CEP 913 The Psychology and Pedagogy of Mathematics
Course Syllabus
Dr. Jon Star
Fall, 2005

General Information:

Instructor: ..................... Dr. Jon Star
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Office hours: ............... Monday, Wednesday, and Friday, by appointment
Course meeting time: .......... Wednesday, 12:40 pm to 3:30 pm
Course meeting location: ....... Room 109, Old Botany Building

Required Readings and Texts

There are no required texts or coursepacks that need to be purchased for this course. Course
readings will be made available to students electronically (and free) through the MSU Library’s
e-journals, electronically (and free) on the course ANGEL site, or via materials on reserve (for
photocopying at your own expense). One copy of the course reserves will be held at the Math
Library in Wells Hall, and an additional copy is in Jon’s office.

Note that we will be reading large portions of several books. While these books will be placed on
reserve for you to read or copy, you may choose to purchase these books for your personal
library.

print but may be available at used book stores or at amazon.com.)
Katona, G. (1940). *Organizing and memorizing: Studies in the psychology of learning and
teaching*. New York: Columbia University Press. (This book is out of print but may be
available at used book stores or at amazon.com.)
print but may be available at used book stores or at amazon.com.)
erlbaum.com or at amazon.com)
Mahwah, NJ: Lawrence Erlbaum. (Available for purchase, $59.50 at erlbaum.com or at
amazon.com)
Hiebert, J. (1986). *Conceptual and procedural knowledge: The case of mathematics*. Mahwah,
NJ: Lawrence Erlbaum Associates. (Available for purchase, $69.95 at erlbaum.com or at
amazon.com)


**Course Description**

**Overview.** This doctoral seminar will focus on psychological theory and research relating to the learning and teaching of mathematics. Our main emphasis will be on developing solid conceptions of what it means to know and understand mathematics from a psychological perspective.

**Rationale.** Discussion and disagreement on what it means to understand mathematics are as old as the field of mathematics education itself. How we have defined mathematical understanding over the years has propelled decisions about K-16 curriculum development, pre-service teacher education programs, in-service teacher professional development, doctoral student preparation, and research programs. Arguably, almost everything we do as mathematics educators requires that we begin by carefully articulating what we want our students/teachers to learn and how we want them to learn it. A central aim of this course is to assist in your formulation of a vision of mathematical understanding by introducing you to psychological and cognitive ways that this issue has been addressed in the past.

Among the strategies that we will use to accomplish this aim are the following. First, our readings will reach deeply into the field of mathematics education’s past. By reading and discussing historical conversations about mathematical understanding in the writings of Thorndike (1920s), Brownell (1930s, 1940s), Katona (1940s), Wertheimer (1950s), Skemp (1970s), and Hiebert (1980s), we will come to appreciate and understand the nature of current debates on this topic. And second, when possible, we will read multiple papers (or chapters) by the same author, in an attempt to ‘hear’ his or her voice more clearly.

**On psychological perspectives.** It is worth noting at the onset of this course that psychological perspectives are not the only way to address issues of mathematical understanding. In recent years, sociocultural and situated frameworks (among others) have become very widely used. These newer perspectives have proven to be very valuable in advancing our understanding of mathematical understanding. However, this course will focus almost exclusively on cognitive psychological perspectives on knowing and doing mathematics. Why? I offer three reasons.

First, psychological perspectives were dominant in the field of mathematics education for most of its history (until very recently), and they proved enormously helpful in our early attempts to develop theories of mathematical learning and teaching. No matter where your interests lie in the mathematics education landscape, it will behoove you to become familiar with how others have tackled problems similar to the ones you are pursuing. And in many cases, prior research in your area of interest will use a psychological lens.
Second, problems of mathematics education are extremely complex. Multiple theoretical perspectives offer us a variety of ways to view these complex problems. Through examining educational problems and issues using multiple theoretical lenses and a variety of methods, we stand a greater chance of making headway and of generating potentially converging evidence.

Third, and more pragmatically, this course (primarily listed as a CEPSE course) is perhaps the only course experience you will have that focuses on psychological perspectives on mathematical understanding. Many would argue that cognitive psychological perspectives on mathematics learning and teaching should be in the “toolbox” of any well-rounded scholar of mathematics education. The material that I’ve chosen to include in this course is, in my opinion, seminal – articles and topics that someone with a Ph.D. in mathematics education should know about, even one who does not use a psychological lens directly in his/her work.

Course Assignments and Expectations

Students will be expected to engage in five types of activities in this course: completion of weekly readings, completion of weekly reflection assignments, participation in class discussions, a mid-term analytical paper, and a final course project.

Completion of weekly reading assignments. As detailed below, each week you will be assigned approximately 100 pages of reading. The readings are a mixture of empirical and theoretical articles. I have tried to keep the reading load reasonable, because it is my expectation that every student will complete all of the assigned readings prior to class.

