

SC READY National Percentiles Linking Methodology

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National percentile ranks for SC READY are derived from the equi-percentile linking studies South Carolina has completed between SC READY and nationally normed assessments. This methodology documents that derivation: the source studies and the conditions they must satisfy, the equi-percentile procedure that maps SC READY vertical scale scores to the reference distribution, the composition step that converts the linked reference score to a national percentile rank, and the smoothing and interpolation applied to produce a complete operational lookup table. It further documents the extension of the resulting table, in which the SC READY vertical scale serves as the common metric through which additional assessments are linked to national standing without a separate norm study.

Assessment Background

SC READY is a statewide, standards-based, criterion-referenced assessment aligned to the South Carolina College- and Career-Ready Standards in English Language Arts and Mathematics. Its technical characteristics include:

- **Vertical Scale Scores (VSS):** A vertically articulated scale within subject areas that supports developmental interpretations across grades.
- **Achievement Levels:** Performance standards established through formal standard-setting procedures that classify students relative to grade-level expectations.
- **Criterion-Referenced Interpretation:** Scores are interpreted against defined content standards rather than relative to a national comparison group.

SC READY is not administered nationally and as populations shift re-norming is challenging. National percentile standing on the SC READY scale is therefore derived by linkage rather than measured directly, and the derivation is the subject of this methodology.

Source Linking Studies

National percentile ranks for SC READY are derived from the equi-percentile linking studies South Carolina has already completed between SC READY and nationally normed assessments administered across multiple states, specifically NWEA MAP Growth and i-Ready. Each study provides, by grade and subject, a concordance between SC READY vertical scale scores and the reference assessment's scale scores, established on a common population of South Carolina students who took both assessments within a defined administration window. Each reference assessment supplies national percentile ranks drawn from its own nationally representative norm sample.

A source study is admissible to the derivation when it satisfies four conditions.

- **Common population:** Both assessments were taken by the same students within an administration window

short enough that intervening instruction does not materially alter relative standing.

- **Documented reference norms:** The reference assessment publishes national percentile ranks with a stated norm sample, norming date, and sampling design.
- **Grade and subject specificity:** The concordance is estimated separately within each grade and subject rather than pooled across grades.
- **Scale preservation:** The SC READY vertical scale is retained as the target scale, so the derivation adds a reporting layer without altering the operational scale.

Where more than one admissible study exists for a grade and subject, one reference is designated primary and the derived table is built from it. Remaining studies are retained as independent verification: a second reference will not reproduce the primary reference's percentiles exactly, and the magnitude of that difference is a direct empirical check on linking error. Reconciliation rules are documented where a composite is reported.

Statutory Context

S.C. Code § 59-18-325(C)(1) requires that the summative assessment compare the performance of South Carolina students to the performance of students on comparable standards in other states "with the ability to link the scales," on a vertically scaled, benchmarked, standards-based system of summative assessments. The derivation documented here is the mechanism by which that comparison is produced: scale linking to assessments administered across many states, on the SC READY vertical scale.

Derivation of National Percentile Ranks

Conceptual framework: Equi-percentile linking¹ aligns SC READY and the reference assessment such that corresponding scores occupy the same percentile position within their respective distributions in the linking sample. Let s denote an SC READY vertical scale score and r a reference scale score, with FS and FR

¹ Equi-percentile linking is a statistical concordance procedure that aligns score distributions across assessments based on cumulative percentile rank and does not constitute test equating, which requires stronger design assumptions and evidence of construct and form comparability (Kolen & Brennan, Test Equating, Scaling, and Linking). Because the method is

distribution-based, it does not impose an equal-interval transformation or establish score interchangeability. In large-scale applications, smoothing techniques such as log-linear presmoothing are commonly applied to stabilize score distributions prior to percentile inversion.

the corresponding cumulative distribution functions estimated on the linking sample. The equi-percentile relationship satisfies:

$$F_S(s) = F_R(r)$$

The reference score linked to an SC READY score s is therefore:

$$r = F_R^{-1}(F_S(s))$$

Composition with the national norm: The linked reference score is converted to a national percentile rank by the percentile function NR published for the reference assessment.² The derived national percentile rank for an SC READY score is the composition of the two functions:

$$NPR(s) = N_R(F_R^{-1}(F_S(s)))$$

The derived percentile is thus a property of two documented mappings: the linking function, estimated on South Carolina data, and the reference assessment's national percentile function, estimated on its norm sample. Both are reported with the crosswalk, and neither is re-estimated by the other.

