

Early Childhood Indicators of Progress

Using the ECIPs to Connect the Language, Literacy and Communications Domain with the Mathematics Domain



Introduction

Children’s development of language, literacy, and communication skills, and mathematical understanding begins in the very first months of life and continues to grow and expand as they interact with others and with the world around them.

- Babies recognize voices and turn their heads toward their mother, father, or caregiver. They coo and cry as ways to communicate their needs and emotions. They begin to see patterns in the world in familiar caregiving routines and attend to objects and sounds relative to themselves.
- Toddlers put two and three words together in their home languages as they imitate the language around them and communicate their needs and wants. They ask for a favorite story to be read again and again and point to the pictures. They experiment with crayons and writing tools to make their mark. They begin to understand the words “one” and “more” and maneuver through their world with growing spatial understanding.
- The vocabulary of preschoolers grows as they learn through experiences in their homes, neighborhoods, and communities. They express themselves, describe what they are doing, and converse with others. They show enjoyment in being read to and may read the pictures or retell the stories in books they know well. They begin to make some sense of letters and numbers as they play with writing and counting. Their math understanding is directly related to their playful explorations of blocks, water, sand, puzzles and games. They sort, classify, compare, and measure with real objects and items from nature. As they do so, their geometric and spatial knowledge grows along with their understanding of quantity and number sense.

The domains of language, literacy, and communications and mathematics in the ECIPs are filled with distinct developmental indicators. Yet, they are more closely related than may have been thought in the past.

“We typically think of early literacy and numeracy skills as separate constructs, or separate areas of development. Generally, we assess these skills using different tasks and we use different instructional activities to promote skill acquisition in these areas. Interestingly, however, research suggests there are rich connections between early literacy and early numeracy skill development that may help us think more broadly about children’s early academic learning. Ultimately, we can use this information to create rich environments that support both early literacy and numeracy skill development.” (Hojnoski 2014)

Young children’s development in these two domains is a work in progress. The reasonable expectations that are set out in the Minnesota Early Childhood Indicators of Progress (ECIPs) recognize that, in the early years, children are developing the foundational knowledge and skills that will lead to more rigorous academic study in the mathematics and English language arts domains in the elementary school years. The ECIPs provide guidance so that teachers and providers can know appropriate expectations for young learners and understand how best to support children so that they have the necessary foundation for later learning.

The Importance of Connecting the Language, Literacy and Communications Domain with the Mathematics Domain

When teachers and providers connect these domains, they are implementing best practices in early childhood that recognize the valuable learning occurring when children can integrate knowledge across domains. Young children "...learn best when the concepts, language, and skills they encounter are related to something they know and care about, and when the new learnings are themselves interconnected in meaningful, coherent ways." (Copple and Bredekamp 2009, 21)

Research has shown that when children develop strong mathematics skills before kindergarten, they have higher achievement in later grades, not only in mathematics, but also in reading.

"Supporting children's early mathematical thinking has implications for school readiness which, in turn, impacts later achievement. A recent analysis of the links between school readiness indicators and school achievement in six large-scale studies revealed a strong correlation between mathematics skills at school entry and later mathematics and reading achievement." (Brenneman, Stevenson-Boyd and Frede 2009, 4)

Why is this connection so important? What do these domains have in common? They both involve spoken and written language.

"During the early childhood period, young children's language skills are growing rapidly, and children's use of language appears to underlie both literacy and numeracy related skill development. For example, young children often tell stories and adults frequently provide prompts for children to engage in storytelling, asking "what did you do today" or asking a child to retell

a part of a storybook following shared reading. This skill, generally termed narrative ability, is an important element of children's overall language use, and aspects of children's narrative skills are related to later mathematical performance in both typically developing children and children with learning disabilities (Feagans & Applebaum, 1986; O'Neil, Pearce, & Pick, 2004). Specifically, the more children used certain elements in their story telling, such as conjunctions (e.g., but, and, or, because, after), descriptions of events, and emotional or belief statements (e.g., sad, think), the higher their mathematics performance approximately 2 years later. There is also a connection between specific language-based skills and numeracy development. For example, children's vocabulary and grammar predict their numeracy skills when measured at the same time and when measured one year later (Davidse, Jong, & Bus, 2014; Kleemans, Peeters, Segers, & Verhoeven, 2012; Purpura et al., 2011)." (Hojnoski 2014)

Teachers can enhance children's mathematical understanding by helping children learn the vocabulary of numbers, measurement terms, and geometric shape names. As young children move in space or place objects, they can hear a teacher or provider describe, or describe themselves, the spatial relationships between themselves and the objects. As they attempt to put items into a bucket or basket, they learn about volume and quantity. Teachers and providers can use vocabulary words such as "full" and "empty" or "more" and "less." As children try to match and sort, they can use language to solve problems and determine the attributes of the various items.

