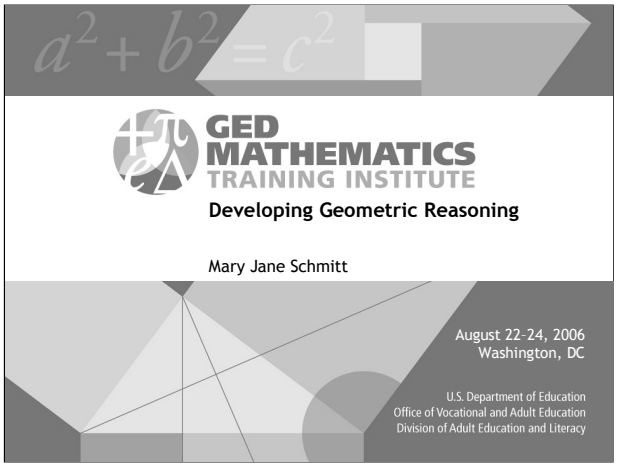
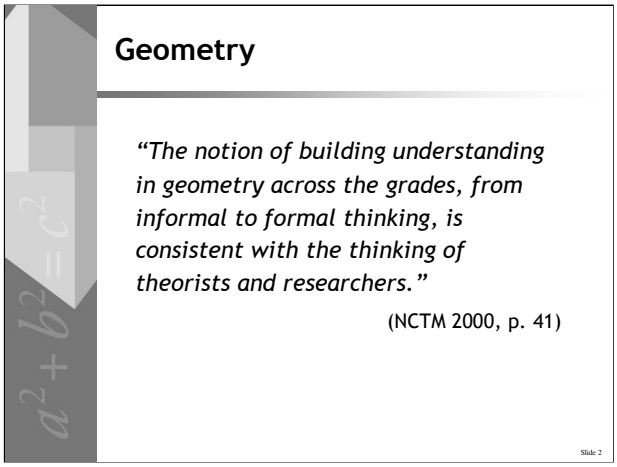

$a^2 + b^2 = c^2$
GED
MATHEMATICS
TRAINING INSTITUTE
Developing Geometric Reasoning
Mary Jane Schmitt
August 22–24, 2006
Washington, DC
U.S. Department of Education
Office of Vocational and Adult Education
Division of Adult Education and Literacy



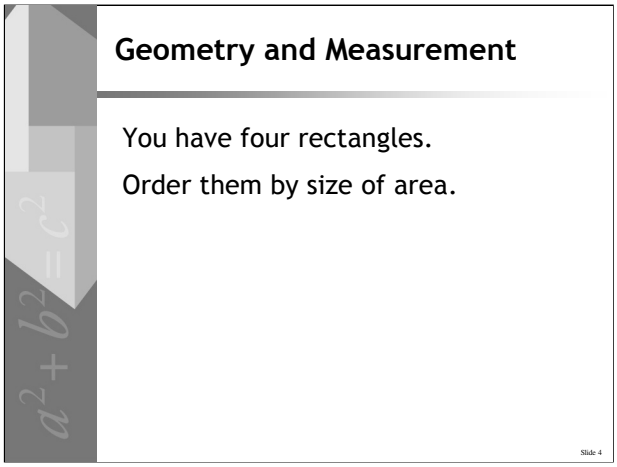
In a previous presentation, this quote from the NCTM Principles and Standards introduced the section on geometry and measurement. In this session, we will focus more specifically on what researchers and theorists tell us about how geometric understanding develops. Then we will explore some activities where the theory becomes apparent.

Do you sleep on a rectangle, drink out of a cylinder, eat ice cream from a cone, or have meals at a square table? Then you have experienced geometry. Geometry touches on every aspect of our lives. It is important to explore the shapes, lines, angles, and space that are woven into our students' daily lives as well as our own. In fact "geo" means earth and "metry."

