Interactive Whiteboards in Early Childhood Mathematics

Strategies for Effective Implementation in Pre-K–Grade 3

Sandra M. Linder

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In a first grade classroom, children rotate through a variety of centers. A group of four children approaches the math center, which is stationed at the interactive whiteboard (IWB) this week. The children have been investigating money during the past few weeks, and this center provides an extension to these investigations. At the top of the IWB, there is a picture of a quarter labeled "25 Cents." Below it are pictures of pennies, nickels, and dimes that can be moved around the board and duplicated, depending on the activity. One child presses a picture of a horn, activating an audio file that asks the children to make 25 cents in a variety of ways using the coins on the IWB. The children work together to use the pennies, nickels, and dimes to create sets of 25.

Teachers are using technological innovations—including interactive whiteboards—in pre-K–grade 3 classrooms across the country. An IWB is a wall-mounted, touch-sensitive flat screen. When connected to a computer (or another electronic device) and a projector, it displays enlarged instructional content (such as a math word problem, pictures or graphics, or an excerpt from a story). Teachers and children can manipulate this content. Many early childhood teachers are incorporating this technology in their mathematics instruction. This article will help educators use IWBs and other technologies in ways that coincide with best practices in early childhood math instruction. It also shares examples of how to integrate other digital tools into mathematics instruction.

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Math lessons in early childhood should use child-centered practices to develop children's conceptual understanding of a variety of topics. However, teachers sometimes use IWBs merely to complete electronic worksheets or to show examples of problems to be solved during the lesson. By making small tweaks to their approach, teachers can alter the focus of a task to promote children's active learning. For example, a second grade teacher might bring up place value in the number representing the day on the calendar ("Today is January 31. How many ones are in 31? How many tens are in 31?"). Instead of ending the discussion here and showing a representation of the tens and ones on the IWB, have the children form small groups and draw a representation of the place values for the 3 and the 1. Ask the groups to share their representations by redrawing them on the IWB.

The current literature on interactive white boards is limited; however, there are examples of early childhood teachers incorporating IWBs effectively. Murcia (2010) relates a case study describing how elementary school teachers integrate IWBs into their science curriculum. Murcia's findings show that the use of multimodal representations—such as tables and graphics children can manipulate on the IWB—increase the richness of lesson plans and the collaboration and communication among students. In a study of kindergartners working with an IWB and other forms of technology during math lessons on fractions, Goodwin (2008) finds that children who use these forms of interactive technology have more complex understandings of fractions than children in settings where the technology is not incorporated into lessons.

Essential characteristics of early childhood mathematics lessons

The table below describes characteristics that should be present in every early childhood math lesson. These characteristics reflect the process standards of the National Council of Teachers of Mathematics (2006). Although the list does not include all effective practices, it can be helpful when designing mathematics instruction. By including these practices in every lesson, you can help children be active, rather than passive, learners of math concepts.

Essential Characteristics of Early Childhood Mathematics Lessons

Building communities and communication	Create activities that build a **community of learners** in your classroom. Have children work collaboratively. Structure discussions so that interactions occur between children, between you and the children, and between the children and you (meaning that they ask you questions or pose thoughts rather than you eliciting information from them). For example, ask children multiple open-ended questions as they work together on a math task, and incorporate time in each lesson for whole-group discussions so that children can reflect on their task and describe their strategies for solving it. Structure your lessons so that all children feel ownership of a task and so they can all engage in the discussion.
Making connections	Make **connections** between mathematics and other content areas, and between mathematics and real-world situations. Children need to understand why they are engaging in tasks. Insert discussions about math concepts into informal situations, such as during free play or while setting the table for snack or lunch. When math concepts are meaningful for children, they can see the value of mathematics and relate the information to what they already understand.
Representing understanding	Provide opportunities for children to **represent their thinking** in a variety of ways. For example, ask kindergartners to show their strategies for breaking up (decomposing) the number 5 into groups, using both pictures and numbers, as well as discussion. Ask second-graders to show their strategies for solving a two-digit addition problem in pictures, numbers, and written sentences. These different representations help children move from concrete to abstract understandings.
Exploring with materials	Provide opportunities for children to use different **materials** or **manipulatives** to help solve math tasks. Remember, mathematics instruction should not be just hands-on; it should be *minds-on*—meaning that children should use the manipulatives as a tool to help represent their understanding. Instead of asking them to use materials in prescribed ways, allow for flexibility in how children decide to use the materials.
Child-centered tasks	Design math **tasks** in which children can approach a challenge in a variety of ways. There should be no one way to solve a problem. Avoid telling children how you would solve the problem. Allow them time to explore the task, which will give you an opportunity to ask questions and understand and build on their thinking.

