

**SCI 6170 – RESEARCH TRADITIONS: EARTH SCIENCE EDUCATION**  
**Fall 2007, Wednesdays 5:30-8:30**  
**2734 Wood Hall**

INSTRUCTOR: Heather Petcovic

E-MAIL: [heather.petcovic@wmich.edu](mailto:heather.petcovic@wmich.edu)

OFFICE: 3138 Wood Hall

PHONE: 269-387-5380

COURSE WEBSITE: <http://homepages.wmich.edu/~hpetcovic/sci6170.html>

### **Course Description**

This course is designed to familiarize students with the more productive research traditions in science education and with their historical, philosophical, and methodological foundations. Each offering of the course will focus on a particular tradition, for example, problem solving research or conceptual change research.

### **Course Goals**

1. Students will become familiar with the philosophical and methodological characteristics of research in the field of earth science education.
2. Students will become familiar with current areas of active research in the earth sciences.
3. Students will gain experience critically analyzing published research papers in the area of earth science education.
4. Students will apply their knowledge of earth science education research traditions and critical analysis to prepare a proposal to conduct original research in this field, and to peer-review proposals created by classmates.

### **Required Reading**

We will be reading primarily from the earth science education primary literature, thus we do not have a textbook for this course. Papers are available for you to download from the course website as .pdf files where indicated with a \*.

#### An Introduction to Earth Science

Orion, N., and Ault, Jr., C. R., 2007, Learning earth sciences. In: Abell, S.K., and Lederman, N.G., (eds.), Handbook of Research on Science Education, Lawrence Erlbaum Associates Inc., Mahwah, New Jersey, p. 653-687.

\*Frodeman, R., 1995, Geological reasoning: Geology as an interpretive and historical science. GSA Bulletin, v. 107, p. 960-968.

#### Conceptions Research in Earth Science

\*Vosniadou, S., and Brewer, W.R., 1992, Mental models of the Earth: A study of conceptual change in childhood, Cognitive Psychology, v. 24, p. 535-585.

\*Gobert, J.D., and Clement, J.J., 1999, Effects of student-generated diagrams versus student-generated summaries on conceptual understanding of causal and dynamic knowledge in plate tectonics, Journal of Research in Science Teaching, v. 36, p. 39-53.

\*Dodick, J. and Orion, N., 2003, Cognitive factors affecting student understand of geologic time, Journal of Research in Science Teaching, v. 40, p. 415-442.

\*Libarkin, J.C., Anderson, S.W., Dahl, J., Beilfuss, M., and Boone, W., 2005, Qualitative analysis of college students' ideas about the Earth: Interviews and open-ended questionnaires, Journal of Geoscience Education, v. 53, p. 17-26.

\*Libarkin, J.C., and Anderson, S.W., 2005, Assessment of learning in entry-level geoscience courses: Results from the Geoscience Concept Inventory, *Journal of Geoscience Education*, v. 53, p. 394-401.

### Spatial Thinking and Visualization

National Research Council, 2006, *Learning to Think Spatially*, Committee on Support for Thinking Spatially: The Incorporation of Geographic Information Science Across the K-12 Curriculum, National Academies Press, Washington, D.C., p. 12-13 and 25-48.

\*Linn, M.C., and Petersen, A.C., 1985, Emergence and characterization of sex differences in spatial ability: A meta-analysis, *Child Development*, v. 56, p. 1479-1498.

Kastens, K.A., and Liben, L.S., 2007, Eliciting self-explanations improves children's performance on a field-based map skills task, *Cognition and Instruction*, v. 25, p. 45-73.

\*Black, A.A., 2005, Spatial ability and Earth Science conceptual understanding, *Journal of Geoscience Education*, v. 53, p. 402-414.

### Teaching and Learning in the Field

Orion, N. and Hofstein, A., 1994, Factors that influence learning during a scientific field trip in a natural environment, *Journal of Research in Science Teaching*, v. 31, p. 1097-1119.

Elkins, J.T., and Elkins, N.M.L., 2007, Teaching geology in the field: Significant geoscience concept gains in entirely field-based introductory geology courses, *Journal of Geoscience Education*, v. 55, p. 126-132.

### Cultural Issues in Earth Science Education

\*Riggs, E.M., 2005, Field-based education and indigenous knowledge: Essential components of geoscience education for Native American communities, *Science Education*, v. 89, p. 296-313.

\*Padgett, D.A., 2001, Teaching race, class, and cultural issues in earth sciences to enhance multicultural education initiatives, *Journal of Geoscience Education*, v. 49, p. 364-369.

