GED® Knowledge & Skill Gaps
Mathematical Reasoning

Session 1

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Greetings and welcome!

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General Announcements

This presentation will be posted

We will be stopping throughout for questions, with a general Q&A afterward

There's a lot of examples in this presentation; answers are included at the end

Questions before we begin?

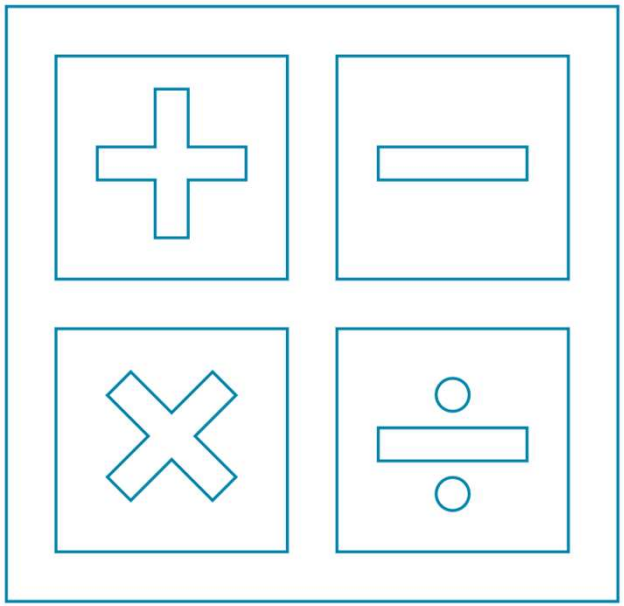
Today's Focus

Some students have gaps in the knowledge and skills that they need to succeed on the GED® Mathematical Reasoning test.

Students may need more instruction and practice in these areas during test preparation.

What we will be covering

- How items and tests are developed
- How skill/knowledge gaps are identified
- Specific skills and GED® indicators where students have the *most* difficulty
- Possible reasons *why* students are having difficulty
- What educators can do to address these gaps



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What we won't be covering

Test takers tend to underperform on some items simply because the concepts they assess are more difficult.

In other words, we *expect* the items to be difficult because the concepts are difficult (e.g., permutations and quadratic equations).

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

{*ABC, ACB, BAC, BCA, CAB, CBA*}

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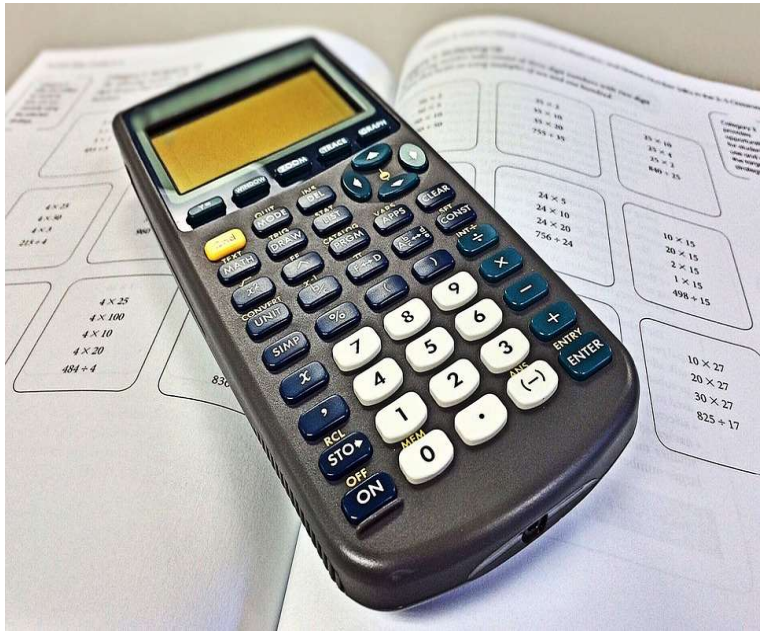
Data Summary: Passed 3 of 4 Subjects

Over the past two years, GED Testing Service has tracked 77,000 test takers who have passed the GED® test in 3 of the 4 subject areas.

Subject left to pass:

- 2% Science
- 5% Social Studies
- 11% RLA
- **82% Math**



Item and Test Development

Item development

The basis for item development is the GED® assessment targets (indicators), which can be found on GED.com in the ***Assessment Guide for Educators***.