Integrating technology and mathematics using an IWB

When building math lessons around the essential characteristics in the table, it is important that the IWB not be the only tool children interact with during lessons. The best way to use an IWB is either before or after a small-group task in which children use concrete materials, such as plastic cubes that children can link together and pull apart. Use the IWB to introduce a topic, to stimulate discussion, or to connect math concepts to real-world situations. Avoid using the IWB to show children how to complete the task.

The following are examples from practicing teachers showing how to incorporate an IWB in each early childhood mathematics content area (number and operations, data analysis, measurement, algebra, and geometry).

Number and operations

In a pre-K classroom (with 4-year-olds), Ms. Carlin is teaching counting skills and the concept of cardinality (understanding a set of objects as a total quantity or sum rather than as individual parts). Children gather on the rug in front of an IWB where Ms. Carlin displays pictures of 10 elephants, all slightly different (in terms of height, color, trunk length). She asks the children to talk about the different ways to count the elephants (count them all, count just the gray ones, count just the tall ones). They then discuss how to tell if an elephant meets the criterion set by the group.

Ms. Carlin: How can you tell if this elephant is tall or short?

Quoila: It is large when it is next to this elephant, and it is short when it is next to this elephant.

Phin: It is large when it is bigger than the things around it.

Following this discussion, Ms. Carlin gives each child an opportunity to count a set of elephants and tell how many there are in all. The children go to the IWB and use their fingers to drag the elephants from one side of the board to the other to represent the action of counting, and to demonstrate their understanding of one-to-one correspondence. Once they have all taken a turn with the IWB, they work with a partner to group and count sets of plastic animals in different ways.

Quoila: We counted them by color.

Phin: We counted them by number of legs.

LaMont: We put them in groups of two and then counted by twos.

Following every turn of counting, the pairs draw each set on a piece of paper and label it with a number.

Data analysis in kindergarten

When introducing the parts of a pictograph in a kindergarten class, Ms. Nocenti uses the interactive whiteboard to do a class survey of favorite types of apples (red, green, or other). Children begin the lesson on the carpet in front of the IWB, where the teacher holds up a bundle of apples and asks the children to come up with questions to ask about them.

Ms. Nocenti: What are some questions we can ask about these apples?

Malik: How big are they?

Sera: How many apples are there in the bundle?

Marzuk: Which one do you like best?

Matt: What is your favorite one?

From the list of questions generated by the children, they choose "What is your favorite type of apple?" to explore. Ms. Nocenti uses this question to guide the creation of, and conversation about, a pictograph on the IWB.

The best way to use an IWB is either before or after a small-group task in which children use concrete materials.

Ms. Nocenti: How can we find out what everyone's favorite type of apple is?

Matt: We can each take a bite of apple and then choose.

Malik: We can raise our hand when you say the type we like best.

Sera: We can draw a picture of the apple we like best.

Throughout this discussion, Ms. Nocenti records on the IWB children's responses about ways to learn which type of apple they like best. After recording everyone's responses, she asks children to draw a picture of their favorite apple. Ms. Nocenti then calls each child up to the board to draw a circle (in the appropriate color), representing his or her choice. The drawings are scattered on the IWB, with no apparent method of organizing the data.