### **Recommended Reading (for those going on in Earth Science Education)**

Ault, C.R., 1994, Research on problem solving: Earth Science. In: Gabel, D.L., (ed.), *Handbook of Research on Science Teaching and Learning*, Macmillan Publishing Co: New York, p. 269-283.

Manduca, C.A., and Mogk, D.W., 2006, *Earth and Mind: How Geologists Think and Learn about the Earth*. Geological Society of America Special Paper 413.

National Research Council, 2006, *Learning to Think Spatially*, Committee on Support for Thinking Spatially: The Incorporation of Geographic Information Science Across the K-12 Curriculum, National Academies Press, Washington, D.C.

*Journal of Geoscience Education*, 53(4), (2005). Special issue on conceptual change in earth science.

*Journal of Geoscience Education*, 54(2), (2006). Special issue on place-based learning.

### **Grading & Assignments**

Please type all work in a 12 point font, using 1-inch margins and 1.5 or double line spacing. Number all pages. Use the word count feature in your word processing program to make sure your work is within required word/page limits.

### Being Prepared (30% of grade)

Come to each class meeting having carefully read the assigned pages. Bring any notes you have taken on the readings and reflections from your own research experiences. Turn in a summary (2-4 pages) for **each** reading. The summary should include:

- An introductory paragraph that states the purpose of the article (why did the author write this paper?) and the main conclusion(s) of the reading.

- A short (page or so) summary of the main arguments presented in the article. This is not a “blow-by-blow” recounting of the paper, but instead should focus on summarizing the main arguments that the author(s) present(s) and the evidence supporting these arguments.
- A critical evaluation of the article – some things to consider:
  - Is the information provided accurate?
  - Did the author(s) provide sufficient evidence to support claims, interpretations, and conclusions? Are the interpretations plausible? Are the main conclusions justified by the evidence presented?
  - Is the research methodology sound and are the assumptions clearly identified?
  - Is earlier work adequately recognized and credited? [You may not be familiar enough with the research in this area to make a certain judgment on this].
  - Did the author(s) achieve the purpose of the paper? For example, did you find the arguments presented persuasive or not? Why?
  - Is the paper well organized and readable?
  - Are the study and its findings significant? Does the study contribute significantly to the knowledge base in this area?

It is acceptable to use quotes in the summary, however please keep these short (less than 2 lines) and use sparingly. I want to know what you took away from the article, not a restatement of what the author(s) said. Remember to cite the article page number if you take any quotes.

#### Discussion Leadership (20% of grade)

For one discussion period with assigned readings, prepare discussion questions for the class as a handout (approximately 1 page of questions). Lead the discussion during class. Focus the discussion on a critical evaluation of the reading.

For one student-led discussion period, choose 1 article related to your research paper (see below). At least one week prior to the date for which you are the discussion leader, provide copies of the article (paper or electronic) to the class and instructor. Prepare discussion questions for the class and lead the discussion of the article you have chosen. This should be an article that you feel is critically important to the paper topic you have chosen. You may consult with your instructor in choosing which article you would like to present in the student-led discussion period.

You are excused from writing the summary for the articles for which you are the discussion leader.

#### Research Paper (50% of grade)

Choose one of the research areas we have examined in class that is of interest to you (for example, conceptions research in earth science, learning in the field, etc.). Within this research area, narrow your topic down to a specific focus. Conduct a thorough literature review of what is known about your earth science education research focus area. Write a 12-15 page paper covering the following:

- Review of the literature and summary of what is known about your earth science education research focus area
- Description of an original research project designed to advance your understanding of this earth science education research area

The paper should follow the format and criteria of a WMU Human Subjects Institutional Review Board (HSIRB) application and proposal. Follow the instructions on the HSIRB application for project review, except as noted below. You may want to check out the general information on the HSIRB website.

Paper preparation instructions:

