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Elinor J. Albin
The Advent School

Gretchen Vice
The Advent School

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Cover Page Footnote

Acknowledgements We would like to acknowledge the children in the ECC Brimmer classroom as well as co-teacher, Karen First, for their essential contributions to this investigation of mathematics and social emotional learning.

Power to Change: Math as a Social-Emotional Language in a Classroom of Four- and Five-Year-Olds

Elinor J. Albin and Gretchen Vice

"Can I help you? I see you're not feeling that powerful." A five-year-old girl quietly approaches a peer who has just moved a picture of herself down a number line from a 10 to a 1. The number lines are part of an interactive documentation wall on the side of the classroom nearest to the block area. The child, who was approached by her peer, looks up from her work at a round table nearby and makes eye contact with the other child. The two girls sit next to each other at the table, occasionally looking up and smiling at one another as they work.

The connection between numeracy and social-emotional learning may not be obvious when discussing the ins and outs of school for four and five year olds. Social-emotional learning—teaching children how to manage their emotions—is a foundation of any early childhood classroom (Tominey, O'Bryon, Rivers, & Shapses, 2017). Building emotional intelligence happens during every interaction, not to mention through dramatic play, storytelling, and reading books.

Mathematics is ever present within the early childhood classroom as well. Children construct with blocks, sort and categorize at the sensory table, and develop numeracy skills through morning meeting routines, such as finding patterns on the calendar or counting how many people are at school each day (Fosnot & Dolk, 2001). Mathematical thinking is intrinsically part of every young child's day.

In this paper, we—Elinor Albin, a classroom teacher in the pre-kindergarten classroom at an independent elementary school in Boston, Massachusetts, and Gretchen Vice, the school's dean of faculty—review our work in the early childhood classroom there. In the fall of 2014, we, along with Elinor's co-teacher, Karen First, joined together to explore the many ways we could incorporate numeracy, measurement, algebra, and logical thinking into our daily schedule in relation to the growth of children's social-emotional skills. While the development of both mathematical and social-emotional skills is immersed within our school's early childhood classrooms, we seldom use numeracy as a tool for building emotional intelligence. Through our work with students around the question, *What does it mean to be powerful?*, we found a way to blend social-emotional learning and developmentally appropriate number concepts in a meaningful way for our students.

As we will describe in what follows, over the course of the investigation we developed several theories about why bringing mathematical thinking to social-emotional intelligence seemed to have a strong impact on the students. We noticed that children's understanding of their emotions was clearer when we attached the feelings they had to concrete ideas—in this case, to a number from one (least powerful) to 10 (most powerful). Second, because of this clarity, the scale or weight of the emotion became easier to define and consequently change. For example, accepting a friend's apology did not mean that a child necessarily changed from feeling frustrated to feeling happy right away; instead, the impact of the

apology could be more gradual, so that a child's feeling changed from a one to maybe a three or four. Finally, as the class began to play with how their individual numbers could be combined, the students saw the impact of how one child's feelings affected the greater group, allowing the class to explore more complex understandings around empathy and the strength of being and learning together.

Social-Emotional Learning Within the Early Childhood Classroom

Early childhood teachers are tasked with educating young children not only in the development of their academic skills, but also in learning how to navigate their social-emotional world. Fostering social-emotional learning involves teaching children how to label and deal with their feelings, make friends, enter into play, and face hardships, among other things. This kind of learning prepares children to work collaboratively, persist through challenges, and advocate for their own needs and for the needs of others. Tominey et al. (2017) explain that "Developing emotional intelligence enables us to manage emotions effectively and avoid being derailed" (p. 1).

At the beginning of the year, teachers in early childhood classrooms often focus on building a community of friends and learners. The children may create their first classroom agreements, participate in classroom jobs, and think deeply about themselves and who they are as individuals (Denton & Kriete, 2000). Students often begin to communicate their thoughts and observations through drawing self-portraits and pictures of the world around them.

Early in the year as they observe trends in how children enter into play with each other and with materials, teachers discuss their observations, reflect, and construct new opportunities for exploration based on what they notice. In our early childhood classrooms, long-term investigations emerge in which, through teacher facilitation, children explore a topic together over the course of many weeks. These long-term investigations often center on the big questions that continue to surface, such as *How do you measure love? Is a bad guy always a bad guy? What does the best possible community look like?*

In the fall of 2014, after carefully observing the children's play, we had questions about the patterns of interactions that we hypothesized were related to the children's sense of efficacy or—as we ended up naming it with the class — "feeling powerful." We had noticed that the children spent a great deal of energy using physical actions, such as giving strong, tackling hugs or knocking down blocks, to say hello, ask to enter play, invite others into play, and maintain play scripts. Some of these actions were problematic because they created more conflict rather than leading to the collaborative play that the students wanted to take part in. Children entered the classroom with a wide range of strategies and different experiences with sharing and coping with their emotions. We began to wonder how we could help our students find more effective ways to communicate their feelings, needs, and desires to one another.

