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Joyful Number Talks in Kindergarten

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Abstract

This article discusses the use of number talks to engage kindergarten children in regular joyful math opportunities in the classroom. As an educator of four- and five-year-old students in a full day kindergarten (FDK) program in Ontario, Canada, I embrace inquiry-based learning to guide children's activities. Inspired by the childcare centres in Reggio Emilia, Italy, I continually support and scaffold the expressed interests of children in the form of projects. This means that children are engaged in and discover answers to self-directed questions on a regular basis. I have always compared kindergarten to a dance; sometimes I lead and other times I follow.

As an educator of four- and five-year-old students in a full day kindergarten (FDK) program in Ontario, Canada, I embrace inquiry-based learning to guide children's activities. Inspired by the childcare centres in Reggio Emilia, Italy (Novakowski, 2015), I continually support and scaffold the expressed interests of children in the form of projects. This means that children are engaged in and discover answers to self-directed questions on a regular basis. I have always compared kindergarten to a dance; sometimes I lead and other times I follow.

According to Wein (2008), educators who embrace emergent learning are attuned to children's "interests and concerns, and curriculum expands into genuine inquiry, as [they] together become participatory co-learners who attempt to understand some aspect of real life" (p. 1). As part of my personal professional development, I read Sherry Parrish's work regarding number talks (2010, 2011) and I was curious to see how this might be implemented into our play-based classroom. I began to see the facilitation of math instruction as less compartmentalized and more integrated, a reflection of how learning happens in real life. My own excitement about math grew and I realized that it was easy to make number sense the heart of our kindergarten math program. As a result, the children's confidence and interest in math grew substantially, and by the end of the year many had easily surpassed the curriculum standards. We began to see math emerge in many surprising areas of our program; children would include ten frames and numbers spontaneously in their drawings, create numerous math games using subitizing tools such as dice,

dominoes and spinners in their play, and notice and name the math they found in the world around them (e.g., numbers located around the building, patterns in nature, etc.). What I observed was that number talks naturally complemented an emergent program and can exist as enjoyable, joyful math activities. If one honours the interests of the children, it is easy and effective to embed math into authentic inquiries and experiences in order to make the subject more meaningful and engaging for children.

In her work, Parrish (2010, 2011) challenges us to rethink our relationships with math. Many educators, myself included, grew up with a fear or dislike of math. We sometimes defaulted to the sterile system of memorized rules we learned as children and applied these to numerical situations instead of celebrating math as a system of relationships to investigate, understand and apply. Parrish recommends engaging children in regular, short conversations about purposeful problems. These are intentionally crafted to draw children into specific computational situations. When we observe children carefully in play and notice mathematical opportunities, it is imperative that we name this learning and make it explicit for children (e.g., "I see you are sharing the cubes with Jack. You each have an equal amount which makes it fair because you both have the same number of cubes"). Clements and Sarama (2009) remind us that taking a child's perspective helps one to understand more deeply what is happening in their play and how to better support the experience. Children begin to independently solve the problems mentally and then share the strategies they used for achieving their answers with others, resulting in shared learning. Discussing our misconceptions and mistakes helps us become better mathematicians as we grow our mindsets and realize that math is something at which one can become better with patience, practice, and hard work (Boaler, 2016). Robust discussions often follow regarding the efficiency and accuracy of the solutions. As children listen to one another verbalize math questions and processes aloud they begin to build a repertoire of strategies from which they can draw in future computational situations.

Classroom Environment and Community

Narrator: Ian and Esme look at the growing collection of cans donated to the food drive on display in our classroom.

Ian: "I think there are 24!"
Esme: "No, I think we have more than that."

Narrator: After observing their conversation their teacher asks them to consider how they might accurately count the number of items we have.

Ian: "We can count each one but that would take a really long time."
Esme: "We could stack them up and see how high they are."
Ian: "No, that would be too tall."
Esme: "We could make a really long line of them on the carpet."

Ian: "I know, we can use the big ten frames. We can put one can in each spot and then see how many ten frames we use."

Narrator: The children retrieve the large ten frame mats from the shelf and begin organizing the food using the tools. After a few minutes they observe that the class has collected 33 items. Their teacher asks them how they arrived at that total.

Esme: "Easy! We just put one can in each spot."
Ian: "Yes! One can in each spot, you can't have more than one. And then you count how many ten frames you have. We have three full ones and one with three in it, so that's 33!"
Esme: "We should write that number down so we can tell everyone else how many we have!"

Narrator: The children get to work using mini clipboards as they draw a sketch of the four ten frames, filling in 33 with circles and writing the corresponding number on the paper.

