WORKING GROUP #4: MATHEMATICAL HABITS OF MIND

Organizers

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Objectives

- to discuss various views and aspects of mathematical habits of mind,
- to explore avenues for research,
- to encourage research collaborations, and
- to interest doctoral students in this topic.

Tentative Schedule

- Meeting 1 (Thurs, 1:30pm – 3:00pm, International D
  - An overview on mathematical habits of mind
  - Individual 10-min presentations on research related to habits of mind
    - **Richard S. Millman**, Georgia Institute of Technology
    - **Kien H. Lim**, University of Texas at El Paso
    - **Dionne I. Cross**, Indiana University-Bloomington
    - **Annie Selden & John Selden**, New Mexico State University
    - **Karen Graham & Todd Abel**, University of New Hampshire
    - **Richard Lesh**, Indiana University-Bloomington
  - An open forum to discuss theoretical and pedagogical issues related to mathematical habits of mind
- Meeting 2 (Fri, 3:30pm – 5:00pm, International D
  - A brainstorming session to identify worthwhile avenues of research
  - Small-group breakout sessions to identify research opportunities, formulate research questions, and discuss research designs
- Meeting 3 (Sat, 10:45am – 12:15pm, International D
  - Small-group presentations of plans for research
  - Discussion of next steps

A paper for this working group can be downloaded at http://works.bepress.com/kien_lim/13/.
Information about this working group is posted at http://www.math.utep.edu/Faculty/kienlim/mhom.
The professional network site for this working group is http://habitsofmind.ning.com.

Descriptions of 10-minute Presentations

1. *Mathematical Habit of the Mind for Preservice Elementary Teachers*
   Richard S. Millman, Georgia Institute of Technology

   The concept of Mathematical Habit of the Mind (MHM) urges preservice teachers (PST) to use, in their teaching, such ideas as "Is there a different way to think about this problem?", "What is there that I am not seeing?", possible generalizations, the necessity and use of careful definitions, or dealing with the vagueness of open-ended questions-- basically understanding how mathematicians might think. The work of George Polya has many examples of MHM and MHM is including in the Mathematical Preparation of Teachers [CBMS, 2001]. This report will describe the introduction of MHM into the content math course for future teachers through its inclusion in Mathematical Reasoning for Elementary Teachers (Long/DeTemple/Millman, 5E) and the reactions of PSTs and ten reviewers of the text (6 of whom used the text and five of whom didn't) about the inclusion and emphasis of MHM in preservice teacher education.

2. *Undesirable Habits of Mind of Preservice Teachers*
   Kien H. Lim, University of Texas at El Paso

   Many preservice K-8 teachers enter colleges with undesirable habits of mind such as (a) spontaneously proceeding with an action that comes to mind without analyzing the problem situation, and (b) not attending to meaning of numbers and symbols. Such habits of mind will negatively impact what and how they learn mathematics. For example, students tend to focus on procedures for solving problems rather than on their underlying mathematical structures. One strategy is to pose problems for which a recently learned idea would not work, and thereby presents a need for students to investigate the principles that underlie the idea. Another strategy is to emphasize the need for understanding the quantities embedded in a problem situation and how these quantities are related. A study has been conducted to investigate the viability of these two strategies in addressing students' tendency of using proportional approaches to solve missing-value problems that involve non-proportional situations.

3. *Transforming pre-service teachers' dispositions towards mathematics through reflection in-activity and post-activity*
   Dionne I. Cross, Indiana University-Bloomington

   Mathematics education is still undergoing a transition from a transmission view of instruction to one that involves students actively engaging in 'doing' mathematics. One way we have sought to address this problem was by working with pre-service teachers to begin transforming their ideas about mathematics and mathematics learning. In the presentation I will describe, with the use of examples, the transformation of the teachers' approaches to non- traditional problems, from initially being unable to solve problems that did not have a singular solution or problems that prioritized thinking and reasoning to making generalizations and aligning algebraic notation to specific aspects of the problem. Students' development of these habits of mind (Driscoll, 1999) are attributed to our focused efforts to teach students how to engage in reflection both during activity and following the activity (Schon, 1983) and to articulate their thoughts both verbally and in writing.

4. *Habits of Mind in the Proving Process*
   Annie Selden & John Selden, New Mexico State University

   We view the proving process as a sequence of mental or physical actions that cannot be fully reconstructed from the final written proof. Such actions often appear to be due to the enactment of small, automated situation-action pairs that we call behavioral schemas. A common beneficial behavioral schema consists of a situation where one has to prove a universally quantified statement like, "For all real numbers x, P(x)" and the action is writing into the proof something like, "Let x be a real number," meaning x is arbitrary but fixed. Focusing on such behavioral schemas, i.e., small habits of mind, has two advantages. First, the uses, interactions, and origins of behavioral schemas are relatively easy to examine. Second, this perspective is not only explanatory but also suggests concrete teaching actions, such as the use of practice to encourage the formation of beneficial schemas and the elimination of detrimental ones.

5. *Mathematics Immersion and Educators' Habits of Mind: Preliminary Results from Two Programs*
   Karen Graham & Todd Abel, University of New Hampshire

   Mathematics immersion is a professional development model in which educators are encouraged to work through unfamiliar mathematical content in ways that simulate the activities and practice of mathematicians. We would like to briefly describe two such programs that we have examined. The use and development of habits of mind by participants in these programs will be discussed. We will also highlight some aspects of the programs that seemed to encourage the use and development of mathematical habits of mind.

6. **Richard Lesh**, Indiana University-Bloomington

   Do students develop rigid and unchanging profiles of habits, dispositions, and attitudes? Or, do productive problem solvers manipulate their own profiles to suit circumstances? In our presentation, we will describe evidence showing that (a) productive-but-implicitly-functioning habits of mind can be developed using reflection activities similar to those used by athletes and performing artists; (b) students can develop more powerful ways of seeing (or interpreting) their own problem solving experiences; (c) both learning and application of ideas and processes develop synchronously during mathematical model-development activities; and (d) the productivity of relevant processes, beliefs, dispositions, and habits of mind vary across time; so, productive students learn to manipulate their own profiles to suite circumstances. Our research is based on models and modeling perspectives of mathematical problem solving, learning, and teaching. A two-page summary of related excerpts from Lesh and Zawojewski's (2008) chapter on *Problem Solving and Modeling* and implications for research on habits of mind is posted at http://www.math.utep.edu/Faculty/kienlim/HoM_A6Lesh.