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Exploring K-3 Educator Perspectives on STEM Learning:

Lessons Learned From a Professional Development Training

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ABSTRACT

Science, technology, engineering, and mathematics (STEM) instruction has become a priority across the globe in recent years. Elementary educators are seeking ways to integrate STEM in all areas of learning. However, research indicates that most elementary teachers grapple with identifying and using appropriate STEM tools and instructional strategies that teach STEM as an integrated subject. This paper reports on an exploratory study examining the experiences of K-3 teachers (n=26) who contributed to the development of a summer STEM institute. It also examines in greater detail the perceptions of twelve of those participants who participated in the professional development institute. The study used quantitative and qualitative approaches to collect and analyze data. Findings indicate that teachers appreciate the use of inexpensive STEM tools and that they recognize the potential that an integrated STEM project-based learning approach has for young students. Implications for teacher education and professional development are offered along with recommendations for future research.

KEYWORDS

Elementary, K-3 Educators, Professional Development, Project-Based Learning (PBL), STEM Integration Strategies, U.S

INTRODUCTION

Discussions on how teachers should integrate science, technology, engineering and mathematics (STEM) in early learning kindergarten through third grade (K-3) have been at the forefront in the U.S. education system for some time. This is due to the "growing concerns that American students are unprepared for the 21st century workforce and global economy compared to Asian students whose performance in science subjects is relatively higher" (LaForce, Noble & Blackwell, 2017, p. 1). This issue had been documented earlier by The National Science Board which noted that low numbers of students in the U.S. pursue STEM disciplines and degree programs (National Science Foundation, 2010). Existing literature also points to how most young children lack early STEM skills due to lack of early exposure to STEM learning As a result, there is growing interest across society to find reasons for the low numbers of students pursuing

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STEM disciplines and degree programs. The same research suggests that early exposure to and experiences with STEM learning initiatives and activities positively impact early elementary students' perceptions and dispositions (Bagiati, Yoon, Evangelou, & Ngambeki, 2010; Bybee, & Fuchs, 2006; DeJarnette, 2012). Likewise, current early learning research supports these findings confirming that early exposure to STEM learning results in positive impacts across the entire spectrum of learning (McClure, Guernsey, Clements, Bales, Nichols, Kendall-Taylor & Levine, 2017; National Research Council, 2012) even as it increases young children's interest in future STEM careers. Even though armed with knowledge of the benefits and potential that early STEM learning brings to young children's cognitive development, many teachers still do not integrate early STEM learning into the curriculum. It is still not clear whether lack of exposure of young children to early STEM is caused by lack of knowledge of early STEM tools and STEM pedagogical knowledge among teachers or other reasons. In order to respond to early STEM needs and extend early STEM literature, this study sought to accomplish three objectives. First, to examine K-3rd grade teachers' current STEM integration strategies and barriers to effective integration of STEM, second, provide professional development based on the initial findings of the study, third, to share the experiences and recommendations of teachers after attending the STEM professional development (PD) training, and guide future directions for STEM PD based on the study's findings.

LITERATURE REVIEW

Developing STEM Skills in Early Elementary

Many teachers and adults trivialize early STEM learning due to the misconception that young children (0-8 years) cannot grasp STEM concepts (Hadani & Rood, 2018). Research indicates that young children are capable of engaging in STEM activities at developmentally appropriate levels, those scientific practices that high school students carry out (McClure et. al, 2017). Studies across the past 30 years demonstrate that starting from infancy, children develop and test intuitive theories about the world around them in the same ways as scientists (Gopnik & Wellman, 2012; Hadani & Rood, 2018). As young learners test cause and effect, they can become more flexible in their thinking sometimes outperforming adults and older students when trying to infer cause and effect from a pattern of evidence or life experiences (Gopnik et. al., 2017). This suggests that young children are more flexible cognitively than previously thought and that they should not be denied interesting and challenging STEM opportunities. While most educators agree on the value of early STEM learning, they report barriers such as pedagogical challenges, curriculum challenges, structural challenges, student and assessment concerns, and lack of teacher support (Margot & Kettler, 2019).

Research suggests that teachers and other adults who teach young children focus on content knowledge because they are not fully aware of the STEM practices. Specifically, studies indicate that most early elementary teachers are not aware of STEM practices including key "cross-cutting concepts and practices" (Bardige & Russell, 2014; McClure, 2017; National Research Council, 2015). Professional development support in early STEM pedagogy remains necessary and should ensure that teachers understand the importance of introducing and using STEM practices and common language with young children, teaching them to speak the language of STEM as they work with developmentally appropriate STEM materials (Ntuli & Ray, 2020). Examples of vocabulary, early STEM practices, and "cross cutting concepts" include but are not limited to terms and practices such as observe, ask, imagine, plan, design and test, cause and effect, create, collaborate, connect, improve, investigate, model, problem-solve, organize, visualize, and hypothesize. STEM vocabulary and practices should be integrated by every teacher in daily classroom routines and activities since STEM is as critical today as early literacy exposure (McClure, 2017).