Early Childhood Educator Self-Efficacy for Implementing Early Stem childhood teachers

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ABSTRACT

Research substantiates that providing high-quality STEM activities at an early age is important for young children to become college and career ready (Moore et al, 2016). However, not all educators are as knowledgeable and/or confident in supporting STEM instruction. Research suggests individuals with strong self-efficacy tend to commit to goals that challenge their current capabilities (Bandura, 1993). Therefore, educators may be more inclined to implement STEM lessons if they feel knowledgeable and confident. The study used a multiple methods design including surveys, and self-reflection logs to explore how intentionally designed professional development impacted early childhood educators' self-efficacy in planning and implementing early STEM activities for preschool-age children. The findings found a significant increase from pre-survey to post-survey in early childhood educators' self-efficacies for supporting preschool-age children's STEM activities.

KEYWORDS

Early STEM, self-efficacy, Head Start, STEM instruction, professional development, early childhood educator preparation, preschool

Science and engineering careers are predicted to grow nearly 10% in the United States by 2029 (Bureau of Labor Statistics, 2020). To address the United States' workforce needs, many professional organizations (e.g., National Association for the Education of Young Children (NAEYC), National Council of Teaching Mathematics (NCTM), National Science Teachers Association (NSTA)) through standards, frameworks, guidelines, and position statements advocate for the inclusion of STEM curriculum during the early years (i.e., birth to age five) while young minds are most malleable and capable of developing lifelong thinking skills (Sarama et al, 2018). Purposefully designed STEM activities can help young children develop the character traits of curiosity, problem-solving, and perseverance (Lange et al., 2019). Therefore, young children can and should be engaged in intentionally

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designed and developmentally appropriate early STEM activities as a means of developing interests and a foundational background in STEM (Lange et. al, 2019: NAEYC, 2001).

Effective early STEM activities should simultaneously incorporate many or all four STEM disciplines (i.e., science, math, technology, and engineering) using a "play"-based format (Stipek, 2017) to investigate and/or solve phenomenon-based, real-world problem (Lange et al., 2019; Sarama et al., 2018). Phenomenon-based problems are observable facts or events occurring in young children's everyday life or world. Common phenomenon-based events for preschool-age children may include understanding changes in the weather or seasons, why stars shine in the sky or make patterns, how cold it needs to be for water to freeze, why soda pop makes a bubbly sound, or what plants need to grow (Penuel & Bell, 2016). In addition, early childhood (EC) educators should design STEM activities that encourage young children to: (a) wonder; (b) use multi-modal senses to observe and explore; (c) notice and discover patterns; and (d) learn through trial-and-error (Lange, 2019). These types of experiences increase opportunities for children to take the lead, have more ownership in the learning process, and actively engage in learning.

When EC educators plan early STEM activities such as designing the strongest bridge, tallest tower, or a habitat for a particular animal, children act as engineers, designing and testing possible solutions or prototypes. Based on the results or lack of results, EC educators should encourage children to adjust and/or improve their plan or prototype through trial-and-error (Lange et al., 2019). However, many EC educators report having low self-efficacy related to their ability to design and facilitate early STEM learning due to past experiences and current attitudes and are thus, less inclined to provide STEM opportunities for young children (Gerde et al., 2018). How educators feel, think, and motivate themselves on the job can be influenced by their self-efficacy beliefs (Bandura, 1993). Therefore, educators may be more inclined to implement STEM lessons if they feel knowledgeable and confident for planning and implementing early STEM activities. Providing professional development (PD) designed to develop EC educators' knowledge and/or confidence to support STEM learning may increase the likelihood of early STEM implementation.

Current Study

The purpose of this study was to determine how professional development (PD) designed to support participants' knowledge for planning and implementing early STEM with preschool-age children impacted EC educators' self-efficacy. There were two main research questions:

1. What impact does a targeted professional development have on early childhood educators' self-efficacy of early STEM instruction?
2. What impact does a targeted professional development have on early childhood educators' planning and implementation of STEM instruction?

Participants of the study were, thirteen white, English-speaking females, working in Head Start programs as preschool classroom teachers (54%) or managers/coaches supporting preschool classroom teachers (46%) in the same midwestern state. Most participants fell within the 26 –to-35- year age range (54%), with 31% of the participants in the 36-to-45-year age range. All participants held a bachelor's degree and for the majority (77%), the degree was in early childhood education (ECE). Those without a bachelor's degree in ECE had degrees in related fields (e.g., elementary education, social services). On average, participants had seven years of experience working directly with preschool-age children (e.g., ages 3-5) with a range of 3 to 17 years of experience. The participants were enrolled in the same online graduate-level STEM courses and engaged in an ongoing, collaborative STEM project at a midwestern university. The project provided a cohort model of instruction with online graduate courses over a span of one year: two with early STEM concentration, one math, and one specific to deeper understanding of developmentally appropriate practices in ECE.

