Coding Is Lit

Integrating Coding and Literacy in Early Childhood Inclusive Settings

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Mrs. Finn and Mr. Olive are special and general education co-teachers working in an inclusive prekindergarten classroom. They have been hearing and reading about the importance of providing access to activities related to science, technology, engineering, and mathematics (STEM) to all children beginning at an early age. Therefore, they have been attending a series of workshops surrounding how to integrate coding in early childhood settings. The workshops have been focused on unplugged or low-tech precoding activities. Researchers suggest that because young children learn best through play, when introducing coding to young children, it is important to begin with concrete, hands-on, low-tech precoding activities to help build toward a strong foundational understanding of coding (Lee & Junoh, 2019). The first few workshops focused on helping teachers gain a fundamental understanding of precoding. Precoding involves activities such as coding games that encourage hands-on, game-based play and are appropriate for children in early childhood settings (McLennan, 2017). The workshops then progressed to supporting teachers with brainstorming, designing, and developing lessons that integrate precoding with components of early literacy. The two teachers are now ready to begin implementing some of the strategies they learned in an effort to provide their students with early access to 21st-century learning skills as well as meaningful opportunities to engage with and deepen understanding of components of the literacy curriculum (Kazakoff et al., 2013; McLennan, 2017).

Coding and Precoding

Coding is "the process of creating the step-by-step instructions a computer understands and needs in order for its programs to work" (McLennan, 2017, p. 18). When coding is introduced to young children, it is typically in the form of precoding activities, like coding games. Coding games allow young children to experience coding concepts, such as creating commands and giving directions, in developmentally appropriate and meaningful ways (McLennan, 2017). Coding games are often grounded in coding stories, which provide a narrative for giving commands and directions that structure movement. Precoding may have a reciprocal positive relationship with literacy. Specifically, precoding can be used to expand and deepen student interactions with routines, procedures, and text-based stories (Lee & Junoh, 2019; McLennan, 2017). Relatedly, connecting routines and stories to precoding can provide students with the meaningful context needed to gain fundamental understandings about coding.

There is a growing body of literature examining the use of coding with young children. The majority of this literature surrounds the impacts of using computer programming and robotics with typically developing children. Overall, researchers have found positive impacts of various low-tech and high-tech robotics curricula (e.g., KIBO, ScratchJr) on young children's attitudes, interests, and understanding about programming concepts (e.g., Sullivan & Bers, 2018). Fewer studies have focused on young children with disabilities. Albo-Canals et al. (2018) examined the impact of using robotics on the social-emotional development of two young children diagnosed with autism spectrum disorder (ASD). Taylor et al. (2017) examined the impact of using physical manipulatives and robotics on the computer programming skills of three first- and second-grade students diagnosed with Down syndrome. Also, Taylor (2018) examined the impact of using a robotics intervention on the computer programming skills of prekindergarten-through-first-grade students diagnosed with intellectual disabilities (ID). Finally, Di Lieto et al. (2020) examined the impact of introducing robotics to 42 first-grade students with varying disabilities (e.g., ASD and ID). Across studies, researchers found increases in social interactions, executive function skills, and basic computer programming skills across participants. Researchers suggested that future investigations leverage the strong emphasis on literacy in the early childhood curriculum to integrate coding.

Fundamental Aspects of Unplugged Precoding

Precoding activities can either be unplugged (low tech) or plugged in (Lee & Junoh, 2019). Plugged-in precoding may involve work with tablet applications or robotics. Unplugged precoding activities provide hands-on, real-world practice and are very conducive to curriculum integration (Campbell & Walsh, 2017). The three components that constitute unplugged precoding are (a) precoding commands or directional language, (b) grids, and (c) coding stories (McLennan, 2017).

