

Ramps and Pathways: Integrating Physical Science and Engineering in Early Childhood

Background

The *Next Generation Science Standards* makes clear that science and engineering are complementary. Nowhere is this more evident than in the early childhood years. Young children are budding physical scientists; they are curious about the world and possess an intrinsic desire to figure out how the world works. They also have a strong need to be physically active, and inquiry into physical science provides them opportunities to actively explore and control physical phenomena. For example, building ramp structures and rolling marbles down them allows children to investigate how to control force and motion to achieve a goal (maximize speed, make a turn, create interesting effects, etc.). In the process, they begin to construct simple causal relationships. For example, when the angle of incline on a ramp is reduced, the marble travels more slowly. Or, a heavier marble is better at knocking down a block at the end of a ramp than a light marble is. In addition to building content knowledge, such classroom activities also engage children in actively exploring their environments, making sense of them, and using what they learn to design things—the beginnings of both scientific inquiry and engineering.

The Ramps and Pathways project reflects an approach to engaging young children with physical science and engineering that is both developmentally appropriate and intellectually rigorous. It capitalizes on young children's intrinsic desire to *make something interesting happen*; specifically, it engages children in designing, building, and using increasingly more complex ramp structures on which to move spheres and other objects. In doing so, it engages children in the design process: ask a question or identify a problem, plan, create, test, improve, and evaluate. Most engineering curricula for older children include linear models of the design process that consist of variations of these steps. However, such linear models fail to capture the realities of young children's exploratory play and investigation of physical phenomena. The Ramps and Pathways project subscribes to a model of the design process in PreK-2nd grade classrooms that does not reveal itself as steps, but rather as non-sequential components that are often enacted simultaneously (sometimes within a few seconds). The Ramps and Pathways' process emphasizes the iterative nature of the design process which is sometimes quite messy.

The Ramps and Pathways project, funded by the NSF, addresses two overarching goals: (1) to develop an age-appropriate physical science and engineering curriculum based on the movement of objects along ramps and pathways, and (2) to design and implement professional development materials for early childhood educators to best support young children's learning about physical science, scientific inquiry, and engineering within the context of ramps. The Ramps and Pathways project was tested with 42 teachers (PreK-2nd grade, including special education) in four states.

Three recommendations that were specifically highlighted in *Monitoring Progress toward Successful K-12 STEM Education: A Nation Advancing?* (NRC, 2013) stand out as particularly relevant to Ramps and Pathways: Time allocated to teach science in K-5th grade; adoption of instructional materials that embody the *Common Core State Standards* (CCSS) and the *Framework for K-12 Science Education*; and classroom coverage of content and practices in the CCSS and the *Framework*.

Professional development in Ramps and Pathways focuses on both science and engineering content and early childhood pedagogy. Teachers learn about concepts of force and motion as applied to moving objects down inclined planes, causal relationships among variables, and scientific and engineering practices. They engage in the design process themselves, and learn how to support it with young children. They learn how to create learning environments that respect young children's development, how to intervene and ask questions that promote reasoning and concept development, how to document children's learning, and how to integrate across curriculum areas, particularly mathematics and literacy.

Potential Applications

The *Ramps and Pathways* curriculum can be implemented in any early childhood classroom serving children ages 3 years through 2nd grade—including Head Start, public schools, and center-based and home-based childcare. It can also be easily adapted for older children or utilized as an after-school enrichment or summer activity. Various levels of professional development are available, ranging from a three-hour introductory workshop to a one-week in-depth course.

For More Information

Contact betty.zan@uni.edu

Van Meeteren, B. & Zan, B. (2010, November). Revealing the work of young engineers in early childhood education. *Early Childhood Research and Practice*. Retrieved from <http://ecrp.uiuc.edu/beyond/seed/index.html>.

Zan, B. & Geiken, R. (2010). Ramps and pathways: Developmentally appropriate, intellectually rigorous, and fun physical science. *Young Children*, 65(1), 12–17.