Operational steps: For each grade and subject:

1. Estimate the SC READY vertical scale score distribution on the operational population.
2. Estimate the reference score distribution on the linking sample and derive the equi-percentile function between the two scales.
3. Convert each linked reference score to a national percentile rank using the reference assessment's published norm tables.
4. Construct the lookup mapping: SC READY VSS → reference scale score → national percentile rank

Smoothing and Interpolation

Need for Interpolation Percentile ranks are discrete, and not all SC READY vertical scale score values align exactly with a tabled reference percentile. Linear interpolation between adjacent percentile-linked points produces a complete operational crosswalk. For known points (p_1, y_1) and (p_2, y_2) , and a percentile p between them:

$$y = y_1 + \frac{(p - p_1)}{(p_2 - p_1)}(y_2 - y_1)$$

Distribution Smoothing: Score distributions are presmoothed before inversion to reduce irregularities caused by sampling noise. The general log-linear form is:

$$\log(n_i) = \beta_0 + \beta_1 x_i + \beta_2 x_i^2 + \dots$$

where n_i is the frequency at score x_i . Cubic spline smoothing is not to the derived percentile table, and the smoothing model used is documented with the crosswalk.

Grade- and Subject-Specific Linking

Derivation is conducted separately by grade (3–8) and by subject (ELA, Mathematics), which preserves developmental and distributional differences across grades and content domains. Pooling across grades is not performed, because the SC READY vertical scale and the reference norm distributions change shape by grade.

Each derived table includes:

- SC READY Vertical Scale Score (MathVSS, ELAVSS).
- Linked reference scale score.
- Derived National Percentile Rank (MathNPR, ELANPR).
- Standard error of linking at that score point.

Extension: Linking Additional Assessments

Once the SC READY vertical scale carries a documented national percentile mapping, that scale serves as the common metric through which additional assessments are linked to national standing. No further national norm study is required for each new assessment.

For an assessment A administered to South Carolina students, an equi-percentile link to SC READY is estimated on a common population within grade and subject, with FA the cumulative distribution function of assessment A scores:

$$s = F_S^{-1}(F_A(a))$$

National percentile standing for assessment A then follows by composition with the derived SC READY table:

$$NPR_A(a) = NPR(F_S^{-1}(F_A(a)))$$

This is chained linking: each new assessment is linked once, against the state scale, and inherits the national percentile mapping already established. A single maintained derivation therefore serves every assessment linked to the SC READY scale, and each additional link is estimated on South Carolina operational data rather than against a separate commercial norm sample.

Linking Error and Uncertainty

All linking introduces statistical error. Primary sources include sampling variability, construct misalignment, norm group differences, and distributional irregularities, particularly in the tails. The standard error of linking may be approximated as:

$$SEL(s) \approx \frac{\sigma_s}{f_S(s)} \sqrt{\frac{p(1-p)}{N}}$$

where σ_s is the SC READY standard deviation, $f_S(s)$ is the score density at s , p is the percentile expressed as a proportion, and N is the linking sample size. The error is largest where the score

² National percentile ranks are properties of the reference assessment's norm sample, not of the linking sample. The derived SC READY percentile therefore inherits the recency, representativeness, and documentation of the reference

assessment's norms, and the reference assessment's re-norming schedule governs the useful life of the derived table.

density is lowest, which places the widest uncertainty in the tails and near performance-level cut regions. For a chained link, where the errors of the two stages are treated as independent, the combined standard error is approximated as:

$$SEL_{chain} \approx \sqrt{SEL_1^2 + SEL_2^2}$$

The independence assumption is not exact where both links are estimated on overlapping South Carolina populations, and the approximation is reported as a lower bound in that case

Assumptions, Interpretive Boundaries, and Limitations

Assumptions The derivation assumes construct overlap sufficient to justify alignment within grade and subject, population stability and representativeness of the distributions used, monotonic correspondence between scores across assessments, and cumulative distributions smooth enough for inversion and interpolation. It further assumes that the reference assessment's norm sample is current and nationally representative as documented. The methodology does not assume identical content blueprints, equivalent reliability, common scaling models, or interchangeable achievement standards:

Interpretive Scope The derived table supports percentile-based translation of relative student placement, approximate alignment of scale score locations within grade and subject, and the extension of that placement to additional assessments linked to the SC READY scale. It does not support cross-assessment growth inference, claims of content equivalence or psychometric interchangeability, or the reporting of a derived percentile as a score obtained on the reference assessment.

Because SC READY is criterion-referenced and vertically scaled while the reference assessments are norm-referenced, the linkage reflects distributional concordance rather than mastery equivalence. Reporting language identifies the derived value as an

approximate national comparison and names the reference assessment and norm year from which it was derived.

External Verification

Derived national placement is monitored against NAEP, which provides a large, current, cross-state benchmark at grades 4 and 8. NAEP is used as an external plausibility check on aggregate placement over time rather than as a linking partner, because its matrix-sampled design does not produce individual scores suitable for student-level concordance.

References

- S.C. Code Ann. § 59-18-325 (summative assessment; cross-state comparison; vertically scaled, standards-based system).
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