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Precoding Commands

Precoding commands *and* directional language *refer to coding arrows that allow for directional movement. When designing precoding activities, teachers can choose to introduce and reinforce familiar or new vocabulary through (a) sequencing (e.g., "first," "next," "then," "last"), (b) ordinal numbers (e.g., "first," "second," "third," "fourth"), or (c) directional movement (e.g., "forward," "backward," "right turn," "left turn"). Coding arrows coupled with the use of precise directional language affects how movement is carried out. Because these concepts are new, it is best to explicitly and systematically introduce precoding vocabulary to young children (Campbell & Walsh, 2017). Teachers may focus on reinforcing vocabulary that may be more familiar to some students, such as "first," "next," "then," and "last." They may also focus on introducing new vocabulary such as "first," "second," "third," and "fourth" or "forward," "backward," "right turn," and "left turn."*

Grids

Grids are the platform on which precoding commands or movement occurs. Grids, such as squares marked off on the floor or on a game board, may start off with one-by-four squares and gradually progress to four by four, eight by eight, or any numeric combination that is developmentally appropriate. It is also important to introduce grids systematically to young children (Lee &

Table 1 **Connecting Precoding to 21st-Century Learning Skills in Early Childhood Settings**

Skill	*Components*	*Precoding examples*
Collaboration	Children work together to fulfill a shared goal or solve a problem.	Children work together to plan how to move directional arrows on the grid.
	Children participate cooperatively and demonstrate team work skills.	Children take on different roles (e.g., programmers and robots) as they work together on the grid.
Communication	Children organize and share thoughts orally and nonverbally.	Children share ideas, orally and nonverbally, with each other or with adults surrounding movement of directional arrows on the grid.
	Children share thoughts to facilitate collaboration.	
Creativity	Children apply information they have learned to organize tasks.	Children devise new start and stop points on the grid.
	Children apply information they have learned to develop new solutions to problems.	Children develop new and varying paths to follow on the grid.
		Children use varying directional arrows to follow paths on the grid.
Critical thinking	Children explore problems that require higher-order thinking skills.	Children examine a start and an end point on the grid and devise a way to use directional arrows to move from place to place.
	Children explore problems that have open-ended solutions.	Children recognize when they have made an error with the directional arrows and develop and execute a plan to fix the error.
	Children use their reasoning skills to analyze and solve problems.	When alerted about an error with the directional arrows, children develop and execute a plan to fix the error.

Junoh, 2019). Teachers may begin with a one-by-four grid, for example, that allows for teachers and students to a focus on sequential movement or directional movement before progressing to more complicated grids that allow for right- and left-turn movement (McLennan, 2017). Grids can reinforce gross motor skills by having students walk on a large grid taped to the floor and fine motor skills by having students move game pieces around a smaller grid made from a poster board or printer paper.

Coding Stories

Finally, coding stories situate precoding commands or directional language and grids in the context of the curriculum. Integrating the traditional curriculum with STEM concepts may positively impact academic outcomes in STEM subjects in young children (McLennan, 2017). There are a variety of rudimentary curriculum contexts that teachers may use to integrate and introduce coding stories. These include integrating precoding with daily routines and procedures, such as handwashing or lining up. Literature may also be used as a more advanced context for practice (Lee & Junoh, 2019). It allows students to use precoding to help retell the events of a story or change the events of a story through coding commands. Importantly, students may practice a variety of 21st-century learning skills through coding stories. For example, students may work in pairs or small groups and use collaboration and communication to complete precoding story activities or tasks. Coding stories often involve students acting as programmers who use creativity and critical thinking to decide how to code a path for robots. One or more other students take on the role of robots who follow the commands. For example, a programmer may use commands to program or code a path to complete the steps in a classroom routine or retell the events of a story. The robot is expected to follow the commands in order to complete the routine or retell the story. ***Table 1*** provides a summary of 21st-century learning skills, their components, and examples specific to precoding activities.