Through collecting observational notes as our students played, we came to hypothesize that if the children had a better understanding of personal feelings of power or powerlessness, they might be better able to think about how to effectively get their social needs met. Through this reframing, we landed upon

the question that became the guide for our long-term investigation. We wondered together, *What does it mean to be powerful?*

After we introduced that guiding question to our students, we worked with them to develop a list of supporting questions that were important to our understanding of children's learning:

- What does being powerful look like?
- Who do you know who is powerful?
- How do you get your power back?

Mathematics Within the Early Childhood Classroom

The mathematics of the early childhood classroom includes concepts of sets, number sense, counting, number operations, patterns, measurement, data analysis, spatial relationships, and shapes (Brownell et al., 2014). These concepts emerge through play and are reinforced and primarily taught through daily explorations or activities, such as building with blocks, participating in snack time, or answering the morning question. Throughout the year, these concepts emerge informally as children do mathematical things; it is the teacher's job to be aware of, name, and in some way formalize the mathematics that is occurring, connecting it to mathematical language and more explicit mathematical explorations. In this way, children can explore concepts, deepening their understandings as the year progresses.

We believe that mathematics should play a role in our long-term investigations, and we routinely delve deeper into mathematical concepts, reimagining ways they might provide various access points for exploring the topic of our investigation. Key questions we ask are:

- How does math naturally fit within this investigation?
- What concepts or ideas within this investigation are illuminated or better understood if we include mathematics concepts in the explorations?
- How could mathematics make this investigation more meaningful to our students?
- How will children be able to engage with mathematics or "mathematize" their world within this investigation?

Making connections between mathematics concepts and long-term investigations is not always easy. We found this to be the case at the beginning of the 2014–2015 school year as we asked ourselves which math concepts might naturally fall within our long-term investigation about feeling powerful. Many of the obvious links between mathematics and the guiding questions for that investigation highlighted issues within the classroom community that we were trying to avoid. The most obvious initial mathematical connections to feeling powerful involved physical strength or power: *How much weight can I lift? How far/*

fast can an object go? However, we wanted the children to move beyond the concept of physical power. Instead, we began to think about feeling powerful as an emotional state that could be envisioned as existing on a numerical scale, and we decided to explore the number line as an interactive way for the children to represent how powerful they felt.

Exploration of Number Lines Within an Early Childhood Classroom

Because we decided to connect the concept of feeling powerful to a numerical scale, we wanted to make sure that the students understood the mathematical concepts behind using a number line—numeracy concepts such as quantity, the steady pattern of growth, and even the spatial distribution of quantity—from the outset. Therefore, we set up numerous explorations for our students around number lines before connecting number lines with the social-emotional language.

One of the first investigations our students made was to look for number lines that were already present in their world, and one of the first number lines that the children found was on a ruler. Typically, we teach measurement through non-standard units, such as cubes, teddy bears, or hand lengths. However, in this investigation, we used rulers and meter sticks (using both US customary units and metric standard units) to measure items within the classroom and around the school because we felt that rulers provided a real-world example of the use of number lines.

We had the children explore using the number lines on rulers through measuring the depth of snowfall and the heights of their classmates and objects around the room. Working with small groups, we introduced the incremental pattern of growth that occurs on a number line by building number lines using blocks, gems, and other manipulatives. Children recreated these number lines as they played at the light table or with natural materials—pine cones, leaves, rocks, etc.—during morning exploration. Similarly, students investigated incremental changes in sizes and sounds in connection to music: playing xylophones and discovering how changing the quantity of water in a glass jar altered the pitch of the sound they heard when they struck the jar.

Through these experiences of seeing and touching the differences between numbers of objects in sequence, children developed an understanding of the increasing quantities of the numbers on the number line. We observed that through this repeated exposure to quantity in conjunction with a number line, students developed the ability to sequence and subitize numbers up to 10.

Number Lines and Quantifying Power

While students interacted with these number lines, we introduced math vocabulary. The concepts of *most* and *least* and of *more* and *less* provided the first connections to using number lines as a concrete representation of feeling powerful. One (1) represented feeling the least powerful, while 10 represented feeling the most powerful. The children then began to quantify feelings of "sort-of powerful" or "only a little powerful" within this range.

