CONVERSATION AS A SPACE FOR STUDENTS' LEARNING IN MATHEMATICS CLASS: RE-VISIONING COMMUNICATIVE INTERACTIONS

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ABSTRACT: The importance of communication for the learning of mathematics is well established in mathematics education literature. The context of the reported inquiry looked beyond cognition in mathematics class related to specific content to explore how students could develop learning processes to improve their approach to high school mathematics. Conversation, as a specialized construct of communication, holds promise to inform how teachers and students could attend to growth in learning processes and selves in the context of mathematics class. The curriculum inquiry first identified key studies from mathematics education which use conversation as context for students' mathematical learning. Philosophical approaches that underpinned the studies were examined, such as hermeneutics, narrative, dialogism, care, epistemological frames, and enactivism. The philosophical traditions contained assumptions and conceptualizations of conversation which provided theoretical potency for this type of communicative act in mathematics class. The results of synthesis of the philosophical traditions indicates that conversation can be an effective space for high school mathematics students in engaging in learning to learn mathematics given consideration for five key features, learning and growth as aim, and the relational space of conversations.

Keywords: conversation, mathematics education, curriculum inquiry, learning to learn

INTRODUCTION

Communication has been identified as a crucial process within mathematics classrooms. Mathematics educators have invested significant energy into researching various aspects of mathematical communication (Choronaki, & Christiansen, 2005; Elliott & Kenney, 1996), including communicating through writing (Masingila & Prus-Wisniowska, 1996; Author1; Morgan, 1998; Pugalee, 2004), effective instructional strategies for increased student understanding (Nathan & Knuth, 2003), and one-on-one and whole class communication (Bills, 2000; Gresalfi, Martin, Hand, & Greeno, 2009; Pimm, 1984). The range of methodologies in researching communication in mathematics classrooms rivals the various foci, such as discourse analysis (Truxaw & DeFranco, 2008; Zolkower & Shreyar, 2007), action research (Herbel-Eisenmann & Cirillo, 2009; Raymond & Leinenbach, 2000), hermeneutics (Davis, 1996; Gordon Calvert, 2001), and semiotics (Radford, 2003).

While most studies focus on talk about mathematical content, what seems to be subordinated to the mathematics is the educational moment embedded in the communication. A kind of dialogue which attends to the educational moment – a *conversation* – among a teacher and her/his students cultivates a different kind of learning experience. *Conversation* allows a teacher to attend to students – as students, learners, individuals, and relational persons – and to be present with them in the classroom. *Conversation* enables students to make sense of the mathematics they are learning and the ways in which they go about learning mathematics. In other words, *conversation* provides space and time to not only inquire into mathematics, but to inquire into students' learning processes.

In high school mathematics class, students are often advised to do more practice questions or study harder in order to get better grades. These platitudes leave many frustrated and with declining achievement. Rather, students with their teachers can work on adapting these platitudes to develop personalized learning strategies which support them in actively making connections among mathematical ideas so that the skills they practice are meaningful. Attention is given to how students go about learning mathematics—the learning processes they use—to improve their approaches. Students require opportunities to work and talk with peers and with their teacher to create and refine learning processes, where *conversation* supports students in learning (how) to learn mathematics. *Conversation* provides opportunities for teachers and learners together to (re)form their identities, their relationships among each other, their approaches to learning mathematics, and their relationship with mathematics.

This significant shift in communication in the mathematics classroom has prompted a re-examination of literature, both of research in mathematics education and the locations in which the mathematics educators have grounded their notions of *conversation* in the broader endeavor of curriculum inquiry. C*onversation* can be viewed in at least two different manners: as a way of inquiring into curricular issues and as the phenomenon being explored.

However, as *conversation* is not the only label that educational researchers use to name a specific communicative act, I included *dialogue*, *discussion*, and *discourse* as forms of communication in mathematics class.

Interpreting the author's meaning of terms related to conversation in literature was challenging. Occasionally, it became clear that the author would use a word in a colloquial manner, where the meaning was simply that there was some form of communication and terms could be exchanged without change the author's claim. As well, communication among individuals does not necessarily need to be restricted to an oral/aural mode, but also a written interaction between individuals.

