Early childhood teachers today are faced with unprecedented challenges and opportunities. Our classrooms are increasingly diverse, in terms of the cultures, languages, previous experiences, and strengths of the children we teach. We are faced with pressures to provoke the interests and capabilities of children in an increasingly complex world, with higher standards, high-stakes testing, and pressures on children to accomplish more at a younger and younger age.

The Approach of This Book

As a field, we need to do a better job teaching mathematics and science to young children at a time when this is more important than ever. We need to do this without reverting to traditional, non-constructivist practices. And in order to do this, we need to be guided by how children learn—we need to capitalize on the ways children think, explore the world, experiment with materials and ideas, and construct knowledge in contexts that are interesting and meaningful to young children. Standards change and programs come and go, so thinking about who you are in the lives of children needs to guide teaching development.

How to do this? Change how we think about math and science for young children. Instead of separating the disciplines, planning lessons and topics and projects aimed at math or science content, let’s look at the world the way the child does. Children think in terms of big ideas. And we, as teachers, can capture children’s interest and facilitate the construction of both science and math knowledge by seeing this knowledge as interconnected through big ideas.

How This Book Will Help You Understand and Teach Math and Science Concepts

This book offers a way to think about the future classroom and meet the needs of children who come to us with diverse experience, knowledge, and ability. In the first part of the book, we start with the reasons why it is important to think about thinking, and the underlying
framework of big ideas as a way to integrate math and science. Assessment is the focus of the second chapter because the teacher must plan for assessment before teaching begins. Then we move into setting up the environment that will support the construction of the big ideas that join math and science.

In the second part of the book, each chapter focuses on a big idea: patterns, transformation, movement, balance and symmetry, and relationships. Each chapter includes two modules to be used for in-depth exploration of different aspects of the big idea of the chapter. The modules can act as stand-alone units or models for lesson planning.

This book is not meant to cover every topic that can come up in math and science; rather, it is meant to be an exploration of learning and thinking, with examples of big ideas that can be used as a framework for integration. The final chapter discusses curriculum planning, and the generation of big ideas beyond those in this book.

Features of This Book

*Classroom Scenarios.* This book teaches through scenarios to give insight into the teacher’s thinking and planning. Rather than a list of activities, we have concentrated on *real-life* experiences that teachers can plan for and take advantage of.

*Illustrations.* We’ve provided graphic illustrations to help pre-service educators understand important concepts.

*Photos.* Authentic photos of children engaged in constructivist activities illustrate how learning should occur.

*Modules.* In Chapters 4–8, modular explorations are provided so that students can use these to try out, modify, and have first-hand experience with math and science learning activities.

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Introduction

In this book, we are intending to provide a framework of “big ideas” for meaningfully integrating mathematics and science in early childhood classrooms, preschool through primary grades. In Part I we will provide the background and context for the big ideas that will follow in Part II of the book.

First, we will discuss the underlying framework of constructivism and big ideas, as well as the different ways of thinking about both curriculum and curriculum integration—both why it is important and the different approaches that influence the one in this book.

We then address the issues of assessment. We see assessment as something that needs to be thought of as an important part of curriculum planning and classroom practice, rather than a disconnected summation of children’s learning.

Finally, we discuss the importance of the physical and social environment in which teaching and learning occurs, because classroom environments are an essential part of how we put constructivism and curriculum integration into practice.
Learning Outcomes

After working with the ideas in this chapter, you should be able to:

• Define constructivism and theory-building.
• Describe big ideas and their characteristics.
• Analyze the views of teaching and learning underlying constructivism and big ideas.
• Understand different frameworks for curriculum integration, including the project approach and work inspired by Reggio Emilia.
CHILDREN AS THEORY-BUILDERS

Children do not think in terms of mathematics and science, nor do they separate their activities into disciplinary categories. Children engage in theory-building by experimenting with the world in order to understand it, always applying their theories—what they’ve constructed to explain what they have experienced—and learning from their experimentation, leading to the construction of more complex theories.

In this process of theory-building, mathematics and science are inextricably linked. Here’s an example:

Rebecca has noticed that the carrot that she put into the gerbil’s cage in her kindergarten classroom is shriveled up. She takes it out and exclaims, “Look at this! It’s weird!” Marsha, her teacher, suggests they talk about this at their morning circle. The children have different thoughts about the carrot, focusing on the ways it is different from a fresh carrot. The children decide to watch what happens to a carrot; they put several fresh carrots on a plate. The children write their predictions of what will happen on a chart—some are focused on the size of the carrot, others on the color or texture of it.

Based on their predictions, they make documented observations of the carrots. They begin by measuring the carrots, marking their lengths using a string that is put next to each carrot. Rebecca also takes digital photographs of the carrots, posting the pictures on the wall next to the chart. Other children write descriptions of the texture of the carrots—“hard,” “wet,” “crunchy.” In following discussions, Marsha asks questions about what happens to other food that is left out, and brings in resources on decomposition.

In this example, Rebecca’s curiosity is capitalized on by the teacher, who facilitates a more extensive exploration of the changes that carrots undergo over time. These changes involve both mathematics and science—measurement and comparison in mathematics, and transformation in science. The questions and interests in this exploration are integrated and linked, and provide a context for the teacher to facilitate the study of both disciplines.
What Is Constructivism?

This view of children as theory-builders is grounded in constructivism, a belief that children learn by constructing knowledge. Constructivism comes from Piagetian theory (Piaget, 1977), as well as Vygotskian theory (Berk & Winsler, 1995; Bodrova & Leong, 1996), and is an important way to think about how children learn, with serious implications for our educational practice. What does constructivism mean? It means that children have theories or ideas about the world, and that they are constantly applying these theories in an attempt to understand and construct new knowledge. As children apply their theories, they encounter complexity, variation, and differences, and through these encounters their theories build. Take the child who rolls a ball down an incline. She builds a theory that objects roll down inclines. She picks up an object that is not a ball, a cube, and places it at the top of the incline. Her theory is that it will roll, but it does not—it slides. She tries it again; again it slides. Her theory changes—it becomes “round things roll, square things slide”—in response to the variations she experiences in the world. Her theory becomes more complex. This is theory-building, which involves the construction of new knowledge based on applying what is already known.

One interesting and important aspect of theory-building is that it is also grounded in the idea that children are actively seeking to understand the world. There is an inherent motivation to apply the theories that have been constructed. Theory-building does not have to be motivated from the outside, but occurs in the course of all of the child’s interactions with the world. This is why children’s play is so rich and important for their learning (cf. Frost, Wortham, & Reifel, 2011; Kieff & Casbergue, 2000). This aspect of constructivism constitutes one of the greatest contrasts with the theory of behaviorism, which contends that children’s learning is externally motivated—stimuli provoke behavior, and reinforcement is necessary to guide learning. From the constructivist perspective, the child is “wired” to learn. Because of this, the constructivist sees the process of learning as one that is facilitated, not determined, by the outside world, by the environment.

This is not to say that the environment—both social and physical—is not an important element in the learning process. Teachers play an extremely important role in creating the contexts in which theory-building occurs, both in terms of how the physical and social environment is set up and in terms of how teachers provoke theory-building and interact with children to facilitate it, as well as support opportunities for children to theory-build together. Later, we will discuss in
more detail the role of the constructivist teacher in creating the context in which theory-building occurs. The physical environment as well provides the opportunities and provocations for the child to engage in theory-building—the physical environment has been called the “third teacher” in the writings of those inspired by the work in Reggio Emilia, Italy, home to an internationally known system of municipal preschools and infant/toddler centers where innovative ideas and practices have stimulated much interest (Edwards, Gandini, & Forman, 1998).

This view of the importance of the environment does not, however, mean that we believe that children’s learning is determined by the environment. The focus of the constructivist teacher is the child’s mind, and learning has to be looked at with the child as the center. And from the child’s perspective, there are no distinctions based on discipline; there is no delineation of “mathematics” or “science” or any other disciplinary focus. Curriculum integration comes from taking the child’s perspective—as children engage in theory-building, all disciplines blur. So if we as teachers are concerned with ensuring that children learn about different disciplines, we need to understand that we as teachers are imposing the distinctions. In addition, early childhood teachers are challenged by the typical school day that divides the curriculum into distinct periods, which also supports the segmentation instead of integration of the disciplines.

In this book, we are taking the perspective that such differentiation is necessary for us as teachers in order to ensure that we provide opportunities for children to theory-build in the two disciplines of mathematics and science through intentional curriculum. However, we need to be open to the blurring of these lines in actual practice, and to the artificiality of such distinctions from the child’s perspective. We need to intentionally provide opportunities for children to engage in activities, projects, and experiences in which mathematics and science are integrated. By doing so, we also open ourselves to the possibility of unplanned curricular integration, where children apply their theories across many different disciplines and domains. This unplanned integration—which comes out of children’s ideas, interests, and experiences—should be recognized as a positive development, for it means that children are wrestling with the underlying big ideas, big ideas that transcend disciplines and that could involve many other curriculum domains—social studies, literacy, creative arts, technology. It also means that children are seeking the deeper understanding that goes far beyond disciplines, the big ideas that are the ultimate goal of the educational experience.
BIG IDEAS AS TOOLS FOR INTEGRATION

What Is a Big Idea?

A big idea is an overarching idea that engages, inspires, and is relevant to children’s interests, an idea that is rich with possibilities. As children play, they interact with their material and social environment, and are naturally actively interested in the big ideas that surround them. Balance, in the broad sense of the word; movement; transformation—these are big ideas. Within each big idea are many concepts that are connected. When children learn concepts under the umbrella of the big idea, deeper understanding is possible. For example, the big idea of balance incorporates concepts such as symmetry, measurement, one-to-one correspondence, and equivalency. Figure 1-1 shows the relationship between big ideas and concepts.