We supported the children in learning to quantify feeling powerful through using multiple representations of least to most to help them find social-emotional meaning within their understanding of numbers and quantities. To document our exploration, we created a wall of number lines—with one number line for each student—displayed under the question, *How powerful do you feel today?* Because children could use them to answer that question, the number lines were soon nicknamed *power-o-meters*.

On each child's power-o-meter number line, there was a picture of themselves in a powerful pose. The pictures were mounted on a piece of string, which allowed each child to slide them up and down the number line. Children were encouraged to interact with their picture however they wanted. That activity was part of the daily morning routine and also provided a touchpoint for the class at key times of the day, such as after recess or before rest. By using their number line to represent their emotions, children found a consistent way to think about and represent their feelings and to articulate them to their peers and teachers. We began to notice and talk about how a range of emotions was ever present in our classroom, and that these feelings varied throughout the day.

Taking the time to discuss abstract ideas, such as where our feelings come from, allowed us to deepen our understanding of emotions and their role within our behaviors. During a conversation around this, one child shared, "They are in your body and they pop out when you feel happy or sad." Another added, "Feelings live outside your body and they come in when somebody does something to you. They come in and tell your brain what to do." One child moved her power-o-meter to 1 ("not powerful") every morning when she came into the classroom. Throughout the day, she would change her power-o-meter to reflect how she was feeling. Sometimes she would slide her picture all the way to 10 ("very powerful") and, at other times, just halfway up her number line.

We started asking the children more questions:

- What do you do when you are sad?
- How can you make yourself feel better?
- What do you do when you don't feel powerful?

These discussions led us to work with the children to develop a set of coping strategies to use when they didn't feel powerful. Children revisited these strategies throughout the year and were able to express magnificent ideas, such as "You can learn stuff to make you feel more powerful. You could do lots of yoga poses" or "[You can] listen to [stories on] headphones."

Teachers as Researchers

We cannot provide quantitative evidence that children during the 2014–2015 school year were better at regulating their emotions than their peers in previous years had been. However, we observed such a significant amount of growth within just the first few months of school that it led us to ask what about

the investigation might have contributed to the children's social-emotional development. *Why did our students become better able to see the weight and impact of their emotions on others so clearly?* As teacher researchers, we hypothesized and drew conclusions based on the changes we had made to that year's long-term investigation. We considered the different aspects of the investigation: the materials used, big concepts explored, questions asked. We discovered that the one underlying element that influenced each of these was the inclusion of using numbers as a language for how students felt.

Mathematics as a Language for Expression

"The 100 Languages" is a poem written by Loris Malaguzzi, founder of the Reggio Emilia approach to education. The poem illustrates a key principle of the approach, which is that there are many "languages" that children use to express their ideas, (mis)conceptions, and emotions (Edwards, Gandini, & Forman, 2012). It also depicts the idea that children have an unlimited amount of potential and are capable citizens within our communities. At our school, we are profoundly inspired by this way of thinking about children. The poem represents how we, as teacher researchers, see mathematics as a language that children can tap into to express their emotions.

We found that children's understanding of their feelings and of others' can be deepened by connecting emotions to concrete mathematical concepts. By making feelings visible for children through associating feelings with number quantities, we as teachers were able to build a more sophisticated understanding of our students' emotional journeys throughout the day. Each child expresses feelings differently and with different intensities. For example, when a child quietly enters the classroom, a teacher might interpret their silence as contentedness and readiness for the next task at hand. However, if the child then moves their picture on their power-o-meter to 1, they are indicating the feeling of powerlessness reflected in their quiet demeanor. The visible representation of children's emotions, created through using mathematics, can thus allow teachers to better understand their students' feelings and to support their students in attending to their own needs.

We saw a group of children who were challenged in expressing themselves make tremendous strides in their abilities to connect with peers and advocate for themselves. Further, we knew the children were transferring this knowledge to their home lives as well. More than one family shared that their child was talking about power and lack of power at home. One child even went so far as to create a power-o-meter for herself at her home. By thinking of it as a language of expression, we discovered that mathematics was an incredibly powerful tool that children can use to describe and talk about their emotions.

Defining the Space Between Emotions

We know that for young children, emotions can feel all consuming. Through our investigation, children were taught that they could think about and find satisfactory ways to respond to emotional states. Many of the children came to realize that what they were feeling at a given moment would not last forever and, that after a while, they might feel better. They started thinking about what they could do when peers

were not feeling powerful. We asked, "What could you do to help your friend move up the number line?" Children answered with a multitude of ideas: "By doing something that makes them powerfuller" and "Snuggle with another kid!"