In this article, I represent a search for understanding what it means to be in conversation as a way to sponsor rich learning of mathematics and self situated within a mathematics classroom. This search was a journey along paths that had already been laid down (Varela, 1987) by others by surveying related literature in mathematics education and curriculum inquiry. The landscape metaphor encapsulates well the process of beginning with mathematics educational researchers and then moving along their pathways toward the source pathways that contributed to their journey. The exploration of source pathways highlighted topographical features, for instance paths crossing over each other (direct referencing to each other) or paths being laid down in parallel (attending to similar ideas, in different contexts or described in different metaphors). Within the landscape, the pathways did not converge on one destination, but dispersed across the landscape of communication. The discussion of the curriculum inquiry and mathematics education literature will point to a coherence of the uses of *conversation* in the literature, suggesting how the notion of *conversation* provides a rich space for further exploration of how teachers and students might focus on learning in mathematics classrooms

Mathematics Educational Researchers' Perspectives on "Conversation"

Several mathematics educators have shaped the landscape of communication within mathematics education. In addition to pragmatic issues, they have returned to philosophical notions within curriculum inquiry as a way to be aware of and understand the qualities of communication in mathematics classrooms. In turn, they contribute to a broader, philosophical understand of *conversation* that supports further research by mathematics educators. The representation of the heads of the pathways, in an essay structure, takes on a linear form even though traversing the landscape included moving from path to path freely.

Davis' (1996) earlier work focused on the act of listening in classrooms, and how conversations enacted through listening provided profound opportunities for a teacher to view teaching as conversing. He applies the notion of *hermeneutic conversation* in his inquiry into the teaching of mathematics. Davis makes a clear distinction between *conversation* and *dialogue* in hermeneutic inquiry, where *conversation* is seen as the site in which a hermeneutic inquiry occurs and *dialogue* marks the communication. It is within the site of conversation that a fusion of horizons can occur. As well, he describes a distinction between *discussion*, where there is a goal of imposition of perspectives on others, and *conversation* as "less oriented to point out differences and more concerned with arriving at shared understandings" (p. 39). In emphasizing *conversation*, Davis also remarks that while preparation is essential and fluidity is fundamental, there is a recognition that a conversation can only be realized retrospectively, "when self and other have been altered" (p. 28). For Davis, the aim of conversation is ontological growth and creation of knowledge.

Ernest (1993, 1998) has explored the use of *conversation* as a metaphoric understanding of learning within mathematics, especially within a social constructivist framing. Epistemologically, Ernest (1998) traces the educative notion of *conversation* back to the ancient Greeks through philosophers that view the dialogic interaction as one that forms the foundation of the growth of mathematical knowledge. He uses *conversation*, *dialogue*, and *dialect* interchangeably, yet focuses on the primacy of *conversation* in learning mathematics. Ernest (1993) sees *conversation* about mathematics as an interpersonal endeavor that includes:

- Mutual respect and trust between teacher and learner;
- Listening to learners; showing (and feeling) an interest in their views, in their conceptions, and in their sense-making;
- Making teaching into *real* conversation … where there is space for learner initiative too;
- Treating real subjects and content of mutual interest and of mutual benefit. (p. 7)

Although Ernest's notions of *conversation* are grounded in epistemological stances, he ascribes to *conversation* as a moral form, where rather than "exchanging information ... it entails engaging with a speaker or listener as another human being" (p. 7). Within Noddings' (1984) and Ernest's (1993) writing, the notion of the dialectical emerges.

Their uses of *dialect* seem to point to *discussion* of content that is highly valued (moral actions for Noddings and mathematical concepts for Ernest).

Within mathematics education, attending to epistemological stances of students typically means exploring how students construct knowledge of specific mathematical concepts. The focus is on the mathematical content with minimal awareness of the complexity of the learner. However, Cobb and his colleagues (Cobb & Bauersfeld, 1995; Cobb, Boufi, McClain & Whitenack, 1997; Sfard, Nesher, Streefland, Cobb & Mason, 1998) attend to both the mathematical knowledge being constructed and the quality of the learning experiences for learners in mathematics class. *Discourse* points to the forms and languaging (both verbal and symbolic) used within the community of the mathematics classroom. Cobb et al. (1997) describe *collective reflection* as important in learning about mathematical objects and is "supported and enabled by participation in the discourse" (p. 264). Here, communication is to not only be located intimately between teacher and learner, but within the context of the whole class.

Although Cobb's interest lies in *discourse* as a meta-communicative structure, he views *conversation* as a process in which learners need to engage in order to learn deeply. As well, *discussion* is used as a generic term for talk exchanges in the classroom. Cobb (in Sfard et al., 1998) suggests that research studies need to be located in classrooms to understand the nature of effective conversations. Further, Bauersfeld (1995) makes strong claims that communicating in mathematics class has an "impact on personal development" (p. 272) and "the totality of everyday experiences forms the basis for the personal development, interactively, and in all dimensions of the sense" (p. 283). Situated within communicative acts, there are openings for learners to learn about learning within the process of growth.