Ms. Nocenti: Now that you have each decided which type of apple you like best, how can we organize this information so it is easy to see?

Matt: We can put all of our apple drawings together and then put [same-color apples] next to each other.

Following this conversation, each group receives a bundle of apples and comes up with a different question to ask about them, creates a pictograph on paper to represent their findings, and shares their graph with the class. As the groups share their graphs, Ms. Nocenti re-creates them on the IWB. As she records them on the IWB, the whole class gains an understanding of how each group created its pictograph. In addition, she saves each re-created pictograph from the IWB so that she has documentation of the children's thinking.

Measurement in first grade

Money is often a difficult concept for young children to grasp. In his first grade class, Mr. Jimenez introduces a lesson on pennies, nickels, and dimes by having a picture of each coin on the IWB. The children compare and contrast the characteristics of the coins and create a class list on the IWB of each coin's attributes.

Mr. Jimenez: How are each of these coins similar?

Annie: They all can be used to buy things.

As the groups share their graphs, Ms. Nocenti re-creates them on the IWB. As she records them on the IWB, the whole class gains an understanding of how each group created its pictograph.

Niranjan: They are all round.

Tasunke: They all have faces on them.

Mr. Jimenez: How are each of these coins different?

Niranjan: They are different sizes. This one is bigger than that one.

Akiko: The dime is ten cents, the nickel is five cents, the penny is only one.

Annie: The penny is a different color.

Niranjan: You can get more with the dime.

After the class creates its list, the children break up into small groups and create money amounts using as many coin combinations as possible. Following this task, the children gather back at the IWB and each group demonstrates how they used a combination of coins to make a certain money amount, using their fingers to drag each coin into a set that represents the amount.

Akiko: We used two dimes and two nickels to make 30 cents. Then we used 10 pennies and two dimes to make 30 cents. Then we used 15 pennies and three nickels to make 30 cents.

Mr. Jimenez facilitates a whole-group discussion by asking questions about the children's decision making when choosing certain coin combinations, and by having children compare these decisions to their own thinking. For example, when Akiko describes the three ways that her group made 30 cents, Mr. Jimenez asks the rest of the groups to share other ways to make 30 cents. Mr. Jimenez develops the center activity described at the beginning of this article as an extension to this lesson.

Algebra in second grade

In a lesson on generalizing patterns, second grade teacher Ms. Romita uses the IWB during the reflection period following a math task. Children begin the lesson by discussing the different repeating patterns they see in their classroom and whether they had seen any of those repeating patterns outside of school. For example, one child sees a color pattern of stripes on a classmate's T-shirt and then recognizes that the same pattern is present in a bed of flowers in the yard.

The children then work in pairs to create the same repeating pattern in three different ways (with a picture, with pattern blocks, and with movement). For example, one pair creates a pattern of red square, yellow hexagon, green triangle with pattern blocks, and then represents this pattern with a star, a cat, and a heart. Once they create these representations, they use movement to create a third representation of the same pattern with hop on two feet, clap, and raising both hands above their heads. Next, they write a general statement about each of the three representations.

Following this task, the children gather at the interactive whiteboard, where Ms. Romita has each pair share one of their representations. The pairs come up to the IWB and show the movement representation of their pattern and then draw the picture version of the pattern on the IWB. The teacher then asks a child from outside the pair to make another representation of the pattern using color tiles on the IWB.

The children gather back at the IWB and each group demonstrates how they used a combination of coins to make a certain money amount, using their fingers to drag each coin into a set that represents the amount.

Ms. Romita: How did you represent your pattern?

Gwen: We used sounds. We did clap, stomp, stomp, clap; clap, stomp, stomp, clap.

Ms. Romita: Then what did you do?

Jorge: We made the same pattern with triangle, square, square, triangle.

Ms. Romita: Boys and girls, how can you use the color tiles to show this pattern?

Ciria: Well, you could put the yellow tile first, then put the red tile, and then another red tile, and then a yellow tile, and then keep going.

