Mathematics Education Research: Themes, Processes, and Sensibilities

Course Number: SCE321.2

Credits: 4

Duration: 17 August to 30 November, 2023 [15 weeks]

Day: Tuesdays (3 PM to 5 PM) and Thursdays (11 AM to 1 PM)

Instructor: Dr Shweta Naik

Beginning Date: 17th August 2023

End Date: 30th November 2023

No classes on: 29 and 31 August, 28 September

Course Objectives:

- The course aims to introduce participants to the mathematics education literature by closely studying some of the writings that have had the highest impact in the field. Participants will carefully read the publications listed, participate in informal discussions and critically respond to prompts. Three added perspectives of the course are as follows.
- The course also gives a foundation understanding of current trends in mathematics education via several MER themes.
- Additionally, engaging in mathematics – through sessions on problem-solving or designing, would be an aspect of the course. The idea is to elicit processes and mathematics discussed in the studied literature.
- A third dimension of the course is – learning through problems of teaching – this involves studying classroom scenarios that require reflection from pedagogy and content perspectives. The aim is to analyse student thinking and use that to understand instructional affordances in a formal classroom setting.

Course Pedagogy:

There will be three kinds of sessions in this course.

- Literature Meaning-making Sessions: The course instructor will present some prompts in advance for the discussion, and often complement it with the summaries of the readings. Participants are expected to respond to the prompts critically and connect with examples and theories from the read materials.
- Problem Solving/ Designing sessions: Engage in problem solving or designing that illustrates mathematics and processes discussed in the literature. These problems are generally chosen by the instructor, but participants can also bring problems.
- Scenario/ Narratives Analysis Sessions: These sessions would involve studying narratives from classroom, that present amalgam of content and pedagogy. Discussion would be on addressing student thinking in instruction and in instructional materials.

Course Evaluation:

- Each participant will pursue a topic of interest in the research literature and study representative readings to develop and submit a term paper. (complementing it with field data is optional – but if chosen support will be provided). (60%)
- Critical response to prompts situated in literature and experience in the class (or whichever mode decided with consensus) (40%)

Course Submission Deadline

- Critical response submission (oral / written from 1 September2023 onwards) to given or formed prompts: Every other Friday, till 30th November 2023
- Term paper submission 4th December 2023

Course Outline

Given below is a week-wise schedule of sessions, followed by the detailed list of the readings categorized in themes prominent in mathematics education. There will be a few changes in this, once I meet the participants, given their exposure and expertise, we will remove/add some readings. An edited version would be made available by the end of August 2023.

List of Sessions

Date (Day)	Title of the Reading
Week 1	
	Mathematics – a very short introduction
Week 2	
	Learning through Geometric Constructions
	Problem Solving in Mathematics
Week 3	
	Benny's Conceptions of Rules and Answers in IPI Mathematics.
	Problem Solving in Mathematics
Week 4	
	When good teaching leads to bad results: The disasters of 'well-taught' mathematics courses
Week 5	
	Using a base-ten blocks learning/teaching approach for first-and second-grade place-value and multi-digit addition and subtraction.
	Learning through Problems: Number Sense
Week 6	
	Conceptions of school algebra and uses of variables
Week 7	
	Purposes in school algebra
	Children’s difficulties in beginning algebra
Week 8	
	Why is algebra important to learn?
	Learning through Problems: Algebra
Week 9	
	The arithmetic-algebra connection: A historical-pedagogical perspective.
Week 10	
	The learning and teaching of Algebra: Ideas, Insight and Activities
	Recent Trends in Algebra Research
Week 11	
	Drawing on a Theoretical Model to Study Students' Understandings of Fractions
	Integrating the measure and quotient interpretation of fractions.
Week 12	
	Ratio and proportion: Connecting content and children's thinking
	Learning through Problems
Week 13	
	Fractions: A realistic approach
	Freudenthal, H. (1986). *Didactical phenomenology of mathematical structures* (Vol. 1). Springer Science & Business Media.

Week 14	
	Generating Representations: Division By Fractions
	Exploring New Knowledge: The Relationship between Perimeter and Area
Week 15	
	Teachers' Subject Matter Knowledge: Profound Understanding of Fundamental Mathematics
Week 16	
	Those who understand knowledge growth in teaching
	Teaching problems and the problems of teaching
Week 17	
	The teaching gap
	When the rules of discourse change, but nobody tells you: Making sense of mathematics learning from a commognitive standpoint
Week 18	
	Socio-mathematical Norms, Argumentation, and Autonomy in Mathematics
	Students' foregrounds and the politics of learning obstacles

Details of Readings

Theme 1: Nature of Mathematics

1. Gowers, T. (2002) Mathematics – a very short introduction. OUP. Chapters 1, 2, (17 pages)
2. The Crest of the Peacock: Non-European Roots of Mathematics (some sections)
3. Courant, H. R. R., Courant, R., Robbins, H., & Stewart, I. (1996). What is Mathematics?: an elementary approach to ideas and methods. Oxford University Press, USA.
4. Clarke, D. J., Waywood, A., & Stephens, M. (1993). Probing the structure of mathematical writing. Educational studies in mathematics, 25(3), 235-250.