Gordon Calvert (2001) explored a discourse of conversation, rather than viewing conversation solely as a way to improve mathematical cognition. She defined a mathematical conversation as "something where both persons, together, were trying to come to an understanding of some mathematical phenomenon." (p. 5) Here, *conversation* is seen in a relation between two individuals (there is an intimacy implied) where the focus is on understanding, rather than the mathematical phenomenon itself. *Conversation* emerges and flows in ambiguity around topics valued by all participants, in the interpersonal interaction marked by listening through an opening up of self to be responsive and ethically responsible to others, and toward understanding both the topic and the personal experiences of all participants. Gordon Calvert provides a cautionary note: that conversations, as embodied processes, cannot simply be understood through an attending only to text or words, but to lived experiences of those who enact conversations within a culturally and historically active environment.

After studying pairs of people in conversation around mathematical inquiry tasks, Gordon Calvert (2001) concluded her book by pointing to some features of mathematical conversation. The first feature, *gestural genre*, refers to "interactive gestures – verbal, physical, pictorial, and symbolic" (p. 133) that support communication. The second feature, *addressivity toward the other*, refers to an intimacy of attending to the conversational partner with a person's whole self. The third feature, *addressivity toward otherness*, refers to attending to the relationship between the conversation partners and the mathematics that coemerges between them. The world that is brought forth in conversations, as Gordon Calvert identifies, is contingent on the coemergence of understanding each participant's experiences within the particular context.

"Conversation" Pathways in Curriculum Inquiry Literature

Progressing along each of the pathways that began with an inspection of particular mathematics educators' uses of communicative terms directs this exploration toward the pathways the mathematics educators have travelled as they explored communicative acts in their research. Each of the studies cited above were grounded in particular philosophical traditions that shaped their use of communicative terms. This next section travels the pathways of the philosophical traditions employed within curriculum inquiry to note how they have informed mathematics education and how they might be re-read to support an exploration of *conversation* for growth in mathematics class. It is useful to explore this literature as curriculum inquiry provides the lens through which studies in mathematics curricular issues are carried out.

Etymology

Before exploring the literature, I examined the etymology of *conversation* and the other three terms. According to Oxford Etymological Dictionary (Hoad, 1986), the salient historical constructions of the words are:

> *Conversation* – Latin *conversātiō*; Old French *converser* (p. 96)

(mode of) living, dwell, dwelling habitually
familiar discourse
exchange words
acquaintance, company, associate familiarly *with*
turn round

Dialogue – Old French *dialoge*; Latin *dialogus*; Greek *diálogos* (p. 123)
conversation, discourse
dia-: through, apart (Greek) (p. 123)
-logue: speaking or treating of (Greek -*logos*) (p. 270)
logos is account, ratio, reason, argument, discourse

Discussion – Latin *discutere* (p. 127)
investigate
examine by argument
dash to pieces

Discourse – Latin *discursus* (p. 127)
reasoning
conversation, talk
running to and fro
argument
di-: twice, two (Latin or Greek) (pp. 123 & 126)
-currere: run

Analyzing the etymology of these four words provides some interesting commonalities and distinctions to which we can attend. *Conversation* is the only one of the four that does not have "argument" as a historical connection, but instead includes a relational, intimate stance in the communication as the individuals are familiar with each other, with the connotation of living together.

As well, *conversation*, *dialogue*, and *discourse* form a triad. On one hand *discourse* is a meta- term for conversation (in that a conversation is seen as a particular kind of "familiar" discourse). On the other hand, *conversation* is referred to by both discourse and dialogue. In terms of language and cultural origins, all words have Latin roots, although *dialogue* is unique in its Greek roots. This could mean that *conversation* and *dialogue* were to point to the same phenomenon but arose in different cultures.

Finally, *conversation* is the only word that includes the idea of "turn round," which I see as connoting a turning round of ideas in the talk, rather than a moving back and forth between ideas in the "running to and fro" of *discourse*. This could be understood as an intertwining of ideas (and individuals, in the intimacy) in *conversation*, while ideas are held up against each other in *discourse*.

Hermeneutics and Hermeneutic-phenomenology

Hermeneutics and hermeneutic-phenomenology are two closely laid paths informing curriculum inquiry. Davis, Ernest, and Gordon Calvert have identified these paths as crucial in their understanding of *conversation*. Moving between these two paths seems inevitable, especially in the work of Gadamer (1965/1975) and van Manen (1997) who have both merged the two paths together. The exploration of *conversation* in hermeneutics and hermeneutic-phenomenology is not surprising because of the "persistent questioning of our taken-for-granted-modes of speaking and acting" (Davis, 1996, p. 26) and Jardine's (1992) view that hermeneutics "returns inquiry to the need and possibility of true conversation" (p. 124). In this context, the use of *conversation* is used to point to the engagement of curriculum inquirers in deep and thoughtful understanding of educative experiences for children – an inquiry stance.