Each indicator describes one or more skills.

Each test item is written to target ONE of the skills described by an indicator.

> **Q.1.a** Order fractions and decimals, including on a number line

Assessment Targets and Indicators

GED® *Assessment Guide for Educators*

- https://ged.com/wp-content/uploads/assessment_guide_for_educators_all_subjects.pdf
- **Math Guide**: pages 17 – 72
- **Math Assessment Targets** (Indicators): pages 23 – 26

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Item development

Guiding principles for item development include:

- One item, one construct
- No extraneous information
- Distractors reflect (most) common mistakes
- No testing of definitions or solution *methods*
- No "trick" questions

All items are reviewed by outside experts (i.e., people like you) before they go on a test

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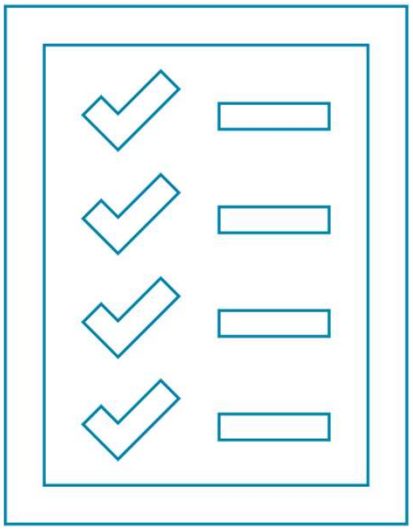
Field-test construction



Once an item has been developed, it is placed in a field-test pool.

Field-test items are embedded in operational—i.e., 'real'—tests, and performance data is collected.

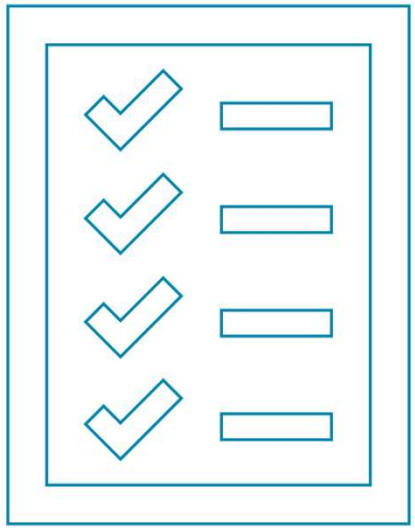
Once enough test takers have taken the field-test items in a pool, that group of items is swapped out for another.

Post-test analysis

Field-test items are analyzed statistically, *and* for content issues, and each item is either:

- Accepted,
- Rejected, or
- Revised and re-field tested

The knowledge and skill gaps are identified through this statistical analysis.



Areas of Knowledge and Skill Gaps

Session 1:

- non-calculator items
- exponents/roots
- three-dimensional shapes
- (compound) probability

Session 2:

- algebraic computation
- inequalities
- slope/graphing
- multiple answers

NOTE: There *is* overlap among many of these gaps.

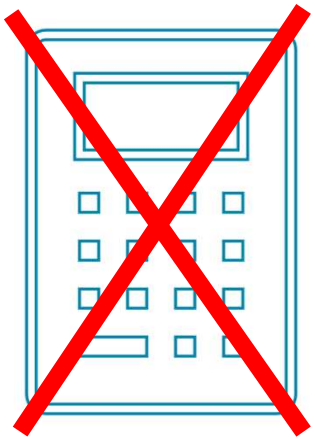

Questions?

Gap 1: Non-Calculator Items

Gap 1: Non-calculator items

One aspect of the statistical analysis of items is comparing the performance of high-, middle-, and low-achieving groups.

On many non-calculator items, there is little difference in performance among these groups. This may be due to over-reliance on calculators during instruction and practice.



Gap 1: Non-calculator items (indicators)

Non-calculator indicators:

- **Q.1.a** – **Q.1.d** (number sense—ordering fractions and decimals, factors, multiples, exponents, distance on number lines)
- **Q.2.a** – **Q.2.d** (arithmetic computation—four basic operations, order of operations, squares, cubes, roots, undefined expressions)
- **NOT Q.2.e** (arithmetic word problems; calculator allowed)

Note: Indicators can be found in the ***Assessment Guide for Educators***

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Gap 1: Non-calculator items (examples)

Place $\frac{3}{8}$, $\frac{4}{9}$, and $\frac{2}{7}$ in order from least to greatest.

