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The Relationship Between the Assessment Process and Children's and Teachers' Knowledge and Identity in Mathematics

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Executive Summary

Over the course of the past three years, our research team examined the relationship among assessment, knowledge, and identity in mathematics for both children and teachers. As a group of mathematics teacher-researchers and teacher-educators, we had noted the way assessment had not only shaped mathematical practice in classrooms, but also had shaped both children's and teachers' mathematical knowledge and identity. Members of our research team had been working with interviews as a way of assessing children's mathematical knowing and knowledge. In this research we came to see our role in assessment and the ways that an interview assessment supported a deeper understanding of children's mathematics understanding. We conclude our report with suggestions for assessment practices in mathematics based on our research alongside children.

Research Background

Looking Back in Order to Situate the Research

In years previous to this research, teachers, curriculum leaders and teacher educators from three school divisions and the University of Saskatchewan came together to organize and facilitate a summer institute for teachers called *Coming to Know.* Initially, the institute was based on the work of Grayson Wheatley (1990, 2002; Wheatley & Reynolds, 1999) and his work on children's thinking in mathematics. Wheatley's work influenced the themes explored in this research. Through the work at the institute and the work of the Early Numeracy Committee (comprised of teachers, consultants and teacher educators from the same school divisions and university), we began to notice the work of the committee influencing the work of the institute and vice versa. It is through the co-emergence of the ideas generated through our conversations around early numeracy and teaching that our research wonders emerged. We wished to understand the role assessment has in shaping mathematical knowledge and identity for both children and teachers and the ways assessment can be a relational act with children.

Over the course of the past three years, our research team examined the relationship between assessment, knowledge and identity in mathematics for both children and teachers. As a group of mathematics teacher-researchers and teacher- educators, we had noted the way assessment had not only shaped mathematical practice in classrooms, but also had shaped both children's and teachers' mathematical knowledge and identity. Members of our research team had been working with interviews as a way of assessing children's mathematical knowing and knowledge. We use the word knowing, instead of knowledge, which we feel reflects the dynamic thinking children use to make sense and explain the knowledge they hold regarding mathematical concepts. Perhaps more simply, we are saying that knowing is the ongoing process of meaning making and that knowledge is the static accumulation after knowing occurs. Embedded in these assessments are our continuing wonders about the role of the assessment in shaping and illustrating children's mathematical understanding and identity, which underscores the relationship between knowing and knowledge. We have also come to believe that the assessment also impacts teacher knowledge and identity regarding their understanding of mathematics, and we wished to explore this further.

Our interest in understanding how interviews reflect children's mathematical knowing and what it indicates to us as educators was a shaping aspect of this research. This is related to the ways children think about number, their ways of partitioning number, and the ways in which they combine amounts visually and mentally. With the development of the new Saskatchewan mathematics curriculum, we found this work timely as it supported us to understand the ways deeper thinking in mathematics can be engendered in children's work. This is reflected in the new curriculum by the decision to cover fewer outcomes, but in a deeper manner.

As teachers come to implement the new Saskatchewan mathematics curriculum, they will be asked to address both the concepts and processes of mathematics. Many teachers in Saskatchewan have been considering the place of mathematical processes in their work with children, and for us it was important to understand

the ways that this is shaping children's and teachers' mathematical experiences. As a research group we wondered how the assessment of these mathematics processes contributes to both children's and teachers' knowledge and identity in mathematics.

Building on the Work of Grayson Wheatley

Members of our research team have been working with interviews as a way of assessing children's mathematical knowing and knowledge. Our interest was in understanding how interviews reflect children's mathematical competence and what it indicates to us as educators. This related to the ways children thought about number, their ability to partition number and combine amounts visually and mentally. During our September 2007 retreat, we had decided that our field text would include video interviews of students, our personal jot notes and personal reflections documented in our little black notebooks, Grayson Wheatley's Primary Assessment tool and audio taped conversations from our meetings.

As a committee we agreed to use Grayson Wheatley's Primary Assessment tool as the means to uncover the students' mathematical understanding and their mathematical identity. The tool assesses the student's ability to subitize, partition and conserve number and length. It also gave us insight about their mathematical reasoning abilities, their mathematical thinking strategies and their spatial reasoning abilities. The strength of the assessment did not lie in the questions alone but in the built-in ability to ask the students "why" or "how" they solved the questions. The Primary Assessment tool has the possibility of uncovering a child's mathematical thinking, capabilities, and identity. Grayson Wheatley's Primary Assessment tool used in the study was:

- An assessment tool where questions could be adapted easily.
- Six pages long with approximately 30 tasks.
- Scripted and included a variety of manipulatives.
- Able to be expanded to meet the needs of the child being assessed.
- Used as a guide to uncover the student's mathematical understanding and their mathematical identity.

Conceptualizing the Research Wonder

The Understandings That Shaped Our Work

The underlying qualitative methodology for this research was narrative inquiry. This frames our understanding of classrooms as narrative places shaped by the stories of the individuals who develop knowledge in these spaces. Individuals live storied lives on storied landscapes (Clandinin and Connelly, 2000). We understand, through our experience with diverse learners, that they all bring stories of experience to their lives in the classroom and that part of that is a story of mathematics. We realize that this occurs at all ages as we have listened to young children and pre-service teachers talk about the ways they have been shaped in relation to mathematics, some in positive ways and others negatively. Clandinin and Connelly (1995) wrote, "Understanding professional knowledge as comprising a landscape calls for a notion of professional knowledge as composed of a wide variety of components and influenced by a wide variety of people, places and things" (p. 5). We see mathematical knowledge as a component of teachers' professional knowledge. We also see the assessment of children's mathematical knowledge as a further component of professional knowledge.

This work builds upon the work of teachers as curriculum planners (Connelly & Clandinin, 1988) which begins with an understanding of curriculum as something that is co-composed between teachers and learners within relationship. This necessarily means that curriculum is something more than the guides on teachers' shelves. Connelly and Clandinin define curriculum as "a course of life" (Clandinin & Connelly, 1992, p. 393). What influence does this have on our work? It implies that we understand mathematics education as something more than just subject matter, that it has implications in the lives of children and teachers.

Schwab (1978) considered four curriculum commonplaces that needed to interact in order for curriculum to be present. He referred to these commonplaces as the teacher, learner, subject matter and milieu. These commonplaces we brought forward in our research to help us frame an understanding of mathematics assessment as a subject matter, the teacher as assessor, the child as the learner being assessed and the shaping of assessment by the child and teacher learning alongside each other.