Planning to Integrate Precoding

When planning, it is important to remember that precoding concepts may be abstract for young children with or at risk for disabilities (Kazakoff et al., 2013). Planning considerations should surround how best to support this population of students as they navigate these new concepts. Young children with or at risk for disabilities need evidence-based instructional practices, such as explicit instruction and peer-mediated activities, to support understanding precoding

Table 2 **Other Planning Considerations**

Consideration	*Description*	*Examples*
Accommodations	Changes how students learn while expectations for what they learn remain the same (Mastropieri & Scruggs, 2018)	Provide opportunities to practice and master simple precoding tasks before moving to more complex tasks.
		Provide accessibility through a variety of tools, such as Velcro or a string attached to objects, for ease of movements.
		Provide easy handling by making coding materials larger or three-dimensional.
Modifications	Changes what students are expected to learn (Mastropieri & Scruggs, 2018)	Allow students to complete tasks using nonverbal communication.
		Work one-on-one with a teacher or aide or on a preferred activity.
Materials	Materials will vary depending on lesson purpose. They may include images of actions, forward arrows, right-turn arrows, left-turn arrows, masking tape, Velcro, poster boards, images of text-based characters, or sheet protectors.	Initial introduction of precoding steps: Images of actions (e.g., hand raising, standing, or sitting)
		Routines and procedures: Forward arrows to direct movement, masking tape to create grids, Velcro to affix the arrows to the grids
		Connecting to read-alouds: Forward, right-turn, and left-turn arrows, poster boards to create oversized game boards, images of text-based characters, sheet protectors, Velcro to affix arrows and character images to game boards

> Integrating precoding "stories" that connect to everyday routines and procedures will help to deepen students' understanding of precoding.

concepts (Archer & Hughes, 2011; Watkins et al., 2015). *Explicit instruction* refers to structured teaching of concepts and skills. This type of instruction supports positive academic and social outcomes for young children with or at risk for disabilities (Archer & Hughes, 2011). Peer-mediated activities are used to "promote child engagement and learning" (Division of Early Childhood, 2016, p. 24) and promote communication skills, active engagement, and opportunities to respond in young children who struggle (Watkins et al., 2015). Peer-mediated activities also support 21st-century learning skills, such as communication and collaboration.

Precoding planning considerations will surround how best to use explicit instruction and peer-mediated activities to structure instructional delivery of precoding concepts. The following key guidelines may be used to facilitate planning: (a) make connections to everyday routines and procedures through explicit instruction and peer-mediated activities, (b) make connections to read-alouds through explicit instruction and peer-mediated activities, and (c) consider literacy standards (e.g., early learning guidelines, standards, and frameworks). ***Table 2*** outlines additional considerations surrounding accommodations, modifications, and materials that are also important to the planning process.

Planning Guideline 1: Make Connections to Everyday Routines and Procedures Through Explicit Instruction and Peer-Mediated Activities

Young children with or at risk for disabilities benefit when "practitioners embed instruction within and across routines to provide contextually relevant learning opportunities" (Division of Early Childhood, 2016, p. 22). In fact, young children with disabilities experience increased communication and social-emotional outcomes when instruction is embedded in everyday routines and procedures (Division of Early Childhood, 2016).

Integrating precoding "stories" that connect to everyday routines and procedures will help to deepen students' understanding of precoding. This allows students who may struggle to draw on

Table 3 **Routines and Procedures for Precoding Practice**

Routine or procedure	*Steps*	*Coding connection*
Asking a question	1. Raise your hand. 2. Wait to be called on. 3. Lower your hand and ask your question.	Children can use forward arrows and images of each component step to move forward on a one-by-three grid through each step.
Lining up	1. Wait to be called. 2. Walk to the door. 3. Line up behind the door or a classmate. 4. Wait for further directions.	Children can use forward arrows and images of each component step to move forward on a one-by-three grid through each step.
Hanging up coat and backpack	1. Walk to your cubby. 2. Take off your backpack and hang it on a hook. 3. Take off your coat and hang it on a hook. 4. Go to your seat.	Children can use forward arrows and images of each component step to move forward on a one-by-four grid through each step.