Completion of weekly reflection assignments. As a way to encourage reflection on the readings prior to class and to “seed” discussion, students are expected to write a very short Reflection Assignment for each class. Several days prior to each class, I (or one of you) will send out an e-mail with a question or two about the readings. These question(s) will attempt to encourage reflection on the readings, raise questions about the readings, make connections between the multiple articles assigned for the next class, and/or make connections between prior classes and the upcoming class. Reflection Assignments should be:

- word-processed;
- single-spaced;
- no more than one page in length (about 400-500 words);
- submitted as an e-mail attachment no later than 24 hours before each class.

Often you will find that you have a lot to say in your Reflection Assignment; you may find it challenging to restrict yourself to one page only. But this is part of the task – to try to gather your thoughts clearly and concisely in preparation for class discussion.

Note that a Reflection Assignment is not a journal entry. It should be firmly and analytically grounded in the readings and the assigned question/issue (rather than a narrative composed exclusively of personal experiences, anecdotes, or stories from your teaching days) and should be an organized, coherent, and finished document (rather than a quickly written, rambling, stream-of-consciousness diary entry).
Attendance and participation in class discussions. As this is a small class, our ability to have a productive discussion is critically dependent on everyone being present and having read (and thought about) the readings. The bulk of each week’s class time will be spent engaged in discussion; everyone is expected to participate. Note that “participation” includes talking and listening, asking thoughtful questions, and making constructive comments to peers and instructor. Initially I will be responsible for leading and managing our discussions, but later in the semester, you will be asked to share in this role.

Mid-term analytical paper. About mid-way through the term, you will be expected to write a paper that uses the course material up to this point in an analysis of recent empirical articles that focus on mathematical understanding. I will select several empirical articles in advance – articles that have been recently published in prominent mathematics education journals. Each of these articles will be about (at least in part) students’ knowledge of mathematics. Your task is to select at least one of the articles that I provide and at least one other recent empirical article of your own choosing, and write a paper in which you compare and contrast the ways that each article defines, measures, operationalizes, conceptualizes, and/or talks about mathematical knowing and understanding. It is expected that you will draw upon course readings to date to assist in your comparison of the articles you choose.

Here are the articles that are on my list (additional ones may be added later in the semester):


This paper is due by the beginning of class on Wednesday, October 19, either an e-mail attachment or on paper. You are encouraged to (a) meet with me outside of class to talk about this paper, and (b) discuss your choice of additional articles that you’ll be writing about with me ahead of time. There is no set length for this paper, although it is difficult to imagine that you could meet the goals of the assignment in fewer than 7 double-spaced pages.
You will be graded on the following aspects of your paper. (1) The degree to which you adhere to the guidelines of the assignment; (2) The thoroughness, completeness, and accuracy of the course material that you choose to discuss. I expect to see evidence that you have attended class sessions, participated in class discussions, and read course material as you employ in your papers the terminology, theories, and concepts discussed in this course. (3) Narrative flow of your papers, in addition to spelling and grammar. Please make your paper reader-friendly. Use an appropriate, consistent format for citations and bibliography. I will take into consideration clarity, organization, and logical progression of ideas.

**Final course project.** You are responsible for defining, shaping, and completing an individual course project, with the twin constraints that the project you propose contributes to your long-term research goals and is consistent with the focus of the course. I am happy to talk with you about possible project topics, but ultimately the choice is yours. However, you are strongly encouraged to use this course project as an opportunity to work on something related to your degree progress (e.g., practicum, proposal, etc). To assist in the development of your project, I am requiring that it be conceptualized and initiated early in the semester. To this end, all projects will be completed in three parts; you will receive detailed feedback on each part. The parts are:

Part I: A one-page project prospectus/sketch, due **Wednesday, October 5**, in class or via e-mail attachment. If you have multiple ideas for a course project, you are encouraged to submit more than one prospectus. In such cases, we can meet to discuss how to select one topic from among your proposals.

Part II: An elaborated outline, due **Wednesday, November 16**, in class or via e-mail attachment. You are expected to show significant progress in your thinking and research development since your prospectus in Part I. Your document should include significant detail about your project, including but not limited to draft sections of text, partial list of references, and outline of sections and major points.

Part III: The complete project, due during Exam week. The specific date will be set during the semester.

**Grading**

Your grade for this course will be determined by the following:

- 50% Final course project
- 25% Mid-term analytic paper
- 25% Participation, including in-class participation and Reflection Assignments

**Meeting with Jon outside of class**

I would very much enjoy meeting with each of you outside of class, either when problems or questions arise or just to chat. Some thoughts about how this can happen this term. (1) E-mail is
the best way to get in touch with me (jonstar@msu.edu). Please use e-mail to schedule meetings, begin conversations in anticipation of meetings, etc. (2) The best days for me to meet with you are typically Mondays, Wednesdays, and Fridays.

**Other Course Details**

*Accommodations for Disabilities.* Students with disabilities should contact the Resource Center for Persons with Disabilities to establish reasonable accommodations. For an appointment with a counselor, call 353-9642 (voice) or 355-1293 (TTY).