Reflect and Respond

Cassandra has been in her student teaching placement site for 2 weeks and the cooperating teacher is expecting her to plan a math lesson for the first graders. After looking at the teacher’s guide, Cassandra realizes that she could use the math concept of graphing to include real data collection from the children’s interest in rocks they have found on the playground. However, the teacher’s guide has several pages of data that the children are supposed to transfer to bar-graph worksheets. Cassandra is wondering how she will bring up her idea with her cooperating teacher.

Question to Think About: What would you do or say if you were Cassandra?
CHAPTER 1 Constructivist Curriculum Framework for the Integration of Math and Science

Characteristics of Big Ideas

Big ideas help children obtain deeper understanding rather than superficial, disconnected content knowledge, or the acquisition of facts. Big ideas allow for connections to be made within and across such ideas and knowledge, through their conceptual links. Big ideas permit children to learn many different things in a larger, more meaningful and engaging context, and allow for the application of knowledge across different content areas. In this way, deeper understanding is constructed.

Returning to the earlier example of Rebecca exploring a carrot, if we were to focus on measurement as the concept to study, our curriculum would be oriented to mathematics, and if we were to focus on biological decomposition, our orientation would be science. But by seeing the big idea underlying both—transformation—integration is at the heart of the curriculum. Children then will make connections between the mathematics and the science involved in the context of the big idea. Projects, extensions, and ideas generated from a focus on transformation all have the potential to further this integration.

In this book, we will be using big ideas—such as transformation, balance, relationships—as the underlying framework of the math and science curriculum for the very reason that curriculum integration is natural and meaningful when you do so.

VIEWS OF TEACHING AND LEARNING

The Child at the Center

As noted earlier, it is the child who is the center of this curricular approach, and all of our efforts to develop curriculum start with this premise. This has huge implications for what we do as teachers, because the primary focus is not on the content of what we teach, but rather on the learner, on the learner’s efforts to understand the world through inquiry. We are interested in, and learn from, how children are seeing the world, how they experiment and explore it, and what theories they are building. We are concerned about, and learn from, the questions children have, the interests that engage them, and the contexts in which they are motivated to build theories. This is consistent with inquiry-based learning, an approach that acknowledges that the source of deep understanding is authentic inquiry that engages children’s experimentation and exploration.
Celebration of the Diversity of Children

This view of teaching and learning recognizes and capitalizes on the strengths that children bring to the learning experience; it acknowledges their remarkable capabilities. When you focus on children’s capabilities you are also acknowledging and cherishing the diversity of the children you teach, diversity of all kinds—diversity of culture, language, socioeconomic class, and ability. For example, if you have a child with limited arm mobility, you look at the ways that she is able to engage in a particular activity—for example, drawing with a pencil in her teeth—and develop contexts where this extraordinary capability is both useful and highlighted. Or, if you have a child whose first language is Spanish, you consider incorporating resources and materials that support him in engaging in the activities and learning English, as well as honoring his capabilities in Spanish. From the constructivist perspective, all children bring special gifts and needs to the learning experience, and our responsibility is to understand, value, and respond to each child in our classroom.

What About Content?

It is our responsibility as educators to think carefully about what it is that children need to be exposed to and to learn. It is also our responsibility to have educational goals for everything we do. The approach
to curriculum that we take in this book is one in which what happens in the classroom is a negotiated dance—one in which the teacher provokes and responds to what children do with goals in mind. But ultimately, the child’s engagement is a necessary part of the process, for if the child is not asking his or her own questions, no deep understanding will occur.

And, yes, we are responsible for teaching to content standards, not only in elementary classrooms but also in many preschools, including Head Start centers and some state prekindergarten programs. As teachers we need to be knowledgeable of mathematics and science standards, those of our professional organizations (National Council of Teachers of Mathematics [NCTM], National Science Teachers Association [NSTA]), as well as those of our states (e.g., early learning guidelines) and districts. For example, your state may have adopted the new Common Core Math Standards (National Governors Association Center for Best Practices and the Council of Chief State School Officers, 2010) that you as a teacher need to address. Our responsibility is to ensure that our students come to deep understanding of those standards, not superficial knowledge. Standards can help us to establish our overarching goals, which assist in our planning and assessment. But how we meet those standards must be accomplished in a way that is consistent with how children learn using culturally and developmentally appropriate practices, and children need to be given the opportunities to construct knowledge in meaningful contexts in order for this to happen. This is particularly important in early childhood education, where professional organizations acknowledge the differences in how young children learn and how teachers approach content (see, for example, the position statement on early childhood science education from the NSTA, a position statement endorsed by the National Association for the Education of Young Children [NAEYC]).

In this book, we will be discussing the math and science standards that need to be considered as the goals of the integrated curriculum; and we will be discussing the different ways of provoking and assessing how and what children are learning in the context of integrated activities and projects.
Child-Centered Versus Teacher-Directed Curriculum: A False Dichotomy

From the constructivist perspective, there is no dichotomy between child-centered and teacher-directed curriculum—although teacher-provoked (rather than directed) curriculum might be a more accurate term. In some early childhood curriculum approaches, constructivism is misunderstood as implying that children’s interests and questions drive the curriculum entirely, with teachers following those interests and questions. In fact, teachers play a significant role in provoking, suggesting, facilitating, and responding to children’s explorations and experimentation. Teachers are an important part of the equation—contributing their own vision of what is of value to learn, of what directions to follow and to stimulate. These actions are purposeful and intentional: Teachers are making constant interpretations of children’s intentions and understandings, and from those interpretations making decisions about what to focus on, what materials to provide, and what questions to ask. This overarching vision of the teacher is guided by the goals and standards that are worth striving for, the goals and standards that articulate the kinds of things that we want children to learn.

Using standards and goals to guide the planning and implementation of the curriculum has become increasingly valued by educators from different perspectives. Harris, Smith, and Harris (2011) discuss the importance of thinking through carefully and planning around the standards in the context of the project approach to curriculum. And with a focus on assessment, Wiggins and McTighe (2005) are articulating the same approach, discussing it as backward design, an approach being implemented in many schools. This process involves looking deeply at the curriculum that is planned,
mapping it to the mathematics and science standards. This enables you to see what may be missing, underemphasized, or overemphasized in your curriculum plan, and to modify your plans as needed to meet your goals.

This puts a greater focus on what the teacher does, and places responsibility on the teacher for carefully monitoring what it is that children are exposed to, what it is that the teacher responds to, and what it is that is provoked and maintained in the classroom as a focus. How much easier to focus on set content and to deliver it in a teacher-directed way! And how much easier to go with the flow of children’s interests and spontaneous activities without thought and judgment! The constructivist approach taken in this book puts much more weight on carefully thinking through what the goals are, and carefully observing what it is that children respond to and do, in order that the curriculum is of value. The teacher acts with intention.

BACKGROUND ON THE MODEL OF CURRICULUM INTEGRATION USED IN THIS BOOK

**Historical Context**

One of the earliest proponents of curriculum integration was John Dewey, who advocated an experiential approach that was grounded in real life: “Relate the school to Life, and all studies are of necessity correlated” (Dewey, 1900, p. 81). Throughout the 1900s, many different approaches to curriculum integration emerged across the grades, approaches summarized by Vars (1996) and Beane (1997). Vars (1996), who examined over 100 integrated curriculum programs that emerged between 1956 and 1995, found that students in interdisciplinary programs do as well as or better than students in conventional programs, regardless of the type of interdisciplinary approach.

With increased emphasis on academic achievement in early childhood classrooms, some question whether integrated curriculum approaches can support student learning. This is addressed explicitly by the Association for Supervision and Curriculum Development (ASCD), which, in its overview of curriculum integration (Drake & Burns, ASCD, 2004), concluded that research supports integrated approaches. The ASCD’s overview contends that not only do students in integrated programs do as well or better on standardized tests than those in regular programs, but teaching and learning is a more engaging enterprise as a result.
Putting the current approach to math and science integration that we take in this text into historical context is important—this is not an unprecedented or even unusual approach. However, it is an attempt to make efforts to integrate math and science in the early childhood classroom, both preschool and early elementary, meaningful to and manageable for teachers drawn to a constructivist perspective.

Models of Curriculum Integration

There are several different ways of implementing curriculum integration, and different models that have been used. All of these approaches are interesting and can lead to effective integration, and the approach taken in this text incorporates elements of each but would probably be best characterized as a transdisciplinary approach.

The first is the multidisciplinary approach, in which different subject areas are organized around the same theme or topic. One way of doing this is to consider a problem or issue from different disciplines. Problem-based learning is an example of the multidisciplinary approach to curriculum integration.

The second is the interdisciplinary approach, in which the focus is cross-disciplinary skills, such as literacy, research, or numeracy. This approach is more commonly applied to middle or high school curriculum.

The third approach is transdisciplinary, which is based on the assumption that an issue or problem grounded in the real world incorporates all disciplines. The project approach (Katz & Chard, 2000) as well as the work in Reggio Emilia (Edwards, Gandini, & Forman, 1993) could be classified as transdisciplinary, stemming from children’s interests and experiences.