familiar context and frequent practice to navigate new and abstract concepts (Lee & Junoh, 2019). When planning to integrate coding stories, teachers may first incorporate the terms "programmers" and "robots" into classroom discussions and provide opportunities to practice role-playing as programmers and robots. Teachers may also brainstorm to create a priority list of everyday routines and procedures they would like to reinforce based on the immediate needs of their classroom. Finally, teachers will need to consider how to organize instruction so that it is explicit and so that young children have opportunities to practice precoding concepts by engaging with peers in meaningful and engaging ways.

Mrs. Finn and Mr. Olive, the inclusive prekindergarten teachers, brainstorm a list of common classroom activities. It includes hand raising, sitting, standing, and several other activities. They plan to incorporate the terms "programmers" and "robots" as often as they can when relevant. They also brainstorm a list of everyday routines. It includes handwashing, lining up, and asking a question. The teachers decide to begin by focusing on handwashing because they have determined that students are having difficulty with the routine and could benefit from additional rehearsal. As they plan for instruction, the teachers discuss how they will use explicit instruction to convey the content. Specifically, they decide who will lead the introduction, modeling, and practice portions of the lesson. They want to also ensure that they provide their students with opportunities to engage in 21st-century learning skills. Many of the students with disabilities in the class have individualized education program goals related to communication. They take this into consideration when they make decisions about the 21st-century learning-skill focus. For example, they will use peer-mediated activities to encourage communication among students as they work together in small groups to program or code the steps in the handwashing routine.

Planning Guideline 2: Make Connections to Read-Alouds Through Explicit Instruction and Peer-Mediated Activities

Precoding activities also connect to read-alouds. They can be used as game-based enrichment that encourages extended interactions and active engagement with read-aloud texts. Active engagement has been associated with decreases in off-task behavior, increases in socially appropriate behavior, and increases in task completion (Watkins et al., 2015) in young students with disabilities. Planning time may involve teachers brainstorming to generate a list of texts they typically read aloud to their students throughout the school year. Teachers may then target those texts that have an explicit focus on action and adventure storytelling and would allow students to rehearse or recreate events through coding story activities. Planning will also involve teachers considering how to ensure instruction is explicit and how to incorporate peer-mediated engagement.

On the basis of the aforementioned criteria, Mrs. Finn and Mr. Olive generate the following short list of texts that they believe would be a good start to integrate coding stories into their classroom: (a) The Three Little Pigs, *(b)* We're Going on a Bear Hunt, *and (c)* The Gruffalo. *They choose* The Three Little Pigs *and brainstorm ways they may integrate coding stories. First, they decide to use a poster board–size grid and have students use directional commands to help the three little pigs escape the big, bad wolf. Second, they decide to ask children to reimagine the wolf as a good character and encourage them to use directional commands to help the wolf get to the three little pigs. As they plan for instruction, the two teachers decide who will lead the introduction, modeling, and practice portions of the lesson. They want to also ensure that they provide their students with opportunities to engage in 21st-century learning skills. For example, they want to make sure they encourage students to work together in pairs or small groups and engage in critical thinking as they make decisions about programming or coding a path between the text's characters.*

Table 3 provides a list of routines and procedures, steps, and their connections to precoding activities. ***Table 4*** provides a list of read-alouds

Table 4 **Read Alouds for Precoding Practice**

Book title	*Characters*	*Coding connection*
Goldilocks and the Three Bears	Goldilocks	Children may use the forward and turn arrows to help Goldilocks navigate the grid to find and fix Baby Bear's chair.
The Gruffalo	Mouse, Gruffalo	Children may use the forward and turn arrows to help the mouse navigate the grid to get to the Gruffalo.
We're Going on a Bear Hunt	Family, Bear	Children may use the forward and turn arrows to help the family navigate the grid to get to the bear. Children may use the backward and turn arrows to escape.

appropriate for early childhood settings, key characters, and their connections to precoding activities.