Parrish (2011) describes a classroom for rich mathematical exploration as a "safe, risk-free environment…based on a common quest for learning and understanding" (p. 202). We start the beginning of the school year with empty walls. Working together we slowly create documentation and displays that reflect our questions and explorations using artifacts of learning (e.g., photos, artwork writing, etc.). The classroom is filled with open-ended materials and loose parts that can be manipulated freely and easily by children in self-directed play (e.g., shells, stones, buttons, recycled lids, etc.). This free flow space invites learning without teacher intervention (Wein, 2008). According to Seize (2008), effective documentation "draws others into the experience—evidence or artifacts that describe a situation, tell a story, and help the viewer to understand the purpose of the action" (p. 88). As the year progresses our walls honour learning by sharing the children's journey, helping them to feel valued, respected, and encouraged to take greater risks in their work with others.

Children also have significant choice and control during play time. We establish norms for cultivating and maintaining a safe and supportive classroom (e.g., creating success criteria and anchor charts). Children choose what centre they wish to explore, how to use the materials, and how to communicate the knowledge they have acquired to others. They enjoy grabbing handfuls of dice and inventing their own math games while laying on our large carpet, or using mini clipboards and pencils to record the preferences of their peers (e.g., "Do you want to come to my birthday party?") as they play together. We notice math in our outdoor playground when the children measure how far they can roll a ball down the hill or count how many shapes they can spot in a large spider web. Offering open-ended materials such as dice, dominoes, Unifix (snap) cubes, ten frames, and loose parts like gems and shells often results in rich, integrated explorations by children that build their personal social development and self-regulation as they control their

own learning. As children freely flow between integrated centres, their learning becomes layered; they are not participating in isolated subject-specific activities but instead using real tools and strategies in new and exciting ways.

This holistic, layered approach to organizing the classroom environment empowers learners as they work together, resulting in a supportive and engaged environment. It also supports number talks by:

- inviting children into a thoughtful space with materials that can be freely manipulated.
- empowering children to question and explore self-directed areas of interest.
- providing multiple opportunities for children to take risks and safely make mistakes.
- applying math strategies acquired during number talks to meaningful inquiry situations through a gradual release of responsibility by using previous knowledge and experience practised in whole group learning to independent explorations in the classroom.

When children exist as equal members in a supportive space, they will be more likely to take risks in all areas of their learning including number talks.

Classroom Discussion

Narrator: It is circle time and the children are reading the morning message together. In it their teacher has asked them to consider what they know about the number ten. In order to help represent the children's collective thinking, their teacher has written the number 10 inside a cloud outline and will create an idea web representing mathematical thinking. The children are familiar working with the anchor of ten, and quite comfortable and eager to participate in the conversation.

Anthony: "You can show a ten in different ways - you can write the number 10 or write the word ten."
Jack: "You can show a ten in tallies!"
Aila: "I know that 5 plus 5 equals 10!"
Aimee: "9 plus 1 equals 10 too!"
Addie: "You can draw a picture of ten dogs."
Teacher: "What if you take away 1 from 11?"
Addie: "That's 10 too!"
Julia: "I like playing with dominoes. I know that lots of dominoes show ten."
Caleb: "I show ten with my two hands; five fingers on each hand."
Sawyer: "Don't forget your toes! You can use your feet to show ten too!"

Narrator: The wealth of the children's ideas during the discussion fills the idea web and indicates that they have a strong understanding of what ten means. They can represent it in multiple ways and are beginning to compose the number ten using different quantities.

A successful whole group number talk according to Parrish (2011) has a number of steps. Once children have mentally found a solution, they can hold their fists to their chests and raise their thumb. Children can also raise their fingers to indicate how many solutions they have used to solve the problem, differentiating the response wait time for learners. Children that quickly solve the problem can be challenged to find alternative strategies for the solution, providing additional think time for those who might need it. We often use sign-in as a chance to engage in a daily number talk during attendance. As children enter the classroom, they find their picture (affixed to a magnet) and put it on a ten frame. Because we normally have an average class size of 25 students, we offer three empty ten frames for children to use. Once attendance is called, we look at the three ten frames and the children are asked how many children came to school. The variety and complexity of their computational strategies grow with experience as they become more confident and proficient and learn from their peers. For example, at the beginning of the year it is not uncommon for children to simply count the number of pictures in the ten frames. Over time they begin to apply other strategies; skip counting the photos, subitizing the photos in each frame and adding these to arrive at a sum, subtracting empty spaces from 30 to find a total, and grouping the photos by friendly numbers (e.g., by 5, 10, etc.) and adding these together. By engaging in regular number talks, children acquire confidence and experience working with complex calculations resulting in more sophisticated ways of solving problems.