The Project Approach

In the project approach, children engage in working in groups on projects that incorporate a variety of disciplines (Katz & Chard, 2000). Curriculum is developed around ideas generated by teachers and children, collaboratively, that result in activities engaged in by children that are connected by a topic or theme. For example, after a visit to a fire station, a group of preschool children might decide to do a project on the fire engine—sketching the fire engine, studying parts of it such as the hoses,
and constructing a fire engine out of cardboard. In the process, mathematics and science can be incorporated into the children’s activities—either by spontaneous interest of the children or by the teacher’s suggestion and facilitation. One way to do this is that the teacher could make sure that measuring devices are available to the children as they construct the cardboard fire truck, encouraging mathematics applications. And, from a science perspective, children could become interested in the way water from the hose has the power to move objects, and could engage in some experimentation around this on the playground. The science and mathematics here is connected because of the “topic” that is the subject of the project, not necessarily because of the project itself.

Such curriculum integration could be seen as temporal rather than conceptual—the mathematics and science are occurring together in time, but are not necessarily linked by the underlying concepts being investigated. There may be some exceptions to this—children could engage in a project on the movement of objects as a result of their exploration of the fire hose, which takes the project work to the conceptual level rather than the topical level. However, it is more likely that conceptual project work would actually entail a number of projects, and thus would be more similar to the use of big ideas as the underlying curriculum framework.

The distinction between projects and big ideas is an important one, and doesn’t just involve using different words. From the teacher’s point of view, how you think of the goal of the curriculum and how you plan what to focus on, what to capitalize on, what to extend, and what to provoke is guided by your curriculum framework. If you are thinking of curriculum in terms of projects, you will be guided by the topic under study—a topic that could be purely content driven. Alternatively, you could be guided by the interests of the children, or an event that happens. On the other hand, if you are thinking of curriculum in terms of big ideas, you will be thinking in terms of the conceptual connections that children are making, as well as the broader scope of possibilities
within the conceptual framework of the big idea. You would, of course, also be responding to the interests and needs of the children, always remembering that children’s engagement is a necessary part of constructing knowledge.

One way to think of the difference is to take a project and think about what the underlying (and overarching) big idea(s) might be. Consider a project on buildings, for example, which begins when a construction project is occurring near your school. The children may have noticed the construction and talked about it in class or you may have realized that this is a good opportunity to relate project work to the children’s world. The children begin studying buildings, and their work can go in many different directions. The children might show an interest in creating their own buildings, and with support from the teacher, and some planning, the children could engage in wonderful work relating to spaces and enclosures that involves area and perimeter. Or, the children could engage in work relating to transformation—again, depending on their interests and the directions the teacher provokes. For example, 4-year-olds might notice that the bricks going up on the building look like blocks and, with the teacher’s help, decide to build walls with their shape blocks. This could lead to a discussion and study of why certain shapes work better than others for different jobs. Similarly, 6-year-olds might notice that the tires on the trucks are much larger than the tires on their family cars. The teacher of the 6-year-olds can set up an opportunity for the children to think about how to measure tires and what tools would be useful for measurement. Different aspects of the project, then, are differentiated according to the standards emphasized, but also according to the children’s understanding and interests.

There are many big ideas that could be the focus of a project on buildings—transformation (change) or spaces and enclosures are just two possibilities. If you use big ideas to guide your thinking, planning, and observations, you will think about different ways of extending, supporting, and guiding children’s explorations.

**Big Ideas, Projects, Concepts, Topics, and Facts: What Are the Differences?**

In the following diagram, we have attempted to illustrate the major differences between aspects of the curriculum discussed in the chapter, which have to do primarily with whether the focus is conceptual or topical.
### Description Example

<table>
<thead>
<tr>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesson plan/activity plan</td>
<td>A plan for a lesson or activity that includes objectives, materials, introduction to children, predictions of what children will do, and predictions of what they will learn</td>
</tr>
<tr>
<td></td>
<td>Building homes: providing children with materials and images for building with blocks</td>
</tr>
<tr>
<td>Unit</td>
<td>A set of lesson plans/activities with an overarching objective</td>
</tr>
<tr>
<td></td>
<td>A series of activities with different building materials</td>
</tr>
<tr>
<td>Topic/theme</td>
<td>“Houses”</td>
</tr>
<tr>
<td></td>
<td>Based on discussion of different types of houses, children engage in activities that may not be connected but that share the topic or theme of houses, such as reading books about houses, building different types of houses in the block area, and using small houses as counters in math games</td>
</tr>
<tr>
<td>Project</td>
<td>Building a house</td>
</tr>
<tr>
<td></td>
<td>Children study different aspects of building a house, including planning, construction, outfitting, and furnishing; might include a field trip to a construction site; culminates in building a house out of cardboard in the dramatic play area</td>
</tr>
<tr>
<td>Concept</td>
<td>Stability</td>
</tr>
<tr>
<td></td>
<td>Building structures with different materials, testing their stability, comparing the different materials</td>
</tr>
<tr>
<td>Big idea</td>
<td>Spaces and enclosures</td>
</tr>
<tr>
<td></td>
<td>Exploring different ways of thinking about spaces and enclosures; could include studying different rooms and buildings, building structures, exploring construction; could go in many different directions and could incorporate many disciplines</td>
</tr>
</tbody>
</table>

#### Reflect and Respond

In the past, when Kristin taught a unit about dinosaurs she simply gathered a lot of dinosaur-themed materials and put them around the room. There was not a lot of effort in connecting the idea of “dinosaurs” to the curriculum; it just seemed fun and many of the children loved playing with the dinosaur puppets or painting pictures of dinosaurs. But her principal has told all the teachers that all of their curriculum must be directly related to standards, so Kristin is not sure where to start.

**Question to Think About:** What can children learn about dinosaurs that would help them understand principles of science? Why do so many teachers use dinosaurs in units and themes? What is the difference between a theme and a project? How does the topic of dinosaurs enable children to learn more about the world they experience on a daily basis?

### The Work of Reggio Emilia

By studying the municipal infant, toddler, and preschool centers that are internationally known for the inspiring work that occurs in and around the city of **Reggio Emilia**, located in northern Italy, we can gain
further insights into how curriculum integration occurs in the context of the work of children and teachers who intentionally break down the separation of disciplines. Many resources are available to provide further background on the work of Reggio Emilia (Cadwell, 1997, 2003; Edwards et al., 1993, 1998; Wurm, 2005).

There are numerous ideas coming from Reggio Emilia that underlie the curriculum model of big ideas (Chaille, 2008), and they will not be repeated here. The way that curriculum is developed, however, is particularly relevant for the purposes of this book. In Reggio Emilia, the curriculum is conceived of as dynamic, and yet very intentional. This combination of careful planning and flexibility, based on what children are doing and what teachers interpret through their observations, is captured by the idea of progettazione, a form of negotiation. Progettazione involves incorporating the voices of teachers and children through dialogue to determine the curriculum. Teachers in Reggio Emilia also have big ideas in mind as they provoke and facilitate what children are doing, and use big ideas to interpret and reflect on what children are doing. For example, all of the schools a few years ago were embarking on the study of writing, with this being very broadly defined and subject to interpretation and variation depending on the particular school, the teachers, and the children. The goal of this large-scale study was to engage in the study of how writing develops. In one school, for example, the very young children and teachers were studying how writing is a form of exchange, of “gifts” from one child to another—an early form of communication. In another school, children and teachers were studying the different ways of making letters, and were inventing alphabets for sounds. The big idea of writing, or communication, is large enough, and conceptual enough, to encompass numerous approaches, interests, and endeavors, all of which are valued and support collaborative study.

Reflect and Respond

Nick has noticed that his second graders are suddenly very interested in an insect someone has brought in from the playground. The next thing on the schedule is math, and Nick feels that there simply isn’t time to talk about the insect so he has the child place the insect in a terrarium on a shelf. He goes on with the math lesson, but is struggling to hold the children’s attention because the insect has become very active.

Question to Think About: What would you do? How could you capitalize on the children’s interest and engagement?
CHAPTER 1 Constructivist Curriculum Framework for the Integration of Math and Science

Review Questions

1. What’s your definition of constructivism?
2. Can you give an example of theory-building from your work with children or your own learning?
3. What is a “big idea”? Describe one big idea that could be used to integrate the curriculum in a classroom.
4. Discuss the views of teaching and learning underlying constructivism and the focus on big ideas.
5. Describe some of the different frameworks for integrating the curriculum.

Summary

In this chapter, we’ve presented the theoretical framework and background for the approach we are taking in this book—using big ideas as the approach to integrating science and mathematics for young children in a constructivist classroom. We’ve looked at constructivism and big ideas, views of teaching and learning, and the different approaches to curriculum integration that have influenced our own. Now that we’ve set the stage, in the next chapter we’ll consider the areas of assessment and creating the environment that will lay the groundwork for this curriculum approach.

Websites

The following websites provide additional information from some of the major professional organizations in math and science, as well as information about Reggio Emilia and the Common Core Standards; they can be found by searching for the keywords below:

National Council of Teachers of Mathematics (NCTM)
National Science Teachers Association (NSTA)
National Association for the Education of Young Children (NAEYC)
NSTA Early Childhood Education Position Statement – endorsed April 2014 by the National Association for the Education of Young Children
Common Core Standards – Mathematics
Reggio Children: This is the official site of the public-private company that manages the educational and cultural exchanges between the municipal early childhood institutions of Reggio Emilia and educators from around the world.
Learning Outcomes

After working with the ideas in this chapter, you should be able to:

• Define appropriate assessment in a science and math classroom.
• Describe how assessment guides our teaching.
• Analyze the impact of appropriate assessment on children’s vocabulary development.
• Create documentation to support assessment.
• Understand the importance of interviewing in assessment.
• Evaluate the use and purpose of standards in assessment.

