABCs of Public Education is a new accountability program which focuses on the performance of individual public schools (rather than school systems) in the basics of reading, writing, and mathematics. Rather than comparing different students from one year to the next, this plan—the School-based Management and Accountability Program—holds schools accountable for the educational growth of the same groups of students (cohorts) over time. At least a year's worth of growth for a year's worth of school is expected.

The growth of students is determined by scores on the North Carolina End-of-Grade Tests of Reading Comprehension and Mathematics. The scores from these tests are reported on developmental scales, which yield rulers to measure growth in these subject areas across time and, therefore, across grades.

Just like height in inches, on average, student scores in reading and mathematics are expected to increase every year. Like height, the rate of growth is somewhat faster in the earlier grades than in the later grades. In addition, the rate of growth varies by subject area, with scores on mathematics tests in these grade levels growing faster than scores on reading tests.

A computer program, ABC Tools, has been developed by the Department of Public Instruction to perform all of the calculations associated with determining growth and whether or not a school has met the expected and exemplary growth standards.

What has been the actual growth rate of North Carolina students?

The North Carolina End-of-Grade Tests were first administered statewide at the end of the 1992-93 school year. Additional equivalent forms of the tests were administered at the end of the 1993-94 school year. The average statewide growth of the students (a cohort) from one grade to the next was determined by subtracting the 1992-93 scores from the 1993-94 scores. In order to determine growth for grade 3, a pretest will be administered each year during the fall beginning with the 1996-97 school year. For grade 3, the average statewide growth was determined during the 1996-97 school year; for grades 8 to 10, it was determined during the 1997-98 school year. These values will be constants in the growth formula of the ABCs Accountability Model until new values based on different school years are approved by the State Board of Education.

For example, the average score of the North Carolina grade 3 students on the reading test was 142.7 in 1992-93 and the average score of grade 4 students was 147.9 in 1993-94. Therefore, the average growth in reading from grade 3 to grade 4 was 5.2 scale score points.

	Reading	Mathematics
Pre 3 to 3	6.2	12.8
Grade 3 to Grade 4	5.2	7.3
Grade 4 to Grade 5	4.6	7.4
Grade 5 to Grade 6	3.0	7.1
Grade 6 to Grade 7	3.3	6.5
Grade 7 to Grade 8	2.7	4.9
Grade 8 to Grade 10	2.3	2.3

Note: These values will be used until the State Board of Education approves data from different years for determining the NC Average Rate of Growth.

North Carolina
Average Rate of Growth
(Grades 3 through 8 based on Spring 1993 to Spring 1994; Pre 3 to 3 based on 1996 to 1997; Grades 8 to 10 based on Grade 10 in 1997-98.)

What about students who are “not average”? Do they grow at different rates?

A teacher or principal might ask these questions knowing that some students in a class or school may be well below or well above average. Since several years of data are available, the student records can be matched and checked to see whether or not all students grow at the same rate.

In fact, different rates of growth are expected for *two* different reasons:

- (1) Students who are more proficient might grow faster. That is how they got to be more proficient in the first place—they already grew faster.
- (2) Students who score high on a particular test one year may not score as high the next year, and students who score low one year may score higher the next year, partly due to “regression to the mean.”

Once we have measured the magnitude of these two effects, we can estimate growth for all students.

How do we estimate “true proficiency” and “regression to the mean” when we have only last year’s test scores?

Note that the two reasons for different rates of growth described above are somewhat contradictory, i.e., if last year’s scores are used as estimates of proficiency, students with *high* scores last year are expected to grow more (reason #1) and less (reason #2) and vice versa for low scores.

Since the end-of-grade reading and mathematics tests are correlated (the correlation coefficients range from 0.73 to 0.80), the sum of the reading and mathematics scores can be an *index* of “true proficiency.” This is like using the “Total Battery Scale Score” of a norm-referenced test as an index of ability or proficiency, except end-of-grade test scores are used.

What is the “formula” for calculating growth?

To calculate the amount of growth a school is expected to make during one school year, three factors are used in an equation. The factors are:

1. The North Carolina *average rate of growth* in the respective grade and subject, (b_0).
2. An estimate for the “true proficiency” of the students in a school, (b_1 = Index for True Proficiency [ITP]).
3. An estimate for the movement of students' scores due to “regression to the mean,” (b_2 = Index for Regression to the Mean [IRM]).

One could say that the formula for determining expected growth is as simple as $A + B + C$. However, it really is:

$$\text{Expected Growth} = b_0 + (b_1 \cdot \text{ITP}) + (b_2 \cdot \text{IRM})$$

The components of the equation are defined below.

The North Carolina Average Rate of Growth (b_0)

The North Carolina average rate of growth (b_0) is the actual growth observed during the second year of the end-of-grade testing program. The same students (in grades 3 through 8) were followed from 1992-93 to 1993-94 for each grade level. The values of b_0 will not change in the formula (see the table on page 2 for the values for each grade and subject) unless approved by the State Board of Education.