Gadamer (1965/1975) highlights the use of *conversation* over other forms of communicative acts. He uses *dialogue* as a counter-example, where truths are constructed through the use of logical arguments or to generally point to communication between two people. *Conversation* is framed by Gadamer (1965/1975) as a careful consideration of other's understandings, focused by the topic under consideration, structured through question and answer (or testing), "ensure[s] that the other person is with us" (p. 331), does not have a fixed destination, and primarily occurs between text and an interpreter. In explaining conversation between two individuals, Gadamer recognizes letter writing as a form of written conversation:

To understand what a person says is, as we saw, to agree about the object, not to get inside another person and relive his experiences. We emphasised that the experience of meaning which takes place in understanding always includes application. (p. 345)

The intimate nature within the etymology of *conversation* is taken up by Gadamer.

Van Manen's (1986) description of the pedagogical relationship makes tangible this intimacy in noticing the growth of a child, where many of his vignettes highlight spoken interactions between child and teacher. van Manen (1977) uses the language "interpersonal communication" (p. 213) as the core of Schwab's (1969) *practical* approach to curriculum development, "a conversational relation" (p. 111) as the basis of putting words to the pedagogic experience, and *discourse* as a overarching concept for forms of speech.

Narrative Inquiry

Narrative inquiry supports researchers in noticing the experiences of teachers and learners in mathematics classrooms. My previous research demonstrates the strength of *conversation* as way of being with students in a classroom and as a method of data collection (Author2). For Clandinin and Connelly, "narrative is the best way of representing and understanding experience" (2000, p. 18) and for Bruner (1986) narrative is a mode of thinking, which means that humans think narratively about their experiences, as they both tell and come to understand their experiences. Clandinin and Connelly (2000) use *conversation* primarily as a form of data construction within a narrative inquiry. *Conversation* is used in place of "interviews" because they are "marked by equality among participants and by flexibility" (p. 109) and act as "a probe into experience that takes the representation far beyond what is possible in an interview … done in a situation of mutual trust, listening, and caring for the experience described by the other." (p. 109) In this way, the use of *conversation* highlights the relational qualities of narrative inquiry (Connelly & Clandinin, 1990).

Moving back to the paths laid down by some of the scholars whom Clandinin and Connelly relied on in shaping narrative inquiry provides some insight into the use of the communicative words in this exploration. Bruner (1986) focuses on the use of *discourse* as a particular form that is comprised of the features of "presupposition", "subjectification", and "multiple perspectives" (pp. 25-26). He also juxtaposes arguments with stories in what and how they convince individuals. Sarris (1993) uses *conversation* to refer to "talking back and forth" (p. 4) and as a general taking up of *dialogue*. Geertz, as described by Clandinin and Connelly (2000), uses *discourse* to refer to a broader system of talk that signifies particularities of authorship.

Taking up narrative inquiry, Florio-Ruane (1991) found that *conversations* needed to be "open and extended" (p. 240), characterized by camaraderie, critical to the research, and moved naturally toward story-telling. She noticed that when the author and audience are close to one another there is a rich common contextual knowledge, so the text is "*exophoric* in reference" (p. 247) – contextual references for the meaning of what is said resides outside of the text. Texts which are *endophoric* in reference mark a distance between author and audience – contextual references for the meaning of what is said resides within of the text. Perhaps *exophoric* writing is indicative of the intimacy of *conversation*, where meaning cannot be drawn only from the single verbal interaction but needs to occur within the whole of the individuals' relationship and shared experiences

Dialogic Reality

Ernest's philosophical exploration of conversation explores a dialogic pathway, emerging from the works of Bakhtin and Vygotsky. Bakhtin saw *dialogue* as a way of being in the world, "as central for defining human existence, not merely a form of communication. To experience what it means to be human, one needs to engage in dialogical relations. We are human in the fullest sense when we engage in dialogue" (Sidorkin, 1999, p. 4). Because living in dialogue is the way in which a person shapes her or his own self, as well as showing her or his identity to others, there is a significance for learning by engaging learners in dialogue. Bakhtin characterizes *dialogue* as an aim for life itself where it places a person in relation with another with no defining cause, and *conversation* as a mode of communication (Sidorkin, 1999).