As we viewed, reviewed and worked with the video recorded assessment moments, we considered the narrative commonplaces of temporality, place and sociality (Connelly & Clandinin, 2006). These were important as they helped us see that interview assessments were happening in the midst of the teachers and children's lives. The teacher and the child were in the midst of a year-long relationship. We were not researchers who dropped into the lives of children to perform assessments. Rather, the teacher and the child had a developed relationship that influenced the assessment moment. These assessments happened in a year-long temporal flow. The teacher and the child both brought previous mathematics and assessment experiences to the moment of the recorded assessment, a way of understanding the narrative commonplace of temporality.

Furthermore, these teachers and children were in relationship with each other. Intentionally, the teacher-researchers who recorded the assessment interviews and talked with both the teacher and the child spent time in each classroom before the assessment in order to become familiar to the child. The child-teacher relationships, as well as an understanding that the children and teachers had ideas about mathematics developed in relationship with previous individuals, highlighted the narrative commonplace of sociality. All of our work existed in relationship: relationship to each other as researchers, relationship with the children and learners, and relationship to the larger community that shaped our understandings to begin with.

The narrative commonplace of place meant understanding that these assessments were situated in the schools where these children and teachers worked and lived. The mathematics learning that shaped these assessment interviews occurred in classrooms known to the teachers and children. The interviews themselves did not happen in neutral spaces. We were aware that some of the spaces for the interviews were less than desirable, but chosen because they would allow for uninterrupted time together, or as spaces where mathematics manipulatives were accessible. It is important to note that some of the interviews happened in non-classroom settings, and we imagine this would and did impact the experience of the interview.

Being in the classrooms before the actual interviews provided the observing researchers with a way to see how mathematical processes were represented at the classroom level in the practice of the teacher and children and the ways mathematical thinking filtered the understanding of the children, teachers and teacher-researchers. Foundational to this work was the manner by which our research team negotiated and lived in ethical relationships with the children and each other through the work of this research. This was established through the relationships the teachers had with the children and, through the children, with their parents. Throughout the interview we were aware of our role as researchers alongside these children and were careful in how we both talked with them and asked them about their work. In fact, one of the teacher-researchers commented about the tensions she experienced in the interview because she could see how the child was responding based on their teacher-child relationship in the classroom. We also considered the implications for teachers and children as they work with the new mathematics curriculum and how we can mentor beginning teachers as they undertake their work with mathematics in schools.

"Grade 1, if I didn't teach this new way, I wouldn't know how smart you are." This was the closing statement of a teacher to his class who had invited the Early Numeracy Committee to observe his teaching of a mathematics lesson. It was a moment all of the committee members have held in our memories. As a group who has worked extensively with children and come to know how practice shapes our knowing, we were captivated by the mathematical thinking of the children in his classroom, the various techniques being explored by the children and teacher, and the culture of mathematics being developed in the relationship among the learners, milieu, teacher and subject matter (Schwab, 1978). Lyons (1990) wrote, "Students and teachers come together in a special relationship in learning, having a clear epistemological basis" (p. 173), and it is evident to us that assessment impacts the ways of knowing, of both children and teachers.

METHOD: WHAT WE DID

Field texts (data) were collected in a variety of ways adhering to ethical guidelines that respect children, teachers, schools, parents and researchers. Methods for collecting field texts included field notes, semi-structured interviews with children and teachers, and meeting notes from the research team, which included the teachers conducting this research in their own classrooms. We were interested in research that looked the same as teachers' daily practice; however, this work, specifically, allowed teachers the time and support to be reflective.

Three teacher-researchers used an interview as a form of assessment about mathematical concepts with two students two times over the course of a school year. The assessment was video recorded, and the teacher-researcher kept observation notes of the interview. A second researcher, known to the child, observed and documented the interview. The observing researcher then video recorded the child and the teacher-researcher watching the video of the interview. During this recording the child was invited by the teacher-researcher to describe the way(s) in which they were thinking about mathematical ideas during the interview. Following each of the two video recordings of the assessment interview with the child, the teacher-researcher and observing researcher sat down and talked with each other about the interview so that the teacher-researcher had an opportunity to reflect on the interview with the child. At another time, the teacher-researcher and the observer-researcher viewed the videotapes of the assessment interview and the follow-up conversation between the child and the teacher-researcher. During this time a commentary between the teacher-researcher and the observer-researcher regarding their understanding of the child's mathematical thinking and the thinking that happened for the teacher-researcher based upon their observations and work with the child occurred. This commentary was also recorded. All of these field texts were then analyzed by the research team, which included the teacher-researchers, observing researchers and teacher-educators. In this inquiry we referred to the teachers in relation with the students as teacher-researchers.

ETHICS: WAYS OF IMAGINING RESEARCH RELATIONSHIPS

Sustaining ethical relationships was foremost in our minds as we designed and then began to live out this narrative inquiry. All of the teacher-researchers, observer-researchers, and teacher-educators were part of the research design. In addition, this research grew out of our relationships with each other through our work in mathematics education. At the same time, it was important for us to bring what Noddings (1986) refers to as an ethic of care not only to the children with whom we would work in this inquiry, but also to our work together. Noddings, in explaining the ethic of care, stated:

> Fidelity is not seen as faithfulness to duty or principle but as a direct response to individuals with whom one is in relation. Natural caring – the sort of response made when we want to care for another – establishes the ideal for ethical caring, and ethical caring imitates this ideal in its efforts to institute, maintain, or reestablish natural caring. From this perspective fidelity may be interpreted as a precondition for subjectively satisfying relations and a continuing condition for their maintenance. (p. 497)

Therefore, to employ an ethic of care in this inquiry was to care for the participants with whom we worked. To have fidelity with them means to act in ethical ways. It implies a relational way of being: one that is a cornerstone in the work of narrative inquiry. Noddings further discussed an ethic of care in the work of research for teaching:

> … caring is a rational way of being in the world and that is neither destroyed by painful pondering on matters of pedagogy, policy, or research, nor does it eschew these. On the contrary, while an ethic of caring cannot provide specific answers to ethical or educational questions, it can provide steady, rational guidance in the form of questions to be asked and directions to be taken. (p. 506)

Because of the relational aspect of narrative inquiry, we understood that the ethical dimension of our work would require ongoing negotiation and a responsive attitude. This goes beyond the typical understanding of ethical research that is best summed up as do no harm. An ethic of care implies putting relationship first, research second.

In Barry Lopez's (1991) story, *Crow and Weasel*, Crow and Weasel have been travelling. They have met new people and have seen new landscapes. They have learned about themselves and have new insights into their relationships with each other and the people of their families and tribes. In a sense they have been researchers. Nearing the end of their journey they meet Badger and here we are privy to a conversation:

> "We are grateful for your hospitality, Badger," said Crow. "Each place we go, we learn something, and your wisdom here has helped us."
>
> "I would ask you to remember only this one thing," said Badger. "The stories people tell have a way of taking care of them. If stories come to you, care for them. And learn to give them away where they are needed. Sometimes a person needs a story more than food to stay alive. That is why we put stories in each other's memory. This is how people care for themselves. One day you will be good storytellers. Never forget these obligations." (p. 60)

These are the obligations of the researchers: to care for the stories of those with whom they work during their research. They were our obligations as we navigated the evolving relationships in this narrative inquiry.

