

CAREER -- Developmental Engineering: An Examination of Early Learning Experiences as Antecedents of Engineering Education

PROJECT SUMMARY

Developmental engineering refers to early childhood education precursors to engineering thinking. Instituted early on, and in custom-made ways, it can allow young learners to develop knowledge about *the what, the why, and the how* of human engineered artefacts and environments. This proposal examines the subject of developmental engineering with preschoolers, ages 3-5, and considers the resultant pedagogical implications for teacher education and developmentally appropriate curriculum construction. The study participants comprise preschool-age children, their parents and teachers from two early childhood education classrooms; each representing a different population. One is a university child development laboratory classroom and the other a Head Start classroom in the same community. Within these environments, the integrated research and education goals articulated below will be fulfilled.

1. Generate knowledge about how young children perceive, understand, and learn about the engineered world of human-made artefacts and environments.
2. Translate findings into developmentally appropriate, inclusive and culturally sensitive approaches to support young children's discovery, and integrate engineering concepts and processes into the early childhood education curricula.
3. Transform teacher education through the integration of developmental engineering pedagogy in classroom practice.

Utilizing a mixed-methods research framework over the course of five years, this project will produce two case studies that systematically document how the children and teachers in each of the classrooms, (i.e., Head Start and university child development laboratory) perceive, understand and learn about the human engineered world of artefacts and environments. Together, the two cases provide a socially, ethnically, and economically diverse sample that informs the study of developmental engineering.

The initial phase of the project will involve the modification of both classrooms to include elements serving as exemplars of and inspirations for engineering. Data will be collected on the interactions of both children and teachers with these elements and their derived understanding of them. This data will in turn inform the ongoing development of a conceptual model of how children learn about and understand engineered artefacts. In the second phase, the conceptual model will be translated into the design of developmental engineering curricula and associated pedagogy to further support young children's interest in and learning about basic engineering concepts. The two classroom settings will serve as test-beds, where the impact of the developmental engineering intervention on children and teachers will be assessed and fed-back into the design process. The third phase of the study will involve the dissemination of knowledge gained in the first two phases through teacher education. Training will be offered to undergraduate and graduate students interested in science technology, engineering and math (STEM) education and to in service teachers in the form of courses, mentoring, and the opportunity to observe and participate in the laboratory classroom. Through-out the duration of the project, the phases will be iteratively traversed, ensuring the refinement of the research methods and resulting findings.

Intellectual Merit

Developmental engineering is a new research area at the disciplinary crossroads of human developmental science and engineering thinking as a fundamental creative human activity *par excellence*. Understanding how young children perceive, understand and construct meaning from the world around them is an important goal in human development and education. Appreciating how such meaning is constructed vis-a-vis the human engineered world of artefacts and environments can fundamentally transform how we view modern early childhood education as part of the continuum that leads to engineering education.

Broader Impact

Results from this study of developmental engineering will address the fundamental questions of children's understandings of artefacts as proxies of the engineering world and the role that early learning experiences play in the critical P-6 period in terms of developing interest in engineering. A deeper understanding of behavioral and experiential antecedents will positively impact efforts to enhance diversity and increase the number of qualified students directed to engineering.