MTE 598: Research in Undergraduate Mathematics Education I

Time and location: Wednesdays, 5:00-8:00 p.m., PSA-303

Instructor: Prof. Luis Saldanha

Office Hours: Wednesdays 1-3 p.m. However, feel free to make an appointment. The best way to contact me is by email, at Luis.Saldanh@asu.edu. My cell phone is 503-940-9019 if you do not get an email reply.

Materials

- Stigler, J. W., & Hiebert, J. (1999). *The Teaching Gap: Best Ideas from the World's Teachers for Improving Education in the Classroom*. New York, NY: The Free Press.
- Sierpinska, A. (1994). *Understanding in Mathematics*. London: Falmer Press.
- Carpenter, T. P., Dossey, J. A., & Koehler, J. L. (2004). *Classics in Mathematics Education Research*. Reston, VA: NCTM.
- Assorted articles and artifacts made available electronically

Syllabus

This course is your introduction to research in undergraduate mathematics education. By the end of the semester you will be able to read, discuss, criticize, and draw practical conclusions from research articles. You will also have broadened your perspective on areas of past and current mathematics education research. Towards this end, the course will engage you in three interrelated strands of activity: 1) directed readings and critical discussions of research on mathematical reasoning and learning; 2) analyses of existing student data—in the form of videotaped classroom/interview excerpts—collected in recent research projects in the learning of mathematics; 3) generation and analysis of empirical data involving a student interacting with you in an instructional context.

Although this course is about research on learning and teaching undergraduate mathematics, it is important to note that undergraduate mathematics students are not born as undergraduates. Their thinking develops over 12 years of schooling and life experiences and they arrive in college at many different levels of proficiency and with many different understandings of the mathematics they were taught. As such, we will read research literature drawn from several content areas and grade bands:

Early learning of algebra
Proportional reasoning
Algebra
Calculus
Probability and Statistics

This course is also an introduction to research in mathematics education. But, just as we must understand the evolution of students' mathematical thinking prior to their entry to college to understand their mathematical learning in college, we can understand research in mathematics education as it exists

today only by understanding its development over the past 50 years. As such, we also will read selected articles from the book *Classics in Mathematics Education Research*

The discussion topics for this course will be posted on the Discussion Topics page of Course Forum. Questions on individual readings will be posted on the Assignments page. Class will be conducted as a seminar. Participants are responsible for preparing to discuss the assigned readings each week. You will also have a minor and a major research project to conduct during the semester. The research project is described later on this page.

Participation (1/3 weight)

The nature of your participation in discussions of ideas, issues, and topics will determine the benefit you draw from this course. To help you prepare for productive discussion of each assigned article, I will post a number of discussion questions on Course Forum to which you must reply using Course Forum. The nature of CF discussions is that you reply not only to the discussion question, you also contribute to the ongoing conversation as it has evolved to the point of your contribution. Discussions can also be threaded. I will show you how to created a threaded discussion during the second class.

Participation will be graded on a 10-point scale for each discussion question, and I will assign scores by the following rubric:

10=Thoughtful, incisive, analytic and synthetic contributions
8 = A good effort
6 = You posted something related to the discussion question
0 = You didn't post anything

Minor Project: Data Analysis and Interpretation (1/3 weight)

The course will initiate you into the practice of making sense of empirical data drawn from past mathematics education research projects. You will be provided with data excerpts and guidelines to help you analyze them and write coherent narratives about them. Your analyses and the sharing of them amongst participants will form the basis of relevant seminar discussions. Guidelines for this minor project will be distributed early in the course.

Syntheses

There will be summaries and syntheses of selected readings, and presentations of your research projects (see next section). A later handout will provide guidance on preparing your project presentation.

Major Project (1/3 weight)

Devise a research question of interest to you (the issue of how to form a powerful research question will recur throughout the course). Then:

1. Locate and read at least six research articles related to the topic of your choice. Google Scholar is a good starting point.
2. Write a 3-4 page summary of each research article. Include: the purpose of the

research, the methods used, the results, the author's interpretation of the results, and your own reaction to the article. (You might need to deviate from this structure for some articles. For example, case studies and ethnographies might not have a section entitled "Results.")

3. Locate a student of the appropriate age and educational background for your topic. Please do not select a student who you are presently teaching.
4. Prepare a carefully crafted set of questions to use during an interview with this student. Your aim in this interview is to gain insight into this student's understanding of the topic you have chosen. It is imperative that you discuss your questions with peers and with me early and often in your development of this project.
5. Interview the student while videotaping the interview. We will discuss the mechanics of good and bad interviews during the semester.
6. Transcribe the interview, or at least the most relevant portions of the interview.
7. Write a 10-15 page paper in which you analyze and describe the student's understandings, reasoning, intuitions, and images of the ideas entailed within your topic. Include a description of your interviewee and the set of interview questions as appendices (the 10-15 page limitation does not include references or appendices).
8. End your paper with a revised research question and interview protocol. That is, view this project as the first round in an iterative process of refining your question and investigative procedures. Incorporate issues raised in the course readings and/or your own literature review into your discussions. Use excerpts from your interview liberally to illustrate your points and to provide concrete contexts for your discussions. List your references at the end of the paper, using APA style (references in the course reading list are in APA style).