In our classroom we utilize the gradual release of responsibility model of instruction. We often use circle time as a chance to come together and share our ideas with each other. This is also when new concepts are introduced by the educator in order to meet curriculum needs that might not have been fulfilled through the emergent play block. Children listen respectfully to one another and learn that there are multiple perspectives and points of view to any given discussion. We have multiple circle time sessions each day, providing the opportunity to come together many times.

Gathering children together in a safe and familiar space for discussion helps support number talks by:

- giving children repeated practice speaking in front of others in a non-threatening space.
- engaging children in rich math discussions that build on their intuitive desire to make sense of the world.
- emphasizing the process of learning over the product.
- encouraging a regular time each day for number talks to occur.
- helping to dispel the belief that math is a solitary activity.
- demystifying the notion that making mistakes is a bad thing.

Topics explored in a whole group format often trickle into free choice play time as children use the information gleaned from lessons and apply this knowledge to independent activities in the classroom.

The Teacher's Role

Narrator: It is springtime and the children are fascinated by the budding leaves and sap dripping down one large tree's bark. Again and again each day they are drawn to the tree. Their teacher spends time carefully observing their interactions. She notices their questions about the age of the tree. She steps closer to a small group of children huddled by the trunk, gently rubbing their hands on the bark.

Brodee: "This is such a big tree, even though I want to hug it, I can't put my arms around it."

Mackenzie: "It's so tall I have to squint my eyes when I look at the top because it's too sunny up there."

Opal: "My mom said that tall trees are old trees."

Scottie: "I bet this tree is older than me."

Olive: "I bet this tree is older than Mrs. McLennan! I think this tree is at least one hundred years old."

Narrator: At this point the teacher enters the children's conversation, eager to capitalize on their emerging interest in the tree's age.

Mrs. McLennan: "How can we figure out how old this tree really is? What might we do?"

Narrator: The children discuss the question and agree that in order to figure this out, they should measure around the trunk. They know the bigger the trunk is, the older the tree. Their teacher questions them further in order to help them formulate a plan.

Mrs. McLennan: "It sounds like we need to think about how big this tree is. Can you think of a time when we have measured something before? What tools did we use? What did we do?"

Scottie: "Well, my dad uses a long stick with numbers to see how tall I am on my birthday."

Olive: "At our house we stamp our hands in paint on our birthdays and see how much bigger our hands have grown each year."

Opal: "I know! What if we use our hands! Let's hold hands and stand around the tree to see how big around it is!"

Scottie: "And then we can see if we can find the measuring tape to wrap around it. That's like the measuring stick my dad uses at my house!"

Narrator: Their teacher is amazed at the children's enthusiasm, the complexity of their thinking, and the rich mathematical background knowledge and confidence they bring to the task. The children quickly head indoors to gather their materials and then set to work.

According to Parrish (2011) number talks are most successful when a teacher's role shifts from "being the sole authority in imparting information and confirming correct answers to assuming the interrelated roles of facilitator, questioner, listener, and learner" (p. 204). In emergent practices, the teacher is considered a co-learner together with the children, actively observing, documenting, reflecting, and planning next steps on a daily basis. Emergent educators must be reflective and flexible in all facets of the program. Prompting and asking open-ended questions will help children reflect upon prior experiences and engage actively in the journey of understanding and applying several strategies in math situations (Clements & Sarama, 2009).

An emergent curriculum can be exciting, but it can also be overwhelming if one is not comfortable with the curriculum or assessment practices. When educators are unsure, it is hard to focus on what our children need and we sometimes revert back to previous mindsets, especially regarding math. Number talks help us gather unique strategies and build our own confidence and fluency. I found that the more I participated in number talks along with the children, the more excited I became about math personally and professionally. Wein (2008) reminds us that collective understanding in an emergent space can occur through "multiple ways of learning and creating (in drawing, dance, clay, wire, and so forth) so that new cultures of identity and classroom citizenship develop from it" (p.1). Teachers who feel renewed engagement see themselves as facilitators of learning and support number talks by:

- acknowledging that math happens everywhere—both inside and outside of the classroom space—and is powerful when integrated with other areas of interest including the arts.
- Helping children to see that there is beauty in math as they ask robust questions and explore rich connections between math and their everyday lives (Boaler, 2016).
- playing together with children in order to model inquisitive learning and demystify the notion that the teacher holds all the answers.
- discussing the math concepts contained in children's ideas using correct terminology.
- encouraging families to rethink their own mathematical mindsets as they learn from their children.

