Consciousness, Collectivity and Culture: Experiences of Intimacy in Mathematics Learning

HELENA MIRANDA, MARY BEISIGEL & ELAINE SIMMT
University of Alberta

BRENT DAVIS & DENNIS SUMARA
University of British Columbia

Over the past decade, there has been a pronounced shift in discussions of the learning and teaching of mathematics, moving away from a focus on the solitary individual as the locus of learning toward a an emphasis on the "collective" as a learning unit. As Davis and Simmt (2003, 2006) argue, there has been a movement away from viewing a classroom as a collection of "I's" and toward a conception of a collective "we," from collections of isolated learners to learning collectives. Similarly, other researchers have noted the importance of framing the work of teacher education in terms of learning collectives (cf. Davis & Simmt, 2003).

More broadly, like other systems of knowledge, mathematics has itself been characterized as emerging from a collective. For example, Lakoff and Núñez (2000) describe discipline as "one of the greatest products of the collective human imagination constructed jointly by millions of dedicated people." For us, such assertions prompt a desire to better understand how learning collectives create mathematics, and our ongoing work with practicing teachers has honed this interest to matters of intimacy with and within the subject matter. Thus, we ask the question: How do researchers' attentions to complexity contribute to senses of intimacy among teachers and their mathematics?

Journal of the Canadian Association for Curriculum Studies
Volume 4 Number 2 Winter 2006

Our interest in intimacy and mathematics emerged from a research project that involved eight mathematics teachers in a teacher development program focused on mathematics for teaching. The teachers worked with two mathematics education researchers (Davis and Simmt) and an educational ethnographer (Sumara) to interrogate the teachers' mathematical knowledge, as well as some of the issues faced in the teaching of mathematics when dealing with topics that include negative numbers, division of and with fractions, the number line, and algebra. Two research assistants (Miranda and Beisigel) reviewed the transcripts with Sumara, and their analyses serve as the basis for this discussion of intimacy and mathematics learning.

We begin with a brief introduction to the complexity framework that informed the researchers' work with the teachers. We then develop the concept of consciousness of mathematical experience. Ideas around consciousness as an emergent process and as an intersubjectively open form of cognition will be introduced and linked to the emergence of intimacy and relationship among the teachers, with the mathematics, and within the mathematics. Lastly consciousness, as supported and mediated by the cultural form of mathematics, will be discussed within the context of the teachers' views on their experiences in the research project.

Attending to the Conditions of a Complex Learning System

Complexity might be defined as the study of systems that learn (Davis, Sumara, & Luce-Kapler, 2007). That is, complex systems (or 'complex unities' or 'complex phenomena') are adaptive, self-maintaining, self-determining forms that maintain their coherence across experience.

Davis and Simmt (2003, 2006) describe some of the conditions that are necessary for the emergence and ongoing coherence of complex systems, included among which are internal diversity, internal redundancy, decentralized control, and neighbor interactions. Briefly, *internal diversity* is understood to define the range of system's responses—or, phased differently, the diversity among the agents that come together into a system define its intelligence. In the case of the research with teachers, some sources of diversity included the different grade levels that they taught, locations of their teaching, extent of

disciplinary knowledge, expertise with different types of students, and extent of teaching experience.

The complement of internal diversity is *internal redundancy*, which refers to the commonalities among the agents that constitute a system. Redundancy is what enables agents to work together, to fill in for one another, to communicate effectively—in brief, it is the basis of a system's robustness. In the teacher research group, redundancies included a shared purpose of deeper mathematical understanding, very similar backgrounds in mathematics, and highly compatible experiences as teachers.

The conditions of *decentralized control* and *neighbor interactions* refer to the relational dynamics among agents within a system. Complexity cannot be predetermined or scripted, and so collectives must be organized in ways that allow control of purpose and action to be distributed, negotiated, and adjusted. In the context of the research group, teachers chose which topics to explore, their interpretations and experiences were represented, and they participated with the researchers in determining where attentions would be directed. More descriptively, structures were co-constructed that allowed for neighbors to interact—where neighbors were recognized to be not only the teachers, but also the ideas and questions the teachers presented. The orienting conviction here was that new possibilities for insight and interpretation would arise in the juxtaposition of understandings and the blending of ideas, which could only occur by bumping thoughts together.

