The Missing T & E in Early Childhood STEM: Young Children as Programmers and Engineers

Background

The Developmental Technology (DevTech) Research Group examines the role of computational technologies that are developmentally appropriate for young children and that help them learn about new things in new ways. DevTech is exploring the notion of what is "developmentally appropriate" in the light of the opportunities for inquiry and active construction of knowledge offered by new technologies that engage children in programming activities. Through NSF funding, the DevTech Research Group has created a low-cost developmentally appropriate robotics construction kit for children in grades PreK–2 called KIWI (Kids Invent With Imagination). To accompany KIWI, DevTech developed the CHERP programming language, which allows users to create both physical and graphical computer programs to control the robot, as well as several curriculum units. The DevTech Research Group is also collaborating with the MIT Media Lab to develop *Scratch Jr.*, a software designed to engage children in grades K–2 in programming and storytelling. *Scratch Jr.* will be released as a free app in early 2014.

The DevTech Research Group developed the Early Childhood Robotics Network, a virtual community for early childhood educators interested in using robotics and computer programming in their own classrooms. This network features curriculum resources as well as project videos and pictures from educators across the country.

DevTech has developed several curriculum units for use with a variety of robotics kits (LEGO® Wedo™, LEGO® Mindstorms™, and KIWI). These curricula provide a hands-on introduction to a selection of computer programming and robotics concepts, as well as powerful ideas that are integrated with math, science, social studies, and language arts core curriculum frameworks. DevTech regularly offers child-only programs, such as Summer Enrichment Programs, that engage young children with new technologies. Additionally, DevTech offers parent-child programs focused on robotics, such as Project Interactions and professional development programs for early childhood educators with robotics and *Scratch Jr*.

Documented Results

The DevTech group has been doing research with more than 2,000 children and teachers in grades PreK–2 to document young children's abilities and learning trajectories when engaging in programming. The DevTech group has focused on design features of the technology that make it developmentally appropriate. With *Scratch Jr.,* the DevTech group has also been exploring what elements of the software need to be in place to support executive function.

Findings from DevTech work with the KIWI robots have shown a statistically significant impact on sequencing skills after exposure to KIWI programs, including an increase in collaboration and gender neutrality. Results from these studies can be read in publications found here:
http://ase.tufts.edu/DevTech/publications/

The DevTech Research Group has gathered a combination of qualitative and quantitative data from all early childhood teachers participating in studies, and the teachers' changing (or unchanging) technological content knowledge, self-efficacy, and pedagogical views related to

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19

technology. Additionally, both qualitative and quantitative assessments on children's knowledge of various robotics and computer programming topics have been collected.

Potential Applications

DevTech's work has been implemented in both public and private early childhood settings, rural and urban schools, with a diverse population of both students and children. In early 2014, the free *Scratch Jr.* app for iPads will be ready to launch. Collaborations have been initiated to commercialize the KIWI robot and make it widely available to all early childhood settings.

For More Information

Marina Bers website: http://www.tufts.edu/~mbers01/
DevTech website: http://ase.tufts.edu/DevTech/
KIWI website: http://ase.tufts.edu/DevTech/ReadyForRobotics/readyforrobotics.asp#technology
Scratch Jr. website: http://ase.tufts.edu/DevTech/ScratchJr/ScratchJrHome.asp
Early Childhood Robotics Network: http://tkroboticsnetwork.ning.com

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20