Margaret had just started teaching first grade. She believed that part of her job was to check children’s accumulation of school readiness skills, so she handed out worksheets on the first day of school and asked children to circle certain letters, count groups of objects, draw shapes, and record or respond to other bits and pieces of information. Most of the children struggled to complete the worksheets, and two cried. Margaret was very frustrated by this experience, and disturbed to see that many, if not most, of the children did not seem ready for first grade.
How does this scenario fit into your image of assessment? How do children feel when they are expected to do things that they are not ready to do? If we teach toward children’s strengths, how would a checklist help us make decisions? Are the most important ideas we want to assess in math and science readily assessed by tests?

WHY BEGIN WITH ASSESSMENT?

You have probably experienced assessment as grades given at the end of a course, or as a summative evaluation of what has been learned, but in this chapter we are concerned with formative assessment. Formative assessment is what happens every day when the teacher is thinking about the goals of the activities and lessons and how children are meeting those goals and what needs to be done to further children’s success. The teacher uses formative assessment on a daily basis by observing children’s responses to curriculum, taking notes, working with small groups and individuals, and tracking projects, among many other strategies. Formative assessment is the foundation for teachers’ decisions, and guides the design of the curriculum. Formative assessment also can capture experiences that can guide the curriculum in new directions. Formative assessment in early childhood education is done to:

• Plan the curriculum to meet individual children’s needs,
• Communicate children’s learning to various audiences such as families and the school,
• Support the diagnosis of special needs, and
• Evaluate instructional plans and materials.

Here is one way formative assessment can be structured:

<table>
<thead>
<tr>
<th>Name</th>
<th>Sept</th>
<th>January</th>
<th>May</th>
<th>Sept</th>
<th>January</th>
<th>May</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emma</td>
<td>/</td>
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<td>✓</td>
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<td>Sean</td>
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</tr>
<tr>
<td>Gina</td>
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</tr>
</tbody>
</table>
Formative evaluation form for Common Core State Standards for Math: The teacher would assess each child individually. If the child was able to meet the standard the teacher would check the box; if the child showed partial understanding the teacher would use a slanted line; if the child showed no understanding the teacher would use an X. This information would then be used in planning teaching activities, choosing materials, and communicating with parents and caregivers. At the end of the year the teacher would use an individual activity as a final assessment.

<table>
<thead>
<tr>
<th>Name Date</th>
<th>Emma June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Met</td>
<td>CC.K.CC.4a When counting objects, say the number names in the standard order, pairing each object with one and only one number name and each number name with one and only one object.</td>
</tr>
<tr>
<td>Has not met</td>
<td>CC.K.CC.4a When counting objects, say the number names in the standard order, pairing each object with one and only one number name and each number name with one and only one object.</td>
</tr>
</tbody>
</table>

It forms our decisions and informs our practice, and our relationships with children and their families. The best formative assessment is woven into the daily life of the classroom and is done with children, not to them.

In this chapter we will look specifically at the general knowledge needed by early childhood teachers about young children’s development in math and science, how formative assessment works in early childhood classrooms where math and science are integrated, and the factors that impact the kind of assessment that may be needed.

**Understanding Children’s Development**

In early childhood education it is essential that the teacher have knowledge about the development of children. It is where we begin when we start planning our educational experiences with and for children.

Normal development in education simply means that the child’s physical, intellectual, social, and emotional development falls into a standardized part of the continuum that has been recorded for many children of the same age, but it doesn’t mean that all children will have reached the same growth at the same time. Many things can impact a child’s development, including family culture, economics, nutrition, place of residence, and genetics. For example, consider
the factors affecting the development of each child in the following vignettes:

Aaron’s dad was a professional baseball player and his mom received baseballs and bats at her baby shower. Even before Aaron could walk his dad would roll balls to him to hit at with his hand. By the time Aaron began kindergarten he was able to stand at home plate and hit balls tossed to him when most of his 5-year-old friends had to have a stationary ball in order to play. He could count the number of balls he had hit or tried to hit and he could estimate where the ball would go if he hit it.

Seven-year-old Cassandra’s mom worked two jobs, so when Cassandra got up in the mornings her mother was still in bed. Her mom put breakfast supplies out for Cassandra the night before, but it was up to Cassandra to eat, get dressed, and arrive at school on time. Cassandra’s second-grade teacher noticed that Cassandra could not always use the correct math vocabulary, but she could estimate the amount of liquid needed for a science activity and she could be relied on to prepare the materials correctly for inquiry activities.

One issue in assessment is the expectation that all 4-year-olds or all 7-year-olds are supposed to understand or know the same things simply because of their chronological age. There are theorists in the history of early childhood education (Gesell Institute of Child Development, Ilg & Ames, 1985) who studied children and connected the behaviors they observed to specific and recognizable stages. Unfortunately, this has led some to think that the stages of development are the same for all children of a given age, but they may not be. Stage theories certainly help us understand the development of children in general, but may be less useful when thinking about individual children in today’s diverse society.

**PRINCIPLES OF DEVELOPMENT**

It may be useful to think of development principles rather than stages. The principles of development still apply even when children have physical and mental challenges or when they exceed expectations for a given stage. The principles help us think about what individual children need in order to keep supporting each child’s growth.

When thinking about math and science development it is helpful to consider trajectories of development. We can assess a child’s understanding of a concept and plan for experiences that will help them construct ideas that move them along the trajectories of development for specific concepts. This does not mean that learning a new concept will follow smoothly from previous learning, but if we know what to look for in concept development we will be ready to support the child’s growth.
For example, it has been found that most children have a good conceptual understanding of basic shapes when they enter kindergarten. But teachers have not been building on this knowledge with accurate math education and experiences. Teachers have commonly used one type of triangle to teach the concept of triangle, but children also need to see lots of different types of triangles, and discuss what makes a triangle a triangle. It is important for preschool teachers to understand that children need more than learning the names of shapes (Cross, Woods, & Schweingruber, 2009).

We can spend hours planning our teaching, but if we are not in tune with the learners then we run the risk of nothing being learned. What do we need to understand about young children to maximize the possibility that our plans actually result in the intended learning? Many studies of appropriate pedagogy in early childhood education begin with the development of children (Berk, & Winsler, 1995; Bodrova, & Leong, 1996; Frost, Wortham, & Riefel, 2011).

Some of the principles of developmental assessment in math and science are:

1. The whole child is kept in mind when doing assessments. Many forms of information are used to evaluate the outcome of assessment. Families should be part of the assessment conversation. Special needs are taken into account.
2. Children should be assessed in many different settings. Math and science understanding may look different in a whole group setting as compared to the child’s performance one on one.
3. The assessment system should be well planned, consistent, and focused on specific questions. The teacher’s background knowledge about what is being assessed should be considered.
4. The information gathered from assessment should produce a picture of learning and movement along the trajectory or path of development. Decisions are not made based on one item.
5. Assessment is used to make decisions about teaching, communicating with parents, and meeting individual children’s needs.

Responding to Children’s Needs

Teachers knowledgeable about child development understand that their response to one child’s needs can support the development of all
the children in the classroom. By planning for one child who has specific needs, the teacher can realize how much the other children will be supported by what is planned, as in the following vignettes:

Tim is a third grader with Asperger syndrome. He was easily upset when the schedule was changed, so the teacher knew that planning ways to communicate the daily schedule to the whole class would not only help Tim adjust, but would also help other children who found changes upsetting but didn’t act on their anxiety. She also knew that children’s understanding of time as a math concept had strong developmental implications. Therefore, planning for Tim helped everyone with multiple math concepts.

Shemeka used a walker in the classroom. The teacher looked at the environment with the perspective of making sure pathways were clear for Shemeka’s walker, but this was also helpful to all the children in the class who might not have good large muscle control or were easily distracted and could walk into furniture. It was important to the teacher that all children had access to materials for math and science inquiry.

The teacher also modified her assessments by comparing children’s growth over time to her records of where they started.

For example, she knew that Marty, who had impaired vision, should be able to read all the data on charts created by the children as long as the data was large enough; but she also knew that there may be some data that Emily, a child with Down syndrome, would struggle with and would take longer to recognize easily. So the teacher modified her goals for Emily. The teacher focused Emily’s attention by having her use a cardboard frame that showed one word at a time, so she made an accommodation for Emily, but the expectation that Emily would be able to also read the data and use it was the same. So, the modification was the amount of time it would take Emily to read and comprehend the data, and the accommodation was the added cardboard frame.
CHAPTER 2  Assessment

The accommodations for both Marty and Emily supported the rest of the class’s ability to participate because they could more easily see the data from a distance and they were free to use the cardboard frames to help them keep track on the list. No distinction was made that the accommodations were there for specific children; all the children accepted the changes as just part of the regular way of doing things.

Culture and Context

For assessment purposes we will define culture as the values, beliefs, and practices that certain social groups share.

Read the following vignettes and discuss what cultural values are being acted on or being referenced. How would the people in these situations feel? What could others do to support their experience? How do our assumptions keep us from learning?

Shelly had just moved to the northwestern United States and begun her new job teaching kindergarten. The weather was not at all what she was used to—she had moved from Arizona, which had a much drier climate. The first time it rained lightly she kept the children inside for recess even though they argued with her. At the end of the school day she was told rather firmly by the principal that in the future she was to send the children outside wearing their rain gear.

Some areas of the country experience lots of rain. Should children stay inside?
LaVette really enjoyed teaching third grade in a highly diverse school. Her classroom was made up of children from several different nationalities, including children from Vietnam, Honduras, and Russia. She struggled with teaching math because it had never been her strong subject. But she had heard that “math is a universal language,” so she thought that surely math would be one of the easier subjects for the children who had moved to her school from their native countries. That’s why she couldn’t understand why she was having so many problems. The children seemed to not know how to make a “9” or the names for the numerals. She observed them playing games on the playground that involved counting, but then in the classroom they wouldn’t respond to her questions about number order.