(Q.1.a)

What is the least common multiple of 4, 9, and 12?

(Q.1.b)

Simplify $(-3)^6 \times [(-3)^2]^4$

(Q.1.c)

Gap 1: Non-calculator items (examples)

Multiply $\frac{2}{5} \times 0.85$

(Q.2.a)

Simplify $-1 \times 9 + (42 \div 7) \div 3$

(Q.2.a)

Simplify $-2\sqrt[3]{64}$

(Q.2.c)

Gap 1: Non-calculator items (strategies)

Some students don't feel confident without a calculator.

Students should practice both with and without calculators on the skills assessed by the non-calculator indicators.

Encourage students to make a habit of checking their work.

Gap 1: Non-calculator items (resource)

"Tips for Non-Calculator Math" can be found on GED.com here:

English:

https://ged.com/wp-content/uploads/Tips-for-Non-calculator-math_EN.pdf

Spanish:

https://ged.com/wp-content/uploads/Tips-for-Non-calculator-math_ES.pdf

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Questions?
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Gap 2: Exponents and Roots

Gap 2: Exponents/roots (indicators)

- Specific indicators: Q.1.c (laws of exponents);
  Q.2.c (cubes/cube roots)
  Q.2.b (squares/square roots): test takers mostly do well with this, but struggle a bit with squaring negatives

- Related indicators: Q.4, Q.5 (measurement of 2-D and 3-D shapes); A.1.d, A.1.f, & A.1.i (computing with, factoring, and evaluating polynomials); A.7.c & A.7.d (quadratic functions)

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Gap 2: Exponents/roots (answer types)

- Numerical answers:

  Q.2.b (squares/square roots); Q.2.c (cubes/cube roots); Q.4, Q.5 (measurement of 2-D and 3-D shapes); A.7.c & A.7.d (quadratic functions)

- Exponential answers:

  Q.1.c (laws of exponents); A.1.d, A.1.f, & A.1.i (computing with, factoring, and evaluating polynomials)

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Gap 2: Exponents/roots (examples)

Simplify $(-3)^8(-3^3)^4$ [answer: $(-3)^{20}$]

(Q.1.c)

Simplify $-2\sqrt[3]{64}$ [answer: -8]

(Q.2.c)

Simplify -6^2 [answer: -36]

Simplify $(-6)^2$ [answer: 36]

(Q.2.b)

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Gap 2: Exponents/roots (examples)

$(-6)^2$ → squaring of -6

-6^2 → the negative of the square of 6

Negative sign is equivalent to subtracting

Exponents first

$6^2 = 36$

$-6^2 = -36$

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Gap 2: Exponents/roots (examples)

Subtract: $(4x^2 - 3y^2) - (2x^2 + y^2)$

(A.1.d)

Multiply: $(4x^3 - 3y^3)(2x^3 + y^3)$

(A.1.d)

Factor completely: $8x^9 + 12x^6 - 24x^3$

(A.1.f)

What is the value of $4x^2 - 3y^2$ when $x = -6$ and $y = 5$?

(A.1.e)

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Gap 2: Exponents/roots (examples)

What is the volume, in cubic inches, of a cylinder with a radius of 2 inches and a height of 9 inches? ($V = \pi r^2 h$)

(Q.5.b)

What is the volume, in cubic inches, of a cone with a radius of 2 inches and a height of 9 inches?

$(V = \frac{1}{3}\pi r^2 h)$

(Q.5.d)

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Gap 2: Exponents/roots (examples)

A right triangle has two legs measuring 16 inches and 12 inches. What is the length, in inches, of the hypotenuse of the right triangle?

(formula: $a^2 + b^2 = c^2$)

(Q.4.a)

Gap 2: Exponents/roots (strategies)

Master the laws of exponents

Understand that squaring and square roots are inverse operations (just like add/subtract and multiply/divide); same for cube roots

Understand that the calculator will not help compute with variables

Practice on the specific indicators first, then related indicators

Practice using formulas that contain exponents

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Questions?

Gap 3: Three-Dimensional Figures

Gap 3: Three-dimensional shapes (indicators)

Q.5.a – Q.5.f

Skills assessed:

- calculate surface area
- calculate volume
- determine dimensions (e.g., length, height, radius)

Figures: prisms*, pyramids, cones, cylinders, spheres, composite figures

*Students tend to do well on items assessing prisms.