*Observing a Major Religious Holiday.* You may make up course work missed to observe a major religious holiday only if you make arrangements in advance with the instructor.

*Participation in a Required Activity.* To make up course work missed to participate in a required activity for another course or a university-sanctioned event, you must provide the instructor with adequate advanced notice and a written authorization from the faculty member of the other course or from a university administrator.

*Attendance.* Students whose names do not appear on the official class list for this course may not attend this class.

*Disruptive Behavior.* Article 2.3.5 of the Academic Freedom Report (AFR) for students at Michigan State University states that “The student's behavior in the classroom shall be conducive to the teaching and learning process for all concerned.” Article 2.3.10 of the AFR states that “The student has a right to scholarly relationships with faculty based on mutual trust and civility.” General Student Regulation 5.02 states that “no student shall . . . interfere with the functions and services of the University (for example, but not limited to, classes . . .) such that the function or service is obstructed or disrupted.” Students whose conduct adversely affects the learning environment in this classroom may be subject to disciplinary action through the Student Faculty Judiciary process.

*On Academic Integrity.* Article 2.3.3 of the Academic Freedom Report states that “The student shares with the faculty the responsibility for maintaining the integrity of scholarship, grades, and professional standards.” In addition, the College of Education adheres to the policies on academic honesty as specified in General Student Regulations 1.0, *Protection of Scholarship and Grades* (excerpted below); the all-University Policy on *Integrity of Scholarship and Grades*; and Ordinance 17.00, Examinations. (See Spartan Life: Student Handbook and Resource Guide and/or the MSU Web site: www.msu.edu.)

“The principles of truth and honesty are fundamental to the educational process and the academic integrity of the University; therefore, no student shall: (1.01) claim or submit the academic work of another as one’s own. (1.02) procure, provide, accept or use any materials containing questions or answers to any examination or assignment without proper authorization. (1.03) complete or attempt to complete any assignment or examination for another individual without proper authorization. (1.04) allow any examination or assignment to be completed for oneself, in
part or in total, by another without proper authorization. (1.05) alter, tamper with, appropriate, destroy or otherwise interfere with the research, resources, or other academic work of another person. (1.06) fabricate or falsify data or results” (From MSU’s General Student Regulations, Protection of Scholarship and Grades).

Students are strongly encouraged to discuss the course material, papers, writing assignments, and projects with peers and advisors, both in and out of class. However, it is expected that all submitted written work will be completed by students individually and will be the result of each students’ own individual thoughts and ideas, unless otherwise indicated (by citation). Students who violate MSU rules may receive a penalty grade, including but not limited to a failing grade on the assignment or in the course and/or removal from the program.
Schedule of course meetings, readings and assignments

Legend for readings availability:
R = Book or article on reserve at Math Library and in Jon’s office for you to photocopy
@ = Scan of book or paper available on ANGEL for free (click on @ to go to ANGEL)
L = Link available for you to download article via MSU Library for free (hot-linked text
only works from MSU or MSU-Proxy-Server computers)

Class #1: Wednesday, August 31
1. Introduction to the psychology of mathematics learning

Class #2: Wednesday, September 7
2. Thorndike and mathematical knowing as the formation of bonds

Class #3: Wednesday, September 14
3. Brownell and mathematical knowing as meaning making

Class #4: Wednesday, September 21
4. Katona and understanding

Class #5: Wednesday, September 28
5. Wertheimer and productive thinking
Class #6: Wednesday, October 5

**Final project prospectus/sketch due by class time**

6. Skemp and instrumental/relational understanding


Class #7: Wednesday, October 12

7. Resnick and the psychology of math for instruction


Class #8: Wednesday, October 19

8. Conceptual and procedural knowledge


Class #9: Wednesday, October 26

9. Cognitive studies of procedural knowledge

**Mid-term analytic paper due by class time** (no reflection assignment due on this day)


Class #10: Wednesday, November 2

10. Recent views on conceptual and procedural knowledge

Dowker (Eds.), *The development of arithmetic concepts and skills: Constructing adaptive expertise* (pp. 1-33). Mahwah, NJ: Lawrence Erlbaum.


Class #11: Wednesday, November 9

11. Mathematical knowledge and the Math Wars


R@  11.4 Star, J.R. (in press). Reconceptualizing procedural knowledge. *Journal for Research in Mathematics Education*.

Class #12: Wednesday, November 16

12. Alternative perspectives on knowing mathematics

**Final project elaborated outline due by class time** (no reflection assignment due on this day)

*Note*: You will be assigned to one of two groups and asked to read and present only those articles assigned to your group.

12a. Pirie and Kieren


12b. Sfard


Class #13: Wednesday, November 30

13. Knowledge of teaching mathematics (part 1)


Class #14: Wednesday, December 7

14. Knowledge for teaching mathematics (part 2)