The power-o-meter also gave children a way to discuss less extreme emotions because it allowed children to see that not everything is a 1 or a 10. Instead, there are many numbers and emotions that fall on a continuum. This understanding of the in-between areas gave children more information about how to process their feelings. In one case, a child explained the complexity of an in-between, dual emotion: "Sometimes I feel happy and sad at the same time. Like when my brother breaks my Legos and then helps to fix them."

Although all the power-o-meters had the same numerals on them, the way that each student used their number line was unique. Each child's continuum of 1 to 10 represented their personal emotional state, which could not be measured against another student's. We discussed whether it mattered if each child interpreted their emotions in a different way and decided that that did not impede our group understandings of number or emotions. Instead it allowed each student flexibility in thinking about what their 3 might feel like. We talked about how one child might feel a power level of 3 when their blocks fell down, while another child might feel a power level of 1 under the same circumstances. That idea led the group to have conversations centered around empathy and perspective taking.

Building on the Emotions of Others

Young children are developing their understanding of how they can be both an individual and part of a larger group. During the investigation of the meaning of power, we started with individual number lines as a way for children to concretely express and share their own independent feelings of power or powerlessness. We eventually began asking students to notice when their peers had a low number on their power-o-meter and what that might mean for those children. We asked, "How can you help your peer who feels like a 1?"

At the same time, students were fascinated by larger numbers and counting past 10. During morning meeting, we decided to explore what would happen if we added the numbers on each individual's power-o-meter together. Every student in the class collected the quantity of gems that matched the number on their individual power-o-meter. We laid the gems along a longer number line and began to count them together. The children remarked that students whose meters were at higher numbers increased the collective sum more than those whose meters were at lower numbers. Students also noted that the sum would be smaller if all of the addends were smaller or, conversely, greater if all of the addends were greater. With this as inspiration, a class community power-o-meter from 1 to 100 was created on our documentation wall for children to explore how their individual power numbers could combine to make a greater whole.

As students began to make the connection between adding numbers of different quantities and the magnitude of the sum, we again drew the connection between the math and social-emotional learning. The following conversation occurred during a class meeting in response to the class community power-o-meter:

Teacher: Are you looking at this?

Child A: Yeah!

Teachers: It feels good?

Child A: Yeah!

Teacher: What does it tell you about the group?

Child A: We feel 52 altogether.

Teacher: And what does 52 feel like?

Child A: Powerful!

Child B: It's a good thing and a bad thing 'cause a couple of us are feeling 1 and some smaller numbers, but a couple of us are feeling more powerful.

This comment—that 52 is both a good thing and a bad thing—demonstrates how the children were recognizing that the community is impacted by each individual's emotions. Following this, the class came to their own conclusions around how a community cannot thrive if members are feeling powerless and how we, as a community, were stronger together than each of us was alone.

The mathematical understanding of numbers and quantity impacted the children's emotional awareness. The more we discussed the quantity of each number and what emotions it represented for each community member, the more the children's understanding of both emotion and number increased. In addition, exploring the larger number line taught the students that each child's power-o-meter played a significant role in our class community power-o-meter. Individual feelings of relative powerlessness (represented by low numbers on a child's meter), compounded together in the greater community power-o-meter, resulted in a less powerful group. It became important to help each student feel powerful to benefit the whole.

Conclusion

During this investigation, we followed our interest in children's efforts to communicate feelings, needs, and desires to their community. By connecting mathematics with this concept, we could use the concrete language of mathematics to help the students understand the social-emotional realm. During this long-term investigation, the children thus simultaneously developed an extensive set of social-emotional skills and a greater understanding of mathematical concepts. As their math skills grew, the children's understanding of the complexity of social-emotional ideas and their ability to talk about those ideas grew as well. Furthermore, the numbers became real; the numbers had a voice and gave us a voice. They were more than numbers; they were us.

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Elinor J. Albin is an early childhood educator at The Advent School in Boston, MA. EJ received her Master's in Education in Teacher Leadership with a specialization in literacy at the University of New Hampshire. She is passionate about social justice issues and bringing nature into the classroom. During her 10 years as an early childhood educator, she has shared her expertise with her colleagues through presenting at conferences, leading a faculty committee on social justice, and spearheading the redesign of the outdoor play and learning space at The Advent School.

Gretchen Vice, GSE '01, is Dean of Faculty at The Advent School, an independent progressive elementary school in Boston, MA. After receiving her master's in Early Childhood/Elementary Education from Bank Street College in 2001, she was a classroom teacher for many years before becoming a math instructional coach. Now, with 20 years of experience working in elementary schools, both in the United States and Australia, she is excited about working with teachers on their professional growth and building their pedagogy, especially in regards to mathematics education.