Exact Path

Edmentum Exact Path and the Quantile Framework Linking Study
An Abstract

Evidence Base of Exact Path Quantile Measures

Linking studies are a psychometric method to relate scores from one scale to scores on another scale. This linking study was completed by MetaMetrics®, the parent organization of The Quantile® Framework for Mathematics, to research the link between the Edmentum Exact Path mathematics scale scores and Quantile® measures.

By establishing a link, **information can be used to determine a student's readiness for mathematics instruction on particular skills and concepts** and to compare academic growth across years, using student performance on the Edmentum Exact Path mathematics assessment.

The Quantile Framework for Mathematics Purpose and Design

The Quantile Framework is a tool that helps teachers, parents, and students locate appropriate mathematics materials and track growth. Quantile measures, which are used to measure both the difficulty of mathematics materials and a student's mathematical ability on the same scale, are represented by a number followed by an "Q." Quantile measures can range from below 0Q to above 1600Q; measures below 0Q are represented with an "EM" prefix standing for "Emerging Mathematician". For example, 50 Quantiles below 0 is represented as EM50Q.

Exact Path Scale Score Calculations

Exact Path's computer adaptive diagnostic assessment uses the Rasch model to place student results on a vertical-growth scale. A student's initial ability estimate is based on grade level and adjusts according to performance on each test item. The adaptive algorithm also ensures sufficient domain and item-type coverage as well as measurement precision for each assessment. Scores on the Exact Path mathematics scale range from a minimum of 500 to a maximum of 1500. The scale scores provide a way to monitor student growth.

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Linking Study Design

A single-group/common-person design was chosen for this study (Kolen & Brennan, 2014). This design is most useful "when (1) administering two sets of items to examinees is operationally possible, and (2) differential order effects are not expected to occur" (Kolen & Brennan, 2014, pp. 16–17). The Quantile linking items were administered as part of the Edmentum Exact Path mathematics diagnostic to students in grades K to 12 between September 15, 2017 and April 8, 2018.
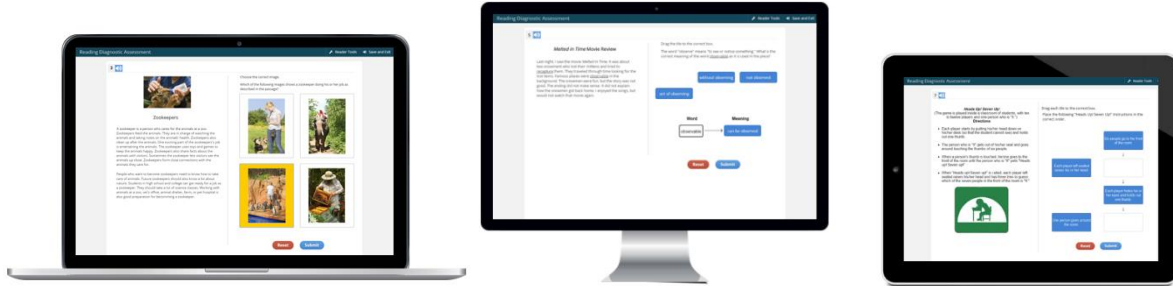
## Linking the Edmentum Exact Path Mathematics Scale to the Quantile Scale

These three steps were performed concurrently for the items in all grades:

1. All Edmentum Exact Path mathematics items and Quantile linking items were concurrently calibrated.
2. The psychometric properties of linking items were evaluated, and a second concurrent calibration was conducted with Exact Path mathematics items and Quantile linking items deemed appropriate for analyses to anchor the theoretical Quantile values to Edmentum's Exact Path mathematics items on to the Quantile scale.
3. A scoring run using only the Edmentum Exact Path mathematics items on the Quantile scale obtained from step 2 was conducted.

Evaluation of Quantile Linking Item Pool Items

MetaMetrics provided Edmentum with 26 linking items per grade to build eight-item, fixed-form blocks of items that were added to Edmentum's online test administration. Each eight-item block contained a range of items varying in difficulty. However, all eight-item blocks represented the typical range of complexity for a fall administration based on grade-level norms. Edmentum then provided MetaMetrics with difficulty values for the range of mathematics items typically encountered by students during their test administration.

After administering the items, the Quantile linking items were reviewed by MetaMetrics. The number of students taking the sets of linking items varied by grade, from 188 (grade 11) to 13,205 (grade 3), for a total sample of 94,711 students taking a block of Quantile linking items across grades K through 12. All items were submitted to a Winsteps analysis (Linacre, 2017) and were reviewed and evaluated for use in the linking study based on item difficulty or potential alternate answer choices being more attractive than the correct answer choice. Eleven items were flagged for removal based on these criteria.