Shotter (1995) extends Bakhtin's dialogic reality toward *conversation*. Although at times he uses *conversation* and *dialogue* interchangeably, it seems that when individuals are in conversation, they are "*responsively* linked in some way" (p. 52, emphasis in the original). As he continues, he describes this connection as "ethically or morally interlinked with others" (p. 54) that is borne out in a sense of responsibility to the other. His primary contribution to the understanding of *conversation* is that it is a joint action, where it is not only the individuals that shape the conversation but the words and the objects that emerge within the conversation (they do not exist before the conversation) act to shape the conversation itself and the identities of the participants.

Gee (1996) extends Vygotsky's interconnection of thought and language, emphasizing the importance of the social interactions in learning through discourse communities. He describes movement from Vygotsky's *spontaneous*

concepts (students learn but "have no conscious reflective awareness of or control over" (p. 275)) to *nonspontaneous concepts* (there is a conscious control) as calling for a "working collaboratively with others who 'know' more than one does *and* (simultaneously) via overt instruction that focuses on putting things into words, conscious and intentional use of the new concepts, and the relationships among forms and meanings" (p. 275, emphasis in the original). This includes talk about new concepts through the collaboration, viewed in this context as *discourse*.

Care as a Moral Stance

The shaping of a moral education, through mathematics education, has been a pathway that mathematics educators like Ernest and I have explored. While my earlier research with at-risk grade 10 mathematics students (Author2, Author3) has been shaped by Noddings' (1984) ethic of care, Ernest highlights *conversation* as a moral way of being with others. His stance has tremendous synchrony with Noddings' work. For Noddings, "ethics" is understood as the study of morality, of how individuals meet each other morally, and she views a relation that is caring as the basis of ethical action in that "we recognize human encounter and affective response as a basic fact of human existence" (p. 4). With the relational, and encountering each other with care as basic to this philosophical stance, it is useful to attend to how individuals ideally interact through speech within a caring relation. Noddings focuses on the use of *dialogue* as one of the central aspects in moral education for "nurturing the ethical ideal" (p. 121). As in her ethic of care, relationships are central to *dialogue* and this form of interaction is marked by being open, genuine, sharing, seeking the best of the other, and reflecting. In the classroom, a teacher and learners would engage in "talking and listening, sharing and responding to each other" (p. 186), where learners are encouraged to think out loud in initiating and trying out ideas, while the teacher listens intensely and then directs. Additionally, Noddings uses *discussion* to point to an open exploration of how individuals have acted and how they could act in moral and ethical ways.

Meier (1995) took Noddings' ethic of care and moral education with her as she developed an alternative public-school program in Harlem grounded in the philosophy of caring. *Conversation* is used predominately in Meier's book, *The Power of Their Ideas*, as demonstrates the significant learning which students engaged in as their voices were valued in their schooling. Although Meier does not define or characterize her use of *conversation* explicitly, observations she shares provide the audience with a sense of how conversations were taken up in her school. There is an openness where ideas flow in the midst that provides opportunities for students' voices to emerge (through their valuation) and be heard, where voices build on each other in the development of ideas, and conversation is held within a relationship of mutuality. Additionally, Romano (2000) uses *dialogue* to represent interactions where the teacher listens intensely with the aim of understanding learners, attending to them in multiple ways, and where the learners feel a sense of respect and openness where all are included and valued. She views *dialogue* as a crucial aspect in forming an educative community within a classroom.

Epistemological Frameworks

Another region in the landscape of communication that could inform an understanding of *conversation* are paths of epistemological models. Both Ernest and Cobb (and his colleagues) have traversed this area of the landscape in developing their understandings around *conversation*. Noddings (1984) noted that caring is rooted in a feminine ethic, which has lead to considering two epistemological frames that consider gender as informative in epistemological stances. In Belenky et al.'s (1986) frame, the ways in which women interact in order to come to know is highlighted within connected knowing. Connected knowing seeks to build knowledge from personal experience, and connecting relationally with others is important in coming to understand their personal experiences for the creation of knowledge. These scholars tend to favour *conversation* over other forms of communication, because they view mutuality, drawing on personal experiences to connect to one another, listening carefully, cooperation, openings for emergent ideas, and equality of individuals within the talk. They juxtapose *conversation* with *discourse*, which they view as a "masculine adversary style" (p. 221) and as something done *to* another and not *with* another. In contrast, Baxter Magolda (1992) predominantly uses *dialogue* to point toward meeting others relationally in the classroom, where there is an openness and a responsiveness to individuals' experiences as being educative.