While the teachers involved in this research project were not explicitly aware of the researchers' attention to complexity, several noticed the value of some of the components of the researchers' efforts to ensure the presence of these conditions for complex emergence. In particular, one teacher stated that the diversity of group helped her find a "sense of what is happening across all twelve years and how every part matters." Another teacher recognized the value of internal diversity and redundancy in the group: "There's a commonality there, but we all hear different things. We all process things differently, so I think you get a bigger base of information." Several teachers commented on how the ability to share ideas and experiences added to their knowledge of and thought processes about mathematics.

Consequently, it was through the complexity framework that teachers were able to experience a new approach to the teaching and learning of mathematics, of expanding their mathematical knowledge through the experience of the learning collective. We will now show that this experience contributed to teachers' awareness of their own knowledge, as well as cultivated feelings of understanding, relationship, and intimacy among the teachers and with the mathematics.

Consciousness and Mathematical Experience

The root of the word *consciousness* is the Latin verb *scire*, "to know"—and, more precisely, "to separate one thing from another" or "discern." This notion of consciousness-as-discernment can be related to the various neurobiological, psychological and cultural processes by which our sensory perceptions become embodied knowledge. Our self-identity (awareness of our own consciousness) depends not only on our own cognitive processes but also upon the social and cultural milieu that we inhabit.

This paper draws from several studies previously done on consciousness that include ideas from neurobiology (Edelman, 2004; Damasio, 1999; Ramachadran, 2004), philosophy (Dennett, 1991, 1995), cognitive psychology (Donald, 2001), complexity science (Capra, 2002), popular science (Johnson, 2001, 2004), and mathematical embodiment (Lakoff & Núñez, 2000). Three themes emerge that are relevant to the task of developing an understanding the experiential engagements of teaching and learning mathematics that create conditions for the education of consciousness:

- *consciousness as an emergent process* – In general, consciousness is better understood as an emergent process, rather than a physiological entity (Capra, 2002; Damasio, 1999; Edelman, 2004). Consciousness is a complex cognitive process that emerges via neurophysiological interactions occurring in the brain, but cannot be explained as merely a by-product (epiphenomenona) of those interactions. Both consciousness and cognition are understood as distributed across the entire organism embedded in its context. Human consciousness has emerged as a special kind of cognitive process that allows us to track our own subjectivity within this

emerging complex bio-cultural matrix (Capra, 2002; Donald, 2001). Therefore, the unified sense of self we rely on to control our actions is an emergent property of both the brain's organization and its enculturation (Donald, 2001).

- *consciousness as a form of knowing* – Thompson (2001) argues that human consciousness is not developed from the inside-out but is instead a complex form of cognition that emerges via the "dynamic co-determination of self and other" (p. 4). As he further explains, the "very meaning or sense of my perceptual experience refers to the perceptions of possible others" (p. 15). In this way, a certain *alterity* or *otherness* is an intrinsic part of consciousness, even though we may experience it as a unified and self-contained phenomenon. Therefore, consciousness does not emerge from the independent and isolated workings of individual brains; rather it is an elaborate process that emerges as the conscious self and the "other" interweave and enfold one another in a complex and intimate choreography of co-specification.

- *consciousness as supported and mediated by cultural forms* – Menzies (2005) argues that deep understanding of one's own identity depends on extended engagements with others within social contacts that include physical proximity and opportunities for dialogue. She further suggests that sites of public education may be one of the last sites for such contacts, since these are places where human bodies collect for purposes of communication and inquiry.

Consciousness, awareness of one's place in the world, and knowledge inevitably evolve by and through interactions with others and with cultural forms. It thus becomes clear that working closely with fellow teachers, as undertaken in this research project, is a profound and transformative experience. Davis and Simmt (2006) connect and summarize these phenomena within the working of teachers around mathematics: "mathematical knowing is rooted in our biological structure, framed by bodily experiences, elaborate within social interactions, enabled by cultural tools …." Consequently, the

connectedness inherent in a collective learning system can be seen as requisite for learners, in this case teachers, to experience meaningful, embodied experiences with mathematics and, essentially, an education of consciousness. As one teacher remarked, "You have to have an understanding of yourself" in teaching mathematics.

