TE 955 Contemporary Issues in Science Curriculum and Teaching

DEVELOPMENT OF LEARNING PROGRESSIONS FOR ELEMENTARY AND SECONDARY SCIENCE TEACHER EDUCATION

Monday, 12:40-2:30 PM, Room 228 Erickson Hall
Fall 2008

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Course Description/Objectives:

Over the past several years, there has been growing effort in the science education research community to understand how knowledge of important scientific concepts deepens and becomes more sophisticated over time. Taking the research on student learning as a starting point, much of this work has focused on the development of powerful assessments that can describe and evaluate this progression of understanding. In this seminar, we will focus our attention on articulating how research on learning progressions across diverse populations (e.g., elementary-, secondary- and more recently, college-aged students) might inform our work in teacher education—in particular, on the design of articulated programs and curricula for the preparation of elementary and secondary science teachers. These efforts will allow us the opportunity not only to become more knowledgeable about learning progression work more generally, but also to develop a learning progression-based framework that might guide the preparation of those planning to become teachers of science at the elementary or secondary level.

Course Requirements and Grading

Discussant and Synthesis Group Work (35% each, for toal of 70% of final grade)
Everyone is expected to complete the assigned readings before seminar each week and be able to thoughtfully discuss these focus papers throughout the semester. Each person taking the course for credit also will (a) serve in the role of discussant for one faculty member or research group's presentation and the reading assigned for that presentation and (b) be a part of a "synthesis group" for one of the two weeks in which this is the focus (i.e., 6 October or 3 November). The former will require that you meet with the indiidual(s) making the presentation, preparing an activity or a set of questions for discussion based on the presentation and reading, and leading the post-presentation part of the class. The latter will require that you meet with other members of the synthesis group to construct a PPT presentation summarizing what we know from the work in this area and what this work suggests in terms of some future research

directions. You may also want to use the faculty members who have been working in this area as a sounding board for your ideas.

Group Project (30% final grade)
The group project for the course can focus on one of the following:

1) Select a scientific concept that holds a critical place in the achievement of scientific literacy. Create an argument, based on the literature, about its importance, and identify the component principles around which students at different age levels (select one age range, such as elementary, secondary, college-level) might develop principled ways of reasoning about this concept (i.e., construct a proposed learning progression).

2) Select a skill or idea that it is critical for a teacher of science to understand and be able to enact critically. Create an argument, based on the literature, about its importance, and construct a proposed learning progression for this skill or idea that extends across the pre- and in-service years.

Other ideas are encouraged, as long as you have a group that shares the same interest and this interest is related to the course focus. You should feel free to negotiate an alternative with me. NOTE that since this is a group project, each group member's role should be adequately described.

Note about Participation and Attendance: The success of any seminar course hinges on active participation by each member. Each participant is expected to come to class ready to contribute thoughts and prepare for class each week through readings and course projects. In this way, each person will not only benefit from his/her own efforts and experiences, but also from those of the whole community. Because it's not possible to participate if you do not attend and because we only meet as a group once a week, your final grade will be affected by anything beyond one excused absence. Please let us know in advance if you anticipate missing a class.

Course Schedule: Course Readings & Assignments

August 25 First class

- Introduction to course and to learning progressions; negotiation of class day/time; sign up for discussant slot and synthesis group presentation

September 1 Labor Day. No class.

Reading: Duschl, R.A., Schweingruber, H.A., & Shouse, A.W. (Eds.). *Taking Science to School* (ch. 8): Learning progressions.

September 8: Perspectives on Student Growth, Identity, and Learning

Presentation: Edna Tan

Readings:
Tan, E. and Calabrese Barton, A. (2007). From peripheral to central, the story of Melanie's metamorphosis in an urban middle school science class. *Science Education*, 92 (4), 567-590.

Discussant: HsingChi von Bergmann

September 15: Learning Progressions in K-12 Students (A)

Presentation: Amelia Gotwals, Michelle Williams

Readings:

1) Songer, N.B. & Gotwals, A.W. Multi-scaffold assessments: Making a case for an assessment system that includes middle knowledge in science. Ms. in review.

2)

Discussants: Takumi Sato (Gotwals); Courtney Schenk (Williams)

September 22: Learning Progressions in K-12 Students (B)

Presentation: Environmental Literacy group

Readings: Anderson, C.W. (2008). Conceptual and empirical validation of learning progressions.

Mohan, L., Chen, J., and Anderson, C.W. (2007). Developing a multi-year learning progression for carbon cycling in socio-ecological systems.

Discussants: Hayat Hokayem

September 29 : Learning Progressions in K-12 Students (C)

Presentation: Christina Schwarz

Reading: Schwarz, C., Reiser, B, Davis, B., Kenyon, L, Acher, A., Fortus, D., Hug, B., & Krajcik, J. (2008, under review). Designing a learning progression of scientific modeling: Making scientific modeling accessible and meaningful for learners. *Journal for Research in Science Teaching.*

Discussant: Adie Slaton & Ibrahim Delen

October 6: Synthesis of work on K-12 student learning progressions

Presentation: (graduate student group)

October 13: Learning Progressions in College Students—General Population

Presentation: Joyce Parker & Merle Heidemann

Reading: Wilson, C., D., Anderson, C.W., Heidemann, M., Merrill, J.E., Merritt, B.W., Richmond, G, Sibley, D.F., Parker, J. (2006). Assessing students' ability to trace matter in dynamic systems in cell biology. *Cell Biology Education—Life Sciences Education, 5,* 323-331.