There is a common misconception that math and science are very objective and do not contain interpretative ideas or cultural concerns. Some think that at least science and math are easy to teach because as curriculum topics they are straightforward. However, science and math are human endeavors. The knowledge we have gained over the years comes from people who are part of their cultures, and is greatly influenced by the cultural context. Number systems, counting language, algorithms, calendars, natural observations, questions about nature, and data collection are all impacted by the cultures in which they developed (Leung, Graf, & Lopez-Real, 2006; Wang, 2009).

A brief search on the Internet makes it very clear that math and science information can change every day. However, traditionally, math and science are often taught as though the answers are static and unchanging. For example, some of us may have learned a mnemonic device to remember the nine planets in the
solar system, such as “My Very Educated Mother Just Served Us Nine Pizzas.” But because scientists have changed Pluto’s classification, the sentence no longer fits. If it was the only way you thought of the relationship of planets to each other, then you may have been upset by this change! When math and science are taught as separate, disconnected subjects, with rules and labels to memorize, we are teaching children to think about science and math as things that have already been done with nothing left to discover. If math and science are taught as mainly rules to memorize, we are teaching children to think that math and science only require memorization.

Children are natural mathematicians and scientists. They are constantly wondering, questioning, discovering, and theorizing about what the world is all about. Children can pick up an earthworm from the sidewalk, pluck a flower from the yard, flip a light switch off and on, pour water through a tube, or blow bubbles and see themselves as mathematicians and scientists.

If teachers then hand them a worksheet with words to memorize, lists to number, or even pictures to color, they begin seeing math and science as something that happens at school during a 30-minute time slot in the afternoon, with no connection to their rich lives outside of the classroom. The children in our classrooms come to us with widely differing experiences, understanding, abilities, and interests. When we think about assessment we have to consider each child’s individual situation and background. Again, our assumptions about who children are can positively or negatively impact our teaching decisions.

**PRINCIPLES OF ASSESSMENT**

Assessment has to be sensitive to individuals, but certain general principles in early childhood classroom assessment hold true in most situations. The following assessment principles have been adapted from the
National Association for the Education of Young Children (NAEYC), the National Council for Teaching Mathematics (NCTM), and the National Science Education Standards (NSES). The Common Core State Standards for Math (National Governors Association Center for Best Practices and the Council of Chief State School Officers, 2010) include standards for mathematical practice that can be used as a guide for the integration of assessment into math and science tasks.

Assessment Should Be Valid

Validity means that you are measuring what you intend to measure. Validity means that there is a strong connection between what was taught and what is being tested. The intentional teacher thinks carefully about the connection between what was taught and what will be assessed. For example, if the concept being taught is change over time in the life cycle as a big idea, then the assessments would not necessarily only document children’s ability to list the stages of a frog’s development, but would also document the child’s understanding that the frog goes through big changes over time. Listing the stages would document a child’s ability to remember labels in a certain order, but would not indicate that the child understands the idea of change or change over time. Instead we would want to know that the child has begun to understand the connections from one kind of life cycle to another life cycle, whether it is a butterfly, a plant, or a human. Similarly, if we spend all of our time teaching children the rules for adding and subtracting double digits, then we have missed the bigger underlying idea of grouping and regrouping. The children may be able to tell you that when subtracting 25 from 42 you have to mark out the 4 make it a 3 and give a 1 to the 2, but that simply tells you that they can memorize a procedure. It does not tell you that they understand the underlying concept.

Assessment Should Guide Teaching Decisions

Assessment is cyclical. Something is taught, assessment is done and interpreted, and then a decision is made about re-teaching, reinforcing, moving on, or rethinking the goals. Without assessment, teaching would be a series of activities that move forward whether they make sense or not. Good assessment will guide your decisions as a teacher about each child in your class. Formative assessment tells us what to teach next or what project to begin. For example, one math practice from the Common Core is the use of modeling. Teachers can easily use a child’s ability to model a math idea as a form of assessment (National Governors Association
The teacher could create a rubric for what parts the model must have to show understanding by the child (see Figure 2-1). Consider the teacher’s use of a rubric in the following vignette:

Louise used a rubric to guide her observations of her preschoolers’ play with paper-clip chains. She challenged them to find things that were the same length, longer than, and shorter than chains of various lengths. She watched carefully to see if they tried to match the starting points, if they were aware of the size of the units, and if they could match the lengths closely to the objects they found. She noticed that some children had little awareness of these attributes for measuring, but a few actually made chains the exact length of the objects.

**Figure 2.1**
Rubric for General Knowledge Development

<table>
<thead>
<tr>
<th>Level</th>
<th>Make sense of problems and persevere in solving them</th>
<th>Reason abstractly and quantitatively</th>
<th>Construct viable arguments and critique the reasoning of others</th>
<th>Model with mathematics</th>
<th>Use appropriate tools strategically</th>
<th>Attend to precision</th>
<th>Look for and make use of structure</th>
<th>Look for and express regularity in repeated reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Planting seeds</strong></td>
<td>I don't know where to start. Loses interest</td>
<td>I don't use math thinking</td>
<td>I don't see any connection between the problem and what others are doing.</td>
<td>I'm not sure what math I am supposed to use. Doesn't have basic number sense/doesn't know numeral names</td>
<td>I did not try to use any math tools.</td>
<td>I did not understand that my response was not accurate.</td>
<td>I looked to the teacher or others for clues where to start.</td>
<td>I see no connections between this problem and others.</td>
</tr>
<tr>
<td><strong>Growing</strong></td>
<td>I started with the part of the problem I knew, but only solved that part.</td>
<td>I have some mathematical thinking.</td>
<td>I listened to others and added to the math conversation.</td>
<td>I used symbols and numbers to express one idea.</td>
<td>I used math tools, but had several errors in use.</td>
<td>I questioned my answer.</td>
<td>I could classify one part of the problem/saw a pattern but had trouble connecting it.</td>
<td>I saw a repeating functions.</td>
</tr>
<tr>
<td><strong>Blossoming</strong></td>
<td>I understood the problem.</td>
<td>I used math to solve the problem correctly.</td>
<td>I could explain my thinking/I could point out issues with other solutions.</td>
<td>I could write/draw 2 different ways to solve the problem.</td>
<td>I chose an appropriate tool and used it correctly.</td>
<td>I knew my first answer was incorrect and changed my reasoning.</td>
<td>I saw a pattern during the process and used it to help solve the problem.</td>
<td>I used regularities in math to solve the problems.</td>
</tr>
<tr>
<td><strong>Flowering</strong></td>
<td>I understood the problem and used math rules to solve it.</td>
<td>I used the rule to extend my explanation.</td>
<td>I explained other’s ideas using correct math terms.</td>
<td>I could write/draw 3 different ways to solve the problem.</td>
<td>I could use more than one tool correctly/and explain why it worked.</td>
<td>I could explain why my solution was correct</td>
<td>I saw more than one pattern/rule during the process.</td>
<td>I could explain how the problem could be extended.</td>
</tr>
</tbody>
</table>

*Source: Ken Davis*
You can focus on math or science when doing assessments with rubrics. A general rubric for math might be applied to a science project in order to document children’s thinking in specific situations.

**Assessment Should Be Part of a System That Is Designed to Support the Whole Child**

The intentional teacher chooses assessments that make sense in the context of his classroom, his approach to developing a community of learners and his knowledge of the children, their families, and their needs. If children have been collecting data about their observations of the tree they have adopted, for example, the assessment used would take into account each child’s abilities, language, and social development, as well as information needed by diverse audiences—the children, their families, and the administration. The teacher may have to be more focused on certain individual children at times in order to compile a needs assessment request or find out the source of a particular problem in learning. One of the strengths of an integrated math and science approach is the ability of the teacher to work with a child’s strengths rather than always focusing on things the child is struggling with.

**VOCABULARY DEVELOPMENT AND ASSESSMENT**

In today’s classrooms, diverse cultures and languages mean that teachers have to be aware of all the ways children communicate and understand ideas. Appropriate and useful assessment is not going to happen without children’s communication, and this underscores the importance of language development. Children’s vocabulary and ability to talk about their ideas can develop rapidly when they have been genuinely engaged in an interesting topic.

Math and science offer opportunities for engagement that will result in not only the growth of
vocabulary, but also deeper conceptual understanding and communica-
tion of ideas through language. In order for this to be supported, the
teacher must value children’s talk. However, when teachers depend on
worksheets and prescribed curriculum, children’s talk is kept to a mini-
mum. Those teachers may see teaching as transferring information, which
doesn’t really leave a lot of room for children’s talk, other than simply
responding with the answer the teacher is expecting. For some teachers
classroom management might mean keeping children quiet and working
alone. The idea of the teacher as the center of attention and the controller
of all talk is a strong image that is difficult to change.

In order to change this image, it is helpful to consider what consti-
tutes learning. Although you can learn new words by memorizing them,
this doesn’t help you communicate complex ideas. You have words in
your conversational and professional vocabulary that are there because
they are useful, meaningful, and interesting. In order to support chil-
dren’s vocabulary development, it is important that classroom teachers
provide and support opportunities for language use and language learn-
ing that are linked to math and science. Consider the following vignette:

In one first-grade classroom the children were studying physical properties
of matter. The teacher had 30 minutes in the schedule each week to focus on
concepts in science, and if there was a school assembly or other special event
this 30 minutes often got left out. Today she passed out worksheets that had
black-and-white drawings of various materials. The children were to circle
the pictures that showed matter as a solid, a gas, and a liquid. She walked
around the room, keeping the children quiet and helping them find the cor-
rect examples. She found herself more and more frustrated by their apparent
lack of effort. It seemed so easy to her; she couldn’t understand why they were
struggling. One child had circled the picture of an ice cube for the example of
liquid, and another child circled the picture of a puddle for gas. A few children
had completed the worksheet and were now talking to their neighbors, playing
with markers in their desks, and disturbing others. It made her think that this
30-minute science period could have been used for more math.