Planning Guideline 3: Consider Literacy Standards

When planning to integrate coding stories, it is also important that teachers consult literacy standards. All students, including those with or at risk for disabilities, should have access to the expectations set forth by standards-based instruction. When standards are used to guide instruction of young children with or at risk for disabilities, it is important that the instruction is explicit. This ensures structured delivery of curriculum concepts.

Each state has early learning guidelines or standards. However, the closest comparable set of national standards that explicitly outlines the knowledge, skills, and dispositions that young children need are the Head Start (2015) Early Learning Outcomes Framework (ELOF). Regarding precoding activities, the Language and Literacy domain and subdomains of the Head Start ELOF, specifically Communication and Speaking, are conducive to integrating coding stories. When examining the domains, teachers may consider the primary goals of their lesson. These goals may include, among other areas, expecting students to use verbal and nonverbal communication to convey ideas, demonstrate understanding, or solve a problem.

In an example, Mrs. Finn and Mr. Olive's class has been struggling with proper handwashing, and so they decide to focus on reinforcing this classroom routine by integrating coding stories. Their objective is to provide opportunities for students to use precise directional language to describe the steps needed to successfully complete this routine. The following Head Start (2015) ELOF goal supports this objective: "Goal P-LC 6. Child understands and uses a wide variety of words for a variety of purposes." In another example, the two teachers decide that they will have students engage in a precoding activity where they use directional commands to help a reimagined good wolf get to the three little pigs. Their objective is to help deepen student understanding of the text through extended discussions about the text. The following Head Start ELOF goal supports this objective: "Goal P-LIT 5. Child asks and answers questions about a book that was read aloud."

Integrating Precoding Through Instruction

Each instructional session will be organized according to the following steps of explicit instruction: anticipatory set, modeling, guided and independent practice, and conclusion. Instructional sessions will also provide opportunities for children to practice 21st-century learning skills and work collaboratively to practice precoding concepts. ***Table 5*** provides an overview of each component of explicit instruction along with connections to precoding.

Connecting to Everyday Routines and Procedures

Young children with or at risk for disabilities may need an accommodation that involves distributing initial introduction of precoding concepts across multiple sessions. The first session may introduce students to the overall concept of precoding and to the key terms, "programmers" and "robots." The materials for the first session may include images of actions and bags for holding the images. The second session may introduce students to the forward arrow and the corresponding grid. The materials for the second session may include forward arrows, masking tape, and Velcro. Finally, during the third session, teachers may make connections between a target routine (e.g., handwashing) and precoding. The materials for the third session may include masking tape, cards containing both forward arrows and parts of the target routine, and Velcro. The goal of each session will be for students to use precise directional language to describe the steps needed to successfully complete classroom routines and procedures. Each of these sessions will primarily be guided by the following Head Start (2015) ELOF goal literacy standard: "Goal P-LC 6. Child understands and uses a wide variety of words for a variety of purposes." An important modification across sessions may be to allow some students to complete tasks using nonverbal communication.

Session 1.

Mrs. Finn begins the first session with an anticipatory set that introduces precoding. She states, "Today we are going to do something new. We are going to learn how to code. Coding is when you give directions for someone or something to follow." She encourages students to share what they know about giving directions. Mrs. Finn then explains, "In coding, the person who gives directions is called a programmer, and the person who follows the directions is the robot." She asks students to repeat the word "programmer" and asks for a volunteer to remind the class about what a programmer does. Mrs. Finn asks Mr. Olive to come up and help model through role-playing. Mrs. Finn shows the class a bag and explains, "In this