Project Evaluation

ARTICLES: 60 POINTS (10 POINTS EACH ARTICLE) Purpose (2 points) Methods (2 points) Results/Findings (2 points) Author's interpretations/conclusions (2 points) Personal reaction (2 points)

PAPER (60 POINTS) Research question (6 points) Appropriateness of interviewee (4 points) Interview questions (10 points) Interpretation/Analysis (20 points) Relevance to articles read in class and in literature review (10 points) Quality of writing (including organization) (10 points)

Course Grading Scale

A	95%	B	85%	C	75%	D	65%
A-	92%	B-	82%	C-	72%		
B+	88%	C+	78%	D+	68%		

Readings

Brownell, W. A. (1947). The place of meaning in the teaching of arithmetic. *The Elementary School Journal, 47*(5), 256-265.

Dubinsky, E., & Harel, G. (1992). The nature of the process conception of function. In E. Dubinsky & G. Harel (Eds.), *The Concept of Function: Aspects of Epistemology and Pedagogy* (pp. 85-106). Washington, DC: Mathematical Association of America.

Erlwanger, S. H. (1973). Benny's conception of rules and answers in IPI mathematics. *Journal of Children's Mathematical Behavior, 1*(2), 7-26.

Harel, G. (1995). From Naive-Interpretist to Operation-Conserver. In J.T. Sowder & B. P. Schappelle (Eds.), *Providing a foundation for teaching mathematics in the middle grades*. SUNY Press: Albany, NY.

Herscovics, N. (1989). Cognitive obstacles encountered in the learning of algebra. In S. Wagner & C. Kieran (Eds.), *Research issues in the learning and teaching of algebra (Volume 4 of Research agenda for mathematics education, pp. 60-86)*. Reston, VA: NCTM

Hiebert. J. & Lefevre, P. (1986). Conceptual and procedural knowledge in mathematics: An introductory analysis. In J. Hiebert (Ed.), *Conceptual and procedural knowledge: The case of mathematics* (pp. 1-27). Hillsdale, NJ: Lawrence Erlbaum.

Kieran, C. (1989). The early learning of algebra: A structural perspective. In S. Wagner & C. Kieran (Eds.), *Research issues in the learning and teaching of algebra (Volume 4 of Research agenda for mathematics education, pp. 33-56)*. Reston, VA: NCTM

Monk, S. (1992). Students' understanding of a function given by a physical model. In E. Dubinsky & G. Harel (Eds.), *The Concept of Function: Aspects of Epistemology and Pedagogy* (pp. 175-193). Washington, DC: Mathematical Association of America.

Oehrtman, M. C., Carlson, M. P., & Thompson, P. W. (2008). Foundational reasoning abilities that promote coherence in students' understandings of function. In M. P. Carlson & C. Rasmussen (Eds.), *Making the connection: Research and practice in undergraduate mathematics* (pp. 150-171). Washington, DC: Mathematical Association of America.

Schoenfeld, A. H. (2000). Purposes and methods of research in mathematics education. Notices of the American Mathematics Society, June/July, pp. 641-649.

Sfard, A. (1992). Operational origins of mathematical objects and the quandary of reification - the case of function. In E. Dubinsky & G. Harel (Eds.), *The Concept of Function: Aspects of Epistemology and Pedagogy* (pp. 59-84). Washington, DC: Mathematical Association of America.

Sierpinska, A. (1994). Understanding in Mathematics. London: Falmer Press.

Sierpinska, A. (1992). On understanding the notion of function. In E. Dubinsky & G. Harel (Eds.), *The Concept of Function: Aspects of Epistemology and Pedagogy* (pp. 25-58). Washington, DC: Mathematical Association of America.

Sierpinska, A, Kilpatrick, J. K., Balacheff, N., Howson, A. G., Sfard, A., & Steinbring, H. (1993). What is research in mathematics education and what are its results?. *Journal for Research in Mathematics Education, 24*(3), 274-278.

Skemp, R. R. (1978). Relational understanding and instrumental understanding. *Arithmetic Teacher, 7*, 9-15.

Stigler, J. W., & Hiebert, J. (1999). *The Teaching Gap: Best Ideas from the World's Teachers for Improving Education in the Classroom*. New York, NY: The Free Press.

Resnick, L. B., & Ford, W. W. (1981). *The psychology of mathematics for instruction*. Hillsdale, NJ: Lawrence Erlbaum. (Excerpts from Chapters 2 & 3).

Thompson, A. G., & Thompson, P. W. (1996). Talking about rates conceptually, Part II: Mathematical knowledge for teaching. *Journal for Research in Mathematics Education, 27*(1), 2-24.

Thompson, P. W., & Thompson, A. G. (1994). Talking about rates conceptually, Part I: A teacher's struggle. *Journal for Research in Mathematics Education, 25*(3), 279-303.

Thompson, A. G., Philipp, R. A., Thompson, P. W., & Boyd B. A. (1994). Calculational and conceptual orientations in teaching mathematics. In A. Coxford (Ed.), *1994 Yearbook of the NCTM* (pp. 79-92). Reston, VA: NCTM.

Thompson, P. W. (2008). Conceptual analysis of mathematical ideas: Some spadework at the foundation of mathematics education. In O. Figueras, J. L. Cortina, S. Alatorre, T. Rojano & A. SÈpulveda (Eds.), *Proceedings of the Annual Meeting of the International Group for the Psychology of Mathematics Education*, (Vol 1, pp. 45-64). MorÈlia, Mexico: PME.

Vinner, S. (1992). The function concept as a prototype for problems in mathematics learning. In E. Dubinsky & G. Harel (Eds.), *The Concept of Function: Aspects of Epistemology and Pedagogy* (pp. 195-213). Washington, DC: Mathematical Association of America.

Vinner, S., & Dreyfuss, T. (1989). Images and definitions for the concept of function. *Journal for Research in Mathematics Education, 20*(4), 356-366.