Learning About Identity Making and Assessment Making: Conversations With Children About Their Mathematical Knowledge

Learning With Children About Assessment

Our task with this research was to administer mathematics assessments and attend to what was happening to identity: both the student's identity and our own. Through the process, we learned that human thought is not standardized. It is not quantifiable, either. Human understanding, the process of learning, is as unique as the individual. It is only in relationship with the individual that we can hope to gain insight into individual understanding. Learning is a process that supports identity making. The shifts for us in identity making that occurred over the course of this research resulted in a transformation from thinking of teaching and assessing mathematics as a step-by-step process to thinking of them as something that is organic: something that is lived together in the relationship between the teacher and the learner. It's something that we have to create a space for, not just something that we say we do. Furthermore, we can't talk about our identities as teachers or, for that matter, as learners without talking about our relational connection to students. One does not exist without the other.

As we worked through the course of this research, we grew to recognize that focusing on relationship between teacher and learner reframes the context of mathematics learning so that children can make their own sense. This is not to say that the process is owned by the teacher. A lot of the mathematical knowing comes from the students. We help build on that and help it to grow or make it accessible to the students. It's more than being student-centred: it's allowing the learning to be student-led.

> *"There are some days when the discussions are rich in all kinds of knowledge and as a teacher, I have to contain it and make sure that we value all those pieces and make sense of them together. The biggest point is in that moment when, as a teacher, I don't feel that I'm in a different spot from the students. I'm learning with them. There is no line between student and teacher as learners."*
> (Journal entry, teacher-researcher)

This is what we're talking about when we talk about shifting perspectives. It's more than looking in another direction: it's like moving to another country. You are living in a completely different culture when you focus on relationship and identity in your teaching.

Even as we approached the end of our journey together as researchers on this project, we found ourselves faced with more questions than answers about the relationship between identity and mathematics assessment. We kept trying to conclude with a definitive answer but the point is, there is no end to this journey: we have to keep asking those questions, and other questions, questions we don't even know about yet. It makes us uncomfortable because we want things neatly packaged and easily categorized. We are, after all, products of this education system. We have learned very well how the system values the concrete, the measurable and the obvious. Nothing we have done here has been concrete or obvious, though we have qualitatively measured the essence of relationship

between learner and teacher. In the end, for us, it always came back to the children. We were fascinated by what they were teaching us about whom they were, what they thought and even about whom we were ourselves.

- Our work with the clinical math interview and identity has opened up the assessment door even wider to include assessment ***as*** learning.
- We have to stop trying to separate assessment and learning. Assessment doesn't happen in a space void of learning. Humans are wired to learn, at all moments, in all contexts, no matter whether they are doing a mad minute or not. We might just not realize or even like what they are learning.
- The day-to-day relationship of being a learner/teacher has assessment embedded in it.
- Consider how the assessment moment changes when you pay attention to the questions you are asking, the directions you are steering the tasks towards, the subtle validation (or lack of validation) that you are giving in response to a child's answers. Considering your own identity opens up a space for deeper learning to occur.
- Relationship, identity, connection and context are things that ***drive*** understanding.
- Because we're engaging in assessment at a deeper level, assessment is automatically more authentic.
- Changing how we assess requires concomitant changes in how we teach and in what we expect to grow out of the learning moment. It also requires a change in how we view ourselves, both as learners and as teachers.

> *"As a teacher, even though I value the constructivist nature of how I like to experience and teach math with my students, I still continuously catch myself saying and doing things that are prescriptive – this is how you do it. You constantly are reminded that your identity has formed in a quantitative world. Because I do value the more authentic learning space based on relationship, I catch myself in those moments and I reshape my own identity to bring myself back to the processes I know and believe are more valuable for students in terms of learning."* (Journal entry, teacher-researcher)

Thinking About Doing the Work With Children

A Teacher-Researcher Narrative

Being the researcher and not in my typical role as classroom teacher during these assessments was difficult for me. Watching the child from my classroom, Michael, struggle and knowing I had to let him fight through the problems was tough. During the assessment many teachable moments occurred; however, as the assessor all I could do was watch Michael push through. Observing his struggles had me question my ability as a classroom teacher. I wondered if I was teaching my students all the mathematical tools required to build a strong foundation.

As a classroom teacher my assessment always seems to be happening on the fly. The traditional pencil and paper tests do not exist in my classroom. I assess using one-on-one interviews or making anecdotal notes when students are

sharing their work with peers. Unfortunately, the students' understanding of mathematical concepts does not always happen with my record book in hand. I find my students regularly display their understanding of a concept when I am not expecting it to happen. Much of my mathematical assessment takes place outside of math class. For example, a boy getting ready for recess became upset when he realized he forgot his snack. His friend quickly came to his side and said, "That's okay. I have four cookies so you can have two because two and two is four and that means we each get two." As I was darting out the door for recess supervision, I quickly grabbed a pen and wrote on my wrist his understanding of doubles and equality. During an assembly one of my students blurted out, "That man talking has a math shirt on – see: ABABAB." Again, I jotted down on my wrist - able to identify patterns in the environment.

This assessment interview allowed me to focus on understanding how my students think about mathematical problem solving. It was a wonderful experience for me if I exclude the struggle to keep quiet during the teachable moments that arose. I continually reminded myself by saying, "Rachel, just say okay or thanks," as the students talked through their solutions.

Throughout the assessment I could not successfully identify myself as the assessor; instead, I viewed myself as a classroom teacher who could not teach for that block of time. When I truly listened to Michael it gave me a better understanding of his thinking. Watching the assessment with the student, and then again with the other researcher, allowed me to reflect about which tools the student feels most comfortable using. Now, after student assessment, I ask myself the following questions: What does the student understand and where does the understanding take my instruction?

During the question about conservation of length, Michael was shown two rows of six rods laid end to end in a straight line. Michael was told a bunny rabbit was hopping along each row, and then he was asked if each rabbit had the same distance to go; Michael responded, "Yes." For the next question I was to alter one road by changing its path from straight to a zigzag pattern using the same six rods (see Figure 1). Michael was again asked if the rabbits had the same distance to go; Michael responded, "No."