Table 5 **Connecting Precoding With Explicit Instruction**

Explicit instruction step	*General components*	*Example precoding connection*
Anticipatory set	Teachers tell students the purpose of the lesson	Lesson purpose: Understand the fundamentals of coding
	Teachers provide key terms	Key terms: "programmer," "robot"
	Teachers state target skill	Target skill: Understand the concept of giving and taking directions
	Teachers activate or build background knowledge	Background knowledge: Giving and following directions
Modeling	Teachers tell students each step of the target skill	Steps of target skill: Programmer shows picture to robot, robot does the action, robot states what they are doing (if appropriate)
	Teachers use think-alouds to show students how to work through each step of the target skill	
Guided practice	Teachers provide support as students work through the steps of the target skill	Practice with teacher support: Some students volunteer as programmers as robots during whole-group practice
	Teachers provide frequent feedback to students	Teacher feedback: Teachers provide positive and corrective feedback
Independent Practice	Students work through steps of the target skill with little to no teacher help	Practice without teacher support: Students practice being programmers and robots in small groups or pairs
	Teachers provide frequent feedback	Teacher feedback: Teachers move from group to group and provides positive and corrective feedback
	Students are encouraged to show how they work through each step of the target skill	
Conclusion and wrap-up	Teachers review lesson purpose and key terms	Review: Teachers review the concept of coding and the terms "programmer" and "robot"
	Teachers reviews steps of the target skill	

bag, I have several pictures of kids doing things. I am the programmer, and I will pull one picture from the bag and show it to Mr. Olive, the robot. Then the robot will do the action and tell me what he is doing." She pulls a picture of a student raising his hand from the bag and shows it to Mr. Olive. Mr. Olive raises his hand and says, "I am raising my hand." Mrs. Finn then invites a student volunteer to come up and model performing another action as the robot. The teachers then provide students with some time to practice together in small groups. Each group gets its own bag of actions to perform. The students are instructed to take turns being programmers and robots. Mrs. Finn and Mr. Olive conclude Session 1 by asking students about some of the actions they performed as robots. They also review the terms "coding," "programmer," and "robot." Finally, they tell students that they will get a chance to act as programmers and robots in future lessons.

Session 2.

Mrs. Finn begins the next session by reintroducing the vocabulary terms "coding," "robot," and "programmer." She asks if anyone remembers what each term means. She restates the definitions provided during the last session. Mrs. Finn begins the anticipatory set by holding up a large square card that contains an image of a forward arrow and explains, "This is called a forward arrow. It is how the programmer gives directions to the robot to move from place to place. Last time, the programmer gave directions, but the robot moved parts of its body while standing in place. When the robot sees this arrow, it knows that it should move forward." She then points to a one-by-four-column grid outlined on the floor and states, "But the robot can only move from place to place on this grid." She begins the modeling process by asking Mr. Olive to go over and stand in front of the grid. She then places a forward arrow on each of the four

Figure 1 **Integrating coding with handwashing**

squares of the grid. Mrs. Finn explains, "I'm the programmer. I've just given directions, or programmed a path, for Mr. Olive, the robot, to move forward four spaces along the grid." Mr. Olive moves forward and counts as he moves forward in each space. Mrs. Finn invites a student volunteer to come to the front of the room and model moving forward on the floor grid. The two teachers then direct students to several premade one-by-four floor grids and allow them time to practice in small groups by providing them with their own set of forward arrows. Mrs. Finn and Mr. Olive conclude the session by reviewing the key vocabulary concepts—"coding," "programmer," and "forward arrow." She also asks students to recall the sorts of actions they completed when they took on the role of programmer and robot.

