Ms. Christa is a preschool teacher in an inclusive mixed-ability classroom and is leading a small group activity with four students. Kolby, a 4-year-old identified with a pervasive development disorder not otherwise specified (PDD-NOS), is sitting beside her as she introduces him to a new learning activity with the iPad. His peers wait for their turn on the iPad as she introduces Monkey Math, one of several science, technology, engineering, and mathematics (STEM) apps available on the classroom’s iPad. Across the hall, Ms. Lena is introducing a new learning activity to her class by using the classroom iPad. In her class, students are learning about engineering through a BridgeBasher app. Students are strategically grouped so that each student has the opportunity to lead and learn from others. Ms. Lena is amazed by the students’ engagement and success rate as all the students have a variety of abilities when navigating the BridgeBasher app.
There are many technology opportunities within a preschooler's daily environment, such as computers, interactive screens at the supermarket, smart phones, and video games. Many preschool classrooms, however, have only one computer or only have limited access to computers in a computer lab. The disconnect between a child's community and home technology experiences versus his or her educational technology experiences can be attributed to several factors, such as lack of teacher preparation coursework (Judge & O'Bannon, 2008), limited research on the efficacy of technology infusion in the preschool environment (Floyd, Canter, Jeffs, & Judge, 2008), or teacher apprehension due to the potential interference with personal relationships with young children (Laffey, 2004). Yet, preliminary research shows that, by targeting the youngest learners, student achievement is dramatically improved over the long term when technology is integrated into the classroom (Pentimonti, Zucker, Justice, & Kaderavek, 2010), especially when the teachers and students work together to design and construct learning (Bers, Ponte, Juelich, Viera, & Schenker, 2002).

In recent years, the United States has attempted to increase student proficiency in STEM education to boost the number of students entering into these professions (Lacey & Wright, 2009). Policy makers and educators are concerned with recent STEM test scores of U.S. students, who ranked 25th in mathematics and 17th in science out of 30 countries on the 2007 Trends in International Mathematics and Science Study (National Center for Education Statistics, 2009; U.S. Congress Joint Economic Committee, 2012). As of yet, early childhood has not been a focus of the modern push toward integrating all students with STEM curriculum, nor has the infusion of instructional technology been a priority in early childhood settings (Pargette, Quesenberry, & Blum, 2010). However, the need to design rich learning environments in early childhood settings that address STEM has never been more important.

In order to increase motivation and interest, teachers need to use improved strategies and work with students on STEM concepts at younger ages (Moomaw & Davis, 2010). In fact, Moomaw and Davis found a direct correlation between the use of STEM curriculum with preschoolers and an increase in collaboration skills, vocabulary, and the ability to create and discuss scientific relationships. To that end, we explored how STEM concepts and careers can be presented and taught in inclusive preschool settings utilizing an iPad. While in small mixed-ability groups, preschoolers in inclusive preschool classrooms were provided brief instruction with apps focused on pre-engineering, math, and science content to interact with the technology and gain understanding of STEM concepts and careers.

**Selection of iPad and Apps**

iPads were chosen because they allow for flexibility in the location of where the teaching and learning may occur due to the portability and plethora of educational early childhood apps available at no or low cost. There are several generations of iPads available and it is not necessary to use the most current one; in fact, older ones can be purchased for less money and can often come refurbished with extended warranties. Additionally, if an iPad is not an option, other tablet devices could be utilized. There are countless opportunities to match children's preferences, strengths, and needs with developmentally appropriate apps that link relationships between the abstract and everyday technologies relating to mathematics, science, and engineering.

Four important principles that were considered when picking out apps for preschoolers—especially ones with disabilities—were:

1. The student should be the source of the action to make the outcome more scientific.
2. The students should be able to see cause and effect relationships by changing the beginning action and seeing how it reflects the outcome.
3. The outcome of changing the variable must be observable to the preschooler.
4. The action and reaction must happen immediately for the child to see and make connections between the cause and effect (DeVries & Kohlberg, 1990).
"One of my favorite quotes is from Carl Sagan, who said it's suicidal to create a society that depends on science and technology in which no one knows anything about science and technology—and that's the road that we are headed down. . . . You need to generate the scientists and engineers, starting in school—elementary school, middle school, you have to fund the research that those scientists go on to do—the fundamental research. You have to generate the engineers that can turn those scientific breakthroughs into products and services."