FIGURE 1

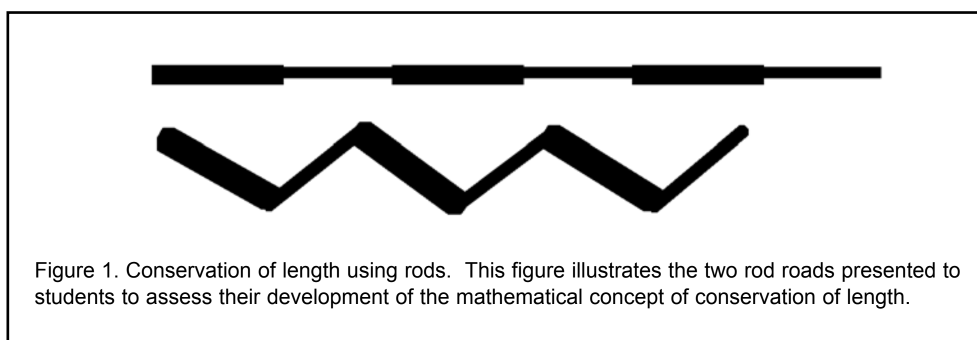

Figure 1. Conservation of length using rods. This figure illustrates the two rod roads presented to students to assess their development of the mathematical concept of conservation of length.

I think Michael saw the two roads as a race and stated his concern that the slight break between rods in the zigzag road might cause the rabbit to fall off the road, thus making the rabbit slower. He could not understand what same length means. Length and equality were concepts I thought he understood from his work with length and distance months earlier in the classroom. He continually looked to me for some type of cue to help him understand what I was looking for in this question. I found it hard to explain what the question was asking without prompting him. I believe Michael thought I was trying to trick him. Often in my classroom I ask students how many ones are in the ones' house when there is

zero or how many nickels are in a piggy bank which only has quarters and dimes. Because of this classroom trickery, I feel Michael was looking for much more than the question asked.

Michael found the tangram section of the assessment most frustrating. I had never used tangrams before so this was new to Michael and me. Prior to the assessment I viewed Michael as a student who could confidently solve any problem given to him. Thus, I was very surprised to see him struggle with the tangrams. After a couple of minutes had passed and Michael's frustration grew, I decided the reason he was struggling was because I had given him an incomplete set of tangrams. The idea that Michael's spatial ability was not as strong as his numeracy had never occurred to me. As his frustration continued, I blamed my instruction for his struggles. Because of this experience, I introduced tangrams to the class the following week. Michael was quite excited knowing he had worked with something the rest of the class had not. He loved being the expert that day even if many of the students were having more success creating the rectangle and square than he did his first time.

During the second assessment in May, Michael's experience with the tangrams was different. Instead of being frustrated, he showed confidence and expressed that he found tangrams easy now because he had worked with them before.

Reflecting on the assessments, I thought about my teaching practice and my work with students developing their math strategies. One reflection I had was about the amount of trickery I use during math lessons. Perhaps this is not what my students need to develop confidence. Perhaps just listening to their explanations and continuing to challenge them further is a better approach.

Interlude 1: Notes From the Retreat

> *September has always felt like the turning of a new year for me. Autumn colours and cool winds always evoke for me the scent of freshly sharpened pencils and new erasers, and the feeling of a blank notebook opened before me. It seems very appropriate to smell the autumn air and feel the fall sunshine as we negotiate the beginning of our research together.*
>
> *A cedar-lined room, four long tables pushed together to form a meeting place. Nine educators, diverse experiences and many stories to share as we collectively describe the journey we have made to come to this place. We are classroom teachers, resource room teachers, teacher-educators and school division support personnel. We are parents, children, mathematicians, athletes, musicians and poets. We have come because we feel passionately about children and about mathematics education and because we believe that, by building a community of learners together, we may help to enhance the teaching of mathematics in schools. We negotiate the norms of this community focusing on the support and encouragement we will all need to be able to make this journey. We want to feel safe in wondering and vulnerable in questioning. We will constantly need to collaboratively renegotiate this research relationship to ensure that all voices can be heard.*
>
> *This is a group that can be described more by its openness than by its boundaries. There is an atmosphere of earnestness as we share our stories, a willingness to attend and a desire to listen deeply to all voices. I feel respected and valued here, and I feel myself wanting to build connections with all of the individuals around the table. There is so much to learn from this rich variety of experience*. (Field note, research retreat, September 2007)

I feel honoured to be a part of this group, and I also feel a bit out of place. The research work of this group has its roots in another group of people: one my mother was a part of. Recently retired, my mother is a popular and well-loved kindergarten teacher. She has presented her work and ideas at many conferences and in many classes and was a founding member of the Learning Disabilities Working Committee, the group that spawned the creation of the Early Numeracy Committee and then this research project. In some ways I feel as though I am helping to continue what she began, and in other ways I am all too aware of the big shoes I feel I should fill. This research project involves student and teacher identity in mathematics and is focused on Grade 1 classrooms. When first asked to work with this group, I was surprised: my experience has been primarily with middle years children, and I wasn't sure I would be able to contribute anything of value to the conversation. I felt reluctant and yet I was eager to participate in the project and excited to work with such a wonderful group of people. I accepted the invitation and I am proud of what we have accomplished this far. (Field note, research retreat, September 2007)

Forming a Research Team: Cory and Kristi

Our discussion continues and partnerships are formed: one observer-researcher with each classroom teacher (a teacher-researcher). I am partnered with Cory, a Grade 1 teacher. Cory and I attended the same high school and I am instantly comfortable with our working together. We discuss what the research might look like for us, and begin to schedule times for me to come and begin to get to know his classroom and students.

The students' desks are arranged in groups. There is a long rectangle of 10 desks facing each other and three lines of four desks each. There is a round table with chairs at the back of the room, a little away from the clumps of desks. On the floor at the front of the room, there are soft foamy mats in the shape of puzzle pieces and a multicoloured mosaic that creates small working and talking spaces. One of these pieces is Cory's "green square," a special place he stands when addressing the class. It is a non-verbal signal that he has important news or instructions to share.

This classroom is filled with colour and life. Assorted bins and cubbies are filled with books, manipulatives and activities. This classroom invites creativity and exploration and provides support for the children to do both.

As Cory works with his students, I listen to the ideas and thoughts being shared. In response to Cory's repeated instructions for an activity, a student remarks, "You shouldn't have told him. I wanted it to be a challenge." Another student arrives late, coming in just after the morning recess. The class is jubilant, following Cory's lead as he says, "Alli's here! She was ill this morning and now she's here!" Alli walks to her desk beaming, her face still showing the effects of her cold. After speaking to a child about an activity paper and suggesting revisions, Cory says, "There's always another chance." "There's always another chance" seems to encapsulate for me the atmosphere in Cory's classroom. Mistakes can be corrected and learned from, apologies are given and received, and life moves forward. Cory's warmth and obvious care for his students seems to help them to feel that they are safe to try and try again if need be. (Field note, first visit to Cory's classroom)

As I review what I wrote about my first experience in Cory's class, I notice how much of my own teaching experience comes out in my words describing Cory. As a classroom teacher the construction of a safe learning community was always

my first priority. I hoped my students would feel safe in our classroom, willing to take chances and grow as learners. I felt kinship while watching Cory; I felt like I was watching myself.