Gap 3: Three-dimensional shapes (formula sheet)

Mathematics Formula Sheet

Area of a:

square	$A = s^2$
rectangle	$A = lw$
parallelogram	$A = bh$
triangle	$A = \frac{1}{2}bh$
trapezoid	$A = \frac{1}{2}h(b_1 + b_2)$
circle	$A = \pi r^2$

Perimeter of a:

square	$P = 4s$
rectangle	$P = 2l + 2w$
triangle	$P = s_1 + s_2 + s_3$
Circumference of a circle	$C = 2\pi r$ OR $C = \pi d$; $\pi \approx 3.14$

Surface area and volume of a:

rectangular prism	$SA = 2lw + 2lh + 2wh$	$V = lwh$
right prism	$SA = ph + 2B$	$V = Bh$
cylinder	$SA = 2\pi rh + 2\pi r^2$	$V = \pi r^2 h$
pyramid	$SA = \frac{1}{2}ps + B$	$V = \frac{1}{3}Bh$
cone	$SA = \pi rs + \pi r^2$	$V = \frac{1}{3}\pi r^2 h$
sphere	$SA = 4\pi r^2$	$V = \frac{4}{3}\pi r^3$

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Gap 3: Three-dimensional shapes (formula sheet)

The Formula Sheet can be found on GED.com here:

English:

https://ged.com/wp-content/uploads/math_formula_sheet.pdf

Spanish:

https://ged.com/wp-content/uploads/math_formula_sheet_es.pdf

Gap 3: Three-dimensional shapes (examples)

A sphere has a diameter of 16 inches. What is the surface area, in square inches, of the sphere?

($SA = 4\pi r^2$)

(Q.5.d)

A cylinder has a radius of 3 inches and a height of 9 inches. What is the volume, in cubic inches, of the cylinder?

($V = \pi r^2 h$)

(Q.5.b)

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Gap 3: Three-dimensional shapes (examples)

A sphere has a surface area of 200.96 square inches. What is the radius, in inches, of the sphere?

($SA = 4\pi r^2$)

(Q.5.d)

A cylinder has a volume of 339.12 cubic inches and a height of 12 inches. What is the radius, in inches, of the cylinder?

($V = \pi r^2 h$)

(Q.5.b)

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Gap 3: Three-dimensional shapes (strategies)

Know the dimensions of 3-D figures, including their relationship to each other (e.g., diameter and radius).

Practice using formulas—all three skills.

- Suggest beginning with volume, then surface area, then missing dimensions; or start with the least complex formulas.

Understand that the process of using a formula to find missing dimensions is like solving an equation—it requires "working backwards."


Questions?

Gap 4: Compound Probability

Gap 4: Compound probability

Part of indicator Q.8.b

Skills:

- simple probability*
- compound probability of sequential or multiple events
- compound probability with replacement
- compound probability without replacement

*Test takers tend to do well on items assessing simple probability.

Gap 4: Compound probability (examples)

Sequential events

A coin is flipped 3 times. What is the probability that the result is "heads" each time?

Multiple categories

Amy flips a coin and rolls a standard die. What is the probability that the coin lands on "heads" and the die lands on 3?

Gap 4: Compound probability (example)

Replacement

Martin has a bag containing 20 pieces of candy. There are 4 pieces each of apple, cherry, grape, lemon, and strawberry flavors. Martin randomly selects a piece of candy from the bag, puts it back, then randomly selects another. What is the probability that Martin selects a lemon, then a strawberry candy?

Gap 4: Compound probability (example)

No replacement

A fish tank at the aquarium store contains 5 male and 5 female goldfish. An employee is moving the goldfish 1 at a time from one tank to another. What is the probability that the first 2 goldfish removed are male?

Gap 4: Compound probability (strategies)

Make sure students have mastered the concept and applications of simple probability.

Understand how the concept and mechanics of simple probability extend and relate to compound probability.

Understand the difference between "replacement" and "no replacement."

Understand that the onscreen calculator will likely not help when trying to determine fractional answers.


Questions?

Areas of Knowledge and Skill Gaps

Session 1:

- non-calculator items
- exponents/roots
- three-dimensional shapes
- (compound) probability

Session 2:

- algebraic computation
- inequalities
- slope/graphing
- multiple correct answers

Q&A

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Thank you!