—Sally Ride (in Thomasian, 2011)

Strategies for App Implementation

Although you may be eager to incorporate an iPad or similar tablet into the preschool classroom, you may have some apprehension as to its durability with this age group. Overall, the iPad is stronger than one might suspect and, with minimal instructions (i.e., that it needs to stay on the table and be passed gently to classmates), durability should not be a concern; however, you might want to consider the type of case you use to protect any technology used in the classroom from being dropped. With this primary concern for the equipment out of the way, it is now time to focus on the feasibility and efficacy of using the iPad in your classroom. We recommend a teacher-led learning station with small groups of three or four students of mixed-ability levels as a natural way of presenting the new technology. However, one of the keys to success is to brainstorm ways to introduce the various STEM apps and discuss what skills are necessary for the students to successfully navigate and interact with the iPad. Explicitly teaching students how to use the iPad includes focusing on the skills needed to appropriately hold and handle the iPad; determining the appropriate level of applied pressure required when using it; and demonstrating how to drag and drop icons or other items, tap, access different apps from the bookshelf, and navigate the activities within the app. For example, some students may require hand-over-hand instruction to manipulate the sliding transitions and establish correct pressure. Each child should have multiple opportunities to practice each skill needed for each app presented and, therefore, only one app should be introduced at a time with the main STEM concept and the function of the app. Since all of the suggested apps in this article are play-based (see Table 1), the motivation for the students to engage and explore should be high, with the students quickly learning the games and demonstrating willingness to jump right into the activities while learning to wait for their turn with the iPad.

Making use of the small group format allows students to have repeated exposure to STEM concepts and learn from peers. One strategy for implementation when introducing the Monkey Math app, for example, is to have students with differing abilities sit on either side of the teacher. As the different level questions arise in the game, the teacher can then give the iPad to the student for whom the question is most appropriate. Additionally, the teacher can talk through the problem, allowing for both peer modeling and listening to "math talk" (Klibanoff, Levine, Huttenlocher, Vasilyeva, & Hedges, 2006). Therefore, students are able to gain confidence and develop a high comfort level with the iPad, the

We recommend a teacher-led learning station with small groups of three or four students of mixed-ability levels as a natural way of presenting the new technology.
### Table 1. Recommended Apps for Preschool Classrooms

<table>
<thead>
<tr>
<th>App</th>
<th>Cost*</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monkey Math School Sunshine</td>
<td>$.99</td>
<td>Interactive games using basic preschool mathematics concepts including patterns, counting, basic addition, tracing, and recognizing numbers.</td>
</tr>
<tr>
<td>My First Tangrams HD – A Wood Tangram</td>
<td>Lite version: Free</td>
<td>Create your own Tangrams or build one that exists. Matching of shapes and creating pictures.</td>
</tr>
<tr>
<td>Puzzle for Kids</td>
<td>Full version: $1.99</td>
<td></td>
</tr>
<tr>
<td>i Learn With Poko: Seasons and Weather!</td>
<td>Trial version: Free</td>
<td>Includes three games to identify weather situations and appropriate clothing and activities.</td>
</tr>
<tr>
<td>BridgeBasher</td>
<td>$.99</td>
<td>Design your own bridge, then test its strength.</td>
</tr>
<tr>
<td>Builder Blocks Preschool</td>
<td>$.99</td>
<td>Use traditional wooden ABC blocks to build towers. The app can be set to have towers tumble as they would with gravity or set to stack mode where the blocks won’t fall down.</td>
</tr>
<tr>
<td>Build a Robot</td>
<td>$1.99</td>
<td>Encourages children to create robots with a variety of materials.</td>
</tr>
</tbody>
</table>

*All prices are as of 12/10/2012.

Having the teacher at the learning station provides an excellent opportunity for the teacher to ask students "what if," "why didn't that work," and "what could you do differently next time?"

### When students' confidence and independence with the iPad increases, the opportunity should be taken to lead discussions and expand the learning from the apps to the classroom environment and to careers in various STEM fields.

students’ ability to interact with the apps, the teacher should remain at the learning station while the iPad is in use to facilitate social interaction, expand on the skills being taught, and to collect data on student performance. For example, in one of the apps (BridgeBasher) the goal is to create a sturdy bridge through the use of various tools. Once the student feels he or she has created a strong and safe bridge, the student tests the bridge by dragging balls onto it to see how many balls it can hold. Students can then go back and reinforce their bridge or start again to try to build the strongest bridge.