What do you think the teacher might have found out if the chil-
dren had been encouraged to discuss their choices? What would chil-
dren be learning from this worksheet? What is assumed by a using a
worksheet like this? What could the children be doing instead?

In another first-grade classroom, children were at various stations around the
room investigating air. Two children were holding scarves above a homemade
wind tunnel and laughing delightedly at the movement of the scarves when
they let go of them. Three children were making pinwheels, coloring shapes on
CHAPTER 2 Assessment

The teacher walked around the room, jotting down things the children were saying, taking photos of some of the products being created, writing down notes about materials she wanted to add to the things available, and listening for ways to support the language being developed. At the end of the project exploration period the teacher had a large chart available so she and the children could record some of the ideas and words they had learned and used. The chart already contained words from an earlier investigation about air, and now the children excitedly added new observations.

How is this scenario different from the first one? How does this scenario support children’s learning and our image of teaching? How does this scenario describe children’s language development? Why was the teacher in the second scenario not frustrated?

Teacher Language

Research tells us that the language used by teachers is extremely important (Johnston, 2004). In math and science, language becomes a key to communicating ideas clearly and accurately. For example, when teaching children to group and regroup in addition, teachers often say “Carry the 1,” but it is not a “1” we are carrying, it is a “10,” and we are making a new group, not simply moving a digit. We may think that this is just shorthand for what we mean, but the concept of “1” is very powerful in children’s thinking. Similarly, in science we may always refer to insects as being in a classification group separate from people, dogs, birds, and other animals, which is true when talking about classification in one sense, but this ignores the grouping of insects as being part of the Kingdom Animalia.
Insects are first grouped as animals and then in that grouping are classified further as insects if they have three body parts, three pairs of jointed legs, two antennae, and a hard outer skeleton.

Another aspect of teacher language that we know impacts children’s experiences in math and science is the kinds of questions teachers ask. This becomes especially important to think about when doing assessment.

If we are constantly looking for the “right” answer we tend to ask questions that have one answer. This does not help us assess children’s understanding and thinking. Children do not get opportunities to discuss their theories when teachers create questions that have only one answer. Teachers sometimes say they want the children to participate in discussions, but then they create many rules controlling children’s talk.

Suggestions for language that supports assessing science and math ideas include the following:

<table>
<thead>
<tr>
<th>Instead of</th>
<th>Try This</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the right answer?</td>
<td>Tell us more about your thinking.</td>
</tr>
<tr>
<td>You didn’t include __________________________</td>
<td>What else do you notice?</td>
</tr>
<tr>
<td>What is the name of this shape?</td>
<td>What do you know about _____________________________?</td>
</tr>
<tr>
<td>You need to count again.</td>
<td>Can you count another way?</td>
</tr>
<tr>
<td>You should raise the ramp to make the car go faster.</td>
<td>What could you do to make the car go faster?</td>
</tr>
<tr>
<td>You made a mistake.</td>
<td>Can you show me what you did?</td>
</tr>
</tbody>
</table>

Consider the following vignette:

*Asha decided to research children’s talk in her third-grade classroom. She took notes and listened carefully to children’s discussions when they were in small groups working on projects investigating things they could do to improve their*
neighborhood’s environment. Before she did this, she had thought that the small groups might not be working because the noise level in the room got higher than she was comfortable with; however, after a few sessions of note taking she was pleasantly surprised to find that the children were engaged in very rich discussions about all sorts of environmental concepts. The noise level was just the result of children becoming passionate about their ideas and theories. This helped her realize that the children actually needed a lot more time rather than cutting back on small-group work.

Documentation of Children’s Learning as Assessment

When we document children’s work we are recording and saving evidence of their thought processes as they write, draw, talk, act out, and communicate, in order to support our understanding and analysis. **Documentation** of children’s work leads to more authentic assessment. Authentic assessment, as opposed to standardized assessment, is a general term referring to the analysis and measurement of meaningful products. Usually authentic assessments are of more use to the classroom teacher because they are sensitive to individual children’s abilities, interests, cultural experiences, skills, and construction of knowledge. Sometimes teachers design authentic assessments in connection with children’s input. Authentic assessments are generally done often and are collected so they paint a more complete picture of the child’s progress and knowledge.

Documentation is also a cornerstone of classrooms inspired by the work in Reggio Emilia (Edwards, Gandini, & Forman, 1998). Educators in the municipal schools in Reggio Emilia believe that documentation is essential. It guides their interpretation of children’s learning, provides the basis for ongoing reflection on classroom experiences, and empowers the child, who is involved in the process.

There are many ways teachers can document children’s learning, including these:

- Photographing children working and then photographing their final products
- Writing a narrative of the process of a project
- Taking notes about individual children’s actions during a project
- Collecting samples of children’s work over the course of a project or about specific topics
- Recording comments from others as they view the child’s work
CHAPTER 2  Assessment

- Recording children’s comments as they work and as they look at a final product
- Completing checklists of expected behaviors, dating the time and place they occurred, with room for explanatory notes
- Videotaping segments of a project or topic being explored by children
- Creating class-made books that use children’s illustrations to tell the story of learning about a topic
- Creating documentation panels that record the steps the class took to learn about a topic

In an integrated math and science classroom all of these might be used, but before this is useful teachers have to understand how to support children’s learning and the skills involved in the use of tools. We don’t just hand children a sheet of paper and expect them to be able to produce a picture that we can add to their portfolio. Learning to express their ideas and thinking through a variety of forms of representation is an important part of the curriculum. Documentation is integrated into the curriculum, and is an integral part of the curriculum plan.

Documentation Strategies for Integrated Math and Science

There are methods and materials that teachers can use to document children’s work in math and science that are particularly powerful, as discussed in the following sections.

Representations

When we talk about drawing or manipulating materials as part of assessment (for example, creating three-dimensional structures) we are not talking about artistic ability, but rather about the representation of thinking. Young children can be supported in representing thinking by looking at their work as a form of communication. In Reggio Emilia classrooms, children’s drawings and other representations are a central part of the way teachers interpret what children understand, what they are interested in, what their questions may be, and their planning (Wurm, 2005). It is not necessarily “art”—in fact, there is no time set aside for the arts in Reggio Emilia classrooms, it is woven seamlessly and extensively into the life of the classroom. Creating representations as a form of communication of one’s thinking is embodied in the idea that children have “one hundred languages” (Edwards, Gandini, & Forman, 1993). Children are taught the skills for arts-related representations as
they are needed and are encouraged to apply them in numerous contexts.

Children need to be taught about, and given access to, many different media and opportunities so they can choose materials that best support the ideas they want to convey. For example, a teacher might plan a lesson where children are focused on moving different parts of their bodies. The children then have that knowledge and can use it to represent their understanding of how a machine works or for acting out the water cycle.

**Observational Drawing**

Observational drawing requires looking closely. Observational drawing is different from other types of drawing because you pay less attention to the pen or pencil and spend more time looking at the object you are drawing.

Young children are quite capable of observational drawing when given the opportunity as well as experience with the tools needed. To create the best drawings children usually need to use pencils and pens, but the particular tool will vary depending on the child’s age. In general, markers are good for coloring in spaces, but not for fine details. Markers are considered more of a painting medium.

We can teach children to be close observers for observational drawing by first having a discussion about the object to be drawn. You can ask the child to look at the lines that make up the object, to find shapes, and to see how the different parts of the object are connected. See Figure 2-2.

The following guidelines support teaching children how to do observational drawing:

- Encourage scribbling. Children’s marks indicate an exploration of lines and shape, and provide experiences with materials that can be used with more intention later.
- Avoid labeling what you think a child is drawing, but do describe the shapes and lines that you see: “You have drawn a large circle with lines coming out of it.”
- Avoid overt exclamations about how well a child is drawing; this will lead children to believe their pictures are supposed to represent something you think is important. It will also lead them to
believe that the drawing is completed, when there may be much more exploration and expression possible.

• Help the children see details and shapes: “Oh look at the sail on the boat; it’s shaped like a big triangle.”

Consider the observational drawing taking place in the following vignette:

Melissa’s second graders were very involved in their project about plants. The children had decided to form small groups that would each study one of the plants found on the school grounds. As part of their research, the children had collected a few samples of their plants and had arranged them in the middle of their group tables. Melissa led the children through close observations of the plants by pointing out parts and labeling them. Each day at least one of the children would carefully observe the plant, sketching the changes that were noticeable. The sketching involved using a good-quality drawing pencil so lines could be erased, lightened, or darkened easily. Another child liked to capture the colors she observed and spent several minutes mixing watercolor paints to get
just the right shades. Still another child liked to use oil pastels to capture the soft colors.

The teacher’s role in this situation is to have goals in mind for the learning that may be taking place. Careful observations of the children’s work and their conversations holds valuable information. In Melissa’s situation she realized that the children needed more support in recognizing the individual parts of the plants, so she found detailed, artistic botanical prints that could be mounted next to the tables so that the children could easily reference the parts of the plants and compare them to the specimens they were drawing. To check for comprehension and see what the children understood about the parts of the plants, Melissa could have them write about plants in general, perhaps encouraging the class to create a book that contained all the information they had gathered.

**Three-Dimensional Materials**

Teachers often forget that children enjoy expressing ideas with materials that they can use for construction. It is sometimes easier to have paper and pencils stored for children, but there are many ideas they cannot express in two dimensions. Children are much more capable of using three-dimensional materials than we give them credit for.

