NEW FORMS OF TEACHING AND LEARNING WITH NETWORKED CLASSROOMS AND METHODOLOGIES TO EXAMINE THEM

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This discussion group will extend work on the development of networked classroom technologies and related activities, turning to examination of classroom interactions these networks foster. Examining the ways in which deep, conceptual understandings of key mathematical ideas are constructed is a common focus across the several projects included. We are also working to understand such phenomena as group-level mathematical discourse and practice (Stroup, Ares, & Schademan, 2004; Abrahamson & Wilensky, 2004), patterns of participation that foster inclusive learning environments (Stroup, Ares, & Hills, 2004; Abrahamson & Wilensky, 2005), phenomenological and psycho-social dimensions of learning (Kaput & Hegedus, 2004), learning about complex dynamic systems by co-constructing them (Wilensky, 2004; Berland & Wilensky, 2004)), and students' cultural practices as resources for network-mediated learning (Ares & Stroup, 2004). Studies of teachers' evolving pedagogies are also underway. Diverse methodologies are being developed to bridge theory and practice across the various projects. This discussion will deepen our interdisciplinary, multi-site dialogue. The specific focus will be to examine the varied evidence we have that teachers and students are affected in unique or important ways as a result of networked activities and the means by which we are gathering and analyzing that evidence. We will leverage this focus to articulate cross-project design principles for framing diverse content vis-ˆ-vis our evolving technological infrastructures and teachers' network-specific practices.

Key Mathematical Learning

We all examine how important mathematical concepts and skills are developed in networked classrooms. For example, students were found to develop calculus-related reasoning and concepts (e.g., relationships among rate, amount, and velocity) as they explored the motion of elevators whose movements they controlled through velocity graphs (Ares, Stroup, & Schademan, 2004). The emerging real-time graphical representations of position and velocity, along with the elevators' motions, were important resources the class drew on to develop increasingly sophisticated understandings. This was evidenced in part by their discourse moving from more qualitative to more quantitative characterizations of rate. Middle-school students who conducted individual statistical analyses pooled collective numerical values that were plotted as sample-mean distributions. The social–mathematical space enabled students to ground the predictive power of numerous samples in terms of a Law of Large *Social* Numbers (Abrahamson & Wilensky, 2004).

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Changing Pedagogies

Interview data indicate that teachers are working harder and differently in networked activities (Ares, Schademan, Evans, & Postell, in prep.). The work is harder because they can't anticipate where the discussions may head. The need to be "light on their feet" in terms of mathematical concepts to pursue, critical insights to highlight, and connections to the course curriculum requires heightened attention and analytical listening. They also cite the fact that students must work collectively for the activities to proceed as changing the ways they manage student behavior and learning, given that students keep each other engaged, cajoling their peers into participating productively. They also worry that the emphasis on public, verbal contributions hinders some students' participation. This aspect also requires a shift for them in the ways they orchestrate participation. In comparing our networked-classroom designs to other reform-pedagogy design, we are addressing possible tradeoffs inherent in the potential homogeneity the network imposes on student engagement and the impact of this in terms of a desired variability in content and activity entry-points.

Methodologies

The approaches by which the projects are gathering and analyzing evidence of networked classrooms' learning-focused activities vary in complementary ways as well, with work focusing on both individual and group-level interactions and knowledge construction. For example, the Patterns of Participation Project (Stroup, Ares, Hills, & Wilensky, 2005) uses the real-time data collection capabilities of these networks to conduct group level of analyses. Evidence of unique influences on mathematical discourse and reasoning indicates that network-mediated learning fosters academic mathematical discourse (e.g., conjecture, visualization, mathematization, prediction, linking multiple representations) in comparison to more procedural knowledge in textbook-mediated activity (Ares, Stroup, & Schademan, 2004). The Project extends those findings by analyzing network-supported interactivity along three dimensions: (1) a content dimension, (2) a socio-cultural dimension and (3) a behavioral biological dimension where the analytical tools of behavioral biology are highlighted. This work moves notions of inclusion beyond deficit driven models that focus on remediation, to approaches that can explicitly engage the full range of learners.

The SimCalc Project's (cf., Kaput & Hegedus, 2004) attention to cognitive and psychosocial features of learning extends analyses of calculus-related learning to examine affective dimensions of network-supported activity and issues of identity. Students invest personal meaning in mathematical objects they construct, which then are given added significance in relation to the collective object that results from individual contributions being displayed together in a public, visual space. Personal investment in contributions to the construction and discussion of mathematical objects (e.g., "that's me up there," "Joe's function." "I'm going backward") is being examined in relation to such things as academic self-efficacy and identity as related to mathematical learning and practice. This focus on affect and identity is integrally related to a focus on cognition, emphasizing the inter-related processes of social and domain-related learning.

The ISME Project (cf., Wilensky, Stroup et al., 2004) examines students' learning to reason about complex systems. we study how student-initiated inquiry into this challenging domain is facilitated by technological tools, and how these practices and contexts impact the implicit formulation of domain-specific heuristics. Student reasoning is viewed through the lenses of "agent-based" and "aggregate" perspectives on complexity - lenses that informed the design

rationale, are embedded in the design of tools and activities, and are fostered as efficacious and complementary cognitive tools. Employed modes of investigation are the cluster of methodologies used in design-research for eliciting individual-student pre/post understandings, microgenetic analysis (Schoenfeld, Smith, & Arcavi, 1993), and a grounded-theory bottom-up/top-down formalization of significant categories of student cognition as expressed in student utterance, gesture, and written work.

The WideNet Project examines networked classroom technologies' potential as culturally relevant technology (Ares, 2004; Ares, Schademan, Evans, & Postell, in prep.). Culturally relevant means design and use of technology in ways that honor the cultural practices of students as valuable, legitimate resources for learning; treat use of those practices as central issues in design and implementation; and scaffold students' learning of rigorous academic content by drawing on those practices in service of generative learning (Stroup, Ares & Hurford, in press). Analyses treat mathematics as discursive practice (Moschkovich, 2002), and examine: "activity building," or interactions that comprise specific activities in specific contexts; "socioculturally-situated identity and relationship building," or beliefs, interaction and communication patterns, and attitudes that comprise participants' identities and relationships in specific situations; and "political building," or valued activities, positions, and/or interactions that accord participants status or power (Gee, 1999, p. 86). Marginalized students' cultural practices are highlighted as resources that may expand both the mathematical and social space of networked classrooms.

Format for Sessions

Day One -- opening remarks about focus and goals, followed by a structured poster format for small group work on the kinds of relationships being fostered with teachers, the types of evidence being generated, theoretical frameworks used, and analytical methods being developed. Each project will bring videos and other artifacts to use as springboards for discussions among participants. Handouts with guiding questions will support audience involvement.

Day Two -- continue with structured poster format, but have people from each research group sitting together at each other's site to foster cross-project discussions to promote a multiple-perspectives approach to looking at data and to collaborating with participating teachers. Day Three -- whole group discussion of what we accomplished with specific attention to how we can further cross-project collaboration and inform classroom practice for practitioners working to implement the networked technologies. This discussion will include co-researcher relationships with teachers.

Selected References

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