A multiple methods research design involving two sources of information (e.g. a pre- and post-survey and ten monthly self-reflection logs) was used to gather information about participants' behaviors and self-efficacies associated with plan-

-ning and implementing early STEM instruction for preschool-age children.

Key Findings

EC educator confidence levels across all four disciplines (i.e., science, technology, engineering, math) increased from pre-survey to post-survey, with a statistically significant difference in the overall survey means (M = 3.3; M = 4.3). The results from the pre-survey (M = 3.3, SD = 0.5) and post-survey (M = 4.3 SD = 0.5) indicate that the participants' self-efficacies for early STEM changed, $t = 25.71$, $p < .0.0001$.

Data from the EC educator self-reflection logs revealed six common themes including: 1) Implementation of Early STEM Activities, 2) Child Responsiveness, 3) Educator Growth, 4) Educator Responsiveness, 5) Sharing with Colleagues, and 6) Hands-on Exploration. The themes are summarized in order of frequency mentioned by the participating EC educators.

Theme 1: Implementation of Early STEM Activities

Participants most frequently described planning and implementing early STEM activities in which young children engineered structures. Examples included children building or creating houses, towers, musical instruments, a sandbox "mud kitchen", water pipes, and sprout houses to plant seeds. They also described using STEM boxes or bins [kits containing purposefully provided materials] to conduct outdoor explorations. For instance, having the children create different-shaped bubble wands with various materials and testing different types of bubble solutions, figuring out how long it took snow to melt, what kind of food ants preferred eating, and building ramps on the playground using different materials to "...zoom matchbox cars down."

Theme 2: Child Responsiveness

Participants often shared perceptions of how children responded to planned/implemented early STEM activities, learning environments, and/or materials. The participants' self-reflection logs frequently included the words, "fun" and "enjoyed" when describing children's responses to planned/implemented early STEM activities. Enjoyment was noted as a motivating factor that led to the preschool-age children asking if they could do the STEM activities again. Some participants mentioned the preschool-age children wanted to complete the STEM challenge more than once, using their imagination to try to improve upon previous attempts. For instance, "Some of them [children] even got excited when their towers fell because they were able to build it better." The participants reflection logs also described children engaging in STEM activities by working together and interacting with one another. Preschoolers used the materials provided, building upon their peers' ideas and designs as well as asking and answering questions while learning from one another.

Theme 3: Educator Growth

Many participants' self-reflection logs contained statements reflecting teacher growth or increased self-efficacy for planning and/or implementing early STEM activities. For instance, one shared, "I love how much easier it is getting to implement STEM into day-to-day activities! I see STEM teaching opportunities in places where I hadn't thought of before." Other participants shared that although planning STEM activities takes time, they perceived that it was becoming easier and more attainable with practice. Participants frequently reflected on gains in confidence. One shared, "I am feeling that what I have learned has made me a better teacher and supervisor because now I am able to teach my staff as well which makes me proud."

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Theme 4: Educator Responsiveness

According to participants' self-reflection logs, not

only did the children enjoy the early STEM activities, but many of the EC educators (participants) reported enjoying them as well. For instance, participants stated: "I am having a blast teaching the [STEM] lessons!" and "Teachers loved the activities because they were easy to follow and kept students engaged in activities." After implementing STEM activities and seeing the children's responsiveness, several shared goals for doing the same STEM activities again but with improvements or adaptations. Many described wanting to modify and adjust the STEM activity for future STEM implementation. For instance, using a "variety of open-ended materials" was mentioned to enhance young children's engagement.

Theme 5: Sharing with Colleagues

Participants described planning to share or sharing information or ideas for early STEM instruction with other educators, colleagues, and/or administrators. Several participants described providing early STEM training for colleagues and/or team members. Connectedly, coaching was frequently mentioned as a means of sharing what they learned about early STEM instruction with colleagues and/or other EC educators. Several participants had already coached or planned to coach by sharing specific information and/or resources with colleagues and/or EC educators from the STEM college courses they completed during the study. One participant wrote, "I have encouraged a few of my teaching staff to try and use my STEM kit [created during courses completed as part of the study] in their classroom."