**Clay:** Good-quality modeling clay is different from dough. It will hold a shape, whereas most modeling dough is too soft. Children who are trying to create a model of an animal will appreciate the fact that they can make legs that hold the animal up. If you have access to a kiln you can use the kind of clay that requires firing, but self-hardening clay will work also. Just like other materials, young children need a lot of time to explore the qualities and nature of the clay. This has to happen before they can make something that is representational. When you introduce modeling materials to children you can talk about how they are going to be used, how to clean up, and how to store the materials.
so they don’t dry up. Children are very aware of taking care of materials when they are trusted to use real things.

Once children are familiar with modeling clay, accessories can be added that will help them think of ways to manipulate the clay, such as small sticks, rollers, straightedges, and water. Cookie cutters and other typical dough toys do not support the child’s own thought processes and representational abilities and should be avoided, as they limit the possibilities of representation.

**Building Materials:** There are multiple materials on the market that are designed to support children’s three-dimensional work; however, very inexpensive materials can sometimes work as well or even better. Manufacturers create materials that are colorful, but that may be distracting to a child. Some teachers avoid plastic manipulatives and building materials so the children can bring their own imagination to the problem and connect more closely to nature. Sticks used with clay might be a better building material than things made to go together in specific and limiting ways. A collection of cardboard boxes and sheets of cardboard will lend itself easily to representational building.

**Capturing the Documentation**

Teachers can save two-dimensional representations done by children in portfolios, notebooks, and files. Photos or videos of three-dimensional representations can also be saved. The materials could be organized for each individual child, by teaching objective, by standard, or by topic. The exact material saved and how it is organized is going to depend on the purpose. If the teacher is documenting learning that she wants to share with families at a conference, then she might be focusing on developmental growth and academic goals that would be similar for each child, but would reflect where the child was at the beginning of the assessment period. The materials for that goal would then be saved in an individual child’s portfolio. If the teacher is documenting a project that the class has been involved in, then the documentation can be organized temporally, telling the story of the project as it unfolds over time.
More Formalized Assessment Tools

Assessment can be either formal or informal. Formal assessments are most often tests that are used to evaluate the acquisition of knowledge and are generally not appropriate in early childhood education; they still may be required despite being inappropriate. On the upper end of the early childhood years, tests may be seen more often as part of the school system’s accountability framework. Teacher-made tests, which lack standardization, may be more authentic and useful, but still need to be a very small part of the assessment process. Informal assessment is generally done in the context of the classroom.

Rubrics

One type of formal assessment sometimes used for math and science in early childhood classrooms is rubrics. Rubrics are used as scoring guides (Stevens, Levi, & Walvoord, 2012). They generally involve a set of criteria about learning goals, with numerical weights used to separate levels of learning. Rubrics are often written in table form with the criteria listed down one side and the points or values distributed across the top. Each section of the rubric describes the expected qualities for the points or values. Like other more formal forms of assessment, rubrics must be used with caution with young children. Proponents of rubrics maintain that there is a fair appraisal of children’s work when everyone agrees on the criteria for quality, but critics of rubrics point out that rubrics limit our imagination. Even though the thought is that rubrics can support authentic learning, the reality is that any assessment tool requires interpretation. There is no formal, standardized assessment tool that should be used by itself. Again, assessment in early childhood education should be a collection of information gathered over time, sensitive to the individual rights of the children and their families. However, there are ways rubrics could be useful in the collection of information about children’s learning in a math and science integrated classroom.

There are basically two kinds of rubrics. Holistic rubrics have generalized descriptions and can be used with a variety of products. For example, a teacher may have a general rubric that describes what children need to include in their science journals. This would be used by the teacher in assessing what children have done and then could serve as a reference during family conferences or could be added to an educational portfolio. Analytic rubrics assign partial scores and are more commonly used with procedural projects, such as a documentation panel the child must make to use in a classroom museum.
Sometimes rubrics are used to evaluate a child’s individual response when compared to responses from a group. This can give the classroom teacher a place to begin in understanding the child’s developmental level of thought. It is important to gather preliminary information about what you expect children to be able to do. This involves having children do a task you can use as a guide for what you will eventually assess. The process is as follows:

- Create an assignment that focuses on what you want to assess.
- Use the children’s work to decide what levels of understanding they have. Engage children in a discussion about what the work shows about their understanding. Create a rubric that mirrors these levels of understanding.
- Create a new assignment that focuses on the same concept or topic.
- Use this particular product for your assessment. (Leonhardt, 2005; Lilburn & Ciurak, 2010; Yoshina & Harada, 2007)

Another appropriate way to use rubrics in early childhood classrooms is to have children analyze their own thinking. By giving them faces showing various emotions, for example, children can mark the face that shows how they feel about specific things that have been taught or have happened in the classroom, as can be seen in Figure 2-3.

Figure 2-3
Daily Rubric for Child Input

My Day

Work

Clean-up

Helping

Source: Ken Davis
Science and Math Journals

In a preschool classroom journaling can take the form of a whole-class activity with the teacher acting as scribe. Children can then add ideas through drawing, write their names on a list, make tally marks or checks, and find pictures in magazines to add to the class page. Three interwoven components—drawing, writing, and thinking—are used fairly widely in early childhood classrooms. The intentional teacher knows that he has to plan for the use of these in assessment.

The first component, drawing, is so powerful that many children will be motivated to add things in writing too, but beginning with the drawing is important for scaffolding children’s thinking. This is not an art opportunity; rather, it is the child’s visualization of her thinking process. It is important to allow the child to use pencils or pens that will support the addition of details. There may be a reason for the child to add color, but it is not necessary to have children color all of their drawings.

The second component, writing, can be a natural extension. Each day as projects are worked on, children may be more willing to try to write down their observations, new vocabulary, or questions. This could be a description of what they tried, or what someone else did. It could include the child’s labels for parts of illustrations. Working in journals is an open-ended activity that will help teachers understand what level of writing children are trying to use.

The third component is the process of hypothesizing, or wondering what is going to happen next: What will I try the next time? Why do I think __________ happened?

Having children keep science and math journals or notebooks offers a wonderful way of integrating content with other aspects of the curriculum. Teachers often choose to not spend time teaching math and
science because of a concern about time needed for literacy concepts and standards, but journals can give teachers opportunities to assess multiple literacy standards, in contexts that children will find engaging. Science and math journals can become authentic sources for assessing the children’s ongoing construction of knowledge. The journals can be reviewed by the teacher during projects for specific concepts, they can be shared among small groups of children for conversations about ideas and what has been learned, they can be shared with parents during conferences, or they can represent part of a larger portfolio of an individual child’s progress (Kostos & Shin, 2010).

Notebooks in primary classrooms could be organized with the following structure:

- **Title/Cover.** This can reflect the topic being studied by the whole class or part of the topic as chosen by the child.
- **Table of Contents.** This can be a set list of items chosen by the teacher for the journal or it can incorporate organizational decisions made by the child.
- **Organizational Features.** These may vary according to what the classroom teacher hopes to accomplish but could include page numbers, dates, activity titles, time, and questions being researched.
- **Glossary/Vocabulary.** The children can keep separate areas of the journal for listing and defining the words they need as part of the projects. This part is often shared with the class in the form of a “Word Wall” or topic chart where children can add words as they are explored. Sometimes teachers give the children several words at the beginning of the project and then these words are illustrated as they are needed during the project.

The journals or notebooks then give the teacher ways of assessing children’s prior knowledge, procedural understanding, language arts skills, and concept construction. Journals and notebooks can obviously become very elaborate and time consuming, but they can also be a way to support the teacher’s ability to collect data and information and give children power over their own learning.

Consider the use of journaling in the following vignette:

In one kindergarten classroom, journals were used as a documentation of children’s science wonderings. The journals were five sheets of copy paper folded and stapled with colored covers. This was about the number of pages needed for individual topics being studied or projects that were under way. Each day
15 minutes was set aside for everyone to retrieve their science journals from a centrally located file box. As the children drew and wrote about their project work the teacher was free to circulate around the room, using a stamp date on their pages, taking dictation from those children wanting to write more than they were capable of doing yet, and nudging those who could write more into stretching their efforts. The teacher encouraged some children to add labels to their pictures. As the teacher observed their work, she could tell where each child was in his or her science concept development based on what they chose to draw and write. She was able to take notes about what misconceptions needed to be looked into and what materials would support further exploration. As the journals were completed, the teacher could easily save them for parent conferences and portfolios.

INTERVIEWING FOR ASSESSMENT

There are many ways to interview children in the classroom for information about their knowledge of math and science. The flexible interview was developed by Herbert Ginsburg at Teachers College Columbia (Ginsburg, Jacobs, & Lopez, 1998). This consists of four main parts: presenting the problem, checking comprehension, investigating thought, and interpreting.

*Presenting the problem:* The teacher gives the child or children a problem that uses materials the child can manipulate. The problem should be very engaging to a young child.

*Checking comprehension:* The teacher makes sure the child understands what she is being asked to do by restating the problem, modifying words, or questioning the child.

*Investigating thought:* The teacher observes the child’s response and asks questions to clarify the response, such as, “How did you figure that out?” The teacher does not correct the child’s answer.

*Interpretation:* The teacher takes everything he knows about the child to come to an interim conclusion about the child’s abilities, thought patterns, skills, and knowledge construction. The teacher needs to know what the child thinks about the problem, not whether the child is right or wrong (Ginsburg et al., 1998).

