A Structure for Mastering Stereonets in Structural Geology

Katherine Boggs; Department of Earth Sciences; Mount Royal University; Calgary, Alberta, Canada

My motivation? Personally was challenged
Most dramatic transformative moment of my voyage to professional geologist involved a hand in a bowl

Methods
4 years of exam marks – question averages
- Part A: Likert Scale
- RCL = Reported Confidence Levels
- (on specific skills)
- - rank helpfulness of instructional techniques
- Part B: Open ended questions about transformative moments

Predicted Results?
*Students like group problem solving & hands on activities
*Students don’t like to read, especially complex material such as Structural Geology
*Students don’t like techniques that they perceive as not being helpful (e.g. textbook problems versus old exam/quiz problems)
*Practice, practice, practice!! (step #3)
*Basic skills involve 1-2 steps; while some advanced skills involve rotations

Threshold Concept "Akin to a portal" (Meyer & Land 2006)
- transformative
- integrative
- probably irreversible
- possibly troublesome

Table One: Ranking Stereonet skill level
<table>
<thead>
<tr>
<th>Skill</th>
<th>Table marks</th>
<th>RCL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pole to Plane</td>
<td>Basic</td>
<td>84.9%*</td>
</tr>
<tr>
<td>Line of Intersection</td>
<td>Basic</td>
<td>92.9%*</td>
</tr>
<tr>
<td>Apparent Dips</td>
<td>Basic</td>
<td>86.5; 89.4%*</td>
</tr>
<tr>
<td>Rake</td>
<td>Basic</td>
<td>89.6; 90.5%*</td>
</tr>
<tr>
<td>Oblique Traverse</td>
<td>Intermediate</td>
<td>63.2; 69.2%*</td>
</tr>
<tr>
<td>Fold Analysis</td>
<td>Intermediate</td>
<td>73.8%**</td>
</tr>
<tr>
<td>Fault Plane Diagrams</td>
<td>Intermediate</td>
<td>74.2%**</td>
</tr>
<tr>
<td>Unplunge/unfold Fold</td>
<td>Advanced(midterm)</td>
<td>57.8; 68.2%*</td>
</tr>
</tbody>
</table>

Though the participants gradually gained the necessary skills:
Some intermediate and advanced skills
*Not all rotation skills were "advanced"; there was no natural break between the old exam/quiz problems

Proposed Model
(transferable to all challenging topics)
1) Introduction to conceptual knowledge,
2) Learn skills in an ammative manner,
3) Use stereonet to solve different problems,
4) Collaborate with peers, and
5) Use stereonet to construct geoscience schematic models

Not rocket science!! (but not in literature)

Surprising Results?
*Students did not recognize that some textbook problems were very similar to the old exam/quiz problems
*Not all rotation skills were "advanced"; there was no natural break between some intermediate and advanced skills
*No evidence for transformative moments as per the following comments that imply that the participants gradually gained the necessary skills:
  "Probably doing apparent dips. I just started to really get it"
  'During the 1st stereonet lab; finding TD etc from given information and relating to cross-sections'
  'The large lab with stereonets. Through doing class examples and then the lab forced you to figure out what was going on.'

Conclusions?
*Structural Geology courses are taught in good scaffolding sequences
*Participants were likely “high initial spatial ability”, one possible reason for a lack of transformative moment testimonials
*Proposed model provides a good framework for teaching challenging subjects
*As professors, never forget that what we perceive as being simple are not necessarily simple for the novice student!

Here – use student voice to understand what really works and what does not

Expected lots of these Personal joy witnessing transformative moments

Part B: Open ended questions about transformative moments
- (on specific skills)

Part A: 4 years of exam marks
- RCL = Reported Confidence Levels
  - Very > 4.0; Helpful 4.0 to 3.0; Least helpful < 3.0
  - Instructional techniques where 5 was extremely helpful and 1 was not helpful.

Table Two: Ranking helpfulness of Instructional Techniques
<table>
<thead>
<tr>
<th>Instructional Technique</th>
<th>Rank</th>
<th>Average; Likert Value</th>
<th>Model Step??</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Exercise</td>
<td>Very</td>
<td>4.6</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Lab Problems</td>
<td>Very</td>
<td>4.7</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Old exam / quiz problems</td>
<td>Very</td>
<td>4.6</td>
<td>1, 2, 4, 5</td>
</tr>
<tr>
<td>Group Work</td>
<td>Very</td>
<td>4.4</td>
<td>4</td>
</tr>
<tr>
<td>Lectures</td>
<td>Helpful</td>
<td>3.8</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Instructor Explanations</td>
<td>Helpful</td>
<td>3.1</td>
<td>1, 2, 3, 4, 5</td>
</tr>
<tr>
<td>Reading Textbook</td>
<td>Least</td>
<td>2.8</td>
<td>1, 2, 3</td>
</tr>
<tr>
<td>Textbook Problems</td>
<td>Least</td>
<td>2.5</td>
<td>1, 2, 3, 3, 5</td>
</tr>
</tbody>
</table>

Liker scale question asked participants to rank the helpfulness of different instructional techniques where 5 was extremely helpful and 1 was not helpful.
Very > 4.0; Helpful 4.0 to 3.0; Least helpful < 3.0

Here – use student voice to understand what really works and what does not

#2

#3