"...talking about mathematics builds language skills. When you discuss and debate about mathematics, you have to be precise in your language and thinking. And you have to explain your reasoning. Also, even more than most other areas, mathematics involves thinking about word meanings. Mathematicians know the importance of accurate definitions and use of terms.

Children develop literacy skills as they think about what words mean and decide which words appropriately describe certain objects and situations. Mathematics is an ideal context

in which to discuss exactly what words mean.”
(Sarama and Clements 2006, 1)

When teachers and providers connect mathematics with language, literacy, and communications, they are being intentional in supporting children’s development in these domains throughout each and every day rather than having a specific time devoted only for mathematics or only for literacy experiences. Teachers and providers report that they can find many teachable moments related to the ECIPs from these domains in daily routines such as arrival and departure, snacks and meals, diapering or toileting, and transitions from activity to activity. They can interact with children as they play, helping them to make connections to mathematics and literacy concepts. They can also plan for focused activities and experiences that connect the indicators from both domains. The art of teaching young children effectively involves such integration, connectedness, and intentionality.

The Basics about the Language, Literacy, and Communications Domain

Children’s language development (whether in English or their home language) is fundamental to their overall development. It is essential for learning, communicating, building relationships, and figuring out how the world works. Children’s experiences with oral language, both as a listener and as a speaker, are highly correlated with their development of literacy skills related to reading and writing. In fact, the more words they know and understand at young ages has now been shown to affect their later academic success in all areas. Language is important!

“Reading comprehension depends on language abilities that have been developing since birth. Basic vocabulary and grammar are clearly essential to comprehension because each enables understanding of words and their interrelationships in and across individual sentences in a text (Kintsch & Kintsch, 2005).”
(Shanahan and Lonigan 2015)

“...children with larger vocabularies at age two

entered kindergarten better prepared both academically and behaviorally than their peers... Children with a larger oral vocabulary at age two not only entered kindergarten with higher levels of math and literacy achievement, but were also found to display greater behavioral self-regulation and fewer anxiety-related behavior problems, such as excessive worrying and extreme shyness. This advantage held even when other variables, such as students’ general cognitive functioning at age two, were controlled for, providing strong evidence for a direct link between two-year-old vocabulary levels and success later in life.”
(Loewenberg 2015, 1)

Literacy in the early years involves learning about reading and writing and is built on the foundation of oral language.

**“Early literacy is an emerging set of relationships between reading and writing. These relationships are situated in a broader communication network of speaking and listening, whose components work together to help the learner negotiate the world and make sense of experience (Thelen & Smith 1995; Lewis 2000; Siegler 2000). Young children need writing to help them learn about reading, they need reading to help them learn about writing; and they need oral language to help them learn about both.”
(Roskos, Christie, and Richgels 2004, 1)**



The goal of early education is to build the foundational skills that will support the development of children as readers and writers in kindergarten and beyond. Teachers and providers, along with parents and family members, support young children's language and literacy development most effectively through naturalistic means rather than formal instruction. Children gain language and literacy understanding when adults:

- Talk with them in the context of caring relationships and in everyday situations.
- Introduce them to the enjoyment and information to be found in books and print materials.
- When appropriate, provide opportunities to use writing tools to scribble and begin to make meaningful marks.

In fact, serious negative consequences can result from pushing young children to learn to read and write too early. Teachers and providers must work closely with parents and family members so that all understand the best approaches to language and literacy learning in the early years.

“Formal instruction to require young children who are not developmentally ready to read is counterproductive and potentially damaging to children, who may begin to associate reading and books with failure.” (Zero to Three 2003, 1)

Adults must recognize how capable young children are related to language and literacy learning and how integrated such learning is in preparing them to develop skills in other domains as well. Language, literacy, and communications are the foundation for children's development across all domains.