Interviewing for assessment gives the teacher more insight into what is needed to plan for teaching, and to better understand individual children’s thinking.
Questions That Help with Assessment

If you need to understand the child’s thinking, then most of your questions will be open-ended, but there could still be specific things you may be paying attention to. Questions are designed to probe the child’s thinking by having children explain to the interviewer how or why they answered as they did. It is important to set things up so that the children can show the interviewer what they were thinking as they manipulate objects.

There are some basic questions that will help when trying to understand the child’s thought process:

- “How did you figure that out?”
- “How do you know?”
- “What do you mean?”
- “Can you show me what you did?”
- “Are you sure?”

The follow-up questions will depend on the child’s answer. As the child explains or expands on a thought process, you can ask authentic questions by not taking what the child says as a final statement.

Questions can be part of regular classroom activity; they don’t have to be relegated to a conference with the teacher. Consider the following example from preschool:

The preschoolers had been playing with ramps all week. They built them in the block center, they created ramps with books for use with toy cars, and they made tiny ramps with craft sticks stuck in clay. Shelly needed more information for the children’s portfolios for parent conferences about their ability to use numeral names. So as part of their play, she helped them make numbered paths out of paper strips the cars would roll onto from the ramps. As they played, she took notes on a clipboard regarding who used number names, who ignored them, and who tried to expand the number paths so the cars would “go to a bigger number.” This assessment during play helped her see what the numbers meant to children and who knew the names of the numbers. If she needed more information from a few children who were not as involved in this play, she could casually ask them where the cars had stopped.

Here is an example from third grade:

Kristin was sure that her third graders understood place value; after all, the concept of place value was taught in the first grade and reviewed in the second. But she was also aware that place value was sometimes only understood as the labels...
for the places in numbers. She had given them a worksheet to assess their ability to recognize place value by labeling the ones, tens, and hundreds in three-digit numerals. They all completed the worksheets successfully. Kristin decided to do a little more assessment by asking individual children to count out 14 buttons and then show her how many buttons were represented by the “4” in “14” and how many represented were represented by the “1” in “14.” She was very surprised when she did individual interviews to find that more than half of them could not show her that the “1” in “14” was actually 10 buttons! She realized that the children needed many more opportunities to count groups and record their findings. She found several simple games that the children could play in pairs or by themselves and planned for the whole class to have at least two times a week of math game time.

**Interviewing Activities**

The following activities, when done for assessment purposes, are not opportunities for teaching as direct instruction. Interviewing for assessment is done solely to understand the child’s thinking. The image of the teacher as one who gives answers and corrections is very strong, but does not support the constructivist theory of learning.

**Preschool**

To investigate the concept of one-to-one correspondence with 3- and 4-year-olds, you can have them compare two sets. For example, place a group of five pictures of dog houses on the table and a group of five pictures of dogs. Ask the child to count the pictures and tell you if there are enough dog houses for the dogs. Take note of what the child says. Ask the child to show you what she is referring to. Take notes about whether the child lines up the dog houses with the dogs, and how the child talks about the similarities in the sets. Then present an uneven set of pictures of matching objects and again ask the child if there are enough of each object. Take notes about how confident children are with their answers. If they say that there are enough but the sets are uneven, ask them to show you.

**First Through Third Grade**

Try this with a child you think should understand place value. Generally children are introduced to place value as a specific math concept sometimes in the first grade, but usually by the second grade they are being asked to add and subtract multiple-digit numbers. Have them
count out at least 14 small objects. Then have them write the number “14” on a piece of paper. Ask them to indicate to you by moving the objects how many the “4” stands for. Once they have done that, have them show you how many the “1” stands for. This is not an absolute assessment of their place-value understanding; other forms of counting, grouping, and labeling will be useful too, but it may surprise you to see that their constructed knowledge about this symbol system is not as deeply understood as you thought.

**STANDARDS AND ASSESSMENT**

Standards and standardized testing are two different things. There has been an ongoing debate in the education world about the role of standards in education.

There are many different content areas of education, each with its own defining ideas about standards. In 2010 national standards for mathematics and English (Common Core Standards) were published by the National Governors Association Center for Best Practices and Council of Chief State School Officers (2010). In 2013, the National Science Teachers Association (NSTA), in partnership with other science groups, released the Next Generation Science Standards (NGSS). These standards are based on *A Framework for K–12 Science Education*, published in 2011 by the National Research Council. States will review the NGSS before adopting them, and national standards for social studies and other curriculum areas may follow.

Standards are designed to give clarity and guidance to the curriculum. The Common Core Standards do not offer advice for meeting individual needs. Classroom teachers trying to implement the Common Core Standards will need a great deal of knowledge and support in implementing the standards. The movement to Common Core Standards is also not without critics, who argue that the implementation of national standards will lead to more standardized testing, less culturally sensitive teaching, and a weaker focus on the learner. This is an extremely important issue to consider, especially in the early childhood years:

No set of grade-specific standards can fully reflect the great variety in abilities, needs, learning rates, and achievement levels of students in any given classroom. However, the Standards do provide clear signposts along the way to the goal of college and career readiness for all students. (Council of Chief State School Officers and National Governors Association Center for Best Practices, 2010, p. 4)
It has been more conventional for professional organizations to develop standards that are then used by states when developing specific content standards. This is currently true for the National Science Education Standards (Schweingruber, Keller & Quinn, 2012), which are becoming a framework approach to what children need in science education.

It is an important point to emphasize that the Common Core Standards for math and science are not meant to take the place of specific lesson content objectives developed by individual school systems, but are intended to guide those school systems so that there is a greater consistency across the United States for the expectations in math and science education. How those standards are addressed in classrooms is still the responsibility of states and school systems, as well as the individual teachers.

It will be part of your job as a professional educator to become familiar with those standards that your state or school system has created or decided to adopt. However, this does not mean that standards should be used like a checklist and that every child will meet every standard. In early childhood education the focus is on the individual development of each child. The teacher must use the standards as a guide, but with the individual child in mind. Teachers also have to understand that to meet a standard in the third grade, for example, children will need to have experience with the underlying ideas in that standard beginning in preschool. Children will not automatically understand the idea of a fraction in the third grade if they have not had prior experiences with parts and wholes.

Standards can have positive benefits:

- They can define a broad field of curriculum to provide some continuity across many different levels and grades.
- They can create a research base to develop better curriculum.
- They can add a component of professionalism to the field of early childhood education.
- They can provide specific ideas for accountability. (Seefeldt, 2005)

The position we take on this subject is that standards are not a “bad” thing; we need standards to guide our systematic decisions on a large scale. However, when meeting standards becomes the focus of the curriculum, children’s understanding runs the risk of becoming a secondary consideration in teaching.
Standardized Testing

Standardized testing means using tests that are designed to be administered and scored the same way for all students. Standardized tests are generally created outside of the immediate context of the classroom and are intended to hold all children to the same measurement criteria. Unfortunately, the use of standardized tests in the earliest grades has grown despite a lack of research to support the reliability and validity of the findings. Research indicates that standardized testing is not appropriate when making decisions about an individual child’s educational program (Viruru, 2006). There are many books on the market examining the issues of standardized testing and the problems that develop when standardized testing is used in early childhood to the exclusion of other kinds of authentic, classroom-based assessment (e.g., Harris, Smith, & Harris, 2011; Kohn, 2000).

EdTPA

EdTPA (formerly known as Teacher Performance Assessment) is a national system for assessing beginning teachers during student teaching experiences. It requires video recordings of planned teaching episodes labeled as teaching segments. It is designed to mirror the types of assessments given to other professional occupations for certification. EdTPA requires specific forms of documentation of children’s learning. In EdTPA language, documentation is referred to as artifacts and includes the documents used to plan and record the planning involved in teaching. The focus is on the achievement of children resulting from the planned teaching segment.

EdTPA is being adopted by many teacher education programs, but to varying degrees. There is a cost to the student when EdTPA is used by a program to cover the expenses of sending materials out for objective assessment and evaluation.

In sum, assessment is a critical part of curriculum, and it is particularly important in this era of accountability and a focus on standards. Teachers need to be cognizant of the power and limitations of different forms of assessment, and consider formative assessment to be a natural part of their role.

Review Questions

1. What’s your definition of appropriate assessment methods for young children regarding their learning and development of science and math concepts?
2. How can assessing young children guide teaching?
3. How can appropriate assessment increase children’s vocabulary development? Provide an example.
4. List some types of documentation that can support assessment. Describe what each would include. Finally, create an example and explain how you would share it with a child’s parent or guardian.
5. Explain the importance of interviewing when assessing young children’s knowledge and capabilities.
6. Name a standard or a couple of sets of standards you will use to assess young children’s knowledge and progress in learning about math and science. Explain how you will use the standards to assess and whether they are purposeful or not.

Summary

In this chapter we have looked at the general principles of assessment and also specific strategies and methods for assessing math and science learning in the early grades. Assessment cannot be separated from the curriculum and involves the teacher’s knowledge about child development, cultural context, and specific curricular content.

Assessment involves the language we use when teaching, the decisions we make about how and what we teach, the methods we use to document children’s learning, and the authenticity of what we expect children to do and learn in our classrooms.

The politics of assessment will impact you in your classroom through the development of common standards and school systems’ reliance on standardized tests, but as a professional you will still make decisions that impact a child’s experiences in math and science that will form the foundation of their lives.

Websites

*EdTPA:* The official website for EdTPA shares all the information needed to understand the purpose and goals for beginning teacher assessment.

*Teaching Channel:* This website provides many videos that show examples of teachers using assessment in their classrooms. Several are specific to early childhood, and many provide overall definitions of assessment concepts.

*YouTube:* If you search under “assessment in education” you will find videos that show early childhood assessment in action. Dan Huber’s YouTube channel provides several of these.