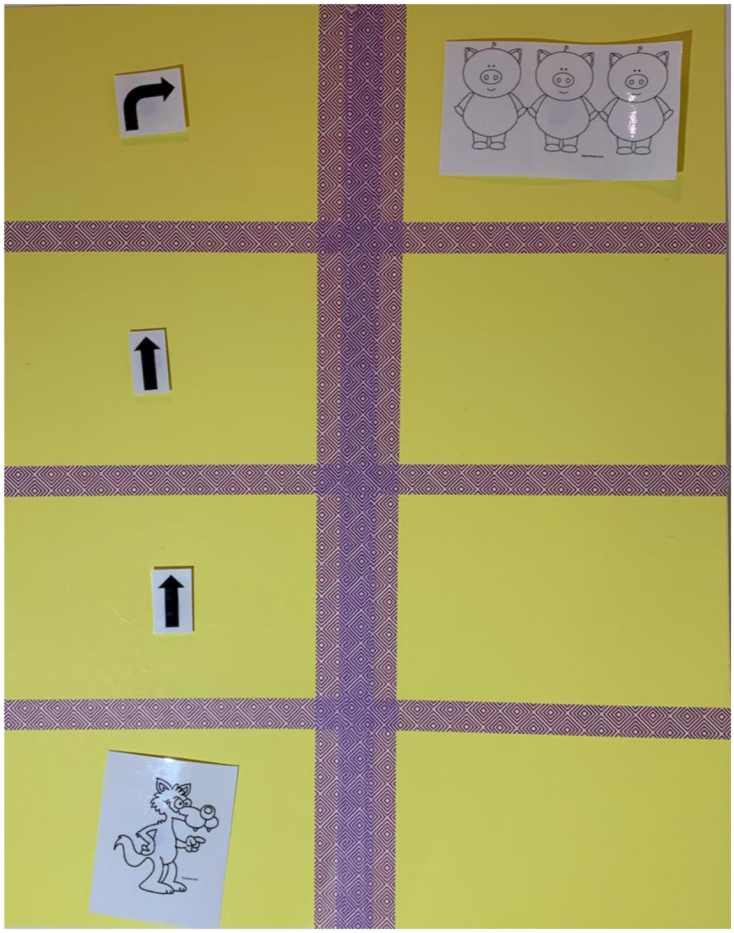
Session 3.

Mr. Olive begins the next session with a review of the key vocabulary concepts so far: "coding," "programmer," "robot," and "forward arrow." He reminds students about what each term means and asks them what they remember about how the programmer used the forward arrow during the last session. Mr. Olive then begins the anticipatory set by explaining, "Today we are going to use the forward arrows and grid to practice the steps of something important: washing our hands." Mr. Olive then states, "Before I show you what steps I take when I wash my hands, I would first like to get a couple of volunteers to share what they do. Who wants to share each step of what they do?" He calls on one student who is raising her hand. The student states, "When I wash my hands, I rub the soap on my hands, and I wash the soap off." Mr. Olive responds, "That is a good example. Would anyone else like to share?" Mr. Olive calls on another student. The student states, "I put soap on my hands, I rub my hands together, and wash my hands with water." Mr. Olive tells the student, "Thanks for sharing your example." He holds up four large square cards that are divided in half. One half of each square contains the forward arrow, and the other half contains a picture of handwashing steps that he has devised. He states, "I'm going to show you pictures of each of my steps in handwashing, and you will tell me what is happening in each picture. Children chorally respond as Mr. Olive shows each of the four pictures. He encourages children to preface each response by saying what happens first, next, and so on. He begins the modeling process by placing the cards on each of the four squares of the grid (programming a path) and asks Mrs. Finn to step in front of the grid. Mrs. Finn moves forward along the path on the grid and states, "First, I put soap on my hands; next, I rub my hands together while I count to 20; then, I turn on the water and wash the soap off; last, I turn the water off and dry my hands." Mr. Olive places students in small groups and allows them to practice taking turns programming robots to walk through each step of his handwashing routine. The teachers complete the session by reviewing some key vocabulary concepts—"coding," "programmer," "robot," and "forward arrow"—and by asking student volunteers to share how they practiced each step of the handwashing routine. ***Figure 1*** *provides an example of the materials used during Session 3's handwashing lesson.*