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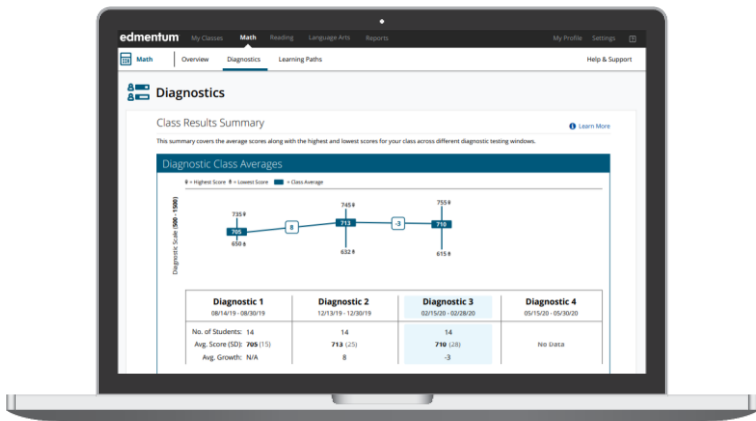
Each Quantile item administered was taken by a minimum of 43 students and maximum of 12,415 per grade. The retained items performed adequately (the average ability measure for the correct answer was highest compared to the average ability measures of the three distractors from the Winsteps analyses) and were retained in the subsequent analyses.

Using this information, along with national normative data and information from previously administered Quantile linking tests, the difficulty for each grade-level linking item pool was determined. To provide connectivity within grades, each within-grade, eight-item set contained two common items.

Linking Analyses

Two score scales (e.g., the Edmentum Exact Path mathematics scale and the Quantile scale) can be linked using linear equating. The linear-equating method is appropriate to use when (1) test forms have similar difficulties and (2) simplicity is desired in conversion tables or equations, in conducting analyses, and in describing procedures (Kolen & Brennan, 2014).

In linear equating, a transformation is chosen such that scores on two sets of items are equated if they correspond to the same number of standard deviations above (or below) the mean in that group of examinees (Kolen & Brennan, 2014). Linear equating by definition has the same mean and standard deviation for the linking equation because the means and standard deviations are the same for the tests being linked. The final linking equation between the Edmentum Exact Path mathematics scale scores and Quantile measures can be written as:

Quantile Measure = Slope (Edmentum Mathematics Scale Score) + Intercept

Here, the slope is the ratio of the standard deviations of the Edmentum Exact Path mathematics scale scores and calibrated Quantile measures. Conversion tables were developed for all grade levels to express the Edmentum Exact Path mathematics scale scores in the Quantile metric.

Quantile measures that are reported for an individual student should reflect the purpose for which they will be used. If the purpose is research (e.g., to measure growth at the student, grade, school, district, or state level), then actual measures should be used at all score points, rounded to the nearest integer. A computed Quantile measure of 772.5Q would be reported as 773Q. If the purpose is instructional, then the Quantile measures should be capped at the upper bound of measurement error (e.g., at the 95th percentile of the national Quantile norms) to ensure developmental appropriateness of the material. MetaMetrics expresses these scores as "Reported Quantile Measures" and recommends that these measures be reported on individual score reports.

Conclusions, Caveats, and Recommendations

The study results showed a strong positive correlation between Exact Path mathematics diagnostic scale scores and Quantile measures. Now, as students complete Exact Path's adaptive diagnostic mathematics assessment, they will receive an accurate Quantile measure. Following multiple administrations, Quantile growth is also tracked in reporting.

The Quantile measure is one factor related to mathematical ability and is a good starting point in determining a student's readiness for instruction on particular mathematics skills. Other factors—such as student developmental level, motivation, and interest, also need to be considered when planning mathematics instruction.

The Quantile Framework for Mathematics is a unique resource for accurately estimating a student's ability to think mathematically and matching him/her with appropriate mathematical content. With this valuable information in the hands of educators, instruction can be more accurately tailored to the mathematical achievement of individual students.

The link that has been established between the Edmentum Exact Path mathematics scale scores and Quantile measures **permits educators to differentiate instruction and determine a student's readiness for instruction on a particular mathematics skill.**

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References

Kolen, M.J. & Brennan, R.L. (2014). *Test equating, scaling, and linking: Methods and practices*
(3rd ed.). New York, NY: Springer-Verlag New York.

Linacre, J.M. (2017). Winsteps® Rasch measurement computer program. Beaverton, OH: Winsteps.com.

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