Education 830
What Are the Roots of Science Education?
Fall 2011

Instructor
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Class Meeting
Tuesdays, 9-12 am, 2334 SEB

Class Web Site
http://www.ctools.umich.edu/

Course Focus

What are the roots of science, scientific thinking, the development of science curricula and textbooks, and the role of scientific theories and explanations in the growth and understanding of scientific knowledge? Is science an abstract discipline, or one in which the individuals, context, history, politics and other factors influence the development and acceptance, of scientific ideas and theories? This course will take a broad look at foundational literature in the disciplines of science, science education, curriculum development, the history of science and science education, learning theories and the learning of science, and the influence of theories and explanations of science in association with how people learn. Individuals will be asked to reflect on these ideas, the products that were developed to manifest these ideas, and application of these foundations to their own learning, teaching, and experiencing of science.

Course Requirements

Expectations
This 3-credit course is organized as a seminar with an emphasis on in-class and reflective dialogue of weekly materials by all attendees. The course will emphasize a forum for supportive, productive, and critical inquiry. Students are expected to attend all class sessions, to complete readings or material review prior to the class discussion, and to participate actively in the design and execution of course activities. Students are expected to inform the instructor in advance of absences. As an advanced graduate level course, the reading load, at times, may be substantial. It is expected that students will come to class willing to share their understandings in order to contribute to the learning of all class members.
Grading Policy and Assignment Descriptions

Your grade in the class will be determined by your participation in the following activities:

- **Class Participation** 10
- **Class Leadership and Group Dialogue** 15
- **Reflection Papers (3 at 15 each)** 45
- **Final Reflective Outline and Paper (5, 25)** 30

/100%

**Class Participation, Leadership, Dialogue**
Class members will rotate responsibility for some of the leadership in discussion of papers and materials. During class, leader will lead portions of the class discussion and activities related to these materials, and identify the main issues, strengths, and weaknesses from class discussions. Students not in charge of leading the discussion should be prepared to respond to activities and questions posed, and to participate fully in the activities proposed by the leader.

**Group Dialogue Activity**
Each student will represent two viewpoints or contrasting perspectives for debate and discussion with the class on one focus topic. For your group dialogue activity or discussion, each student should prepare no more than three PowerPoint slides summarizing the most important features and issues of your perspectives. The class will engage in a dialogue or activity of the topic for approximately 30 minutes of class time.

Sample topics include:
- a. How are historical and current ideas about process skills/scientific practices similar and different from each other?
- b. What influences from the history of science are evident in my science textbook?
- c. Do children hold primitive scientific theories or knowledge in pieces?
- d. Which disciplines outside of science itself influenced scientific theories the most, and why?
- e. Learning science does/does not happen by conceptual change.
- f. Today’s (physical science, life science, earth and atmospheric science) standards do/do not incorporate ideas from historical ideas about science and science education
Reflection Papers

Reflection papers consist of approximately 5 single-spaced pages of thoughtful analysis, original thinking, and literature-grounded critique. All papers are due by 5pm on the due date. Papers will address a common theme although original work is essential.

Grading of reflection papers will be as follows:

<table>
<thead>
<tr>
<th>Category</th>
<th>Points</th>
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<tbody>
<tr>
<td>Original thinking, quality of arguments</td>
<td>5</td>
</tr>
<tr>
<td>Selection and synthesis of relevant literature to ground arguments</td>
<td>5</td>
</tr>
<tr>
<td>Writing style, professional presentation (e.g. APA standard bibliography)</td>
<td>5</td>
</tr>
<tr>
<td><strong>Point total</strong></td>
<td><strong>15</strong></td>
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Paper 1: What is science? What are science theories?

Draw from your own experiences and the literature associated with science and science theories to develop an argument for your definition of science and/or scientific theory. Please illustrate your definition with a small number (one or two) of examples from your own experiences. Some questions you may address include:

a. What are the characteristics of science?

b. What does it mean to “think scientifically” or to “do science”?

c. What are scientific theories? How do they develop or become established?

Paper 2: Your Views on How Individuals Learn Science

Work from your notes from our first class discussion to articulate your ideas on both the factors and the mechanisms by which individuals learn science. Be sure to define both what knowledge you are talking about, and how it is acquired/learned. If you wish, you can use one or two examples to illustrate your factors and mechanism.

Paper 3: Extension and Reflection on More Recent and Most Important Scientific Events

You will be provided with a chronological table of major science discoveries from 3000 B.C. until 1967. Your paper should extend the timeline from 1967 to the present, including ONLY the discoveries you believe are most relevant to your area of expertise and understanding of science and that you believe are revolutionary or substantial. The paper narrative should explain and justify, with literature, your additions.

