RESEARCH TOOLS FOR COLLECTIVITY: TRACKING MATHEMATICS CLASSES

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Our research is guided by the question: 'How might we observe, document, display, and analyze data from a collective systems perspective?' In this colloquium, we will examine our current work involving the development of new methodological tools that address the research question.

Keywords: Research Methods

Introduction

Over the past 25 years, the research colloquium leaders have individually and in subgroups, been theorizing about, as well as collecting, analyzing, and reporting on data related to collective action in mathematics classrooms (e.g., Davis & Simmt, 2006; Martin, McGarvey & Towers, 2011; Martin & Towers, 2011; McGarvey & Thom, 2010; Proulx, Simmt & Towers, 2009; Thom & Glanfield, 2018). While our work has contributed to meaningful insights into mathematical understanding of learners and teachers, we realized that the methodological tools developed and used were limited due to the vast and intricate range of dynamic interactions (Martin, McGarvey & Towers, 2011; Simmt, 2011). This led us to working systemically on the mutual concern: How might we observe, document, display and analyze data from a collective learning systems approach? Building on our previous PME(NA) working group, NCTM research symposium, and PME research forum, in this colloquium we will present our work to date and provide opportunities for the participants to learn about, try out, and discuss the methodological tools we have developed.

Theoretical Background of the Research

We situate this research within a complex systems framework to inquire into how relationships between the parts of a system give rise to new and unanticipated collective behaviours of the larger system. We conceive mathematics classes as dynamic complex collectives; that is, mathematics classes emerge and evolve from the inextricable layering and entanglement of biological, social, societal, and environmental subsystems (Davis & Sumara, 2006; Davis & Simmt, 2003). Events within such systems may be unpredictable in foresight, but are potentially understandable in hindsight. As such, complex systems present "collective possibilities that are not represented in any of the individual agents" (Davis & Simmt, 2003, p. 140). In contrast to considering classroom interactions as strictly a series of distinct contributions by individuals, we recognize that teacher actions and decision making are often not based on the multitude of individual actions, but rather, on a teacher's sense of the class as a whole of which the teacher is a part (Burton, 1999; Towers, Martin & Heater, 2013).

Previous Engagement with Methodological Tools Work

At the 2015 PME(NA) Conference the research colloquium leaders offered a working group on "Collective learning: Conceptualizing the possibilities in the mathematics classroom" (McGarvey et. al., 2015). Participants discussed the theoretical and methodological concerns as well as practical implications related to mathematics class as a collective. Following the working group, we directed

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our attention on the metaphor of "vital signs" to guide the development of tools for observing the collectivity of mathematics classes. Similar to how health professionals monitor bodily systems, we explored how a mathematics class might also have *multiple vital signs*; that is, when monitored simultaneously, such signs afford robust insight into the systemic viability. Here, a suite of "classroom vital signs" were proposed to distinguish between different forms of collective classroom activity while pointing to key elements of dynamic engagement. At the 2017 NCTM Research Conference, we described the potential of vital signs as both a metaphor and tools to inquire into collective learning (McGarvey et. al., 2017) in a research symposium. In 2018, at the International PME conference, we facilitated a Research Forum on the "Vital signs of collective life in the classroom" where we shared our research team's efforts to develop methodological tools for observing the class as a collective (McGarvey et. al., 2018). To date, we have created six new tools with which to observe, track, and identify new patterns within the collective activity of mathematics classes. In this colloquium, three tools will be explicitly examined: Tool 1) ideational networks; Tool 2) dynamics of ideas; and Tool 3) classroom board activity.

Proposed Layout for Research Colloquium

Session 1: 15 min. introduction to the purpose and importance of the methodological research; 10 min. presentation about the development of Tool 1 to date; 20 min. for participants to observe the tool in action and dialogue about its use; 35 min. for participants to exchange ideas and collaboratively work with the tool; and 10 min. for closing remarks, discussion of future implications, and applications for mathematics education research.
Session 2: 20 min. overview of the Dynamical Model/Theory for the Growth of Mathematical Understanding (Pirie & Kieren, 1994) and presentation on the integration of it and the development of Tool 2 to date; 20 min. for participants to observe the tool in action and dialogue about its use; 40 min. for participants to exchange ideas and collaboratively work with the tool; 10 for closing remarks, discussion of future implications, and applications for mathematics education research.
Session 3: 10 min. presentation about the development of Tool 3 to date; 15 for participants to observe the tool in action and dialogue about its use; 25 min. for participants to exchange ideas and collaboratively work with the tool; 30 min. for participants to experiment with applying different combinations of the three tools and explicate the multiple perspectives they afford when observing them simultaneously "all at once"; 10 min. for closing remarks, discussion of future implications, and applications for mathematics education research.

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