It is important to note that this expansion of consciousness is not free from emotion. Current research into the structure of the brain has shown that consciousness and emotion are intertwined in human experience. In particular, research has shown that for most mental activity, emotion and cognition are interacting constantly (Ciompi & Panskepp, 2005). Moreover, "the neural architecture involved with emotional processing overlaps significantly with that which is relative to cognitive processing" (Barrett et al., 2005), leading researchers to conclude that consciousness and emotion are inseparable. Indeed, as "emotions establish global, non-linear dynamic control over perceptual process, memory and learning" (Ciompi & Panskepp, 2005), it becomes important to look at emotional experiences and their impact on learning and embodied knowledge. Through the examination of the teacher transcripts below, we find that their descriptions of this experience with mathematics learning are filled with emotion and, almost inevitably, feelings of love and intimacy.

A Phenomenology of Intimacy

The different relationships that people build with various subjects or their fields of study occur at different levels. That is, the way we actively interact with the subject reveals how dearly we hold that subject.

In this regard, mathematics would seem to have a unique status among the subject matters that are associated with public schooling. In particular, mathematics is characterized as a perplexing subject in its connection to human emotions and relationships. It is often viewed as a subject that is cold or unfeeling, disconnected from peoples' lives. However, when students, teachers, parents, and others discuss how they feel about mathematics, what is most often expressed is filled with emotion. A common response is "I *hated* mathematics," even years after a person's last formal experience with mathematics. Less commonly, but no less intensely, when one is doing mathematics, one's actions and reactions may disclose a sense of intimacy that cannot even begin to be captured by statements such as "I love math" or "I am so in love with

this."

As a part of the research project, Sumara interviewed the teachers about their experiences with mathematics learning and teaching, including their recent experiences working with the research group. While many insights emerged from these interviews, one of the most interesting emerged around the different ways the participants expressed their feelings of love and an intimacy for mathematics and for their shared work with others during the course of the research. The term "intimate" caught our attention, but not because it was directly represented in the transcripts (in fact, no one used the word). Rather, it seemed obvious that the space made available for shared work around mathematics created an intimate distance between and among participants and researchers—one that required a personal engagement in public, but that also exceeded these individual and collective engagements. We argue that the experience of intimacy was an emergent phenomenon that emerged from collective mathematical engagements. So intimate was the experience that some members described it as "love" (another emergent phenomenon).

According to one of the definitions given by the *Oxford English Dictionary*, an intimate relationship is the one that is "marked by a very close association, contact, or familiarity." Other words that are synonymous to the terms *intimacy* and *intimate* include *closeness*, *familiarity*, *confidant*, and *knowledge*. To be intimate with someone or something thus implies closeness and intense trust in one's involvements.

The *OED* defines intimacy as "pertaining to or related to or connected with the inmost nature or fundamental character of a thing" and "entering deeply or closely into a matter," and we would contend that the framework in which Davis and Simmt worked with the teachers occasioned such intimacy. It allowed the teachers to enter deeply and closely into mathematical concepts, to enrich their understandings, to see multiple perspectives, to expose their own vulnerabilities. The teachers were able to engage in close attention to something that was of great interest to them and something that was shared by all of them.

As already noted, the word *intimacy* is not explicit anywhere in the transcripts of teacher interviews. However, a more global treatment the

teachers' articulations has brought us to the conclusion that intimacy was present among the teachers through their "comfortableness," "nurturing," "acceptance," "feeling safe," and "building relationships." From these and similar expressions, we identify and discuss four different characteristics of an intimate experience that the teachers have expressed—namely, conversation, relationship, nurturing, and vulnerability.

Conversation

Most of the teachers' collaborative work consisted of rich, sometimes unsettling or inspiring, though-provoking conversations around mathematical concepts. The roots of the word *conversation* include definitions such as "the action of living or having one's being in a place or among persons," "actions of consorting or having dealings with others; living together, commerce, intercourse, society, *intimacy*," and "occupation or engagement with things" (*OED*, 2005).