Guidelines for Final Paper

Your final paper should be well organized, contain original thinking, and be grounded in relevant literature. The paper should be focused around a topic of your choosing that will extend your understanding of course materials including a) primary class readings, b) additional readings and c) video/discussions/activities from class. Like the short papers, the final paper should be framed around a particular and/or critical perspective, viewpoint or idea that makes reference to or draws from a selected review of key literature. In other words, the paper should go beyond merely reviewing literature and provide, for example, a plan for an original research study that might extend a study from a class paper or the design of modified or original assessment tasks and coding rubric that go beyond work in the literature or an existing research project.

Below are suggested steps for planning, writing, and formatting your final paper.
A. Select a particular compelling, original idea, perspective or research question and state the perspective clearly in the introduction of the paper.

B. In the paper body, present your compelling, original idea, perspective or design of a research study in some level of detail. When each major dimensions of your perspective is described, it should be supported with relevant literature.

C. An important part of the final paper is the choice of literature you use to support or contrast your views, and your justification of your choices. In other words, be sure to describe what dimension of this piece makes it central to your argument or position, and why it was selected. In some cases, it might be a better choice to be more selective of key literature and provide more detail on the connection to your original ideas than to present a very long list of literature that is discussed in only a cursory manner.

D. Begin to write only after careful planning. Papers tend to be stronger and more coherent document through revisions of outlines before you write.

E. The final paper grade includes both the paper itself and a 10 minute interactive discussion of your paper topic in the final class session. For this session, you will be asked to prepare a one-page handout, a few PowerPoint slides, or a poster that you can discuss in a 10-minute presentation of your work.

Format Guidelines
All final papers must contain the following:
1. A title
2. A 200 word or less abstract
3. An Introduction outlining the major ideas and major justification for these ideas
4. Paper body with the expansion of paper ideas and appropriate citations in APA format
5. A Conclusion
6. A Reference list
7. Figures, charts or tables (if applicable)
8. Final papers should be approximately, but no more than, 15 pages single-spaced.

Evaluation Criteria for Final Paper Outline (5 points total)
3 points Quality and originality of ideas
2 points Organization of ideas, clarity and expression of ideas presented

Evaluation Criteria for Final Papers (25 points total)
9 points Quality and quantity of ideas and relevant literature used to support arguments
9 Original thinking, ideas and/or critical stance
7 Clarity, professionalism, and organization of ideas

Final paper outlines are due on 29 November. Final papers are due on 13 December.
Weekly Schedule

Week 1:  Introduction: What are our Views on How Individuals Learn Science?
         In class activities

Week 2:  Fundamental Vocabulary, Ideas, Starting Questions
         Readings:  a. Taking Science to School, Chapters 1, 2 and 3 (CTools)
                    b. Metz, On the Complex Relation Between Cognitive
                       Developmental Research and Children’s Science Curricula
                        (CTools)
         In class: Selections from curricular programs of the 1960s
         Assignment: Brainstorm 20 questions you have about the terms,
                      ideas, and research discussed in this reading

Week 3:  What Are Children’s Ideas in Science? What Learning Theories Apply?
                    b. The Essential Piaget (excerpts) (CTools)
         Assignment: Bring 1-3 pages of ideas of your view of how individuals
                      learn science

Week 4:  What are Scientific Theories?  What is Scientific Thinking?
         Assignment: First short paper due

Week 5:  Key Ideas From the History of Ideas in Science Education
         Readings:  a. DeBoer, Chapters 8 and 10
                    b. National Research Council, The National Science
                       Education Standards (1996) (excerpts) (CTools)
         Assignment: Group Dialogue 1

Week 7:  How Do Students’ Ideas Develop? Knowledge in Pieces and Theory-Theory
                    b. Susan Carey, Conceptual Change in Childhood (excerpts)
                       (CTools)
         Assignment: Second short paper due
Week 8: *How Do Students’ Ideas Develop? Science as Social Knowledge*

**Readings:**

**Assignment:** Group Dialogue 2 and 3

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Week 9: *Current Elements of Science Education: Science Practices, Explanations, and Arguments*

**Readings:**
- a. Toulmin (1958) (excerpts) (CTools)
- c. College Board Standards on Explanations

**Assignment:** Group Dialogue 4

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Week 10: *Current Elements: A Framework for Science Education, Hot Conceptual Change*

**Readings:**

**Assignment:** Third short paper due

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Week 11: *Current Elements of Science Education Reform: Learning Progressions*

**Readings:**
- a. Taking Science to School, pp. 213-250 (CTools)
- b. Songer, Kelcey and Gotwals (CTools)
- c. Mohen, Chen and Anderson (CTools)

**Assignments:**
- Discuss final paper topic with Nancy for feedback
- Group Dialogue 5

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Week 12: *What is Transfer of Learning? What Research Supports or Refutes It?*

**Readings:**
- b. Thorndike, selected excerpts (CTools)

**Assignment:** Final paper outline due

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Week 13: *What Constitutes Knowledge? What Constitutes Learning in Science? Synopsis*

**Readings:** TBD

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Week 14: *Final Class Presentations and Discussion*

**Assignment:** Final paper due
**Course Readings**