Estimates of “true proficiency” and “regression to the mean”

The North Carolina Average Scale Scores (for grades 3 through 8) used in the indices for “true proficiency” (ITP) and “regression to the mean” (IRM) are from the 1994-95 school year. Average Scale Scores for pre to post grade 3 are from the 1996-97 school year; those for grades 8 to 10 are from the 1997-98 school year. These scores will be used until a different school year's data are approved by the State Board of Education.

	Reading	Mathematics
Pre 3 to 3	138.0	130.2
Grade 3 to 4	143.4	141.2
Grade 4 to 5	147.6	147.9
Grade 5 to 6	152.4	154.4
Grade 6 to 7	154.5	160.2
Grade 7 to 8	158.1	166.0
Grade 8 to 10	161.9	173.1
b_1	0.22	0.26
b_2	-0.60	-0.58

Note: These values will not change from year to year unless approved by the State Board of Education.

For example, to determine the expected growth of a group of students during fourth grade in 1995-96, we need to first start with their third-grade scores in 1994-95:

reading = 144.0
 mathematics = 142.0

The North Carolina averages were 143.4 on the reading test and 141.2 on the mathematics test.

From the table on page 2 the average growth rates for grade 3 to grade 4 are:

reading = 5.2 points
 mathematics = 7.3 points

North Carolina
 Average Scale Scores
 (Pre 3 to 3 based on 1996-97 School Year; Grades 3 to 8 based on 1994-95 School Year; Grade 8 to 10 based on 1997-98 School Year.)

Values used to Estimate
 “True Proficiency” and
 “Regression to the Mean”

Estimating “true proficiency.” In order to estimate the true proficiency of the students in a school, the reading and mathematics scale scores from the end-of-grade tests are combined to give a total overall score. The index for true proficiency (ITP) is computed by subtracting the 1994-95 North Carolina averages from the local test scores (see table on page 3). So,

$$\text{ITP} = (\text{LReadSS} + \text{LMathSS}) - (\text{NCReadSS} + \text{NCMathSS}).$$

And the estimate for “true proficiency” for a school is

$$\begin{aligned} \text{“true proficiency”(Reading)} &= b_1 \wedge \text{ITP}, \\ \text{where } b_1 &= 0.22 \text{ for all grades} \end{aligned}$$

and

$$\begin{aligned} \text{“true proficiency”(Math)} &= b_1 \wedge \text{ITP}, \\ \text{where } b_1 &= 0.26 \text{ for all grades.} \end{aligned}$$

Estimating “regression to the mean.” In order to estimate the movement of students' scores due to “regression to the mean,” the index for regression to the mean (IRM) is computed by subtracting the 1994-95 North Carolina averages from the local test scores (reading and mathematics *respectively*). So,

$$\text{IRM(Reading)} = \text{LReadSS} - \text{NCReadSS}$$

and

$$\text{IRM(Math)} = \text{LMathSS} - \text{NCMathSS}.$$

The estimate for “regression to the mean” for a school is

$$\begin{aligned} \text{“regression to the mean”(Reading)} &= b_2 \wedge \text{IRM}, \\ \text{where } b_2 &= -0.60 \text{ for all grades} \end{aligned}$$

and

$$\begin{aligned} \text{“regression to the mean”(Math)} &= b_2 \wedge \text{IRM}, \\ \text{where } b_2 &= -0.58 \text{ for all grades.} \end{aligned}$$

Calculation of expected growth

Now using the formula for expected growth described on page 3, the expected growth for a school would be

$$\text{Expected Growth} = b_0 + (b_1 \wedge \text{ITP}) + (b_2 \wedge \text{IRM}).$$

To estimate the average “true proficiency” of the school the following equations would be used:

$$\begin{aligned} \text{ITP} &= (144.0 + 142.0) - (143.4 + 141.2) \\ &= +1.4 \end{aligned}$$

$$\begin{aligned} \text{“true proficiency”(Reading)} &= \\ &0.22 \wedge 1.4 = 0.31 \end{aligned}$$

and

$$\begin{aligned} \text{“true proficiency”(Math)} &= \\ &0.26 \wedge 1.4 = 0.36 \end{aligned}$$

Note that this school is above average in “true proficiency” and therefore would be expected to grow at a faster rate in reading and mathematics.

To estimate “regression to the mean” of the school the following equations would be used:

$$\text{IRM(Reading)} = 144.0 - 143.4 = +0.6$$

$$\begin{aligned} \text{“regression to the mean”(Reading)} &= \\ &-0.60 \wedge 0.6 = -0.36 \end{aligned}$$

and

$$\text{IRM(Math)} = 142.0 - 141.2 = +0.8$$

$$\begin{aligned} \text{“regression to the mean”(Math)} &= \\ &-0.58 \wedge 0.8 = -0.46. \end{aligned}$$

Note that since this school is above average, the effect of “regression to the mean” will be to lower the school's expected growth.

The expected growth for this fourth-grade class would be

$$\begin{aligned} \text{Expected Growth(Reading)} &= \\ &5.2 + 0.31 + -0.36 = 5.15 \end{aligned}$$

and

$$\begin{aligned} \text{Expected Growth(Math)} &= \\ &7.3 + 0.36 + -0.46 = 7.2 \end{aligned}$$