Don’t be surprised if, after using the app, students want more information about bridges and building. Other activities such as using blocks or other materials to build bridges can then be used in the classroom to build on the knowledge and experience students gained through this app. The teacher can introduce different kinds of bridges through pictures, short movie clips, or a discussion of the different bridges on the playground that may further bring the iPad app to life for preschoolers. It is exposure to this kind of spatial thinking that has been shown to increase interest and, eventually, entry into STEM career paths (Ututal et al., 2012). As a result of student interest in bridge building from this app, you can discuss different kinds of jobs in engineering.

Another example of an app that supports a connection to a potential career in STEM is the Seasons and Weather app. A desired outcome of using the app would be to have the students generalize the skills of picking the correct clothing for the season and weather with the clothes in the dress-up center. Meanwhile, the teacher can take the opportunity to talk about careers in meteorology and how each student is a scientist when discussing the weather.

In addition to the iPad apps, students should be encouraged to work...
with manipulatives relating to the apps while waiting their turn in the small group. For example, while students are playing the tangram app at the iPad station, students who are waiting for a turn can be given actual tangrams to play with. Pairing manipulatives with the app facilitates the transition of learning abstract concepts to a more concrete understanding (Bers et al., 2002), which may be extremely helpful—especially for students with special needs. All students in the small group are then able to make mental translations of shapes to create pictures. One area the teacher will observe is whether the students spend time rotating pieces to fit the picture and which students quickly find the shape that is already oriented correctly.

By allowing students to openly explore the app of their choice, the learning station utilizes differentiated instruction to adapt to students’ interests by content (chosen app), process (which game or exercise played), and product (earning a “virtual sticker,” testing a bridge etc.). As a result, students will look forward to their turn at the center to pick the app and activity. An additional benefit is that students with disabilities relating to speech or expressive language are able to communicate complex thought patterns, knowledge, and interests through use of the iPad. This is especially true for students who struggle with answering “w” questions (e.g., who, what, when, where, and why). Utilizing the iPad and its apps gives the students an additional mode to demonstrate knowledge. The students’ natural curiosity may also be demonstrated by increased verbalizations in students with disabilities, which is congruent with the literature stating how everyday interactions, when in an area of interest, foster language and literacy development (Conezio & French, 2002).

**Support for Learning**

By utilizing the apps mentioned in this article, you may be surprised to note many unintended outcomes. First, consider how easily several of the apps align with the Common Core Standards for preschool. With the increased focus on accountability at the preschool level, the alignment between the apps and the standards provides a fun avenue in which to collect data. Additionally, many of the apps directly align with common preschool goals.
and objectives for students with disabilities and the motivation of playing with the iPad has been shown to increase student’s determination and resolve. For example, using the iPad provides practice and refinement of skills for students with poor fine motor skills and is highly motivating, so students are more likely to stick with the activity. Therefore, the feasibility of iPad use and the efficacy of teaching STEM concepts in the preschool environment can be beneficial both academically and to students with specific areas of need in this age group.

**Challenges and Resources**

One area of concern when using the iPad may be the challenge that some students will face with applying the correct pressure required to manipulate the touch screen. A possible solution for this issue would be to have the students interact with the iPad using a stylus versus their fingertip. However, using the correct amount of continued pressure can assist students with their fine motor development and, for some students, the motivation to use the technology may keep them playing long after they would have normally stopped.

Another issue of concern is that, when the iPad is laid flat on the desk, some students may have difficulty looking down at the screen. Consider propping the iPad up with a slant board or large binder, or purchase a cover with this feature. Also, if necessary, a ruler could be placed over an edge of the iPad to help support the arm of a student who is having trouble applying pressure to the screen in multiple places at a time. Additionally, for students who only have a palmer grasp, a stylus could be placed in a tennis ball for additional support and maneuverability.

**Final Thoughts**

The researched benefits of utilizing an iPad in preschool settings are at the infancy stage of exploration, as is the examination of introducing STEM concepts in this environment. Therefore, a merging of these two worlds is quite timely and important as more and more students become familiar with using technology and teachers gain greater access to it at the same time that educators and researchers continue to find ways to improve STEM instruction throughout all education levels.

**References**


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