Being a reflexive co-learner builds a trusting and supportive relationship with children as inquiries are navigated together, resulting in opportunities for robust teaching and learning.

Role of Mental Math

Narrator: The children are avid builders and have been focused on creating growing linear patterns with mini wooden blocks. Day after day they work collaboratively to build increasingly more complex stacks that demonstrate their confidence and understanding of both physical and numerical patterns. Their teacher assists them to create the first five stacks in their pattern. They quickly realize that they can create an addition sentence to describe what we see happening for each (1, 2+1, 3+2+1, 4+3+2+1, etc.).

Mrs. McLennan: "What do you think the tenth figure might be? Can you predict what it will look like without building it?"

Narrator: This is an easy challenge for the children. Many immediately suggest that the figure will have ten blocks at the start and decrease by 1 each stack (e.g., 10+9+8+7+6+5+4+3+2+1). One particularly invested child, Finn, poses a different idea to the group.

Finn: "I wonder what the one hundredth figure would look like!"

Narrator: The children offer different ideas. Their teacher challenges them to use to the mini blocks to build the one hundredth figure in isolation. The children get to work but become discouraged after a while because there are not enough mini blocks needed to complete the task. After some discussion the children agree to draw the figure instead. Their teacher suggests large graph paper because the size of the grid matches the wooden blocks and it is an easily transferable substitute material to use. The children set to work. At first many are engaged with the task but after an hour, they become fatigued and move on to different activities. However, Finn still remains. Curious as to why he is persisting with the task his teacher sits beside him and helps count the grid.

Mrs. McLennan: "Why are you still working on this problem when everyone else has left?"

Finn: "I really want to know what it looks like, and I want to be able to build it."

Narrator: Mrs. McLennan and Finn work together, slowly and meticulously, to tape paper after paper together. The large carpet in the centre of the room is overtaken with the task. Finally, they are finished. The one hundredth figure in the pattern requires twenty-eight large pieces of chart paper altogether. Finn beams as his picture is taken sitting in the centre of the papers.

Finn: "This is what it looked like!"

Narrator: As Finn discusses his work to the bystanders, his teacher reflects upon the immense perseverance and growth mindset it took Finn in order to complete such a complex task.

In number talks, Parrish (2011) dissuades the use of paper and pencil activities. Worksheets usually have a 'right' answer and do not account for differences in interests and learning preferences. Children may become anxious, preventing them from taking greater risks in the process of solving the problem. In contrast, children who use mental computation are "encouraged to rely on what they know and understand about the numbers and how they are interrelated [encouraging] them to be efficient" (Parrish, 2011, p. 204). Engaging children in a space where they can take risks and feel comfortable orally sharing their ideas with others is essential for math success. As Wein (2008) powerfully articulates, a "positive emotional stance sets a strong tone of invitation, of psychological safety that ideas are welcomed, that children belong to the group and have the right to participate in it" (p. 145).

In emergent kindergarten practices, we do not use worksheet-style activities. Learning centres in the classroom encourage children to integrate subjects and demonstrate their knowledge in exciting ways. For example, a child might use patterning when painting a detailed picture at the easel or arranging loose parts in repetition during sensory play. These examples both demonstrate exploration, practice, and knowledge of patterning concepts. Sarama and Clements (2009) remind us that math and free play experiences including science and the arts enrich experiences for all. Young children are complex, with a variety of domains developing at different rates (e.g., physical, social, language, emotional). Development in one domain sometimes influences the other. If a child cannot yet properly hold a pencil, he may not be motivated or engaged in a written math task; his lack of interest in the work may or may not be linked to his inability to use writing tools proficiently. Therefore, paper and pencil tasks in kindergarten are not typically an effective tool to use for practice or assessment.

Emergent practices that use different learning centres provide greater opportunities for authentic math problems. Learning becomes deeply rooted in the children's play, resulting in their commitment to solving the problem quickly and accurately. Children are empowered to ask a question, use a math concept they have acquired to perform a calculation, and then apply this knowledge to their real world situation in order to see if the original question was answered (Boaler, 2016; Wolfram, 2010). Educators who regularly engage children in authentic, differentiated activities rather than paper and pencil tasks support number talks by:

- demonstrating that *receipts of learning* like worksheets are not always developmentally appropriate and children learn in different ways.
- understanding that children can demonstrate math understanding in a variety of non-traditional ways.

- assessing children in ways that honour their learning and help tell the story of their math journey including the use of photos, videos, drawings, anecdotal notes, interviews with children, and teacher reflection.
- Inviting families to experience the joy and beauty in their children's math work through engaging documentation practices such as learning stories or digital photos and videos.