One teacher described his reason for becoming involved in the research project was to have the opportunity to share, collaborate, and communicate. "More interaction," "information flowing all direction," "a sharing," and "importance of group work instead of sitting in isolation," were some of the remarks teachers made with regard ways in which they have gained from taking part in the project. "What really impressed me in the few sessions that I attended was the conversation development—how people dealt with these different concepts, differently—at every level," one teacher stated. Another teacher added, "The people who succeed are the ones who know how to interact and draw things out of people."

Relationship

Many teachers claimed that their growing relationship with mathematics was enhanced by the personal relationships enacted by Davis and Simmt. This, they indicated, has played a role in getting every teacher in the project interested in the subject. "I think a lot of that is because of the passion that they [Davis and Simmt] have for the subject matter," one of the teachers suggested. He continued: "The excitement that both of them give off in the lessons they're doing with us or the directions that they're giving, that camaraderie that they have, it's like an

old married couple those two." In a way, this points to how individual teachers observe the intimate experiences with mathematics that Davis and Simmt each demonstrate, and that arise at a collective level.

Many teachers felt that an intimate relationship such as that is built on trust over a long period of time. This can be observed especially when someone who is new to either or both the subject and the learners, in which the relationship is weaker. One teacher suggested: "And you know with a substitute walking into a classroom, you see it right there. You could be the best teacher in the world. However, there's no foundation for the relationship, there's no trust." It is from a trusting teacher-learner relationship that one can create a safe learning environment for students' learning of mathematics. Another teacher, from an elementary school, commented that "Davis and Simmt are both great at building relationships. You certainly feel safe having them search out what you're thinking about math and things like that."

Nurturing

Nurturing was another quality of the teacher-researcher interaction that had a great impact on the teachers' reception of and openness to new mathematical understanding. In describing their experience in the research project, teachers used the phrases "very accepting," "really reassuring," "felt at home and comfortable," "validating," "important to know that somebody cared," "very nurturing," "all ideas were accepted," and "non-threatening" to describe the manner in which the researchers worked with them.

One of the teachers, Carol, commented, "What surprised me was I liked learning it [learning the mathematics] and I wasn't afraid—especially given it was collaborative." Commending on Davis and Simmt's approach to the project, Carol says that "they were very accepting of whichever way you came at it—which was really reassuring because it's good to be put in that position of having to take risks and having to possibly do something wrong because you forget what it's like for kids." In a collective, individual knowledge is highly valued.

Vulnerability

With an intimate relationship also comes tension and conflict as part of feeling vulnerable. In the transcripts, most teachers expressed how, in early sessions, they felt vulnerable with the experience of working closely. Formal definitions of *feeling vulnerable* include "having the power to wound" or "open to attack or injury of a non-physical nature" (*OED*, 2005). In the collection of *Essays in Humanistic Mathematics* (White, 2003) we find some recognition of the vulnerability experienced when working with mathematics:

> [Mathematical] problems require attention and courage, and they involve a significant act of self-surrender. A problem is a hopeful enterprise that involves an act of faith.

Consistent with this suggestion, one teacher expressed that in the context of the sessions:

> It was good to feel uncomfortable sometimes because that means you're being stretched. I did feel uncomfortable many times. I felt intimidated—not in a bad way … but that's created an excitement for me afterwards when I started thinking, "Oh, ok, they were trying to get us to understand this concept."

The different approaches taken in the project have also made the teachers realize how collective learning can benefit individual learners. One of the teachers, Carol, got the first impression that Davis and Simmt did not get along when they did not agree on certain perspectives. Carol commented:

> [I]nitially I was a little uncomfortable but I was only uncomfortable because I was observing this and then when I saw the dynamic between the two of them, then I realized it was kind of an interesting pairing…. I realized that this is a very healthy conflict.

Within research concerning emotion and learning, it has been found that emotional experiences can play a role in peoples' attachment to what they have learned. In two separate studies, "emotional has been shown to both capture and facilitate attention" (Phelps, 2005) and "pleasure, joy,

and other 'positive feelings' decrease the distance and create emotional bonds with cognitive objects such as specific persons, places, situations, theories, and ideologies" (Ciompi & Panskepp, 2005). In interpreting the teacher transcripts and finding themes of relationship, intimacy, and love among the teachers' statements about their experience in this project, it became apparent that emotion and intimacy were quite important, even necessary, for teachers to arrive at and claim a new knowledge of mathematics for teaching.