Geometry in third grade

In a third grade lesson on intersecting and parallel lines, Ms. Talamantes uses the IWB during the first part of the lesson to show pictures of intersecting and parallel lines in the real world, including photos of roads and buildings in their community. Children draw over the pictures—using the interactive pen that comes with the IWB—to show where the parallel or intersecting lines occur. She asks children to explain the differences between the examples, which eventually leads the children to come up with their own definitions for intersecting lines and parallel lines.

Ms. Talamantes: How are these two lines here and these two lines here similar?

Malik: They are all straight.

Soo Jin: They are on the edges of the buildings.

Ms. Talamantes: How are they different?

Yasmine: These cross and these don't.

Soo Jin: The ones that cross make a corner on the building.

Malik: The ones that don't cross on either side of the building are connected by another line that crosses over both of them.

Following this whole-group discussion, children work in pairs to draw a picture of a space in their school (for example, the lunchroom, playground, gym, classroom). After they draw their picture, each pair writes a description of their space on paper, giving attention specifically to where they found parallel or intersecting lines. During the week, the children take turns visiting the spaces to determine if there are any examples they had missed.

Other technologies for teaching math

The following are examples of other forms of technology that teachers can use to enhance mathematics lessons—with or without an IWB. Remember to include the essential characteristics (see p. 27) in your math lessons when implementing these examples.

Virtual manipulatives

Rosen and Hoffman (2009) define virtual manipulatives as "interactive, web-based, computer-generated images of objects that children can manipulate on the computer screen" (26). They are available to teachers for free through a variety of websites (see "Resources," p. 35). These manipulatives often look similar to the concrete forms you may already use in your classroom (for example, place-value blocks, pattern blocks, color tiles). However, if you don't have access to such materials, virtual manipulatives are an option.

Websites with virtual manipulatives often offer specific tasks for children to complete. Teachers can easily incorporate these tasks into a math center when an IWB is not available. Invite children to work in pairs at a computer to complete a math task using virtual manipulatives. For example, on the National Library of Virtual Manipulatives website (http://nlvm.usu.edu), pairs can access an *attribute train,* enabling them to identify and complete patterns by analyzing attributes of shapes. Often, these tasks require children to simply answer the questions. (For example, if a task involves using place-value blocks to solve an addition problem, the website might not require the children to describe their strategy for using the blocks.) Enhance these tasks by asking the pairs of children to create another example or to represent their strategies for solving the original problem on a separate piece of paper. For example, after pairs interact with the attribute train, have one child in the pair create her own example of an attribute train on

paper and then ask the other child to complete the pattern. Once the pattern is complete, have the pair switch roles. After all of the children have interacted with the virtual manipulatives at the mathematics center, gather the class as a whole group to discuss their strategies.

With an IWB, you can optimize the use of virtual manipulatives by combining them with concrete manipulatives. For example, during a lesson on attributes of shapes, ask children to form small groups and use concrete manipulatives, such as pattern blocks or tangrams (seven individual shapes that, when combined without overlapping, can form a variety of larger shapes), to make a representation of an animal or a monster. Allow the children to design their own representations rather than telling them what to make. Following this exploration, gather the children together and have them share their representations using the virtual manipulatives on the IWB. Display the virtual manipulatives and ask children to click and drag the shapes to re-create their representation. During discussion, children can explore how to use more shapes to create the same animal. Teachers can also use other computer programs, such as Kidspiration (a free trial is available to download, but the program must be purchased) or Microsoft Word (by inserting shapes into a document), to create their own virtual manipulatives.