Inviting children to participate in organic math experiences that are relevant to their immediate needs and encourage a multi-faceted approach will set the foundation for creative problem-solving in subsequent years.

Purposeful Computation Problems

Narrator: It was spring and to help bring some of the outdoors into the classroom Mrs. McLennan picked a large bouquet of flowers from the garden and placed it in the centre of the snack table. The children were interested in the differences between the flowers and as they ate, they compared the size, shape and quantity of petals on each. Recalling an experience from a book she had read, Mrs. McLennan brought the vase of flowers to the next whole group meeting time. There she asked the children about their conversations. She was curious to know more about what they noticed in the bouquet and how the children might figure out the number of petals on each stem. They had many interesting ideas; one child wanted to count the petals and write the corresponding numbers down on paper, another thought the class could estimate the petals and then represent them with mini wooden blocks, and a third suggested waiting until the bouquet dried out and then picking the petals off in order to count them all.

During the next play time Mrs. McLennan placed the bouquet and the suggested materials on a table and invited the children to visit the centre. She also printed close up photos of the flowers and placed these on the table. She hoped to provide an alternative experience for those children interested in counting petals, but who might feel the bouquet was too abstract or complex to explore. By providing a number of open-ended materials as suggested by the children, as well as some of my own, this teacher was hoping to create multiple entry points into the experience. She also planned to be available at the centre in order to support and scaffold the work of the children, making this a differentiated and engaging activity.

Many children visited the centre exploring the flowers in innovative and diverse ways. Their teacher observed and supported their mathematical explorations and documented their learning using photos and videos. During the consolidation circle at the end of the day some children volunteered to share their experiences and ideas about the flowers and explained their math thinking to the group. Their work was

> *displayed digitally using our smartboard. Towards the end of the discussion one boy exclaimed that he could not wait to come back to school the next day so he could bring the materials outdoors and count all the flowers in our garden during play time.*

According to Parrish (2011), teachers who conduct successful number talks use "just right [problems] that build [on students'] mathematical understanding and knowledge" (p. 204). We want children to be engaged in the math activity; they should have some experience and background knowledge to give them an entry point into—and personal interest and investment in—solving the problem. These problems must be open-ended enough to appeal to a variety of learning interests and abilities. Through scaffolded interactions and thoughtful questioning, an educator can enhance explorations while fulfilling curriculum and assessment obligations.

In emergent programs educators aim to embed rich math resources and opportunities throughout the room and not just in a defined 'math centre' in order to encourage organic exploration (e.g., adding dominoes and dice to loose parts play; using Unifix cubes and links in the building area; bringing ten frames outdoors). The children are investigating and finding solutions to questions or problems generated in the social interactions they have during playtime. Teachers can bring these inquiry-based topics and authentic queries to the whole group for extensive discussion after noticing them in the play, specifically highlighting math and computation when applicable. Because children are highly invested in solving these problems, they will be more likely to work together to brainstorm various strategies for arriving at solutions that meet the needs of many learners.

Finding the balance in emergent practices also means that the teacher carefully selects developmentally appropriate activities that capture children's interests while still fulfilling curriculum expectations. It's amazing to see how many mandated math topics naturally emerge in the children's play and interactions. An attuned educator who is familiar with standards and is interacting alongside the children in play can also make pedagogical decisions based on his or her observations regarding what expectations can be woven into the experience. Interesting materials can be placed in the classroom and the teacher can ask questions or suggest challenges to entice children into exploring these further (e.g., inviting children to participate in subitizing games, creating math challenges at specific centres, adding math tools to unexpected areas of the classroom such as the snack area). An emergent kindergarten program also creates natural opportunities for purposeful computation by:

- providing children with the freedom to explore self-directed areas of interest.
- introducing interesting and challenging materials for children to use independently and with teacher guidance.
- emphasizing a child-centered problem-solving approach when difficulties arise.
- using organic materials and loose parts in place of commercial products.
- honouring children's questions and providing guidance when needed.

Teachers who utilize an organic, emergent approach to curriculum will discover that there are multiple opportunities each day for purposeful and authentic computation.

Growing Number Talks

Kindergarten is an exciting place to be! As children are provided the time, resources, and environment to explore areas of self-directed interests, their engagement turns to passionate inquiry which will lay the foundation for subsequent personal and academic success. Teachers who utilize Parrish's (2010, 2011) approach to number talks will be helping children to become joyful, flexible risk-takers in their mathematical learning, instilling interest and engagement that will provide a solid foundation for future math achievement. They may even discover a renewed passion for math in their own personal and professional lives along the way.

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