Interlude 2: Brother Kites

The excitement in the room is palpable as Cory announces Quick Draw (Wheatley, 1996) as the next math activity. The students immediately locate pencils and paper in their desks as Cory reviews the procedure.

"Turn on your visualizers!" he says. "And what do you need to remember while we're doing this?" he asks, raising his eyebrows.

Automatically Allan replies, "Don't draw until you turn off the overhead."

As Cory flashed the Quick Draw image the first time, Allan cried out, "We already did this one!"

"I don't think we have." said Cory.

"Yes, we did," Allan insisted, "but the line was further that way." He points on the overhead projector to demonstrate what he means. Cory hunts through the file of Quick Draws, searching for one that looks similar to today's figure. He finds a Quick Draw the class discussed much earlier in the year and lays it alongside today's figure (see Figure 2).

"Yes," says Allan. "These two are the same, but this one is bigger and this one is smaller."

"It's a Y," says a boy. "A Y with really long arms," he says, nodding sagely.

"An upside down Y," says a girl.

"It's the same and different," says another boy. "It goes up here more, and that makes it taller and bigger. It's a big Y and a small Y."

"Oh," says Ned. "If we turn them then they're brother kites." Cory stands at the overhead, his expression inviting further explanation. Ned gestures toward the images on the screen. "If we turn them, then they're like brother kites."

Figure 2

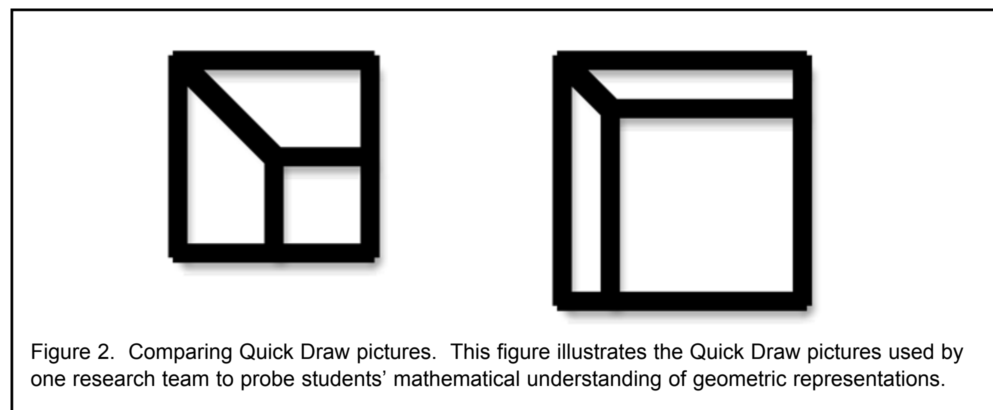

Figure 2. Comparing Quick Draw pictures. This figure illustrates the Quick Draw pictures used by one research team to probe students' mathematical understanding of geometric representations.

Frustrated, I tried to separate my teacher self from this new researcher self I was trying to find. This research is not about me; it's about Cory and his students. I felt that by failing to distance myself from the research, I tainted it with my own experience. In trying to find my voice as a researcher, I looked for an observer self: a persona who could sit in the community and somehow record objectively the interactions witnessed. Try as I might, I can't seem to separate Kristi the teacher from the observer self I'd like to manifest. The longer I took part in this research, the more I came to realize this was not necessary or desired. I came to understand that narrative inquiry expects us to be part of the research, to have biases, but to confront them, to be present in the research moments.

I mentioned this to Cory, and his response was unexpected. Of course I'm unable to separate myself from my observations, of course my experiences and my knowing influence the things I notice and record. This is something to embrace, not distance from myself. I am Kristi: woman, teacher, student and researcher. In validating this identity, in heeding these voices, I enrich the work we constructed together.

Interlude 3: Ned in the Classroom

> *During story sharing, Cory asked the class to think about why one of the characters was responding in a particular way to the events of the story. Several students shared explanations as Ned watched and listened. After three students shared their ideas, Ned smiled. "It's like a story if you put it together." Cory asked Ned to explain his thinking further. "If you listen to what she said, then what he said, then what he said, it makes a story," said Ned, very pleased with his discovery.*

The interlude above introduces Ned, a student whom Cory and Kristi worked with using the assessment tool. In what follows the interview with Ned is discussed.

> *After the initial craziness of finding a quiet spot, the required manipulatives and good camera angles, we were set to begin. Cory and I were both nervous. Although we'd both looked through the assessment several times, neither of us had tried it on a real, live student before. Conscious of the research aspect of this work, we wanted to be correct; we wanted to work through the assessment as carefully and deliberately as we could. We set up the workspace, aimed the camera and Cory departed to collect our first student.*
>
> *Ned entered the room shyly, saying hello to me as he approached the small table and chairs. Cory began asking about the day so far, and assured Ned that if he felt uncomfortable at any time, the interview would end. Ned nodded, and seemed ready to begin.* (Field note, interview day)

As I reflect on that first interview, I remember the awkwardness I felt in trying to position myself within that space. I found myself attempting to construct the "observer self." Sitting across from Cory and Ned, notepaper on my lap and pencil in hand, I felt very clinical. I watched the interview progress and scribbled notes furiously, although I wasn't completely sure what I should be recording. Ned would sneak sidelong glances as I wrote, and I wondered how he perceived my role in the interview.

> *I had no idea I talked so much.*
>
> *As we reviewed the video together, I noticed that as the interview progressed*

my interjections became more frequent with constant "um hmms," laughing and side comments interspersed throughout the tasks Ned was working through.

What did these comments do to the flow of the interview? Am I trying to build community within the interview space? (Field note, video review of Ned's interview)

This idea resonated deeply with me and as I continued to review the video both with Cory and alone, I began to watch for the dynamic and flow among Cory, Ned, and me throughout the interview. I noticed that Cory would ask Ned a question, Ned would direct his answer to Cory, and then Cory would look toward me. In the beginning of the interview I would remain silent, and Ned would turn to look at me and then back at Cory.

The conversation seemed fractured to me. I felt like a dead end. Cory would include me in the interview but in trying to maintain a detached observer persona, I disrupted what might be the natural flow of conversation among three people. I wonder if I attempted to bridge these gaps by increasing the amount of talk I did during the interview. Perhaps I was trying to construct an assessment community within our group of three.