Consciousness, Collectivity, Culture

Consciousness relies on networked relationships between biological and cultural worlds. Although conscious experience depends on primary sensory perception and on nested, overlapping, and interlacing brain functions associated with language and memory, these phenomena are not managed by any central processor or controller. Instead, they are distributed across neural networks and that are linked both to the nervous system and to the agent's context.

Donald (2001) outlines this "bio-cultural hybrid" framework, describing the relationship between consciousness and culture as reciprocal. Consciousness is not only organized by the independent human brain, it is also a symbolic interface produced by the complex interweaving of the biological self with the largely invisible cultural symbolic web. Ultimately consciousness enables us to traverse the distributed cognitive-cultural networks in which we are embedded.

Mathematics is of course part of the cultural symbolic web. As Davis and Hersh (1995) comment, "mathematics of an early period requires that we penetrate the contemporary individual and collective consciousness." They continue:

> A superficial glance at mathematics may be given an impression that it is a result of separate individual efforts of many scientists scattered about in continents and in ages. However, the inner logic of its development reminds one much more of the work of the single intellect, developing its thought systematically and consistently using the variety of human individualities only as a means. It resembles an orchestra performing a symphony composed by someone. A theme passes from one instrument to another,

> and when one of the participants is bound to drop his part, it is taken up by another and performed with irreproachable precision. (p. 56)

This belief is supported by Lakoff and Núñez (2000) as they consider "mathematics to be a product of human beings," shaped not only by our physicality, our brains and bodies, but also shaped by culture and society. Merleau-Ponty (1962) also reminds us that in the cultural object, one feels the close presence of others beneath a veil of anonymity. For example, "*someone* uses the pipe for smoking, the spoon for eating, the bell for summoning, and it is through the perception of a human act and another person that the perception of a cultural world could be verified" (p. 347). What is experienced as "conscious," then, while always personal, always emerges from collectivity and through the adaptation of cultural forms. Or, as Davis and Hersh (1995) explain, personal consciousness, symbolic—such as mathematical—forms, and cultural knowledge/collectivity are always co-emergent phenomena.

The experience of "intimacy" seems to be both required for and emergent from the ironic relation between personal identity and cultural networks. Sartre (1956) has his own way of representing this idea: "The multiplicity of consciousness appears to us as a synthesis and not as a collection, but it is a synthesis where totality is inconceivable" (p. 400). Reflecting on their experiences with mathematics, for example, teachers revealed how their participation in the project has contributed to their relationships with mathematics and to their learning how to teach mathematics effectively. One teacher expressed that she knew pedagogical theory, but it was not until she had the bodily experience that "really solidified things," particularly the need for communication and connection. The words that the teachers used in expressing their satisfaction with this learning opportunity included *love, home, nurturing, comfortable, relationship,* and *passion*. In a way, we see a strong connection between each of these terms and the words *intimate* and *intimacy*. Intimacy is also present around the teachers' discussions of the mathematics and how they feel about mathematics. Most of them describe the "love" and "excitement"—and, on occasion, even "pleasure"—that arise when doing mathematics.

The intimate, interactive, relational qualities of the mathematics sessions with the teachers seem to have supported an understanding of

the subject matter that extends beyond just the *doing* of mathematics. Within the safe, intimate environment established by the two researchers, the collective was able to go beyond where any of the individuals had previously been able to go in their individual understanding. The claim here is that the way mathematics is taught must have an effect not only with the disciplinary knowledge, but also on relationships that arise within that knowledge.

Such an assertion, of course, has immediate implications for the mathematics classroom. When we feel devoted to a subject we can't even explain why or what it is that makes us have such a strong connection with the subject. We hardly can give an account for the way we have been taken by this-or-that subject or/and how it has been taken by us. One teacher, Mina, discussed how she had never realized her love for learning and doing mathematics as a teacher. Only now, she mentioned, can she see what excites her when doing mathematics with her students: "Because I am learning and the kids are learning and I feel excited about it." Carrie, another teacher, pointed to how Simmt had shared with the group about her intimate moments with mathematics in her spare time. She recalled:

> I think it was Elaine [Simmt] who said, "Oh, it was wonderful last night, I was home alone and I could sit and …." She was either doing math problems or reading it and I went, "Holy crump! That's what a mathematician does for entertainment!