While these epistemological frames address learning academic content generally, there is a shift toward positioning with learning as a space for growth. Huber with Whelan (2000) position *conversation* as "a vital way of knowing" (p. 123), where individuals are interconnected as they enter the conversation in mutuality. As well, Huber and Whelan point to the richness of data constructed through conversations. In exploring their tendency toward *conversation*, over *discussion* or *dialogue*, Godard et al. (1994) describe the informal, participatory, fluid, and interdependent nature of *conversation*. Three interesting contributions are made through their writing: first, the

relational intimacy described through the word "betweenness" (p. 120); second, using "collective conversation" to refer to group interactions; and third, their sense that *conversation* refers to an oral/aural space and *dialogue* refers to a textual space of communication. They understand *discourse* to represent a meta- term for all forms of communication.

Clark's (2001) study of teacher learning is situated within *authentic conversations* where "social and intellectual work is done" (p. 6), and occurring both in oral/aural spaces and through letter writing. Clark views learning and growth as occurring with the context of conversations, when *conversation* is thought of as centred on topics that are valued, participation is voluntary yet marked by active engagement, developed over time within trusting and caring relationships where individuals can be personally invested, and aim to understand experience through improvised explorations. He also defines *dialogue* as a particular form of conversation directed at "new understanding, where the participants question, analyze, and critique the topic or experiences" (p. 160).

Enactivism

As a final pathway in this exploration, a theory of cognition key for many mathematics educators is enactivism. In particular, Davis and Gordon Calvert have used enactivism as a framing to come to understand educative experiences within mathematics. Conceptualized and explicated by Maturana, Varela, and their colleagues (Maturana, 1988; Maturana & Varela, 1988; Thompson, 1987; Varela, Thompson, & Rosch, 1991), enactivism turns to biological roots to describe cognition as embodied. This embodiment highlights that "knowledge depends on being in a world that is inseparable from our bodies, our language, and our social history" (Varela, Thompson, & Rosch, 1991, p. 149) and that "knower and known, mind and world, stand in relation to each other through mutual specification" (p. 150). In other words, there is a coemergence of knowledge among individuals in the bringing forth of a reality in the moments of interaction. This stance lead Gordon Calvert (2001) to shape a *conversarial reality*, emphasizing that "humans exist in conversation" (p. 39) and that our experiences occur within conversations as well as our coming to understand our experiences.

A forum at a meeting of the *International Conference of the Psychology of Mathematics Education* explored enactivism within mathematics education. Among the four papers presented and discussed, only *discussion* and *dialogue* appeared in one text to point toward phenomena under study in classrooms. Even in relative silence about communicative acts, each of the papers identified a key understanding from enactivism: that teachers and students are shaped by their environments and how they interact in their environments, and at the same time the environment is shaped by how the teachers and students act on it. Coles (in Brown, Coles, Lozano, & Reid, 2009) describes his interest in "the role of whole class discussion (particularly the teacher's role) in the development of [mathematics classroom] cultures and individual learning" (p. 1-19). He emphasizes the importance of looking for patterns in coming to understand "classroom dialogue" (p. 1-19), especially without forming *a priori* categorizations.

Making Sense of the Literature on Conversations

I have re-presented a broad range of understandings of *conversation* by scholars who have laid down paths within and outside the field of mathematics education. Traversing each of the paths, I attended to the use of *conversation*, *dialogue*, *discussion*, and *discourse* by noting which word is primarily used by the scholars, describing how they have used this word to point conceptually to the particularities of communication, and using the other words to make distinctions.

As I mapped out these paths, I considered the features of these paths and how they might illuminate and inform the shift in *conversation* from focusing on mathematical cognition to focusing on attending to students as they learn (how) to learn mathematics while engaging in the dynamic process of (re)forming their identity. While the other three terms related to communicative acts can be used in some context, *conversation* emerges as a label that points to the type of communicative act that supports a careful and thoughtful attention to learning and to reformation of identity. What follows in this section is a synthesis of the effective elements of *conversation* drawn from the literature represented above.

Etymology

Etymologically, *conversation* can effectively point to how teachers can attend to students and open up space to explore learning processes in mathematics classroom. Two significant aspects that are particular to *conversation*

are the relational intimacy and the turning round. A relational orientation to teaching and exploring learning processes is essential because the explorations are deeply personal and contribute to (re)formation of identity. To become more effective at specific learning processes, turning the processes round within conversations provides opportunities for students to shape the processes and for the teacher to support and scaffold the refinement.