A Narrative of a Child: Oliver's Story

Tensions in Being a Researcher

I have to put this moment in context. I am writing at 8 p.m. after a full day of reviewing the video interviews done with Oliver. I am exhausted. Spent. And feeling both disillusioned and disheartened. This is research. I feel compelled to maintain at least a facade of objectivity to keep the research valid. But the truth is, I am far from objective. Everything that happened today in the viewing of the videos is informed by my mood, my energy levels, the conversations and incidents that have led up to this day. I cannot divorce myself from them so I will try to acknowledge them as I become aware of their influence on this work. There will be times, I'm sure, when I am blind to my own bias. I feel like I should apologize for the inevitability.

As I watched the videos today with my research partner, Trish Reeve, I found myself focussing on the student, Oliver, his comments, his moments of clarity or dissonance. The examiner in the video was a stranger to me. I didn't recognize myself in that person sitting there, conducting the interview. The voice was different from the voice I hear in my ears when I talk, and it was very different from the voice I hear in my head. Her hair was the wrong colour. She didn't look like me but she was me, and I kept peering at her out of the corner of my eyes like some witness to a terrible prank who recognizes the injustice of the moment but is too paralyzed to make it stop. It felt impossible to reflect on moments when the video me was revealing or highlighting her identity. Whoever she thought she was, she wasn't me and I could find no point of connection with her. Throughout the videos, throughout those extended moments of disbelief and disconnection, I kept returning to the same thought. It is one that has haunted me lately as I contemplate the meaning of my job and its purpose. I thought about what we're doing and what we're supposed to be doing. I kept thinking that we are somehow getting it all wrong. Not the interview or the research. Not even our limited interpretations or understanding of the research. It's much bigger than that. It's education in general that we're getting wrong. Somehow, we seem to be missing the point. But what that point is I can't tell you. That requires a deeper degree of

self-awareness than I presently have. I sense that we're missing the mark, but I don't know how to bring it back on track.

So we stumble on, as we always do. Today was no different. We stumbled on through the videos today asking each other questions and pausing to reflect. Trish taped our conversations, hoping to capture in our conversations what we couldn't reproduce in written words later. We learned some things through this process, I think, about Oliver and his mathematical thinking that we didn't know before. We were both struck by how confident Oliver seemed. He said right away that he loved math. He said he was the best at math in his class. He wasn't shy or self-effacing. He stated it as a fact with assertiveness and conviction. Where did that confidence come from? Was it from experiencing enough success to convince him of his own abilities? Or, did it start before that? It certainly seemed to be a well-established and unfaltering character trait.

Working With Oliver

"I'm good at math!" That's the story Oliver tells himself. Whether it is grounded in reality or not, it is his own perception of himself. As far as Oliver is concerned, he is a competent mathematician. In this case perception really is reality. Oliver's perception of himself as a strong mathematician creates resilience and persistence that in and of itself foreshadows success in mathematics. He believes he can figure out the math and arrive at an answer that makes sense so he persists until he does. In some ways with Oliver it is almost as though the teacher doesn't even need to be there. He's living his personal story of being good at math already without reliance on the teacher to confirm or deny its validity.

At the same time, Oliver presented as highly motivated to please. He watched me closely for cues to his accuracy and adjusted both his answers and his strategies when he thought he saw signs that I wanted something different from what he was giving. How do we reconcile this with his seemingly high levels of confidence and independence? I think that confidence is one thing and a desire to please is another. They both exist in Oliver and so they are, at least for him, somehow connected but they are also separate actions or motivators, in some ways disparate from each other. As I write this, I recognize the same dichotomy existing in me: confidence coupled with a desire to please. Now I wonder how much of what I saw in Oliver is really just the things I see in myself? Is there any way, really, to unpack that or does it remain always an unanswered question? Can I ever peel away my own influence and voice from the observations *I* have made? I have made them. *Me*. They are forever coloured by my perceptions of the world.

Early in the first video, Oliver identified himself as having been self-taught mathematics. To Oliver, his knowing, his understanding originates from within. Is this the root of his confidence or is it a by-product? Does it make a difference? Something in me says that it does make a difference. It's a chicken-and-egg inquiry that has two lives: one that goes around and around in circles; the other that reaches way back into origins, the origin of Oliver's sense of himself, a sense that includes already in Grade 1, a narrative of success.

Concluding Thoughts

What We Found Out: Learning to Live Alongside Each Other as Researchers

Our research group came together out of another project related to mathematics: the Coming to Know Summer Institute. Each of us either attended or helped to organize the institute, and we came together as a committee that originally wondered about whether or not it was possible to identify students at risk for experiencing difficulty with mathematics. Those initial questions about mathematics and assessment led to further questions about the connection between identity and assessment for both the teacher who administers the assessment and the student who experiences the assessment. How do our identities impact on our performance? How does our performance or the performance of our students impact on our identities? Sometimes the questions close in on themselves like a snake eating its own tail. It can be difficult to decipher where one question ends and another begins.

Our relationship as researchers was often like the questions that we wondered about: circuitous, innocuous, at times ambiguous but always inexplicably important. We knew our work was touching on areas that were unique and relatively unexplored, especially with respect to assessment and mathematics. We wanted the work we did to make a difference both philosophically and practically. And we were not always sure precisely what we were doing.

Working together as researchers over an extended period both supported our assumptions and challenged them. In a way, the project simulated the systemic difficulty of working collaboratively with colleagues. Our individual schedules created challenges to finding days that we could coordinate in order to work together. When we did find those days, there was the constant pressure of time passing too quickly, coupled with the ever-imminent threat of interruption because we were conducting our research in my home school. Despite bringing in substitutes and posting signs requesting no interruptions, school colleagues were constantly sticking their heads through the door or finding us in the hallway for "one quick question" that lasted 10 minutes or more. In the end, when we began to review the videos of our work, we met in our own homes to ensure that we weren't interrupted. Even though it felt odd to take a day away from school to work from home, we honoured the time we needed by creating spaces to work where we would not be interrupted.

As frustrating as this might seem, it is the ironic reality of most teachers that while we work primarily in isolation, our time is never quite our own. We are not free to take as long as we need in order to teach a concept well or to ensure that the assessments we administer are as close to authentic as we can make them. Time pushes on through the days of the school year more quickly than we can imagine and soon it is time for the second round of videos, assessments, reviewing and reflecting even though it seems like only a short time since we first met around a big table at Wanuskewin imagining how we might work together to look more deeply into the questions that we had about mathematics, assessment and identity.