This, says Carrie, has motivated her to appreciate mathematics and her need to keep learning it.

Such moments of intimacy—with one another, with mathematics, and within mathematics—can and should be the mainstay, not the exception, of school mathematical experience. As one teacher noted the experience in the learning collective would be valuable for all teachers, not just in mathematics teachers, this may very well be the case for school experience in general. Moreover, such moments can and do have profound effects on consciousness, as learners' senses of how they exist in relation to one another and to collective knowledge are continuously negotiated. We close with one brief quote from one of the teachers as

indication and evidence of such effects. We draw your attention here (through italicized pronouns) to what we believe is a shift in teaching style, from instructing individuals to engaging with the collective:

> *I* used to give *them* lots of math notes, and now I don't. I've gotten away from that and *we* use the board and *we* talk through it.

References

Barrett, L.F., Niedenthal, P.M., & Winkielman, P. (2005). *Emotion and consciousness*. Guilford Press: New York.

Capra, F. (2002). *The hidden connections: integrating the biological, cognitive, and social dimensions of life into a science of sustainability*. New York: Doubleday.

Ciompi, L., Panksepp, J. (2005). Energetic effects of emotions on cognitions: Complementary psychobiological and psychosocial findings. In Ellis, R.D. and Newton, N. (Eds.), *Consciousness and emotion: Agency, conscious choice, and selective perception*. Philadelphia, PA: John Benjamins.

Damasio, A. (1999). *The feeling of what happens: body and emotion in the making of consciousness*. New York: Harvest Books.

Davis, B., & Simmt, E. (2003). Understanding learning systems: mathematics teaching and complexity science. *Journal for Research in Mathematics Education*, 34(2): 137–167.

Davis, B ., & Sumara, D. (2006). *Complexity and education*. Mahwah, NJ: Lawrence Erlbaum.

Davis, B., Sumara, D., & Luce-Kapler, R. (2007). Engaging minds: Changing teaching in complex times. New York: Lawrence Erlbaum/Taylor & Francis.

Davis, P.J., & Hersh, R. (1995). *The mathematical experience*. Boston: Birkhauser.

Dawson, S. (1999). The enactive perspective on teacher development: 'A path laid while walking.' In Jaworski, Wood and Dawson (Eds.), *Mathematics teacher education: Critical international perspectives*. Philadelphia, PA: Falmer Press.

Dennett, D. (1991). *Consciousness explained. New York: Bay Back Books.*

Dennett, D. (1995). *Darwin's dangerous idea: evolution and the meanings of*

life. New York: Touchstone.

Donald, M. (2001). *A mind so rare: the evolution of human consciousness*. New York: W.W. Norton.

Edelman, G. (2004). *Wider than the sky: the phenomenal gift of consciousness*. New Haven, CT: Yale University Press.

Johnson, S. (2001). *Emergence: the connected lives of ants, brains, cities, and software*. New York: Scribner.

Johnson, S. (2004). *Mind wide open: your brain and the neuroscience of everyday life.* New York Scribner.

Lakoff, G. & Núñez, R.E. (2000). *Where mathematics comes from: how the embodied mind brings mathematics into being*. New York: Basic Books.

Menzies, H. (2005). *No time: stress and the modern life*. Toronto: Douglas & McIntyre.

Phelps, E.A. (2005). The interaction of emotion and cognition: Insights from studies of the human amygdala. In Barrett, Niedenthal, & Winkielman, (Eds.). *Emotion and consciousness*. New York: Guilford Press.

Ramachandran, V.S. (2004). *A brief tour of human consciousness: from impostor poodles to purple numbers*. New York: Pi Press.

Thompson, E. (2001). Empathy and consciousness. *Journal of Consciousness Studies*, 8(5–7): 1–32.White, A.M. (1993). *Essays in humanistic mathematics*. Washington DC: Mathematical Association of America.