Philosophical Understanding

The (existential) philosophical question of how humans are in this world, the fundamental question of the nature of existence could be addressed through the notion of *conversation*. Coming to understand living within an authentic conversation space could uncover a different way for a teacher and learners to exist in a classroom, so that their experiences lead toward rich learning. The teacher, in conversation with learners, would have opportunities to learn how to invite and engage learners in conversations about their learning, learn more about how her or his learners are learning in mathematics class, and learn how to live with learners in a classroom differently than is the current dominant practice (for instance, the teacher's learning significantly affecting assessment and evaluation practice in the classroom so much so that it changes the nature of the relationship and existence of the teacher). The learners, in conversation with their teacher, would learn more about how they each learn mathematics in particular ways, learn how to shape existing or construct new effective learning strategies, and learn how to exist in empowering ways with their teacher (for instance, the co-inquiry of teacher and learners contributing to a less hierarchical existence).

Five Features of Conversation

In addition to working at a foundational level of coming to understand *conversation* through its etymology and philosophical underpinnings, attending to features which characterize *conversation* is important in sponsoring and noticing conversations in classrooms. Various features arose for me, as a I travelled the paths other scholars had laid down, that spanned across the paths and seemed to contribute significantly to the shaping of the use of *conversation*. In defining or demonstrating what a *conversation* is, scholars relied on detailed, and often extensive, lists of features to support their and their audience's sense making of their use of the concept. I drew out five features that I view as critical to conversations in classrooms that could support learning about learning and growth of the conversational participants.

The first feature, that of collaboration or *withness*. Within a setting where the interpersonal is valued, relationships are formed through an ethic of care. Living within these relationships, individuals meet each other ethically as they mutually negotiate a sense of trust and equality where they feel both safe to talk with others and responsible to be responsive as they nurture the relationship through their interactions. The (inter)connection entails a notion of intimacy that provides space for individuals to learn in collaboration. The sense of *withness* helps create the conversational space and is also strengthened through the conversations that occur within that space.

Taken up within *withness* is a second conversational feature of *listening*. Quite often, explorations of *conversation* focus on what the speaker is contributing, but the non-speaker(s) is/are active participants throughout as they engage in authentic listening in preparation to respond. The act of listening is integral to the conversational space, being present and responsive to the other. It is within the listening stance that all participants can come to a significant understanding of themselves, others, and the object of the conversation. Listening could mean that the teacher does not position herself/himself as an expert in students' learning, but rather a mutual inquiry that attends closely to how learners talk about their learning to prompt, encourage, guide, and respectfully challenge to sponsor richer and deeper understandings of learning. The learners themselves would also engage in listening by maintaining a sense of openness to learning about their learning, supporting other learners in their learning journey (by being in conversation with them and shaping learning strategies together), and by attending to their emergent understandings of learning to see how it is affecting their learning.

While it is important to understand how the conversational participants are relating to each other within the conversational space, their conversations could also be characterized as being *dynamic* (as a third feature). The dynamic nature of conversations could relate to at least two aspects, the topic that is under consideration as well as the flow of the conversation. *Dynamic* could be a particularly useful way to think about conversations because it contains both the idea of being in constant change or flux, and also being energetic or productive. In the first sense, there is a certain fluidity in the course of an authentic conversation, where rather than the participants being in control of the turn-taking and the movement of the topic(s), the mutuality and relatedness of the participants provides space for the conversation to coemerge. There is a notion of fluidity, flexibility, and anticipation of the unexpected within the conversational space.

In the second sense, there is an investment in the conversation by all the participants – an understanding that personal change and growth can occur by their active participation. This investment is sponsored by the focus (topic) of the conversation, that it is something of mutual interest or concern to all participants and participants have a strong sense of its value for their own growth. This focus is something that often emerges within the conversation, rather than being directed at the outset. The *dynamic* feature could be central to a teacher and learners' co-inquiry into how students learn – that ways of learning are co-constructed and subsequently shaped as the conversation flows among the participants and that active engagement talking about how to learn mathematics effectively can be valued by a teacher and her/his learners.

Extending from the fluidity that occurs within the conversation, a fourth feature of a conversation is the *uncertainty* of where the conversation leads participants and how the conversation is understood afterwards. Because the conversation and the focus emerge among the participants, there is no sense of (a predetermined) destination at the outset, nor is there a sense of what specific elements would be achieved at the end of a conversation. The hermeneutic conversation holds the notion of shared understandings as the direction toward which a conversation leads.

There is a tension between the uncertainty that exists in an authentic conversation about learning processes and sharing with students effective learning processes with the expectation that they make use of them. It might help in this context to consider the uncertainty being enacted through series of conversations about learning processes that there is no way to ascertain or fix in what ways and how teachers and learners might grow through ongoing conversations. The *exophoric* notion of conversation extends from the features of *withness*, *dynamic*, and *uncertainty*. This is clearly drawn from social orientations to learning, and supports the notion that rich learning needs to be situated in a conversational space. An *exophoric* orientation to interpreting a conversation highlights the necessity of a researcher to be imbedded in the research context.