Theme 6: Hands-on Exploration

When self-reflecting upon early STEM implementation, participants often described how preschool-age children used hands-on materials and manipulatives (i.e., foam pieces, felt, blocks, cardboard tubes, rocks, glue, markers, straws, wooden craft sticks, and clay) to build or create structures or models. Several participants' self-reflection logs included descriptions of children creating shadows, shapes, houses, buildings, teeter totters, and snowflakes with varied materials. Other participants described how the children solved a particular problem or challenge using hands-on materials. For instance, after reading a story about the Three Little Pigs, a participant described children using materials to design a house that could withstand the wolf's "huffing and puffing." Others described children using hands-on materials to build sprout houses for planting seeds, designing catapults, creating shadow towers, making a volcano out of a pumpkin, crafting animal habitats, and fashioning musical instruments so they could have, "their very our own little marching band." Additionally, some participants described preschool-age children engaging in open-ended opportunities in which they used hands-on materials to explore and create with minimal constraints or directions.

Barriers and/or Challenges to Early STEM Instruction

In addition to the six themes, participants' self-reflection logs revealed perceived barriers and/or challenges related to implementing early STEM activities for preschool-age children. Some participants mentioned being busy or having other job-related priorities as barriers for implementing early STEM activities. Participants mentioned duties such as completing child assessments and/or preparing for supervisory visits. Others noted the time of the year (e.g., early or late in the school year) as being a challenge, which may be due to teacher home visits and/or parent teacher conferences. Time constraints were also mentioned due to staff shortages. Another barrier that was noted pertained to weather conditions being "too cold," "rainy," or "hot."

Implications

There are several implications of this study that educational leaders, institutes of higher learning, and educators can consider, particularly when designing PD opportunities designed for EC educators' self-efficacies and instructional practices for supporting STEM learning. Suggestions based upon previous research and/ or the results of our study follow.

Increasing EC Educators' Self-efficacy for Early STEM Learning

- Create a community of learners by implementing a cohort PD model (e.g., groups of educators receiving similar experiences). EC educatorsare more willing to share and exchange instructional strategies and/or ideas with others when they are confident and feel 'safe' doing so. The cohort model is designed to increase confidence by providing structure, various levels of support, and opportunities for EC educators to collaborate and receive formative feedback in a low-stake format.
- Tailor PD opportunities to EC educators' needs (e.g., time requirements, geographical location, workload, resources, funding, and time of year). Provide multiple meeting times as well as face-to-face or virtual options for cohort meetings and/ or one-one coaching.
- Design purposeful, ongoing, and interconnected PD opportunities connected to personal teaching practice and/ or instructional settings (i.e., preschool educators, instructional coaches, and program directors) to increase content and pedagogical knowledge (Desimone, 2009; McClure et al., 2017).
- Encourage EC educators to engage in ongoing self-evaluation and goal setting through use of reflection logs, videos, discussions with colleagues, and other like methods.
- Empower EC educators to engage as educational leaders through opportunities to facilitate early STEM PD activities for their teaching teams/colleagues including opportunities to rehearse, analyze, reflect on instructional practices, and set goals (Sarama et al., 2018).

Increasing EC Educators' Planning and Implementation of Early STEM Learning

- Align PD with EC educators' educational settings, allowing for purposefully planning and implementation of early STEM, meeting the specific needs of the young children they serve.
- Identify and address potential barriers and challenges to EC educators' early STEM implementation (e.g., workload, resources, and busy times of the year).
- For outdoor early STEM implementation, consider solutions and resources for challenges related to predictable weather conditions (e.g., heat, cold, wind, rain, snow).
- Support EC educators' planning and implementation of early STEM activities in which young children simultaneously incorporate many of the STEM disciplines (e.g., Science, Technology, Engineering, and Mathematics).
- Support EC educators' planning and implementation of early STEM activities in which young children investigate and/ or solve phenomenon-based, real-world problems (Sarama et al., 2018).

Conclusion

It is essential that EC educators consider how STEM knowledge, skills and experiences may impact school readiness and future career choices of young children. In addition, EC educators should self-reflect on their own knowledge, skills, and dispositions for supporting early STEM, setting short-term and long-term PD goals toward increased self-efficacy. EC educators, particularly those providing care and education to Head Start children, often at higher risk of school failure, need to be well prepared and supported in providing developmentally appropriate and purposefully designed early STEM activities. Preparing the future STEM workforce is not only important for meeting the increased STEM workforce demands, but it can provide pathways toward financial stability through higher compensation and benefits often associated with STEM careers.

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