- Download the HSIRB application for project review:  
(<http://www.wmich.edu/research/hsirb/docs/application-project-review.doc>).
- Complete the first three pages of the application. List yourself as the student investigator, and leave the PI section blank. Attach these three pages to your final paper (not counted in the 12-15 page limit). You do NOT have to prepare consent documents (page 4).
- Your **abstract** should summarize the main point(s) of the paper. An abstract is generally a single paragraph that does not contain any citations. The abstract should be between 200-300 words.
- Please subdivide the **purpose/background information** section into two sections. The **purpose** should set up the context of the paper and provide a compelling argument for why your project should be go forward. Why is your research proposal important? How are you planning to advance the understanding of this topic? Set the overall paper into a broad but related context of research, teaching and learning. The **background information** section summarizes what is known about your earth science education research focus area. This is where you cite other people's work on this topic. You might consider sub-dividing this section with several sub-headings to organize your work. This section should make up 40-50% of your final paper.
- The remainder of your paper is the **research protocol**. Follow the outline indicated on the HSIRB application form and use these as section headings (subject recruitment, consent, research procedure, etc.). The section should describe the study you are proposing. How will you conduct the study? Who will the participants be? What data will you collect and how will you collect it? How will you analyze the data and what will the analysis tell you? How will you protect the identity/privacy of your subjects? What are the risks and benefits to participants? What are the advantages and limitations of the methodology you propose? This section should make up 50-60% of your final paper.
- Include a list of **references** cited in the proposal (not part of the 12-15 page limit)
- If you are planning to use data collection tools (interview questions, pre-tests and post-tests, etc.) give examples of these in an **appendix** to your paper. These are not part of the 12-15 page limit.

You will be citing other people's work in the paper. Be sure to cite anything from another source (see academic honesty, below). Please make your citations in the text using the (Author, date) format. Include page numbers when you use direct quotes. For quotes longer than 40 words (about 2 lines of text), single space and indent the passage. You may use whatever format you desire for the reference list, just be sure to include all pertinent information [e.g., author(s), date, title, journal or book title, volume no., pages, publisher and city (if a book)].

Compose the research paper in sections; each section will individually receive feedback from your instructor. We will spend the final class period peer reviewing all papers. Use the instructor and peer feedback to improve the final version of the paper.

- Purpose and background information. Due 10/24
- Research proposal (recruitment, consent, procedure, etc.). Due 11/7
- Full draft final paper: Due 11/28. Please email a copy to your instructor to post on the class website. You will be expected to read all of your classmates' papers for the following class meeting and to produce a written review of 2 papers. Review criteria will be provided.
- Full final paper: Due 12/12 by 5 pm. Can be emailed to your instructor.

### Academic Honesty

You are responsible for making yourself aware of and understanding the policies and procedures in the Graduate Catalog that pertain to Academic Honesty (pp. 25-27). These policies include cheating, fabrication, falsification and forgery, multiple submission, plagiarism, complicity and computer misuse. If there is reason to believe you have been involved in academic dishonesty, you will be referred to the

Office of Student Conduct. You will be given the opportunity to review the charge(s). If you believe you are not responsible, you will have the opportunity for a hearing. You should consult with your instructor if you are uncertain about an issue of academic honesty prior to the submission of an assignment or test.

Students often misunderstand plagiarism; therefore, please refresh your understanding before doing any writing for this course. I strongly recommend that students consult <http://www.indiana.edu/~wts/pamphlets/plagiarism.shtml>

## Daily Schedule

5:30-5:40	Class business
5:40-6:15	Gather/write responses to discussion questions
6:15-7:20	1 <sup>st</sup> discussion period
7:20-7:30	Break
7:30-8:30	2 <sup>nd</sup> discussion period

## Course Schedule

Week	Date	Leader	1 <sup>st</sup> Discussion Period	2 <sup>nd</sup> Discussion Period
1	9/5/07	HP	Intro, syllabus, assignments	
2	9/12/07	1. HP 2. HP	Intro: Orion and Ault, 2007	Intro: Frodeman, 1995
3	9/19/07	1. HP 2.	Conceptions: Vosniadou and Brewer, 1992	Conceptions: Gobert and Clement, 1999
4	9/26/07	1. 2. JL	Conceptions: Dodick and Orion, 2003	Conceptions: Libarkin et al., 2005; Libarkin and Anderson, 2005
5	10/3/07	1. HP 2.	Spatial/Visual: NRC, 2006	Spatial/Visual: Linn and Petersen, 1985
6	10/10/07	1. 2.	Spatial/Visual: Kastens and Liben, 2007	Spatial/Visual: Black, 2005
7	10/17/07	1. 2.	Field learning: Orion and Hofstein, 1994	Field learning: Elkins and Elkins, 2007
8	10/24/07	1. 2.	Cultural issues: Riggs, 2003; Padgett, 2001	Student-led
9	10/31/07		<b>NO CLASS – GSA</b>	
10	11/7/07	1. 2.	Student led	Student led
11	11/14/07	1. 2.	Student led	Student led
12	11/22/07		<b>NO CLASS – THANKSGIVING BREAK</b>	
13	11/28/07	1. 2.	Student led	Student led
14	12/5/07	1.	Student led	Peer review of research papers
15	12/12/07		<b>Research paper due by 5 pm</b>	