Measuring novices’ field mapping abilities using an in-class exercise based on expert task analysis

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Outline:
1) Overview of study
   A) Objectives
   B) Oliver Field School
2) Study design and methods
   A) Expert task analysis
   B) Student modeling exercise
   C) Exercise solutions
3) Results and Implications
4) Conclusions
Study Objectives:
1. Develop a model of expert-like behavior: use it to improve field teaching methods.

2. Based on expert-model, design and implement an in-class exercise to assess expertise in students.

3. Assist students in mastering the process of field mapping more effectively and think creatively in 3D in the field.

Oliver Field School May 2010
Oliver Field School:
• Two-week field school
• Numerous bedrock mapping exercises

• Most importantly:
  - Captive audience!
  Let’s study how the students think!
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What does an expert geologic mapper DO?
Plan field work

To the field...

Develop working model for outcrop

Based on outcrop model(s) generate multiple hypotheses for the 3D geology

Locate yourself then... Geological characterization of outcrop

No Hypothesis Yet?

Test HYPOTHESES

Next outcrop
Plan: define purpose of exercise, background reading, equipment and safety preparation (days to weeks)...

Interpretation of geological relationships observed in outcrop: i.e. develop a working model for the outcrop

Each loop reduces uncertainty and reveals more of the geological complexity (be it large or small)

Based on outcrop model(s) how might you expect to “fill-in” the geology over the rest of the map area? i.e. from outcrop model → generate multiple hypotheses for the 3D geology (lithostratigraphy, structural elements, geometry, cross-cutting relationships) of the whole map area

No Hypothesis Yet?

Test HYPOTHESES i.e., which outcrop should you visit next to best test your multiple hypotheses. [initially very few constraints]

Geological Characterization of Outcrop:
• Lithostratigraphy
• Structural elements
• geometry
• cross-cutting relationships

(Caulkins, Hickey and Bevier, 2010...unpublished work)
Confirmed by UBC colleagues and by surveying 46 mapping experts at GSA (Denver 2010)
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Does model development exercise show expert-like behavior in students?
- 45-minute paper-based exercise (on bus up to field school!)
- Paired students up
- Instruction: Develop as many “possible” models as you can.
Day 1 – two outcrops

Key

- MS – Mudstone
- SS – Sandstone
- Fossil Clam
- Marine Fossil

Name 1:

Name 2:

Brief (1-2 words) Explanation:

Sketch possible relationship:

Brief (1-2 words) Explanation:

Sketch possible relationship:

Brief (1-2 words) Explanation:

Sketch possible relationship:

Brief (1-2 words) Explanation:

Sketch possible relationship:

Brief (1-2 words) Explanation:

Sketch possible relationship:

Brief (1-2 words) Explanation:

Sketch possible relationship:
Day 2 – four outcrops

Brief (1-2 words) Explanation:
Sketch possible relationship:

Brief (1-2 words) Explanation:
Sketch possible relationship:

Brief (1-2 words) Explanation:
Sketch possible relationship:

Brief (1-2 words) Explanation:
Sketch possible relationship:

Key
MS – Mudstone
SS – Sandstone
♀ Fossil Clam
△ Marine Fossil
♀♀♀ Burrow cast (up)
↑ Dip Direction

Name 1:
Name 2:
Day 3 – five outcrops

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**Key**

- MS – Mudstone
- SS – Sandstone
- '?' – Fossil Clam
- Marine Fossil
- Burrow cast (up↑)
- Dip Direction

**Name 1:**

**Name 2:**
How do we assess students on a scale from novice to expert via this exercise?

**Experts**: generate multiple possible models. None are impossible.

**Novices**: generate models but likely very few and/or include numerous impossible models.

**Methods**:  
- Total number of possible models generated  
- Ratio of Possible to Impossible Models (PM/IM+1)
Example Student Model – Assessment is blind

And no “impossible” models

Total = 2
Results: Plotted Student Class Rank against Number of Possible Models
Final Class Rank vs. Number of Possible Models (all data)

$R^2 = 0.2992$

Not a pair

outlier
Final Class Rank vs. Number of Possible Models (outliers removed)

$R^2 = 0.493$
Conclusions:
• The exercise is one measure of expertise in one aspect of field mapping (model creation) and it appears to predict which students will have more trouble with field camp and which will have less.

• Can use this information to target parts of mapping expertise and provide to students focused, appropriate feedback and opportunities to practice.

Next Year:
• Will use exercise as an individual (not paired) pre- and post-assessment and associate it with a lesson on model creation. Post-test will have isomorphic data.