Webquests

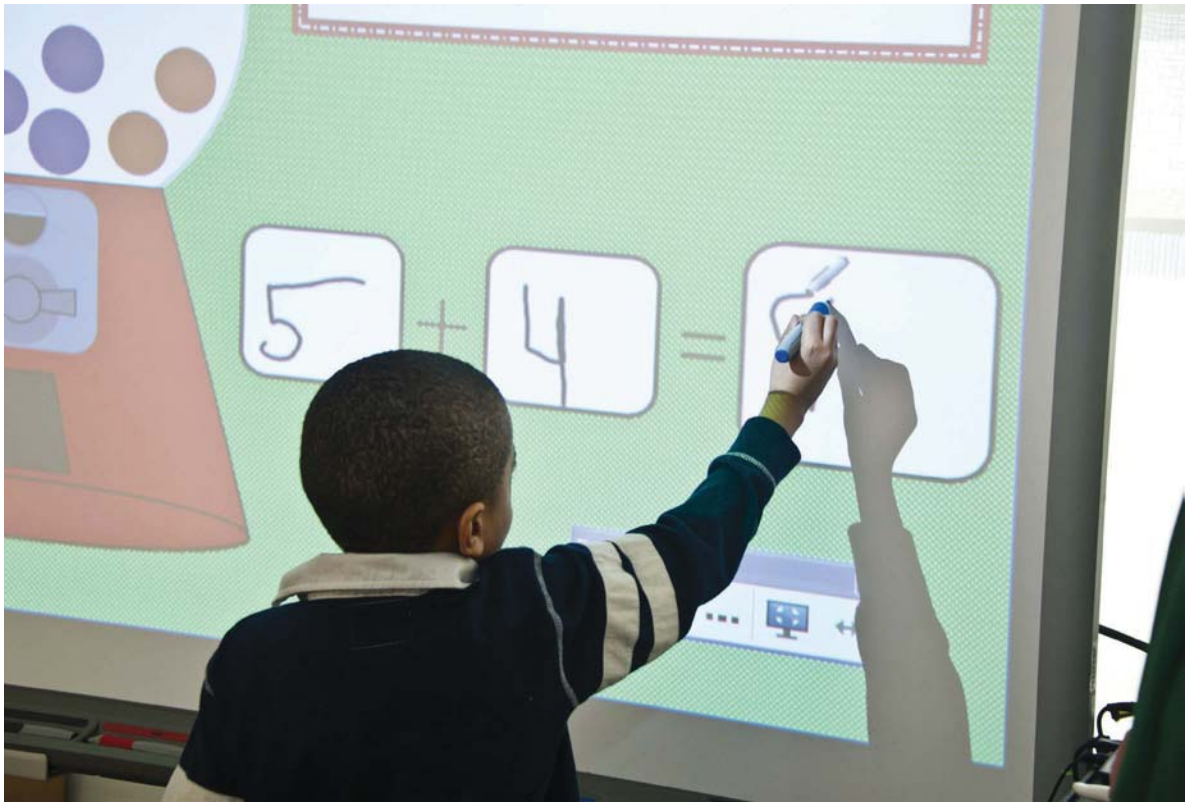
Webquests—Internet-based explorations in which children visit teacher-selected websites to solve a problem or complete a task—are a great way to make connections in mathematics lessons. A variety of websites enable teachers to easily create webquests for any content area for free (see "Resources," p. 35). For classrooms without IWBs, children can pursue webquests on computers in math centers as long as they can easily navigate the sites. Instructions should be succinct, and links should be easy to find so children do not spend more time figuring out the technology than they do working on the math task. Ideally, children work in pairs or small groups to complete the webquest, and they have opportunities to make connections between the webquest and the classroom. For example, if children are completing a webquest on identifying three-dimensional shapes on various websites, ask them to identify the same shapes in their classroom and to represent them in drawings.

Incorporate webquests into whole-group lessons in classrooms with IWBs by developing a math task that can be solved only by exploring a variety of websites as a group. Ms. Romita developed a webquest for her second grade class that connected mathematics and social studies by following an explorer's travels as he visited different communities around the world. Children explore the sites he visited and, as a group, figure out how far he traveled. To encourage more child-to-child interaction, have children work together in smaller groups during the lesson to complete the tasks included in the webquest (such as adding together the miles from one location to another) and then meet back as a whole group to discuss and compare findings.