Discussant: Summer Lindzey

October 20: Learning Progressions in College Students—Elementary Teacher Candidates

Presentation: Ed Smith & Chrstina Schwarz

Reading:

Discussant: Li Zhan

October 27: Learning Progressions in College Students—Secondary Teacher Candidates

Presentation: Secondary Science Faculty (Gail, Joyce, Amelia, Andy; Mark O. also? (Knowles Foundation-funded work)

Reading: TBA

Discussant: Amy Lark

November 3: Synthesis of work on undergraduate student learning progressions

Presentation: Graduate student group

November 10 : Articulating Scientific Literacy through Work on Learning Progressions

Presentation: Ted WIlard & Jo Ellen Roseman, AAAS

Reading: Willard, T. and Roseman, J. Progression of understanding of the reasons for seasons. Paper presented at the Knowledge Sharing Institute of the Center for Curriculum Materials in Science, Washington, D.C., July, 2007.

Discussant: Hosun Kang, Amal Ibourk

November 17: Presentation of Group Projects: Session I (or Guest speaker)

November 24:Presentation of Group Projects: Session II

December 1: Presentation of Group Projects: Session III

December 8: Planning Future Work

Selected Relevant References

Alonzo, A., Gearhart, M., Champagne, A.B., Coppola, B.P., Duschl, R.A., Herman, J.L., McLean, V. (2006). Considering learning progressions from a classroom assessment perspective. *Measurement*, 4 (1-2), 99-125.

Anderson, C.W., Mohan, L., Sharma, A. Developing a learning progression for carbon cycling in environmental systems. Paper presented at annual meeting of the Ecological Society of America, Montreal, CA, August, 2005.

Catley, K., Lehrer, R., Reiser, B. Tracing a prospective learning progression for developing understanding of evolution. Paper Commissioned by the National Academies Committee on Test Design for K-12 Science Achievement, 2005.

Cavanaugh, S. Science interest could foster 'learning progressions'. Education Week, 2006…

Clements, D. and Sarama, J. Learning trajectories in mathematics education. Mathematical thinking and learning, 2004, 6 (2), 81-89.

Draney, K., Mohan, L., Piety, P, and Choi, J. Learning progressions in the carbon cycle. Symposium on Learning Progressions, annual meeting of the AERA, Chicago, IL, 12 April, 2007. (Perhaps the one set of ppt slides from Lindsay's presentation.)

Driver, R. (1989) Students' conceptions and the learning of science. *International Journal of Science Education*, 1989, 11 (5), 481-490.

Duncan, R. G., Rovat, A., Yarden, A. Learning progression in genetics. Unpublished manuscript

Duschl, R.A., Schweingruber, H.A., & Shouse, A.W. (Eds.). Taking science to schools: Learning and teaching science in grades K-8. Washington, D.C.: NAP Press, 2007.

Fortus, D., Hug, B., Krajcik, J.S., Kuhn, L., McNeill, K.L., Reiser, B., Rivet, A., Rogat, A., Schwarz, C., and Shwartz, Y. Sequencing and supporting complex scientific inquiry practices in instructional materials for middle school students. Paper presented at annual meting of the National Association for Research in Science Teaching, San Francisco, April, 2006.

Johnson, P. (1998) Progression in children's understanding of a 'basic' particle theory: a longitudinal study. *International Journal of Science Education*, 20 (4), 393-412.

McNeill, K.L., Lizotte, D.J., and Krajcik, J. (2006). Supporting students' construction of scientific explanations by fading scaffolds in instructional materials. *The Journal of the Learning Sciences*, 15 (2), 153-191.

Merritt, J., Shwartz, Y., & Krajcik, J. Middle school students' development of the particle model of matter. Paper presented at the Annual Meeting of the National Association for Research in Science Teaching, New Orleans, April, 2007.

National Research Council. (2007). *Taking science to school: Learning and teaching science in grades K-8*. Washington D.C.: The National Academies Press.

Rogat, A., Schwarz, C., & Reiser, B. Scientific modeling. Paper presented at the Annual Meeting of the National Association for Research in Science Teaching, San Francisco, CA, April, 2006.

Roseman, J.E., Caldwell, A., Gogos, A., Kurth, L. Mapping a coherent learning progression for the molecular basis of heredity. Paper presented at the Annual Meeting of the National Association for Research in Science Teaching, San Francisco, CA, April, 2006.

Schifter, Deborah. (1995). *What's happening in math class? Reconstructing professional identities*. New York: Teachers College Press.

Shwartz, Y., Rogat, A., Merritt, J., and Krajcik, J. The effect of classroom practice on students' understanding of models. Paper presented at the Annual Meeting of the National Association for Research in Science Teaching, New Orleans, April, 2007.

Smith, C.L., Wiser, M., Anderson, C.W., Krajcik, J.. (2008) Implications of Research on Children's Learning for Standards and Assessment: A Proposed Learning Progression for Matter and the Atomic-Molecular Theory. Measurement: Interdisciplinary Research & Perspective, 4:1, 1 — 98

Stevens, S., Shin, N., Delgado, C., Krajcik, J., & Pellegrino, J. Using learning progressions to inform curriculum, instruction, and assessment design.

Stevens, S., Shin, N., Delgado, C., Krajcik, J., & Pellegrino, J. Developing a learning progression for the nature of matter as it relates to nanoscience.