“During the first three years, young children begin to read their world...The child builds sophisticated understandings, elaborate vocabulary, complex reasoning, and a growing power to influence others by verbal and written arguments. Thus, young children begin to ‘read their world’ and to have wider and greater impact upon it.” (Rosenkoetter and Knapp-Philo 2004, 1)

The Components of Language, Literacy and Communications in the ECIPs:

- Component LLC 1-2 *Listening and Understanding; Receptive Language.*

- Component LLC 3-4 *Communicating and Speaking; Expressive Language.*
- Component LLC 5-13 *Emergent Reading.*
- Component LLC 14 *Writing.*

The Basics about the Mathematics Domain

In their everyday lives, children encounter mathematical concepts and engage in mathematical investigation and problem-solving frequently. Babies grasp for objects and may hold one in each hand – the beginnings of their understanding of one-to-one correspondence. Toddlers want more crackers or more cookies, building their understanding of quantities. Preschoolers sing counting songs, memorize the number names, and begin to connect the number with the amount as they build with blocks or play with manipulatives. Their understanding of volume and measurement grows as they play with water in a tub or pour milk into a cup at the snack table.

For all young children, spatial awareness develops as they become mobile and move through space. Geometric shapes and patterns abound in fabrics, toys, street signs, and books. Young children are surrounded by the potential for learning mathematical concepts. Their understanding and knowledge of mathematics can be enhanced by caring adults who point out the mathematics in everyday life and use mathematical language and vocabulary.

The results of such naturalistic mathematical teaching affect children's learning in other domains as well. This builds toward their success across all curricular areas and helps them develop important skills and concepts that they will use throughout their lives.

“Research on children's learning in the first six years of life demonstrates the importance of early experiences in mathematics. An engaging and encouraging climate for children's early encounters with mathematics develops their confidence in their ability to understand and use mathematics. These positive experiences help children to develop dispositions such as curiosity, imagination, flexibility, inventiveness

and persistence, which contribute to their future success in and out of school (Clements and Conference Working Group 2004).” (National Council of Teachers of Mathematics 2013, 1)

As stated above regarding language, literacy, and communications, the goal of early education related to mathematics is to build the foundational skills that will support the development of children as mathematical thinkers in kindergarten and beyond. Teachers and providers, along with parents and family members, support young children’s math development most effectively through naturalistic means rather than formal instruction. Children gain math understanding when adults:

- Guide children to see the mathematics in everyday life situations.
- Give them opportunities and experiences to engage in mathematical investigations.
- Provide vocabulary and explanations related to mathematical concepts and methods.
- Encourage children (as they are capable) to communicate and explain their thinking related to mathematical experiences.

Young children’s mathematical skills are foundational ones that will build as they grow and develop. The heavy emphasis on numeric symbols and paper and pencil mathematics tasks is not recommended in early childhood. Rather, children gain understanding by hands-on explorations of the world around them, pouring water from one-size container to another, stacking different sized blocks or rings, completing puzzles with varying shapes, noticing similarities and differences among materials and organizing them into categories or patterns. Teachers and providers can turn to the ECIPs for appropriate expectations and communicate with parents and family members about the developmental sequences of learning in these domains. They, then, plan for mathematics (and literacy) activities that are best for the children.

The Components in the ECIPs

- Component 1-6: *Number Knowledge*
- Component 7: *Measurement*
- Component 8: *Patterns*
- Component 9 -11: *Geometry, Spatial Thinking*
- Component 12-14: *Data Analysis*

Ways That Teachers and Providers Can Connect Math and Literacy in the Early Childhood Years

As stated earlier, young children learn best when their experiences are integrated across domains. Intentional teachers and providers connect the math and language, literacy, and communications domains by:

- Imbedding the indicators in the ECIPs from both domains throughout the day, including in daily routines, in play experiences, and in small and large group activities.
- Intentionally planning for activities and experiences that connect math and literacy concepts and skills.

Many early childhood educators are more comfortable with the indicators in the language, literacy, and communications domain and find them easier to address throughout their time with the children. This is important work to be celebrated. No teacher or provider should stop being attentive to this domain. However, some may find it more difficult to connect mathematical concepts and methods to language and literacy. The suggestions that follow will reflect an emphasis on integrating math more fully into the curricular strategies of early childhood programs so that the important benefits of such integration are realized to the fullest.

“...early math...experiences matter because they can support language and literacy development, independent of any effect on later math... achievement.” (Brenneman, et al 2009, 4).

Suggestions for Connecting Mathematics and Language, Literacy, and Communications for Infants

In the context of a strong caregiving relationship, teachers and providers can talk with infants while they diaper them, feed them, and rock them. In this way, adults are building children's receptive language skills and expanding vocabulary. By being thoughtful about the content of what is said, a teacher or provider can integrate mathematical concepts along with the modeling of language expression.

