

Notions and perspectives in mathematics education research

(Centrala begrepp och riktningar inom matematikdidaktisk forskning)

Course leaders: Abraham Arcavi, Michèle Artigue, Christer Bergsten

The course is organised in two themes, A and B.

Theme A: Key issue – theory and practice. Theory of didactical situations, Realistic mathematics education, Mathematics education as a design science.

Theme B: Key issue – different perspectives of learning and teaching mathematics. Cognitive science, constructivism, situated cognition, embodied cognition, interactionism, semiotics ...

There will be one meeting in Linköping, August 28, 1.30 pm – September 2, 3 pm, 2002. This means that it is necessary to read some parts of the literature before coming to Linköping.

Working formats

Group work

Examining and discussing chosen papers in relation to the specific issues that are focused in the course

Seminars

- Reporting from group work
- Discussing chosen topics in relation to the literature
- Discussing students' own data or ideas/designs in relation to the topics discussed in the course

Individual meetings

Forum for discussion of a students' own data or ideas/design with a course leader on an individual basis

Lectures

- Introductory/overview lectures
- Clarifying mini-lectures (when necessary)

A time table for the meeting in Linköping will be provided in August. One excursion with dinner will be included in the programme.

Examination tasks

- (1) Submit¹ no later than August 15 at least three questions/issues you want to discuss during the meeting in Linköping. These questions should be related to some of the papers [6] to [18].
- (2) Active participation in group work and seminars during the meeting in Linköping.
- (3) Submit² no later than October 15 a short paper with comments to 3 research papers *or* a book. The 3 papers can be related to each other and to some theme that was discussed during the meeting in Linköping; they can for example represent three different perspectives on the same issue. Papers can be chosen in relation to individual interests, a list with suggestions will be provided. The book should be a “classic” math ed monograph, a list with suggestions will be provided.

Literature

In the list below [1] and [2] are general/overview texts that provide a theoretical background for the course. These texts should be read prior to the other texts.

Items [3], [4] and [5] give an overview of the theoretical perspectives of theme A.

Items [6] to [18] are detailed research papers to be discussed during the meeting in Linköping, some of them more in detail than others. See *Appendix* for a list of questions to have in mind when reading the papers. More information to guide the reading will be provided by June 7.

Background texts

- [1] Greeno, J. G., Collins, A. M. & Resnick, L. B (1996). “Cognition and learning”. In D. C. Berliner & R. C. Calfee (Eds.), *Handbook of Educational Psychology* (pp. 15-46). New York: MacMillan.
- [2] Sierpinska, A. & Lerman, S. (1996). “Epistemologies of Mathematics and of Mathematics Education”, In A. Bishop et al (Eds.), *International Handbook of Mathematics Education* (pp. 827-876). Dordrecht: Kluwer.

Overview texts

- [3] Artigue, M. (2002). “Didactic engineering and the complexity of learning processes in classroom situations”. In C. Bergsten et al (Eds.), *Research and Action in the Mathematics Classroom, Proceedings of MADIF2* (pp. 5-20). Linköping: SMDF.
- [4] van den Heuvel-Panhuizen, M. (1998). “Realistic Mathematics Education: Work in progress”. In G. Brekke & T. Breitegg (Eds.), *From Theory into Practice. Proceedings of NORMA98* (pp. 10-35). Agder University, Kristiansand.
- [5] Wittmann, E. (1995). “Mathematics education as a design science”. *Educational Studies in Mathematics* 29, pp. 355-374.

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² By e-mail to Christer Bergsten at chber@mai.liu.se

Research papers

- [6] Smith, J. P. III, diSessa, A. & Roschelle J. (1993) “Misconceptions Reconceived: A Constructivist Analysis of Knowledge in Transition”. *The Journal of the Learning Sciences*, v. 3, pp. 115-163.
- [7] Schoenfeld, A. H., Smith J., & Arcavi A. (1993) “Learning: The Microgenetic Analysis of One Student's Evolving Understanding of a Complex Subject Matter Domain”. In R. Glaser (Ed.) *Advances in Instructional Psychology*, Vol. 4. Erlbaum, NJ, pp. 55-175.
- [8] Schoenfeld, A. H. (1992) “Learning to think mathematically: Problem solving, metacognition, and sense making in mathematics”. In Grouws, D. (Ed.), *The handbook of research on the teaching and learning of mathematics*, New York: Macmillan, pp. 334-370.
- [9] Collins, A., Brown, J.S. & Newman S.E. (1989) “Cognitive Apprenticeship: Teaching the Crafts of Reading, Writing and Mathematics”. In Resnick, L. (Ed.), *Knowing, Learning, and Instruction: Essays in Honor of Robert Glaser*. Erlbaum, NJ, pp. 453-494.
- [10] diSessa, A., Hammer, D., Sherin, B. and Kolpakowski, T. (1991) “Inventing Graphing: Meta-representational Expertise in Children”. *Journal of Mathematical Behavior*, v. 10, pp. 117-160.
- [11] Yackel, E. & Cobb, P. (1996) “Sociomathematical Norms, Argumentation and Autonomy in Mathematics”. *Journal for Research in Mathematics Education*, v. 27(4), 458-477.
- [12] Artigue, M. (2001). “Learning mathematics in a CAS environment: The genesis of a reflection about instrumentation and the dialects between technical and conceptual work”. Paper presented at the Second CAME Conference, Utrecht, July 2001.
- [13] Gravemeijer, K. (2000). How emergent models may foster the constitution of formal mathematics. *Mathematical Thinking and Learning*, vol 1(2), pp. 155-177.
- [14] Kieran, C. (2001). “The mathematical discourse of 13-year-old partnered problem solving and its relation to the mathematics that emerges”. *Educational Studies in Mathematics* 46, pp. 187-228.
- [15] Nunez, R.E., Edwards, L.D. & Matos, J.F. (1999). “Embodied cognition as grounding for situatedness and context in mathematics education”. *Educational Studies in Mathematics* 39, pp. 45-65.
- [16] Presmeg, N. (2002). “Semiotics and the “Connections” standard: Significance of semiotics for teachers of mathematics”. Paper presented at the NCTM Research Pre-session, Las Vegas, April 20, 2002.
- [17] Sfard, A. (To appear). “There is more to discourse than meets the ears. Looking at thinking as communicating to learn about mathematical learning”. In the Proceedings of MADIF3, Norrköping, Sweden, January 2002.
- [18] Tall, D., Thomas, M., Davis, G., Gray, E. & Simpson, A. (2000). “What is the Object of the Encapsulation of a Process?”. *Journal of Mathematical Behavior* 18(2), pp. 223-241.
- [19] Laborde, C. (1994). "Designing tasks for learning geometry in a computer-based environment. The case of Cabri-géomètre". In L Burton & B. Jaworski (Eds), *Technology in mathematics teaching - a bridge between teaching and learning*, pp. 35-68. London: Chartwell-Bratt.
- [20] Laborde, C. (2001). "Integration of technology in the design of geometry tasks with Cabri-geometry". *International Journal of Computers for Mathematical Learning* 6, pp. 283-317.