Communicate with GED Testing Service®
help@ged.com

Michael Bell – michael.bell@ged.com

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Answers to Examples

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Gap 1: Non-calculator items (examples)

Place $\frac{3}{8}$, $\frac{4}{9}$, and $\frac{2}{7}$ in order from least to greatest.

$\frac{2}{7}$, $\frac{3}{8}$, $\frac{4}{9}$

(Q.1.a)

What is the least common multiple of 4, 9, and 12?

36

(Q.1.b)

Simplify $(-3)^6 \times [(-3)^2]^4$

$(-3)^{14}$

(Q.1.c)

Gap 1: Non-calculator items (examples)

Multiply $\frac{2}{5} \times 0.85$

0.34

(Q.2.a)

Simplify $-1 \times 9 + (42 \div 7) \div 3$

-7

(Q.2.a)

Simplify $-2\sqrt[3]{64}$

-8

(Q.2.c)

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Gap 2: Exponents/roots (examples)

Simplify $(-3)^8(-3^3)^4$

$(-3)^{20}$

(Q.1.c)

Simplify $-2\sqrt[3]{64}$

-8

(Q.2.c)

Simplify -6^2

-36

Simplify $(-6)^2$

36

(Q.2.b)

Gap 2: Exponents/roots (examples)

Subtract: $(4x^2 - 3y^2) - (2x^2 + y^2)$

$2x^2 - 4y^2$

(A.1.d)

Multiply: $(4x^3 - 3y^3)(2x^3 + y^3)$

$8x^6 - 2x^3y^3 - 3y^6$

(A.1.d)

Factor completely: $8x^9 + 12x^6 - 24x^3$

$4x^3(2x^6 + 3x^3 - 6)$

(A.1.f)

What is the value of $4x^2 - 3y^2$ when $x = -6$ and $y = 5$?

69

(A.1.e)

Gap 2: Exponents/roots (examples)

What is the volume, in cubic inches, of a cylinder with a radius of 2 inches and a height of 9 inches?

($V = \pi r^2 h$)

113.04

(Q.5.b)

What is the volume, in cubic inches, of a cone with a radius of 2 inches and a height of 9 inches?

37.68

($V = \frac{1}{3}\pi r^2 h$)

(Q.5.d)

Gap 2: Exponents/roots (examples)

A right triangle has two legs measuring 16 inches and 12 inches. What is the length, in inches, of the hypotenuse of the right triangle?

(formula: $a^2 + b^2 = c^2$)

20

(Q.4.a)

Gap 3: Three-dimensional shapes (examples)

A sphere has a diameter of 16 inches. What is the surface area, in square inches, of the sphere?
($SA = 4\pi r^2$)

803.84

(Q.5.d)

A cylinder has a radius of 3 inches and a height of 9 inches. What is the volume, in cubic inches, of the cylinder?
($V = \pi r^2 h$)

254.34

(Q.5.b)

Gap 3: Three-dimensional shapes (examples)

A sphere has a surface area of 200.96 square inches. What is the radius, in inches, of the sphere?
(SA = $4\pi r^2$)

4

(Q.5.d)

A cylinder has a volume of 339.12 cubic inches and a height of 12 inches. What is the radius, in inches, of the cylinder?
(V = $\pi r^2 h$)

3

(Q.5.b)

Gap 4: Compound probability (examples)

Sequential events

A coin is flipped 3 times. What is the probability that the result is "heads" each time?

$\frac{1}{8}$

Multiple categories

Amy flips a coin and rolls a standard die. What is the probability that the coin lands on "heads" and the die lands on 3?

$\frac{1}{12}$

Gap 4: Compound probability (example)

Replacement

Martin has a bag containing 20 pieces of candy. There are 4 pieces each of apple, cherry, grape, lemon, and strawberry flavors. Martin randomly selects a piece of candy from the bag, puts it back, then randomly selects another. What is the probability that Martin selects a lemon, then a strawberry candy?

$$\frac{1}{25}$$

Gap 4: Compound probability (example)

No replacement

A fish tank at the aquarium store contains 5 male and 5 female goldfish. An employee is moving the goldfish 1 at a time from one tank to another. What is the probability that the first 2 goldfish removed are male?

$$\frac{2}{45}$$