Conversations can include:

- Descriptions of the activity at hand, including identification of steps in a sequence (as in, "First, I'm going to wipe your mouth with this wet cloth. It might be a little cool. Then, I'm going to take off your bib and take you out of your high chair.>").
- Responses to the child's interest in her toes and fingers ("Yes, those are your toes and fingers. Let's count them together.>").
- Interactions related to feeding ("Do you want more?" or "Have you had enough?").
- Recognition of a child's interest in a mobile or something posted on the wall ("Do you see the elephants on that poster? There's a big one and a small one.>").

Teachers and providers who care for infants can also integrate math and literacy during tummy time or floor time. Choosing interesting and safe objects for the infant to see and eventually reach and/or move toward is essential. Having more than one of some of the toys allows for pairing and matching. Helping the infant to grasp one item at a time begins to build one-to-one correspondence. And, the placement of the objects near the child helps him become more aware of his place in relation to them. Again, verbal interaction is a key for developing receptive language, encouraging expressive language (through movements, gestures, and sounds), and adding

vocabulary that reflects mathematical concepts. (i.e., "That's a big rattle. Can you fit that in your hand?" "That soft toy is a little too far for you to reach. Here, I'll move it closer." "Now, you have one shaker in one hand and one in the other. You have two! Shake, shake, shake!")

Finally, teachers and providers can take advantage of the many cloth, cardboard, and plastic books that have been published for infants that focus on mathematical topics such as counting, shapes, and sizes. Infants love to look at books with photographs of people of all ages, animals, and real objects. Mouthing a book, reaching for it, patting it, and listening as the adult reads or describes the pictures are important first steps in emergent reading. The content can allow a teacher or provider to highlight math concepts in the book experience. It's important that the environments for infant care include a varied selection of books including those with opportunities for counting, for recognizing sizes, shapes, and patterns, and other mathematical concepts.

Connecting Mathematics and Language, Literacy, and Communications for Toddlers

For toddlers, a strong caregiving relationship with teachers and providers provides the foundation for their growing independence. With greater mobility, they can move in their environment and interact with toys, materials, and other children. But they always return to the safe haven of their caregiver for reassurance. Teachers and providers can take advantage of multiple opportunities throughout each day to talk with toddlers and build their receptive language skills, provide new vocabulary, and support them in their growing ability to talk and converse. Such conversations can take place in daily routines, in play times (both indoors and outside), and in book experiences. By being thoughtful about the content of what is said, a teacher or provider can integrate mathematical concepts along with the modeling of language expression.

In daily routines such as diapering/toileting and handwashing, snacks and meals, dressing, and transitions between activities, conversations can include:

- Descriptions of the activity at hand, including identification of steps in a sequence (“What do we do first to wash our hands? Yes, we get some soap and then rub them together under the water. Then, we dry them with a paper towel.”).
- Discussion of quantity and volume at snacks and meals (“You have one spoon and one napkin and one cup.” “Your cup is half-way full of water.”).
- Inclusion of spatial vocabulary in dressing to go outside (“Your coat is hanging up in your cubby next to your backpack.”).
- Use of counting songs and finger plays as children wait for lunch to be delivered or during other transitions (“Who has 3 little monkeys?”).

Play time (both indoors and outside) offers many opportunities for teachers and providers who care for toddlers to integrate math and literacy. Again, by describing and interacting with the children as they play, adults can add vocabulary and encourage the child’s verbal expression. Toddlers love to build up and knock down (“You put two, three, four blocks on your tower and knocked them down. How many will you stack this time?”). They are challenged by stacking rings, sorting boxes, knob puzzles, and cause and effect toys. All have inherent mathematical thinking involved that adults can bring forth. Outdoors, nature provides many possibilities for exploration of measurement with water and sand. The sensory table can even be brought outdoors to extend the children’s interest. Gathering sticks and stones in treasure baskets increases children’s awareness of similarities, differences, and grouping strategies. The commentary, observation, and questioning of caring and interested adults enhance the child’s learning.

Book times can happen in play as well as be a separate part of the toddler day, happening multiple times throughout the schedule. Toddlers are most successful when there are multiple books ready for their little hands to hold and laps available for snuggling while listening to a good story. The goal is for children to interact with the book, turning

the pages, looking at the pictures, identifying what they see, and talking about, gesturing, or pointing to characters and events. Toddlers are not expected to be quiet during book times. They are active listeners and lookers, finding the joy that can be found in reading experiences. It’s important that the environments for toddlers include a varied selection of books for the children to handle. Teachers and providers can highlight mathematical concepts they find in books such as counting, recognizing sizes, shapes, and patterns, and following a sequence of what comes next.