Our work together as researchers has mirrored the strains and pressures of classroom teachers. It has also reflected the incredible opportunity to foster a sense of purposefulness in our daily efforts. I found we needed to consciously focus on the sense of purpose in order to overcome the ongoing frustration of scheduling and interruptions. In the end it always came back to the children. We were fascinated by what they were teaching us about whom they were, what they thought and even about who we were ourselves.

Situating Assessment Within the Context of a Mathematical Community

In a classroom focused around meaning-making and conversation, mathematical knowing is negotiated through the sharing of ideas and understandings. Each individual contributes his or her knowing to the shared learnings of the mathematical community, enriching the understanding of all members. This community is built upon a shared foundation of respect and a willingness to listen to each other. Assessment conversations situated within this community happen in the context of relationships between teachers and students. Lynn Gordon-Calvert (2001) wrote, "The purpose in conversation is not to impose our views on the other or to find the "correct" answer, but to open ourselves to the possibilities of new understanding for the experiences we share" (p. 41-42). Carrying this idea into assessment, the purpose of the conversation becomes the desire to hear how mathematical knowing is constructed and how concepts are connected. Keeping ourselves open to the possibilities allows us to hear more than what we may be looking for, providing the opportunity for greater shared understanding.

During our research, the following points occurred to us:

- Building a caring community within a classroom requires attention and a great deal of commitment. Respectful attitudes must come through in every interaction within the classroom.
- Allowing space for the unexpected provides teachers with opportunities to learn much more about the way students think about mathematics.
- Even though the same assessment tool is used with a group of students, each assessment conversation is unique and individual, reflecting the personalities involved and their relationships.
- As teachers, we cannot separate ourselves from assessments any more than we can separate ourselves from our relationship with our students. Assessments happen in the context of our relationship just as they happen in the context of life in the classroom.

How This Research Has Led Us to Think Differently About Curriculum

Using the interview as an assessment tool, even without the accompanying questions related to identity, causes us immediately to think differently not only about how we teach mathematics, but also about what we teach. Conventional norm-referenced, standardized assessments that measure mathematics performance focus primarily on product rather than process. That is to say, the perspective of these assessments is to determine whether or not the student can produce a correct answer. There is no scope for determining how a student has arrived at that answer or the thought processes that under-pinned the answer.

How can there be? Human thought is not standardized. It is not quantifiable either. Human understanding, the process of learning, is as unique as the individual. It is only in relationship with the individual that we can hope to gain insight into individual understanding.

But this begs the question, why do we want to assess individual understanding anyway? The answer lies, we believe, in assessment's connection to curriculum. Understanding is linked to curriculum or, at least, it ought to be. Current perspectives on assessment contend that assessment of learning is not as valuable as assessment *for* learning. The catch phrase "assessment for learning" has become so popular that it now has its own abbreviation: AFL. AFL contends that assessment must drive teaching. It is only through assessment that teachers learn where to focus their energies and provide targeted teaching in areas of critical concern as determined by assessment.

Our work with the math interview and identity has opened up the assessment door even wider to include assessment *as* learning. When the teacher focuses on the relationship between herself/himself and the child, both in the moment of assessment and in the surrounding moments (before, after), the assessment moment itself becomes an opportunity for learning, or a "curriculum space"(Schwab, 1978). The teacher learns about the student in terms of what he/she understands and in terms of who that student is as a person and as a learner. The teacher also learns about herself/himself by looking at the questions she asks or doesn't ask, the directions she steers the task towards, the subtle validation (or lack of validation) she gives in response to the child's answers. Even further, the teacher learns to understand the context of the child's learning and how his/her life informs the learning process. She/he learns how they (the teacher and the child) might help each other to expand their own understanding of what is important to learn.

Children are not learning consistently. They are not exiting school as strong, diverse and independent thinkers. They are spending years struggling when they are in school to learn things that are essentially irrelevant to them because they have not found a way to connect them to the contexts of their lives. Learning becomes understanding when it makes sense contextually for a child. We've been teaching and assessing as if we existed in a relational vacuum. Norm-referenced, standardized tests pretend that it is possible to construct that vacuum and that somehow the data collected from inside this artificial vacuum is more valuable that the data collected in conversation and in relationship with a child. If assessment for learning demands that we assess for the purposes of altering our teaching, why aren't we talking to children? Why aren't we trying to find out what they think, how they think, why they think?

When a researcher or a teacher pauses to get to know a child she/he is working with, she/he is building connections with that child, building a context for learning to occur. Is it as important for students to learn rote recitation or even sight recognition of math facts as it is for them to realize the value of mathematics in their own lives? Relationship, identity, connection, and context are what ***drives*** understanding. A shift in perspective to emphasize relationship, identity, connection and context requires a rethinking both of curriculum and what or even how we assess. Does it make sense to teach an emphasis on thought and constructing meaning only to turn around and hand the child a timed test on math facts? Changing how we assess requires concomitant changes in how we teach and in what we teach.

Creating Relational Assessment Practices

We would like to conclude with suggestions for assessment with children that we have come to consider in our work alongside the children in this research.

- Assessment drives curriculum and curriculum drives assessment; what we are teaching is what we assess. Assessment comes out of the curriculum making process alongside children, not for children.
- Assessment making influences children and teachers' identity making around mathematics knowing.
- It's a blend of the oral and the manipulative and the paper and pencil.
- We need to establish a relationship with the students before we assess. The assessment happens in a teacher/child relationship that allows the student to feel comfortable and take risks.
- Part of that relationship allows children to believe that they have mathematics knowing; this frees them to take risks during the assessment moment.
- Assessment practices shouldn't be an interruption in the teacher-learner relationship; when learning opportunities happen during assessment, teachers should take advantage of them.
- The full assessment cycle is not complete until student reflection with the teacher has occurred; therefore, there's a place for conversation in assessment practices.
- The one-on-one interview provides teachers with an opportunity to understand their students as mathematical knowers in a different way that provides a stronger ability to respond to student needs.
- Assessment making alongside children scaffolds teachers' ability to make curriculum responsive to the needs of the learner.
- One-on-one interviews allow children to show their learning and knowing in different ways.
- We got better at assessing and being present during the assessment the more times that we did it. The first few times you do it, the process can feel scripted but as you continue and gain more experience with the process, it becomes more natural and responsive.
- The assessment interview gave the children an opportunity to demonstrate their reasoning rather than their final answer.
- The interview assessment doesn't pretend to be standardized. Its strength is that it is not standardized. It's a common assessment that we could un-standardize to respond to the individual student's needs.

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Appendix

PRIMARY MATHEMATICS ASSESSMENT

This assessment is to be conducted with students individually. Sessions are to be recorded for later analysis. Video recording is best but an audio recording will suffice.

1. Say number names.
   Ask the child to say the number names as far as they can go. Stop at 31. Little is to be gained by continuing beyond 31.

