

# EXPLORING THE IMPACT OF A STEM INTEGRATION TEACHER PROFESSIONAL DEVELOPMENT PROGRAM ON EARLY CHILDHOOD TEACHER'S PEDAGOGICAL BELIEFS

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## ABSTRACT

The purpose of this study was to investigate how STEM-focused professional development training influence early childhood teachers' knowledge, beliefs, and pedagogies. Four pre-K teachers participated in this study. The data collected was qualitative in nature. Interview data were transcribed, coded and emerging themes were identified. The findings showed that all four teachers were positively impacted by the STEM professional development, resources and the materials available to them to implement the STEM units/projects. Consequently, children were positively impacted because of their teacher's professional learning and high confidence about teaching STEM-related activities.

## KEYWORDS

Early Childhood, Integrated STEM, Teacher's Belief, Professional Development

## 1. INTRODUCTION

A growing body of research indicates that experiences with science, Technology, Engineering, and Mathematics (STEM) is critical in preparing students to think critically, creatively, and solve problems. These are valuable skills students need to succeed in school, work and life (see Aronin and Floyd, 2013; Chesloff, 2013). This raising awareness of STEM education needs has led to a push for STEM education in middle grades and high schools giving limited attention to the teaching of the STEM in early childhood setting. Lately, a core of research specialists, curriculum developers, and early childhood advocates have called for STEM education in the early years since young children are perfectly adapted to learn STEM concepts (e.g., Alade et al., 2016). For example, Chesloff (2013) argued that STEM education should start in early childhood since "concepts at the heart of STEM—curiosity, creativity, collaboration, critical thinking—are in demand" (p. 27).

Although children show natural curiosity about their world and remarkable capacity for independent learning, they need adult assistance to support, guide and build on their interests to ensure adequate early STEM experiences (Early Childhood STEM Group, 2017). Unfortunately, research shows that many teachers, particularly early childhood teachers, not only lack confidence about teaching STEM subjects but are also ill-prepared in content and pedagogy to effectively engage young children in developmentally appropriate STEM learning (Bagiati & Evangelou, 2015; Nores & Barnett, 2014). Moreover, the implementation of a STEM curriculum is strongly dependent on teachers' attitudes and beliefs toward STEM (Roehrig et al. 2007). Studies (Wang et al., 2011; Park, Dimitrov, Patterson & Park, 2017) have indicated that Professional Development is needed in STEM education for K-12 teachers, especially pre-K teachers, as their beliefs and attitudes about STEM affect their students' perceptions and interest towards STEM subjects.

The purpose of this study was to explore the impact of a STEM integration teacher professional development program on early childhood teachers' pedagogical practices and beliefs about teaching STEM in pre-K settings.

## 2. EARLY CHILDHOOD TEACHER BELIEFS

There is limited research looking at early childhood teachers' pedagogical beliefs regarding STEM integrated curriculum. Kagan defines teachers' beliefs as "tacit, often unconsciously held assumptions about students, classrooms, and the academic material to be taught" (Kagan, 1992, p. 65). Different constructs such as teachers' early formal and informal education, school context, media, and culture could affect their pedagogical beliefs on how certain subject matters should be taught. Fang (1996) argues that "teachers' theoretical knowledge and beliefs" (p. 49), influence how they design and implement their curriculum and how they interact with their students. Chen et al. (2014) report that early childhood teachers' beliefs about what is more important in young children's education influence their decision as to what to prioritize in the classroom. The authors further argue that the misinterpretation of child-centered Developmentally Appropriate Practice (DAP) causes practitioners to think that content areas such as math/science are inappropriate to prioritize in early childhood education. This notion is an example of how teachers' beliefs often function as mechanisms to either confirm or refute new professional knowledge and skills that demand a change in their existing teaching practice (Nespor, 1987). Therefore, the view of early childhood teachers presented in this paper help us explore some of the pedagogical beliefs that they have about a newly recognized phenomenon, which is science, technology, engineering and math (STEM) integration in early childhood education curriculum following a series of professional development sessions

Therefore, the view of early childhood teachers presented in this paper help us deconstruct some of the pedagogical beliefs that they have about a newly recognized phenomenon in early childhood field, which is STEM integration in curriculum following a series of professional development sessions.

## 3. THE METHODOLOGY

**Participants and setting.** The data reported in this study are from two separate yet similar larger studies that investigated the effect of STEM education in early childhood settings. The two studies were conducted in 2013-13 and 2013-14 academic years respectively. Participants included two teachers (Brook and Megan) from a public Pre-K Center and two Pre-K teachers (Jenna and Tammy) from a Head Start program in a small town located in the South Eastern part of North Carolina. Pseudonyms were used to protect the participants' identity. All four teachers were female (three White and one Black) ranging in age from 29 to 40 years old. As B-K licensed lead teachers in their classroom, they were responsible for planning and implementing the curriculum as well as the assessment of their students. The teachers' experience at the Pre-K level ranged from three to ten years of teaching as lead teachers. All four teachers volunteered to take part in this study and were willing to share their project work and documentation as part of this research. The studies these teachers participated were reviewed and approved by our university' institutional review board (IRB).

**Data collection.** The data was collected through an interview protocol lasting for 90-120 minutes each. Observational notes of professional development sessions as well as researchers' field notes of participants' teaching practices were utilized to triangulate what emerged from the interview data.

**Data analysis.** The data collected for this study is qualitative in nature. Interview data were transcribed and coded into categories to explore the emerging themes regarding early childhood teachers' pedagogical practices and beliefs about teaching STEM integrated curriculum.

