Seeds of STEM: The development of an innovative early childhood STEM curriculum

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Project summary

The "Seeds of STEM" project is a collaboration between Head Start teachers and faculty and students from Worcester Polytechnic Institute (WPI) to develop a standard-based STEM curriculum for early childhood programs. This curriculum, developed by teachers and for teachers, will be developmentally appropriate and specifically designed for programs that serve low income and ethnic minority children such as Head Start. The curriculum will be aligned with the recently published Next Generation Science Standards (NGSS) for kindergarten and therefore will provide preschool children with the experiences required for successfully achieving scientific and engineering practices in Kindergarten.

The Seeds of STEM curriculum will be developed by Head Start teachers through an iterative process, with structured guidance from the project team and the project's advisory board. This unique model of working with teachers to develop -> test -> redesign the curricula was chosen to ensure the matching of the activities to a 'real-classroom' environment and enhance implementation and usability of the lesson plans by Head Start and other preschool teachers. The Seeds of STEM model for curriculum development takes an innovative approach to curriculum development. We consider the Head Start teachers to be classroom experts, knowing the pedagogy, students' interests, vocabulary, attention level, and family background. The teachers are also familiar with the daily schedule, the available materials, the available staff and other requirements of the Head Start program. A set of professional development sessions will provide them with the required STEM knowledge and challenges. Knowing that, the teachers will design every lesson plan with the goal of bridging the gap of STEM anxiety reported by many preschool teachers.

This intervention has the potential to produce substantially and better student outcome for several reasons: First and foremost, a K-12 national curriculum that includes engineering practices was only released a few months ago. Preschool curriculum materials that build toward the learning outcomes of the NGSS are just being developed. Second, the development model (for teachers, by teachers) reduces implementation and accessibility challenges and enhances the usability of the curriculum since it will be designed and tested in Head Start classrooms. Third, Worcester Polytechnic Institute is an engineering school and the project's team expertise focus around engineering and STEM education. Third, the topic of engineering practices fits well the needs of the Worcester Head Start Program. As research shows, having administration support is key for the success of the project. Lastly, our Center has recently concluded a 4-month pilot program with the Worcester Head Start teachers that focused on the integration of engineering practices and literacy, and it is our belief that the teachers are ready to move to the next step and use their knowledge on engineering practices to develop lesson plans.

Curriculum development process

The *Seeds of STEM* project focuses on the development of an early childhood STEM curriculum that is focused on the engineering process, developmentally appropriate and aligned with national standards. Specifically, preschool students who experience the curriculum are expected to demonstrate the following STEM related practices:

1. Asking questions and defining problems: articulate, explain the problem in their own words
2. Develop and use models: suggest more than one solution for the problem; use artifacts to model their ideas
3. Analyze and interpret data: Test and evaluate their solution based on a given constraint and justify the best solution

The curriculum will be developed through a partnership between the project's team (content experts) and a team of developer teachers which will be Head Start teachers (classroom experts), and overseen by an advisory board. The advisory board will be comprised of experts of early education, child development, STEM expert, curriculum development, head start administrator, and Head Start teacher. The curriculum will be developed through an iterative process, in which teams of teachers work to develop test and redesign each lesson plan in the curriculum. This model was chosen to ensure the matching of the activities to a 'real-classroom' environment, ease implementation and increase the usability of the curriculum by Head Start and other preschool teachers.

The Seeds of STEM curriculum will include 8-10 lesson plans that gradually introduce STEM practices at a preschool level. The first lesson plan will focus on the engineering process as a whole and provide the rational for following a process to solve problems. The following lesson plans (2-4) will each focus on one engineering practice and builds on previous lessons. The remaining lesson plans will introduce different challenges at a preschool level in which children will be asked to apply the different engineering practices in order to solve the problem. These lesson plans will utilize different areas and materials available in a Head Start classroom, such as problems that involve blocks, challenges found in books, social problems that require man-made solutions, or challenges that focus on the arts. This approach is taken in order to overcome shared stereotypes (i.e. engineering = building), to show that engineering practices can be applied to solve different problems and challenges, and to engage a large group of children with variety of interests. Each lesson plan will include the following components: large group opening activity, small group challenges or cases (at lease 3), large group closing activity, follow up activity for the home or the classroom (extension); additional resources for the teacher, & assessment component. The lesson plan template and the framework for the curriculum will be determined prior to the development process (see study 1 below).

The proposed project's development phase is multileveled and will involve Head Start teachers working in small (center-based) groups to develop and test lesson plans and in large group meeting with teachers from different centers. Worcester Head Start includes 4 centers,

with 6-11 classrooms in each one. Out of the 4 centers, a group of developer teachers will be selected, with consideration given to teachers' expertise and interest in being on the development team, and additional teachers from the program will be the first wave and second wave of lesson testers'. The developers will meet with a project's staff member monthly, and the testers will meet in small center-based groups to combine their feedback into one document. The large group professional development meetings will include teachers from different centers and provide an opportunity for them to learn about a variety of STEM, early childhood and curriculum development topics (see figure 1 for the iterative process of curriculum design).

The development phase is scheduled to last two years out of the overall three years of the proposed project. The first six months will be devoted to establishing the measures and exact topics for the lesson plans, the advisory board meetings and the measures required to evaluate the implementation. A lesson plan development process, lasting 18 months will follow. Lastly, a pilot study will be conducted during the third year of the project.