2. Say the number names backwards.
   Ask child to say the number names backwards from 10. If the child can do this easily, ask her to count back from 20.

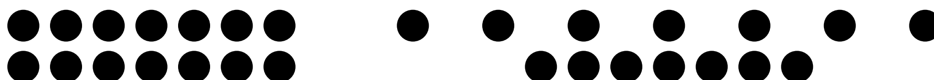
3. What number comes after 8? Before 7?

4. Counting
   Place a set of chips in front pf the child and ask them, “How many are there here?” Begin with five objects and increase the number (not necessarily in order).
   Do they establish a one-to-one correspondence between the objects and number names?
   WHAT are they counting (actual objects, motor actions, words, abstract units)?

5. Thinking in collections. (See attached cards)
   Materials: Dot pattern cards
   Show each card for one or two seconds and ask, “How many dots did you see?” Show cards a second time if necessary.

   Ask, “How did you know?” Then ask “How did you see the dots?” Do students try to count the dots? Can they respond immediately? Do they break a collection into subgroups (evidence of advance thinking) For example, the student might say I saw three and three and knew that three and three was six.

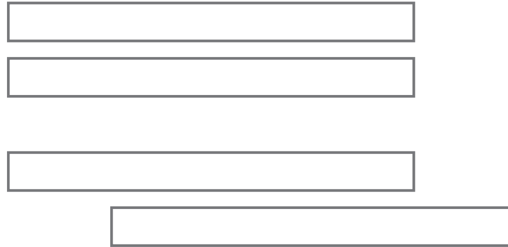
6. Conservation of number



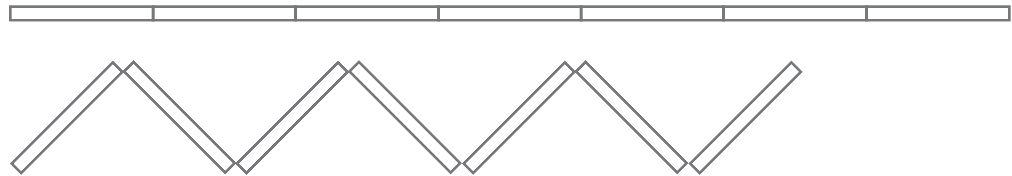
   Lay out two rows of seven chips lined up directly under each other. Ask, Are there the same number of chips in each row? If the student answers yes, spread out the chips in the top row so the chips are equally spaced and the row is about one and one-half times as long, Ask, “Are there the same number in each row now or does one row have more?”

7. Conservation of length

a. In front of the child, display two sticks, The orange Cuisenaire rods or base ten longs work well, Ask, "Are these two sticks the same length or is one longer than the other?" Then move the bottom rod forward so that about one-third of it is to the right of the top rod. Repeat the question.



b. Using the light green Cuisenaire Rods, make two rows of six rods lined up under each other. The rods in each row should be touching, A bunny rabbit is hopping along the rows, Do both rabbits have the same distance to go? If the student answers yes, move the rods in the second row as shown in the diagram below, Ask, "How about now? Do both rabbits have the same distance to go now?"



8. Screened task
   Materials: Thick cloth, and small, flat objects such as plastic chips

Method:

a. Lay out 4 chips. Say, "How many are here? I have put 3 chips under the cloth, how many are there all together?" Follow up with a different number of chips until you are clear on how the child is reasoning.

9. Mathematical reasoning

   a. If I have six pennies and two more pennies, how many would that be altogether? If correct, increase the size of the numbers.

   b. What do I have to put with 3 to make 7? Increase the numbers.

   c. How many do I have left if I have eight and give away 5?

   d. What is 11 take away 9? (reversibility, relate addition and subtraction)

10. Thinking strategies.

   a. Ask, "What is 7+5?" "How did you know?" "What is 19 - 11? What is 21+19?" Look for the use of thinking strategies sech as using doubles, making ten ("7 and 5 is 12 because I put 3 from the 5 with 7 to make 10 and 10 plus 2 is 12), and compensation (I moved one from the seven to the 5 and knew that 6 and 6 is 12).

11. Spatial Visualization:

    a. Quick Draw (see attached figures)

       Show a figure for two seconds and have student draw what they saw. Give a second look. Then ask the student to descibe what they saw.

    b. Tangram task (See attached sheets)

       Materials: Set of Tangrams, three arrangement cards and three corresoponding outline cards.

       Methods: Student has outline of a shape in front of them and you briefly present a card that shows how the Tangram pieces fit in.

       1. Show each card for about three seconds. If needed, show the card a second time.

       2. If a stkudent cannot make the shape after three showings, lay the card in front of her.

       3. Finally, you may need to have him/her put the pieces on the form.

You may want to practice holding cards beforehand, so they will be shown at an appropriate distance from the student.

Discussion

Knowing number names versus counting. There is a difference between being able to say the number names and being able to count Saying the number names is a memorization task while counting is a complex cognitive activity. Students can learn to say one, two, three, ... twenty-three, twenty-four ... similar to memorizing spelling words. Saying the number names is important, but not to be confused with counting objects.

Conservation. Previous studies indicate that only about 30% of entering first graders can conserve number and 10%-15% can conserve length. Consider the implications of thes for use of potential number and measurement activities.

Quick Draw and Tangrams. These tasks give us an indication of studentsd use of mental imagery, an important component of mathematical reasoning. With Tangrams, some students can take one glance at the card and immediately put all the pieces in. At the other end of the spectrum, students give no meaning of the arrangements of pieces shown and have no image at all of what they saw. Some will have difficulty even putting the pieces in place when the picture is placed in front of them, Finally, others will need to have the pattern in front of them to put the pieces in place on the arrangement. Students who cannot form such mentas images and use their images to guide their actions, that is, work from a mental image, will have difficulty giving meaning to an array of dots or geometric shapes. All meaningful mathematics is image-based. These tasks also show whether a student can transform geometric shapes, e. g., rotate an image.

COUNTING IS A COMPLEX ACT

1. Counters of perceptual unit items

   Needs to have physical objects in view to count, usually by touching or pointing to the items one at a time.

2. Counters of Motor Unit Items

   Motor acts substitute for physical objects. Counts their motor acts (finger movements).

3. Counters of Verbal Unit Items

   Saying a word (vocal or sub-vcal) substitutes for motor acts or the physical objects.

4. Counters of Abstract Units Items

   Counting is not dependent on sensory-motor material

   The utterance of the word "eight" can, by itself, be taken to imply the number word sequence, "one, two, three, ... eight" as well a collection of discrete objects. Eight signifies a collection as well as a set of countable items.

   Test: Show 5, hide 4 and say there are 9 altogether. How many are under here?

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