Theme 2: Students' Conceptions of and about Mathematics

5. Erlwanger, S.H. (1973) Benny's Conceptions of Rules and Answers in IPI Mathematics. *Journal of Children's Mathematical Behaviour 1*, Autumn 1973. In T.P. Carpenter, J.A. Dossey, & J. Kochler (eds.) *Classics in mathematics education research*, Reston, VA: NCTM.
6. Schoenfeld, A. H. (1988). When good teaching leads to bad results: The disasters of 'well-taught' mathematics courses. *Educational psychologist*, *23*(2), 145-166.
7. Kaur, T., & Prendergast, M. (2022). Students' perceptions of mathematics writing and its impact on their enjoyment and self-confidence. Teaching Mathematics and Its Applications: An International Journal of the IMA, 41(1), 1-21.
8. Zaslavsky, O., & Shir, K. (2005). Students' conceptions of a mathematical definition. Journal for Research in Mathematics Education, 36(4), 317-346.

Theme 3: Overview of School Mathematics Research (Number sense, Integers, Algebra, Ratio-Proportion – selected readings will be discussed)

9. Learning through Problems
10. Fuson, K. C., & Briars, D. J. (1990). Using a base-ten blocks learning/teaching approach for first-and second-grade place-value and multidigit addition and subtraction. *Journal for research in mathematics education*, 180-206.
11. Usiskin, Z. (1988). Conceptions of school algebra and uses of variables. *The ideas of algebra, K-12*, *8*, 19.

12. Bell, A. (1995). Purpose in school algebra. *Journal of Mathematical Behavior*, 14, 41-73.
13. Booth, L. R. (1988). Children's difficulties in beginning algebra. *The ideas of algebra, K-12,* 20-32.
14. Usiskin, Z. (1995). Why is algebra important to learn? *American Educator, 19*(1), 30-37.
15. Learning through Problems
16. Subramaniam, K., & Banerjee, R. (2011). The arithmetic-algebra connection: A historical-pedagogical perspective. In Cai, J. & Knuth, E. (Eds.), *Early Algebraization: A Global Dialogue from Multiple Perspectives*, pp. 87-107. Springer: Berlin Heidelberg.
17. Arcavi, A., Drijvers, P., & Stacey, K. (2016). *The Learning and Teaching of Algebra: Ideas, Insights and Activities*. Routledge.
18. Charalambous, C.Y. and Pitta-Pantazi, D. (2007) 'Drawing on a Theoretical Model to Study Students' Understandings of Fractions', *Educational Studies in Mathematics*, 64, pp 293-316. – SN
19. Naik, S., & Subramaniam, K. (2008). Integrating the measure and quotient interpretation of fractions. In *International group of the psychology of mathematics education: Proceedings of the Joint Meeting of PME* (Vol. 32, pp. 17-24). – RK
20. Lamon, S. J. (1993). Ratio and proportion: Connecting content and children's thinking. *Journal for research in mathematics education*, 41-61. – KS
21. Learning through Problems – *doing* Mathematics session by Shweta Naik
22. Streefland, L. (1993). Fractions: A realistic approach. *Rational numbers: An integration of research*, 289-325.
23. Freudenthal, H. (1986). *Didactical phenomenology of mathematical structures* (Vol. 1). Springer Science & Business Media.

Theme 4: Analysing Teaching and Knowledge needed to Teach Mathematics

24. Ma, L. (1999) *Knowing and teaching Elementary mathematics*, London: Lawrence Erlbaum Associates publisher. (Foreword, Introduction, Chapter 3: Generating Representations: Division By Fractions, Chapter 4: Exploring New Knowledge: The Relationship between Perimeter and Area, Chapter 5: Teachers' Subject Matter Knowledge: Profound Understanding of Fundamental Mathematics)
25. Shulman, L. (1986). Those who understand knowledge growth in teaching, *Educational Researcher. V*ol. 15, No. 2, pp. 4-14.
26. Lampert, M. (2001) *Teaching problems and the problems of teaching*. US: Yale University Press. (Chapter 2: An Instance of Teaching Practice)
27. Stigler, J. W. & Hiebert, J. (1999) *The teaching gap*, The Free Press. (Chapter 3: Images of Teaching, Chapter 6: Teaching is a Cultural Activity)

Theme 5: Mathematics Education and Society

28. D'Ambrosio, U. (1990). The role of mathematics education in building a democratic and just society. For the learning of mathematics, 10(3), 20-23.
29. Gutstein, E. (2003). Teaching and learning mathematics for social justice in an urban, Latino school. Journal for Research in Mathematics education, 34(1), 37-73.
30. Ernest, P., Skovsmose, O., Van Bendegem, J. P., Bicudo, M., Miarka, R., Kvasz, L., & Moeller, R. (2016). The philosophy of mathematics education. Springer Nature.

Theme 6: Developing Theory from Practice in MER

31. Sfard, A. (2007). When the rules of discourse change, but nobody tells you: Making sense of mathematics learning from a commognitive standpoint. *The Journal of the Learning Sciences, 16*(4), 565-613.
32. Yackel, E. & Cobb, P. (1996). Sociomathematical Norms, Argumentation, and Autonomy in Mathematics. *Journal for Research in Mathematics Education.* 27(4), 458-477.
33. Silver, E. A., & Herbst, P. (2007). Theory in mathematics education scholarship. Second handbook of research on mathematics teaching and learning, 1, 39-67.
34. Skovsmose, O. (2007) Students' foregrounds and the politics of learning obstacles. In E. U. Gellert and E. Jablonka (Eds.) *Mathematization and demathematization – social, philosophical and educational ramifications.* (8 pages)