**Professional Development.** The lead teachers in each study received a series of professional development sessions that were designed to help teachers develop both content knowledge and pedagogical knowledge as it relates to STEM curriculum. Each teacher participated in three formal professional development sessions over the course of study (March – May). Professional development sessions were continuous (90 minutes each) and facilitated by the researchers and a former kindergarten teacher with expertise in science and engineering. The content of each professional development session targeted the STEM curriculum topics that were pre-selected by the teachers themselves: living and non-living, ocean animals, and the human body in the 1st study; weather and water, motion and the human body in the 2nd study. All the topics were explored via project-based learning activities. In each session, the participants discussed, brainstormed on teaching strategies and activities, investigated and practiced the process, as they would do in a classroom with a group of young children. Moreover, the two researchers served as a mentor and support engaging teachers in conversations about their practice and helping out with planning and implementing of units/projects when needed.

## 4. FINDINGS

Five themes emerged from the analysis of the interview data. Researchers' observational notes of teachers' classroom practices helped triangulate the themes. The following section explains each theme exemplified with quotations from the participants' interviews.

**Impact on teacher learning/understanding of STEM curriculum.** The professional development was designed to allow teachers to become familiar and comfortable with both content and pedagogy surrounding STEM curriculum. Teachers in both studies were provided with STEM related resources that they could utilize in their classrooms. Furthermore, the research team supported teachers' curriculum plans with materials that they desired and the research team found helpful. In their interview, all four teachers reported how their pedagogical practice was impacted by such professional development—they explained it helped them widened their knowledge and skills in STEM subjects. Jenna and Brook specifically noted how they came to realize that they had often stayed within the boundaries of the common practice employed in their programs in regards to curriculum planning. STEM professional development sessions encouraged them to try out different pedagogical practices such as intentional teaching or trying different modalities to search new information.

**Increased confidence about teaching STEM.** As part of the professional development, the participants were provided with hands-on learning experiences that focused on pedagogical and STEM content knowledge. As mentioned earlier, our goal was to provide the teachers with some of the same STEM integrated experiences that their students will have in the classroom. This increase in the pedagogical and STEM content knowledge helped boost teachers' level of confidence both in the planning and implementation of the STEM integrated curriculum. Furthermore, as teachers gained more comfort in handling the STEM related activities and materials, they showed more commitment to the STEM. That being said, it is important to note that although all four teachers implemented the STEM curriculum in their classroom, not all showed the same level of knowledge, comfort and pedagogical skills in STEM. This variance in teachers' knowledge, skills and comfort level seemed to have affected what was accomplished in those classes. Nonetheless, all teachers showed some level of confidence with STEM subjects that helped them with both planning and implementation. For example, in her interview, Tammy explained about how the STEM project helped her shift her focus from getting the right answers to using the right process when planning and implementing STEM integrated lessons.

**Need for STEM related materials and resources including access to technology.** Integrated STEM curriculum requires appropriate and stimulating materials/resources for teachers as well as children to investigate, problem-solve, design, and test and retest hypotheses. Schools that have little to no funds to afford appropriate materials and/or consumable supplies may hinder early childhood teachers from effectively engaging their students with STEM related activities. As part of this study, each classroom received a collection of STEM related materials and resources for children as well as teachers. All teachers revealed in their interview that the provision of STEM related materials and resources motivated both their learning and teaching practice.

**Impacts on children's learning.** A common theme found in teachers' interviews was the extent and quality of learning that occurred among children. Overwhelmingly, teachers explained that STEM curriculum offered their students numerous opportunities to be active, engaged, and take initiatives in their own learning. Based on the observational notes taken by the researchers, we saw a significant association between teachers' content and pedagogical knowledge and children's learning. The higher the teachers' competence in pedagogical and STEM content knowledge the greater the students' level of engagement and conversations surrounding the STEM units and activities. This observation/finding is well supported by previous work showing a direct association between the instructional approach of the teacher and student achievement, indicating that students are more likely to learn from teachers with higher levels of instructional competency (e.g., Brophy & Good, 1986; Polly et al., 2013).

**Challenges with integrating a STEM integrated curriculum.** In their interview, although all four teachers unequivocally marveled about the benefits of STEM project, they also explained of a number of challenges in implementing it. As part of the study, teachers were asked to complete reflective journals; collaborate with other teachers to plan if possible; facilitate children's technology use; and document children's learning. However, teachers explained in their interviews that it was hard to keep up with all these while at the same time addressing the goals/assessment required by state and their school

curriculum/curricula. Teachers from Public Pre-K used a combination of curricula, Opening the World of Learning (OWL), Number Worlds and CIRCLE, whereas teachers from Head Start program used Creative Curriculum. The quotations in Table 1, row 6 highlight some of the challenges noted by these teachers.

## 5. DISCUSSION

The data collected from interviews of early childhood teachers from two similar studies revealed that all four teachers were positively impacted by the STEM integrated professional development, resources and the materials available to them to implement the STEM units. Consequently, children were positively impacted because of their teacher's professional learning and high confidence about teaching STEM-related activities. An early childhood teacher's beliefs in what and how young children should learn could critically impact children's acquisition of various emergent knowledge and skills in preschool years. Opportunities to improve teaching practice (e.g., teacher research), ongoing professional development support (e.g., integrating STEM), administrative policies that provide a democratic and liberated work environment for teachers, and most importantly teachers' positive self-efficacy to take on challenges would help early childhood teachers constantly reflect on their beliefs and make more conscious decisions regarding pedagogical issues. The conversations that we had with early childhood teachers in this study made us pay closer attention to the factors affecting teachers' pedagogical beliefs about integrating STEM in their classrooms.

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