Connecting Mathematics and Language, Literacy, and Communications for Preschoolers

Preschoolers are ripe and ready for learning in integrated and interesting ways. Still needing the strong foundation of relationships with teachers and providers, they are growing in independence and capabilities to make their own connections between experiences related to math and language, literacy, and communications. Teachers and providers can build on the greater abilities of preschoolers to express themselves, to question, to understand new concepts, and to begin to represent their thinking through drawing, writing, and constructing. Math and literacy can be imbedded in daily routines, in play times (both indoors and outside), and in shared reading experiences.

Throughout both daily routines and play times, conversations between teachers and providers and children, as well as between children, are vital. Preschool classrooms should be filled with many opportunities for everyone to talk. In this way, children’s vocabularies are expanded. Research supports vocabulary development as an essential component to both math and literacy learning for all children and “...especially important for children from families with low incomes (Hart & Risley 1995), children experiencing speech and language difficulties (Nathan et al. 2004), and dual language learners (Shartz & Wilkinson 2010), who may come to school

knowing or being able to articulate far fewer words than other children (Hart & Risley 1995), and for whom the vocabulary knowledge gap typically widens as they get older (Biemiller & Slonim 2001).” (Christ and Wang 2012, 79-80) Teachers and providers are also building children’s cognitive and analytic skills so that children’s language represents the complexity of their thinking.

“Teacher’s interactions that best encourage language learning include having conversations that stay on a single topic, providing children opportunities to talk, encouraging analytical thinking, and giving information about the meanings of words.” (Shanahan and Lonigan 2015)

Conversations during daily routines and play can include new vocabulary words and phrases related to mathematical thinking. For example, teachers and providers can engage with preschoolers and:

- Invite children to describe their thinking as they set the table (thus, getting at the notion of one-to-one correspondence and problem-solving related to quantity).
- Transition between activities or line up related to various sorting categories (i.e., boys and girls, shortest to tallest, those with belts and those without, etc.).
- Challenge them to arrange their block structure in such a way that they create various geometric shapes (i.e., a rectangle, a triangle, or a cube) and describe where they will place them in relation to each other.
- Provide materials for linear measurement (string, linking cubes, rulers, and meter sticks) during play times (both indoors and outside) and encourage children to measure various items and spaces and compare and record their results.
- Throughout every day, offer opportunities for children to observe, predict, estimate, describe attributes, sort, categorize, combine groups and take them apart, and engage in back and forth discussions related to these experiences.

The more that mathematical language is used in meaningful ways by both teachers and children, the more children’s mathematical understanding will increase.

With preschoolers growing ability to represent their thinking on paper, daily routines and play experiences can also include opportunities for children to draw and write related to mathematical concepts. Teachers and providers can work with the children to:

- Take attendance each day on a simple graph (i.e., home and school).
- Record numerical data on charts (i.e., take surveys, answer questions of the day, measure the growth of plants, etc.).
- Document math problems that arise to familiarize children with numerals and symbols that represent mathematical processes (i.e., two children were joined at the snack table by two more: $2 + 2 = 4$).

Shared reading experiences can also connect math and literacy development. Fiction and nonfiction books related to key math concepts can be read aloud in an interactive, dialogic way. Teachers and children can discuss the math concepts in familiar stories such as “Goldilocks and the Three Bears” and relate the reading experience to other mathematical experiences in the preschool classroom (sorting by size, making groups of three, etc.). It is important to stock the classroom library with a variety of interesting and engaging books that include mathematical concepts and encourage children to explore them on their own, in pairs, or in small groups throughout the day. Teachers can challenge children to go on a scavenger hunt and “find the math” in the library corner. They can invite children to tell stories in their own words to check for comprehension and understanding.

“We know that building language is an important way to support children’s learning of mathematics. One characteristic of children who do better than others in math is that they can explain and justify the mathematics they are doing. At the same time, one of the best predictors of later success in school mathematics is how well children understand and tell stories.” (Samara and Clements 2006, 18)

Conclusion

There is tremendous potential for teachers and providers to connect the domains of language, literacy and communications and math as found in the Minnesota Early Indicators of Child Progress (ECIPs). Young children from birth up to kindergarten entry will benefit from these efforts not only in early childhood, but also throughout their lifetimes. When early childhood professionals are intentional in linking these domains, they are providing a strong foundation for children's later academic and life success.

“Several studies have confirmed that students who enter kindergarten with advanced academic and behavioral skills typically experience greater opportunities as they grow older. For example, children who enter kindergarten with strong early reading and math skills are more likely to attend college, own homes, and have 401(k) savings. They are also more likely to be married and live in higher income neighborhoods once they reach adulthood. “ (Loewenberg 2015, 1)

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