The fifth feature of conversations is the additional form of conversation, aside from oral/aural, contained with *written* pieces. This article begins with this as a premise, but it is also brought forward in several of the pathways. Within a classroom space, it is unrealistic to expect a teacher to regularly have oral/aural conversations with each learner one-on-one about her/his learning within the flow of classroom activities, no matter how intentional the teacher is and how much he/she values that conversation. The process of interactive writing provides space for intimate conversations to occur between a teacher and each of her or his learners, a space that is safe for learners to share their emergent thoughts about their learning and a space where a teacher can scaffold learning about learning in specific and effective ways for each particular learner

Purpose of Conversations

Two purposes of engaging individuals arises along two trajectories: learning and growth. Learning seems to be related to an epistemological stance, while growth seems to be related to an ontological stance of positive movement and development. While the purposes of learning and growth are not mutually exclusive within a classroom, there were some scholars that explored learning (Cobb et al., Ernest, Gordon Calvert), others that explored growth (Bauersfeld, Huber & Whelan) or both (Clark, Davis). Interestingly, the scholars who focused on learning as a purpose of engaging learners in conversation highlighted the effects that conversations have on the quality of learning mathematics. Their concern was within a domain-specific cognitive experience. The set of scholars who focused on growth as a purpose of engaging learners in conversation were interested in how conversations could support the ontological growth of individuals, attending to who they were becoming as it related to their shifts in identity and in relation to others. Clark and Davis, who were intentional about both purposes, noticed that conversations were effective in improving and strengthening practices (teacher and mathematical) that were represented by both learning and growth.

Through inviting and engaging students in conversations about learning processes, learning and growth are tightly intertwined because the learning that a teacher and learners engage in is about each of their selves, how they learn, and how they learn about learning. Rather than focusing on the learning of a subject area content, although contextualized within mathematics, the learning is about self – looking inward at how one learns as an individual, how one positions oneself with coming to know and knowledge (epistemological stance), and how one is being and becoming through the (re)formation of one's identity (ontological stance) and looking outward at how one learns in collaboration with others.

Space of Conversations

Learning and growth, interrelated purposes of engaging in conversation, could occur in at least two different conversational locations. Within a classroom, there are patterns, forms, and languaging that I see creating a *discourse* space. These three aspects of the *discourse* are negotiated between a teacher and learners. In addition to mathematical discourse, there could also be a learning discourse that is shaped. The learning discourse is the location where a teacher and learners actively engage in talking about learning and learning processes with the goal of increasing their awareness of learning and become more effective learners.

Two possible spaces for conversations include those that occur between a teacher and a learner, one-on-one, and conversations that occur among a teacher and a class of learners. The nature and form of a conversation will differ somewhat between these two spaces. The one-on-one conversations are intimate exchanges because there are only two conversational partners that are interacting quite personally and specifically, within the learning needs and goals of the particular learner and at the same time also contributing to the shaping of the pedagogic relationship. These conversations between teacher and learner extends from talk as a whole class about learning, and exists and develops over time. So, in order to distinguish the one-on-one conversations between teacher and learner, they could be labelled as *intimate conversations*.

There is a difference sense of the conversations which occur within a class setting, among a teacher and her or his learners. The talk within the broader discourse space could be seen as a *collective conversation* in the sense that many are involved in the shaping of the community and the learning of the community. The adjective points to the intention of collaboration within the whole community. The space of conversations grows out of a relational orientation, where relationships among conversational participants are negotiated and fostered.

CONCLUSION

The re-investigation of how communicative acts are taken up in mathematics education has been offered in order to imagine an alternative, and potent, possibility for engaging in conversations in mathematics classrooms. Much research has focused on how students communicate mathematically—about the mathematics and in support of reasoning mathematically. But the necessity of attending to the experiences of students in mathematics classrooms calls for the focus and intentions of *conversation* in mathematics classrooms to struggle with what it means for students to learn how to learn mathematics, to develop effective learning processes, and to be ontologically shaped by their experiences in mathematics class.

Conversation takes up a sense of *withness* and *listening* in a *dynamic* process and with a *uncertainty* in destination and understanding that provides opportunities for mathematics educational researchers to explore the essential experiences of learners of mathematics. Acknowledging that students' experiences in mathematics class affect more than their cognition is not sufficient. In order to support the success of *all* students in mathematics classes, coming to understand the qualities of effective conversations for supporting learning (how) to learn mathematics and reformation of identity is necessary. I invite others to engage in the challenges of shaping conversations about learning in mathematics class.

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