

From first encounters to expertise? Pupils' understanding of contour lines across educational levels

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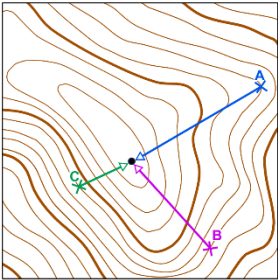
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Abstract:

Contour lines are a fundamental cartographic tool for representing terrain relief, yet their interpretation remains challenging for many map users. Accurate comprehension of contour lines is essential not only for reading topographic maps, but also for informed spatial reasoning in professional contexts such as infrastructure planning, flood risk assessment, landscape modelling, or monitoring soil degradation. Despite their importance, previous studies indicate persistent difficulties in understanding contour lines, even among undergraduate students in geography-related fields. Given that, it is valuable to comprehend how this understanding develops across educational levels and which specific misunderstandings (i.e., misconceptions) persist despite increased educational experience.

This study thus investigates how conceptual understanding and confidence in interpreting contour lines vary across age groups. Data were collected from approximately 1,200 pupils across three educational levels: primary (Grade 4), lower secondary (Grade 8), and upper secondary (Grades 12) in Czechia. These levels were selected to capture pupils before the formal introduction of contour lines in the curriculum (Grade 4), after initial instruction with time for consolidation (Grade 8), and following repeated exposure within a spiral curriculum (Grade 12). A Four-Tier Contour Concept Test (4TCCT), designed to assess cross-age understanding, was developed and employed. The four-tier tests assess both the correctness of pupils' responses and reasoning as well as their certainty in the given responses and reasoning. For an illustrative example of one of the tasks in 4TCCT, see Figure 1.

5. Alex starts from point A, Bella from point B, and Charlie from point C. They all follow the arrows to the top of the hill. Who of them will overcome the greatest elevation gain?



a) Alex
b) Bella
c) Charlie
d) Alex and Bella
e) Bella and Charlie
f) They all have the same elevation gain.

How certain are you with your answer?
• absolutely certain • rather certain • rather uncertain • just guessing

The reasoning behind the answer is:
a) He/She walks up the steepest hill.
b) He/She has the shortest path, but the contour lines are close together.
c) He/She is the furthest from the top and has the longest way to go.
d) He/She goes across the most contour lines.
e) They reach the same elevation, just by different paths.
f) Other reason (write it down):

How certain are you with your explanation of the answer?
• absolutely certain • rather certain • rather uncertain • just guessing

Figure 1. Example of a 4TCCT test task (translated from Czech into English).

The results reveal both the developmental trajectory of contour line comprehension and the persistence of specific misconceptions despite increased educational experience. The findings of our study offer insights into how pupils engage with relief representation and may inform cartography education practices at primary and secondary educational levels.

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