Recordings and photographs

It can be difficult to formatively assess all children as they work together during a math lesson. Use a video or voice recorder to capture discussions and interactions while children engage in math tasks. The information gathered from these tools will help inform your assessment and planning for the subsequent lesson. A video or voice recorder can also enhance a lesson by providing a way for children to record their thoughts so they can think about them later. For example, in a second grade lesson on addition with regrouping, children work in groups to solve a word problem, showing three solving strategies (pictures, words, and numbers). Following this task, the teacher gathers children for a whole-group discussion of the different strategies. The teacher records the discussion, but there is time for only half the class to share their strategies. The

(cont'd on p. 34)



next day, the teacher plays back the recording so the children can remember the discussion. Often, due to time restrictions, the reflection component—which is critical to mathematics lessons—is shortened. By recording their thinking, children can return to this information later to help refocus them on the task.

In classrooms with an IWB, use a video or voice recorder to document assessment data from children in small groups, and then play the recording during whole-group discussions at the IWB. Allow children to watch another small group working, for example, to build a structure with three-dimensional shapes. After watching the small group work, the teacher can ask all the children specific questions about how the small group completed the task, helping children think about mathematical processes. For example, kindergartners building structures with three-dimensional shapes watch a video of another group building a castle and begin to identify castles they had seen in the real world or on television. One of the children in the video struggles to find a place for a sphere, and as the children watch him try out various spots, they predict whether the sphere will fall and volunteer alternative suggestions for where to place it.

Digital photography can also enhance instruction in mathematics. Using a digital camera, children in pairs can collect data during mathematical tasks. For example, if children take a pattern walk (identifying examples of repeating or growing patterns as they walk around the school), have them use a digital camera with their partner to capture examples of these patterns along the way. Digital photographs can easily be shown on an IWB or a computer, or printed and displayed on a board as a means to encourage whole-group discussion and make math connections to the real world. For example, displaying pictures of flowers that children grew in a community garden can encourage a discussion on symmetry.

After watching the small group work, the teacher can ask all the children specific questions about how the small group completed the task, helping children think about mathematical processes.

Conclusion

Technology can be a vital tool in enhancing mathematics instruction for young children. However, if a teacher is standing next to the interactive whiteboard throughout an entire mathematics lesson, or if children's only interaction with an IWB is to come up one at a time to answer a question, then it is not being used in the most effective manner. When early childhood teachers design lessons by integrating the forms of technology discussed here with the essential characteristics for teaching early childhood mathematics, children are more likely to develop conceptual understandings and positive dispositions toward mathematics at a young age.

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Resources

Websites offering virtual manipulatives

Illuminations. National Council of Teachers of Mathematics site featuring pre-K–12 lesson plans and activities related to all content areas. The activities link provides free access to early childhood virtual manipulatives. **http://illuminations.nctm.org**

Kidspiration. Software designed for grades K–5. Originally a language arts program, it now includes a mathematics component, allowing teachers to use pictures, text, and numbers to create math problems and tasks. A free trial version is available, but eventually the program must be purchased. **www.inspiration.com/Kidspiration**

Math Forum. Reviews and links to websites that provide virtual manipulatives or sample lessons using virtual manipulatives. **http://mathforum.org**

National Library of Virtual Manipulatives. Virtual manipulatives for all pre-K–12 math content areas (number and operations, algebra, geometry, measurement, data analysis, and probability). A free trial version is available. **http://nlvm.usu.edu**

Websites for webquests

Discovery Education. Provides Mac and PC templates for creating webquests, plus information on creating and implementing webquests. Sample webquests from practicing teachers are included. **http://school.discoveryeducation.com/schrockguide/webquest/webquest.html**

Education World. Features a detailed description of qualities and components to include in a webquest, plus downloadable webquest templates and links to other webquest resources. **www.educationworld.com/a_tech/tech/tech011.shtml**

TeacherWeb. Information on using webquests across all content areas, and a template for creating webquests. Sample webquests are also provided. **www.teacherweb.com**