Connecting to Read-Alouds

By the time teachers begin integrating precoding activities with read-alouds,

Figure 2 **Integrating coding with *The Three Little Pigs***



> One goal of integrating read-alouds may be to use precise language to describe complex movement of characters from familiar stories around the grid.

students will have had a variety of opportunities to engage with precoding activities and materials. Most students should feel comfortable with concepts such as programmer as well as movement on the one-column grid using the forward arrow. One goal of integrating read-alouds may be to use precise language to describe complex movement of characters from familiar stories around the grid. In addition to the previously cited Head Start (2015) ELOF goals (P-LC 6 and P-LIT 5), read-aloud sessions may also be guided by the following Head Start ELOF goal: "P-LIT 4. Child demonstrates an understanding of narrative structure through storytelling/re-telling." Materials for these lessons typically include forward arrows, turn arrows, Velcro, poster board, masking tape, pictures of characters from various texts, and sheet protectors to prevent the pictures from being torn.

Mrs. Finn begins the lesson with a brief review of some key terms—"forward arrow," "coding," "robot," and "programmer." She starts the anticipatory set by stating, "We have been reading about the three little pigs. What do you remember about the story?" She elicits volunteers to share their memory of the story. She then explains, "We are going to change the story a bit. We are going to pretend that the big, bad wolf is actually a good wolf. He needs to get to the three pigs to help them with their chores. We are going to use our poster board grid and our arrows to help the wolf get to three pigs." She shows picture cards that have the wolf and the three pigs. She then shows the right-turn arrow and says, "Today we will be using a new kind of arrow. This arrow allows us to turn. Up until now, we have been going forward, but now we can turn when we get to a corner." Mrs. Finn asks Mr. Olive to come to the front of the room. She asks him to keep walking forward until he gets to a corner in the room. She asks students what Mr. Olive should do now that he has come to a corner. She connects their responses to the turn arrow. Mrs. Finn explains, "When you come to a corner on the board, you can no longer move forward and use your forward arrow. You must now use your turn arrow." She places the wolf on one end of the poster board grid and the pigs on the other end and models programming the path she would like the wolf to take using the forward and turn arrows. Mr. Olive then models moving the wolf along the path until he reaches the three pigs. As he moves the wolf, he narrates what he is doing: "First, I move him forward; next, I move him forward; and last, I turn him. Hello, little pigs, I am here to help!" The two teachers ask for a volunteer to come up and practice moving the wolf along the path before allowing students to practice in small groups using their own poster board grids, character pictures, and arrows. Students take turns programming a path for the wolf to get to the three pigs. Mrs. Finn and Mr. Olive conclude the lesson by asking for volunteers to share their experiences creating and following the path from the wolf to the pigs. They also review the key terms "forward arrow" and "turn arrow" and spend extra time on the turn arrow and its purpose.

Figure 2 provides an example of the materials used during the coding lesson on *The Three Little Pigs*.

Final Thoughts

Precoding activities may help provide early access to 21st-century learning skills, such

as critical thinking and communication, which are important for all students to meet the needs of our current and future workforce (Vilorio, 2014). Unplugged or low-tech precoding practice allows for low-cost direct integration with the early childhood curriculum. When working with young children with or at risk for disabilities, it is best to start slowly with brief sessions that connect to students' daily lives before progressing to other aspects of the curriculum, such as read-alouds. When brainstorming how to integrate precoding activities, teachers may choose to integrate across other aspects of the curriculum and repurpose previously used materials, such as the forward and turn arrows. In addition, precoding can be used to explicitly reinforce practicing mathematics concepts, such as cardinal and ordinal counting (McLennan, 2017). Precoding can also be used to practice geography concepts by using the grid to create maps that review various locations of the local community. Finally, teachers may consider sharing the precoding activities they have been doing with families through weekly newsletters or social media communication. It may be helpful to share specific activities (e.g., scavenger hunts, creating grids using chalk in the home driveway or parking lot, or sending home copies of game-board grids for at home practice) that families can do at home.

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