Interactive STEM

RESEARCH + PRACTICE BRIEF

Interactive Technologies in STEM Teaching and Learning

Mobile Technology and Mathematics Learning in the Early Grades

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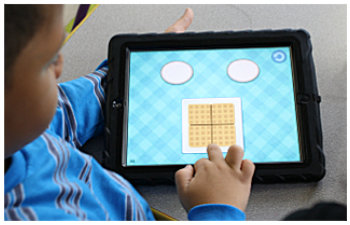

What does technology integration look like? Teacher-supported individual and collaborative gameplay, where all students and the teacher play an active role in the learning process, can support mathematics learning.

Top and bottom photo provided courtesy of WGBH, 2014. Middle photo provided courtesy of SRI International, 2014.

Overarching Issues

The availability and vast selection of touch-screen mobile technologies holds promise for more widespread and tailored use of technology in K–12 learning environments, yet questions remain about the best ways to leverage those technologies. Mathematics teachers may endorse the use of technology yet need guidance on (1) how technology can be used in developmentally appropriate ways to foster mathematics learning, (2) strategies for instructionally sound integration of technology into the classroom, and (3) how to select technology tools that best foster the conceptual learning of mathematics and encourage the use of mathematics practices, such as reasoning and problem solving.

Affordances of Technology for Learning Mathematics

Research supports the assertion that developmentally appropriate technology and media-supported instruction can support learning for young children in a variety of content domains, including mathematics (e.g., Clements & Sarama, 2008; Varol & Colburn, 2007). The developmentally appropriate use of technology has been endorsed by a number of professional associations, including the National Council of Teachers of Mathematics (NCTM), which states:

> Technology is an essential tool for teaching and learning mathematics effectively; it extends the mathematics that can be taught and enhances students learning. (NCTM, 2003, p.1)

NCTM highlights the role of technology in increasing the range of both mathematical content and use of mathematics in real-world contexts that students experience and suggest that technology also increases active participation and interest in the content. Technology also can increase the frequency of engagement with and curiosity about mathematics. Another affordance is that technology allows for multiple learning formats and interaction with multiple symbolic representations (Varol & Colburn, 2007). *The key is to use technology strategically, not just supply access to technology* (see suggestions in later sections).

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Developmental Appropriateness of Technology Use

In a joint position statement, the National Association for the Education of Young Children and the NCTM (NAEYC & NCTM, 2002) detailed a vision for promoting productive mathematics learning for young children. Although focused on children ages three through six, the recommendations laid out in the statement can be easily applied to older students and also maintained as technology is used in the classroom. These recommendations for practice are as follows (NAEYC & NCTM, 2002):

- Enhance children's natural interest in mathematics and their disposition to make sense of their physical and social world
- Build on children's varying experiences and their informal knowledge
- Base mathematics curriculum and teaching practices on current knowledge of young children's cognitive, linguistic, physical, and social-emotional development
- Use curriculum and teaching practices that strengthen children's problem-solving and reasoning processes as well as representing, communicating, and connecting mathematical ideas
- Ensure that the curriculum is coherent and compatible with known relationships and sequences of important mathematical ideas
- Provide for children's deep and sustained interaction with key mathematical ideas
- Integrate mathematics with other activities and other activities with mathematics
- Provide ample time, materials, and teacher support for children to engage in play, a context in which they explore and manipulate mathematical ideas with keen interest
- Actively introduce mathematical concepts, methods, and language through a range of appropriate experiences and teaching strategies
- Support children's learning by thoughtfully and continually assessing their mathematical knowledge, skills, and strategies

Non-digital activities that connect to digital experiences are important components of technology integrated classrooms.

Photo provided courtesy of SRI International, 2014.

Appropriate Integration of Technology into the Classroom

Understanding what is the developmentally appropriate use of technology is the first step in strategically integrating technology into instruction; however, it is not uncommon for teachers to struggle with effective integration, even with a solid understanding of developmentally appropriate use (Ntuli & Kyei-Blankson, 2010). One way to ensure effective integration is the appropriate selection of technology tools and the creation of plans for how they will be used by students in the classroom (see Selection of Technology Tools section). In addition, careful attention to creating opportunities for social learning through joint media engagement with peers and/or teachers to support learning with technology can be useful to successful integration and use of technology in the classroom.

Technology provides multiple opportunities to learn, both through repeated practice and through interaction with peers and teachers during technology use, thus providing a catalyst for social interaction. *Joint media engagement (JME)* is based on research supporting the social interactions in the learning process that involve behaviors such as imitation, observation, and concurrent attention toward a task (Meltzoff, Kuhl, Movellan, & Sejnowski, 2009). Researchers have found that JME creates learning experiences that promote social interaction both among students and between students and teachers (Sarama, 2004). Yet teachers have to scaffold and support these experiences to influence student learning (Penuel et al., 2009). JME can include activities such as playing, searching, experimenting, expanding, and creating in a shared learning setting among students or between students and teachers.

The key to ensuring that JME occurs is for the teacher to mediate the experience so that all students are engaging simultaneously with the task and technology tools as they work toward achieving the learning goal. Practically, this means that teachers must structure activities that use technology in such a way that each participant, student, and teacher has a role to play in achieving the goal. These roles may vary widely based on the task but might include talking about strategies or problems or experimenting with possible solutions. At its core, JME requires that all students pay attention to the task and remain "active" in the learning process, which teachers should facilitate during technology use.

Selection of Technology Tools

The first step in selecting an appropriate technology tool is to clarify the learning goal and ensure that the technology will address that goal and build on prior knowledge. Additionally, a technology tool paired with supported instructional practices should attempt to do some or all of the following:

- Create a well-organized play experience that is within the student's zone of proximal development
- Revisit previously learned mathematics concepts and problems and build upon those previous learning experiences
- Provide multiple opportunities for practice
- Have elements of task scaffolding or feedback, including answer correctness, timeliness, motivational messages, and focus on the learning task to promote successful mastery
- Integrate mathematics concepts and vocabulary into other content areas, such as stories and songs about mathematics content and use of mathematics or music and music games to learn about the underlying mathematical patterns
- Bridge technology use (e.g., gameplay) with everyday, authentic experiences, such as using mathematics in a recipe or relating the use of mathematics to other real-life experiences
- Integrate the learning of mathematics concepts with mathematics practices, such as problem solving; reasoning processes; and representing, communicating, and connecting mathematical ideas
- Avoid exposure to violence or other inappropriate content

Conclusion

Technology holds great potential to engage students in mathematics content and practices. The key to successful integration of technology into mathematics classrooms is to use the technology strategically to accomplish the academic goal and to foster active learning among students and between students and teachers. Teachers should remain deeply engaged in the learning process as children use technology, scaffolding difficult tasks and supplementing learning by linking it to real-life experiences and previous mathematical learning experiences.

In summary, as you plan lessons, (1) match the mathematical goal to the digital resource, (2) create a developmentally appropriate plan for integrating technology into the lesson, and (3), if possible, implement this lesson so that students experience JME with fellow students and with you.

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