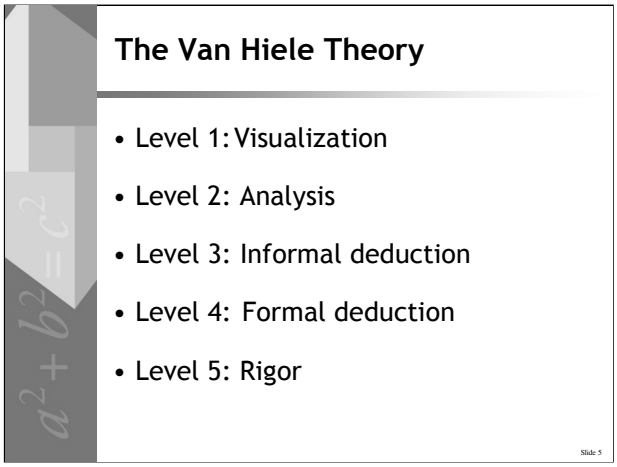
Geometry and Measurement

- How does geometric understanding develop?
- Similarity — a "big idea"
- How does this apply to the GED?

Slide 3



Ask people to talk to a partner about this. Then ask for ideas - write the ideas on newsprint or an overhead transparency.



Present levels -

The work of two Dutch educators, Pierre van Hiele and Dina van Hiele-Geldof, has given us a vision around which to design geometry curriculum.

Through their research they have identified five levels of understanding spatial concepts through which children move sequentially on their way to geometric thinking.

There are four characteristics of these levels of thought:

• The Van Hiele levels of geometric reasoning are sequential. Students pass through all prior levels to arrive at any specific level.

• These levels are not age-dependent in the way Piaget described development.

• Geometric experiences have the greatest influence on advancement through the levels.

• Instruction and language at a level higher than the level of the student may inhibit learning.

Talk about starting with establishing amount of surface covered (example of comparing shapes) - then establishing the square unit as a way to quantify - use example of a 5 by 10 rectangle.

Level 1: Visualization

- Students can name and recognize shapes by their appearance, but cannot specifically identify properties of shapes. Although they may be able to recognize characteristics, they do not use them for recognition and sorting.
- Students manipulate physical models, e.g., lay one shape on top of another.

Slide 6

Level 2: Analysis

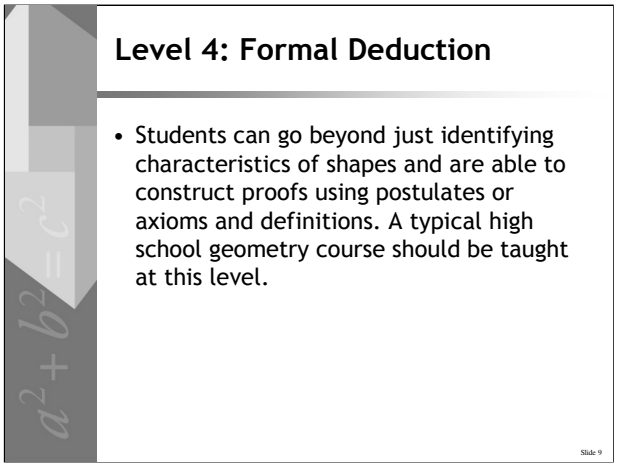
- Students begin to identify attributes of shapes and learn to use appropriate vocabulary related to attributes, but do not make connections between different shapes and their properties.
- In the example of the area of a rectangle, students can count the component square units.

