Facilitating Young Children’s Science Learning through Iterative Cycles of Professional Development: An NSF funded study

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Context of Project:
Professional development is crucial to supporting early childhood teachers’ ability to design and implement lessons that promote young children’s science literacy as envisioned by the Next Generation Science Standards (NGSS). One immediate challenge in designing effective professional development for teachers is establishing first, that the professional development experiences impact their knowledge, skills and dispositions; and secondly, that these enhanced competencies impact the learning of their students. Set within the framework of a diverse school district, the New York City Public Schools, the iterative phase of professional development engages a sample of kindergarten and 1st grade teachers in a series of collaborative experiences that enhance their knowledge, skills and disposition at encouraging young children to think and act like a scientist.

Research Questions:
1. To what extent do teachers participate in the Professional Development Program?
   A. Gain knowledge and skills envisioned by NGSS standards?
   B. Design and implement NGSS lessons integrated with ELA and Math concepts relevant for science?
2. To what extent do students demonstrate learning behaviors envisioned by NGSS Standards and ELA and Math concepts relevant for science?

Data Collection and Analysis Methods:
A case study approach will be used to answer the three research questions. Descriptive analysis of pre-and post-test data from the surveys will generate information about the teachers’ perceptions of their knowledge, skills and dispositions for NGSS learning and teaching. Similarly, descriptive analysis of baseline and post- PD intervention data from a Science and Engineering Practices of Teachers and Students Checklist and Rubric will generate descriptive information about teachers’ and students’ use of science and engineering practices in science lessons. Descriptive analysis of PD session from exit slips, observation notes, questionnaires will generate information about the quality of implementation of the PD intervention. Finally, descriptive analysis of pre-post data from checklists and rubrics will generate information of the quality of teachers’ lesson plans and samples of students’ work.

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Research Design:
Teacher participants, 10 kindergarten and 10 1st grade teachers participated in the study. Prior to the first cycle of professional development (PD) in the spring of 2017, two baseline measures were administered to the teacher participants - A Teacher Knowledge about Next Generation Science Standards for Teaching survey developed by members of the research team and a Teacher Beliefs about Effective Science Teaching Questionnaire (Smith, Smith and Bankowski, 2014). Eight PD sessions, each lasting eighty minutes, followed the administration of the baseline measures and served as preparatory experiences for the next two cycles of professional development. These first PD sessions consisted of general topics on science teaching, learning and assessment and included artifacts, research articles, video clips of teachers and children engaged in science tasks and concluded with a questionnaire administered to the teachers about their perceptions of the PD sessions.

Prior to the start of the second PD cycle in fall of 2017, a third baseline measure developed by members of the research team, Engagement in Science Practices was administered. To follow this administration, a set of opportunities for partners to engage in science and engineering practices. Another eight PD sessions followed that focused on enhancing the knowledge and skills of participating teachers through NGSS-based disciplinary core ideas, supplementing concepts, science and engineering practices as well as its integration with English Language Arts and Mathematics concepts relevant for science. After each phase, questionnaires were distributed to the teachers soliciting their feedback about the session.

Prior to the start of the third PD cycle in the spring of 2018, teachers were asked to submit a self-generated video lesson with accompanying plan and samples of student work for that lesson. The third set of PD sessions (still ongoing) comprises both in-person and asynchronous PD activities pertaining to the design and implementation of NGSS-based lesson plans integrated with English Language Arts and Mathematics concepts relevant for science. Upon completion of the third cycle of PD sessions, three surveys administered earlier as baseline measures will be administered to the teachers to be asked to submit a second self-generated video lesson with accompanying lesson plan and samples of student work. In addition, upon completion of their video lesson, teachers will be asked to complete a reflective prompt about their lesson and lesson plan.

Evidenced-based Results to date:
Teacher Knowledge about Next Generation Science Standards for Teaching
The Teacher Knowledge about Next Generation Science Standards for Teaching (TKNNGSS) Questionnaire, developed by members of the research team, was used to measure teachers’ knowledge about Next Generation Science Standard (NGSS) for teaching. The TKNNGSS includes 21 items in three domains of knowledge: (a) lesson plan (eight items); (b) teaching (10 items); and (c) classroom assessment (3 items). The baseline data on the TKNNGSS indicated that teacher participants had very low levels of knowledge about NGSS for teaching in terms of planning and classroom assessment. However, they reported higher levels of knowledge about certain science related practices - how to sequence tasks in ways that help young children engage in learning tasks that are likely to enable them to meet the objectives of a lesson; what types and levels of questions to ask young children in the beginning, middle and end phases of a lesson to enable them meet the objectives of a lesson; and how to pace the activities of a lesson to allow young children the time needed to initiate and sustain their engagement throughout the lesson.

Engagement in Science and Engineering Practices Survey
A survey, Engagement in Science and Engineering Practices (ESEP) was developed by members of the research team to assess the participants’ perceptions of their participation in engaging NGSS and engineering practices and was adapted from the Measuring Science Instructional Practices Survey (MSIPS; Scheffey & Mayes, 2016). Items included (a) questions and defining definitions, (b) developing and using models, (c) planning and carrying out investigations, (d) analyzing and interpreting data, (e) using mathematics and computational thinking, (f) constructing and designing and solving designs, (g) engaging in argument from evidence, and (h) obtaining, evaluating, and communicating information. Each item was rated on a 5-point scale, ranging from one (Never) to five (Daily). A mean of items scores was calculated, with higher scores indicating higher levels of engagement in Science and Engineering Practices (SE)

The baseline data indicated that teacher participants reported that their children generally engaged in SE practices across dimensions at low frequencies, falling between Rarely (once or twice a month) and Sometimes (once or twice a week). Particulate, teacher participants reported that they generally generated questions about engineering investigations, created drawings to solve science and engineering problems, analyzed and interpreted results from scientific investigations, analyzed and interpreted results from engineering investigations, gathered data to test an engineering design. Relatively, teacher participants reported that their students engaged in NGSS practices slightly more frequently with respect to recording their observations (e.g., drawing, writing, or speaking) and using scientific vocabulary in context of an activity.

Next Steps:
After two more PD sessions, the three surveys administered at baseline will be re-administered and the data from them analyzed. In addition the following data will be collected and analyzed: post PD lesson plans, video lessons and samples of students work. It is expected that the results will show qualitative differences in terms of the impact of the professional development intervention on NGSS teaching and learning.