**INTRODUCTION**

I have been teaching mineralogy-petrology courses at Western Oregon University (WOU), a four-year liberal arts institution, for 14 years. I inherited a single Earth materials course called “Rocks and Minerals”, which focused on hand-sample study of minerals and mineralogy concepts, with limited coverage of petrology. This course featured a scribing lab component and was heavily memorization based. Also, the program lacked petrographic microscopes, so it was not possible to teach microscopy. In developing the Earth materials curriculum for the broad-based Earth Science major offered at WOU, I have wrestled with how to teach mineralogy and petrology in the absence of a yearlong sequence that is commonplace in more traditional geology degree programs. In 2001, I began an NSF-CCLI project to revise the Earth materials curriculum at WOU. The primary objective was to develop an active, inquiry-based approach to teaching mineralogy and petrology within the context of a broad-based undergraduate Earth Science degree. The CCLI grant and subsequent institutional funding have supported the acquisition of student petrographic microscopes and scopes with digital imaging systems. With this equipment, I have established a mineralogy-petrology curriculum that is ongoing, and is more inquiry-based. This curriculum includes development of a lab-driven microscopy course and full-scale revision of the petrology course. As well, an active-learning strategy that engages students in the study of rocks and minerals has been implemented.

**“NUTS AND BOLTS” OF THIN SECTION PROBLEM SOLVING ASSIGNMENTS**

The central idea behind “Thin Section Problem Solving” assignments (TSPSAs) is for students to use thin sections as a geologic data source for conducting authentic scientific investigations. For each TSPSA, students are provided with a thin section (and in most cases, a corresponding hand sample). As depicted in Figure 1, students study the thin section and hand sample, make observations, identify a scientific problem/question, propose a working hypothesis, collect data with computer-based technologies to test the hypothesis, and defend their results in a class-wide discussion session and written reports. Students are instructed to test the hypothesis using observations and data that can be taken directly from the sample. For each assignment, students prepare a short paper (no more than 2 pages) and give a brief presentation to the class (5-7 minutes with 3-5 minutes for discussion). Class members are encouraged to question their student colleagues. Presentations and class-wide discussion sessions require a two-hour class period.

**REDESIGNING THE EARTH MATERIALS CURRICULUM**

To overcome the issue of limited credit hours, the Earth materials curriculum was renovated to include a lab-based Petrographic Microscopy course and an integrated lecture-laboratory Petrology course.

**Petrographic Microscopy Course:** Focuses on student skill development in using a microscope to identify basic rock-forming, accessory, and alteration minerals in thin section. Emphasis is on the optical properties that are needed to identify the different minerals.

**Petrology Course:** Integrated lecture-laboratory course covering broad range of mineralogy-petrology content. Focus is on the study of rocks; mineralogy concepts are presented on “need-to-know” basis.

These courses are framed around an inquiry-based pedagogy that is designed to actively involve students in the scientific process and move away from passive-teach teaching methods. This learning strategy consists of a series of "Thin Section Problem Solving Assignments" that begin in the Microscopy course and continue through the Petrology course.

**ASSESSMENT OF STUDENT WORK**

<table>
<thead>
<tr>
<th>Study Sample</th>
<th>More observations</th>
<th>Identify Scientific Problem/Question</th>
<th>Collect data with computer-based technologies</th>
<th>Prepare presentation and report</th>
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</thead>
<tbody>
<tr>
<td>Make observations</td>
<td>Background research</td>
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<tr>
<td>Defend Results</td>
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<tr>
<td>Test Hypothesis</td>
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<tr>
<td>More observations</td>
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Figure 1: Schematic representation of the process that students undertake when completing a Thin Section Problem Solving Assignment.

**ISSUES & CHALLENGES**

While TSPSAs are designed to actively engage students in doing science, there are some pitfalls to this strategy.

- **Challenging endeavor for students**
  - Requires strong instructor perception, appears to challenge students
  - Requires quite a bit of out-of-class time for students

- **Some students struggle with identifying a scientific problem or question**

- **Some students have trouble developing a testable working hypothesis**
  - In some cases, propose tests that are not readily solvable given sample/materials that are available to them

- **Class-time requirement**
  - Three, 2-hour class periods for presentations and class-wide discussion sessions
  - Grading can be quite time consuming

**POSITIVE ATTRIBUTES**

Despite these challenges, I am optimistic about the long-term potential of TSPSAs as a strategy to engage students in the learning process and move from a fact-based teaching method to a process-oriented model.

- **Conduct authentic scientific investigations**
- **Enhance geologic problem-solving skills**
- **Develop technology skills**
  - Use petrographic microscopes and digital cameras interfaced with computers
  - Employ software to collect images and prepare multi-media presentations
- **Present results in both written and oral formats**
- **Questioned about their interpretations by peers and forced to defend their results**

**CONCLUSION**

TSPSAs are a viable strategy to teach the study of Earth materials within the context of a broad-based undergraduate Earth Science degree program. This approach promotes students in the learning process and has enabled me to move from a passive-teach method to a more active-learning environment. Further, TSPSAs promote the larger objective of students conducting independent research projects, and I am pleased to see an increase in the number of students who are getting involved in these types of activities.

**ACKNOWLEDGEMENTS**

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