Slide 7

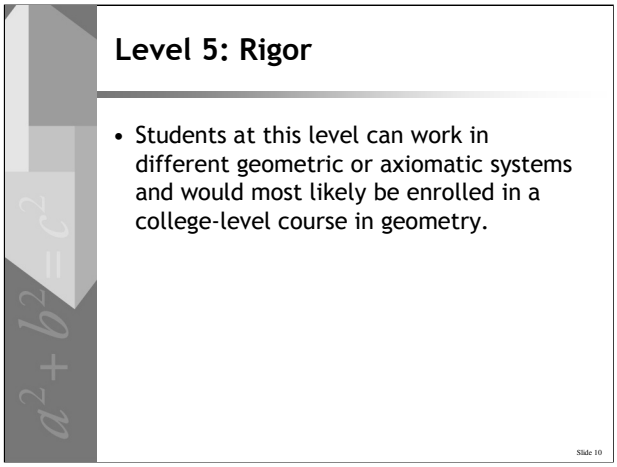
Level 3: Informal Deduction

- Students are able to recognize relationships between and among properties of shapes or classes of shapes and are able to follow logical arguments using such properties.
- See the relationship between length, width, and area for all rectangles.

Slide 8



Students usually do not reach Levels 4 and 5 until high school or college, but teachers should be aware of these levels nonetheless.



The NAEP says most of the 4th, 8th, and 12th graders are operating at levels 1 and 2.

Reflections

- If you were going to teach finding the area of a rectangle to a group of adults in a pre-GED class, how would you start?
- What activities might help students make the leap and connect from Level 1 to Level 2 to Level 3?
- How would you include the three levels when finding the areas of other polygons, circles, or irregular shapes?

Slide 11

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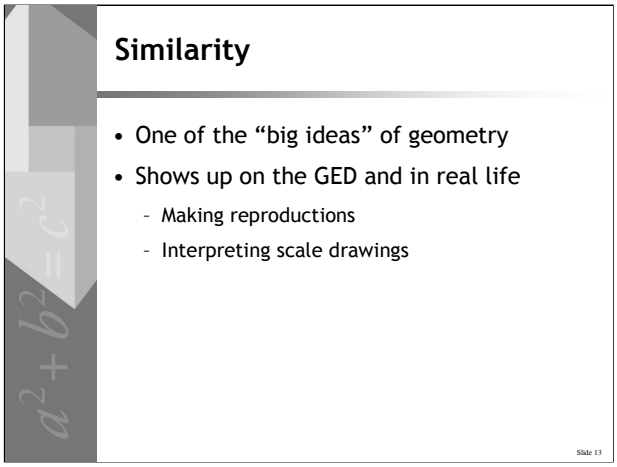
GED Item Writers' Manual

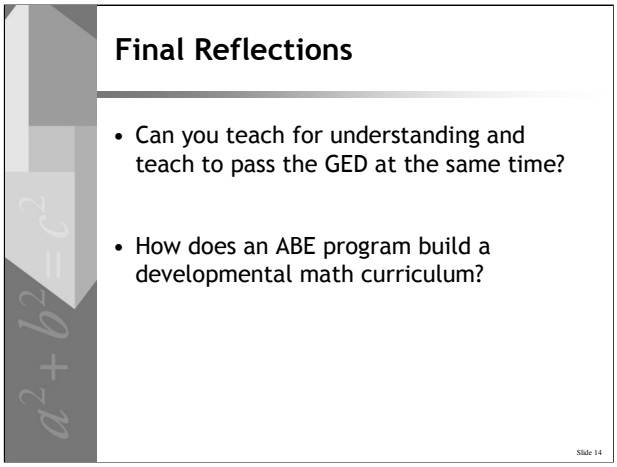
Relevant Content Area Specifications
Geometry and Measurement

- Model and solve problems using the concepts of perpendicularity, parallelism, congruence and similarity of geometric figures (includes polygons, 3-D figures, and circles).
- Use spatial visualization to describe and analyze figures.
- Use the Pythagorean Theorem, similarity, and right triangle trigonometry to model and solve problems.
- Solve and estimate solutions to problems involving length, perimeter, area, surface area, volume, angle measurement, capacity, weight, and mass.
- Use rates in problem situations.
- Read and interpret scales, meters, and gauges.
- Predict the impact of a change in linear dimension on the perimeter, area, and volume of figures

Slide 12



In ABE classes where students are preparing for the GED, the teaching of proof is rarely taught - the first three levels are the focus.



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