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STEAM Learning Centers: A Tool for Early Childhood Educators

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Abstract

The demand for workers in science, technology, engineering, and mathematics (STEM) careers is increasing in the United States. This increase has led to a growing urgency to implement STEM education in classrooms, including early childhood. STEM education is necessary to help students develop the skills to succeed in STEM careers. Integrating the arts within STEM, known as STEAM, encourages a developmentally appropriate method of STEM implementation with room for creative expression in early childhood classrooms. However, research has shown that many early childhood educators lack the confidence to develop and implement STEM/STEAM lessons. This article details how learning centers, a common element in preschool classrooms, can be used to introduce STEAM to students and educators with less stress. In addition, as educators gain experience implementing problem-based STEAM learning centers within the classroom, this may increase their confidence in using STEM overall.

Keywords

educator confidence, learning centers, preschool, STEM, STEAM

Introduction

Learning centers focused on the problem-based integration of science, technology, engineering, art, and mathematics (STEAM) are tools early childhood educators can use to include science, technology, engineering, and mathematics (STEM) in the classroom. The high demand for workers in science and engineering has made it more important to introduce students to STEM concepts at an earlier age (National Center for Science and Engineering Statistics, 2020; McClure, 2017; Yager, 2012). Fortunately, the nature of early childhood classrooms—learning through exploratory play—is a perfect complement for STEM integration. Preschool-age students are curious; they explore cause and effect, build and re-build, create, and express interest in how things work naturally (Campbell, Speldewinde, Howitt, & MacDonald, 2018; Katz, 2010). Additionally, current research on STEM education has encouraged its use in early childhood (Aldemir & Kermani, 2017; Torres-Crespo, Kraatz, & Pallansch, 2014).

However, studies have also shown that early childhood educators lack confidence in STEM content knowledge and their ability to implement STEM education (Dejarnette, 2012; Linder, Emerson, Heffron, Shevlin, & Vest, 2016). These low levels of educator confidence may result from a lack of preparation for pre-service educators and a lack of focus on using STEM in professional development (Aldemir & Kermani, 2017; Brenneman, Lange, & Nayfeld, 2019). Developing and implementing a STEAM learning center may allow early childhood educators to slowly ease into STEM education and potentially lead to more confidence in implementing STEM in the future.

This article details the creation and use of STEAM learning centers in early childhood classrooms. The following sections will review the literature on STEM/STEAM in early childhood, detail the procedures used for developing the learning centers, describe the educator's role during the implementation, and discuss the implications for educators, families, and future research.

Science, Technology, Arts, and Mathematics

STEAM education is an approach to learning that uses problem-solving to build deeper connections across disciplines while developing 21st-century skills such as critical thinking, collaboration, and communication (Bertrand & Namukasa, 2020; Dell'Erba, 2019). Henriksen (2017) argues that STEAM is more than just adding art activities to STEM. Instead, it is about integrating arts to create a more holistic learning experience. Similarly, STEM is more than using science, math, or engineering activities individually; instead, it is the integration of these disciplines to utilize the connections between the skills, activities, and processes of each. STEAM education aims to build upon these areas of connections, not to replace all lessons and activities from the individual fields.

This integration is intended to build more profound levels of understanding and help students learn to solve real-world problems (Henriksen, 2017). The concept that STEM is more than its disciplines is also at the heart of Reynante, Selbach-Allen, and Pimentel's (2020) research, which explored the benefits and challenges of STEM education. One salient benefit determined by their study is an improvement in interdisciplinary knowledge, yet they describe a concern in the differences in practices between some disciplines. These studies show the need to consider how practices and aspects of each discipline connect within early childhood.

Preschoolers and STEAM Learning

Preschoolers are naturally inquisitive and learn through exploratory play, making STEAM education a good match for early childhood classrooms. For example, when allowed to choose activities in outdoor environments, young children will often explore STEM activities such as building tiny houses made of sticks and exploring the homes of local animals (Campbell et al., 2018). This natural inclination is also evident in early childhood classrooms when students explore the work of doctors in a dramatic play center or problem-solve the construction of a tall block tower.

Research has shown that adding STEM learning experiences improves preschool students' conceptual development in science, engineering, and mathematics. For instance, preschoolers

within a Head Start STEM intervention program significantly improved in mathematics and scientific concepts compared to a control group (Aldemir & Kermani, 2017). Similarly, preschoolers from a STEM summer camp emphasizing engineering displayed more substantial knowledge of engineering concepts in post-tests (Torres-Crespo et al., 2014). In the STEM Curiosity Academy, researchers found that including the dramatic arts, such as dress-up clothes, lab coats, and goggles, added to the realism of their engineering projects (Reighard, Torres-Crespo, & Vogel, 2016). This finding suggests that the arts can play a significant role in STEM education, and preschoolers can benefit from the integration of STEAM education while gaining conceptual knowledge in related disciplines. However, the impact of these learning experiences often depends on whether educators are confident in their ability to implement STEM learning and are knowledgeable about related content (Saçkes, Trundle, Bell, & O'Connell, 2011).

Early Childhood Educator Confidence in Implementing STEAM

Several studies have found that early childhood educators display lower confidence in teaching STEM/STEAM (Brenneman et al., 2019; Dejarnette, 2012; Linder et al., 2016). Linder et al.'s (2016) survey of educators' experience levels, interests, and difficulties in implementing STEM education showed that many educators struggle with STEM. They recommend that educators start by creating simple lessons focusing on a problem for students to solve. Then, as educators gain experience, Linder et al. suggest focusing on STEM processes and creating meaningful experiences for learning.

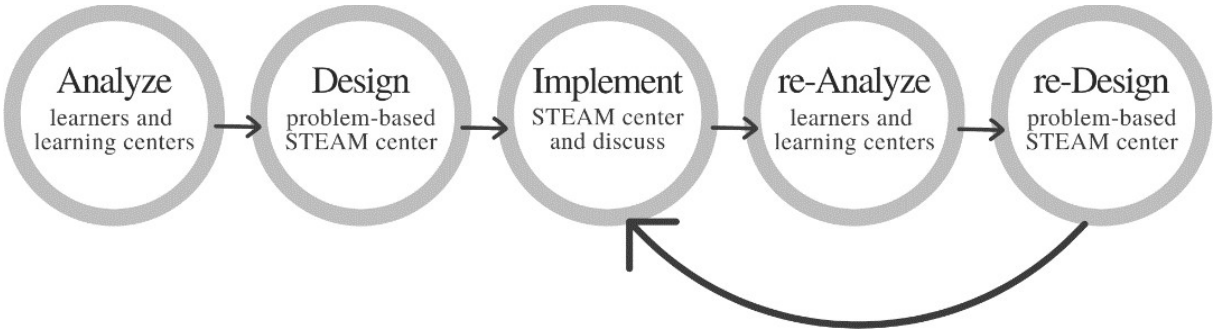
Considering this, developing and implementing a problem-based STEAM learning center may help educators gain experience using STEM in an open-ended manner without the time constraints of structured lessons. These learning centers allow educators to gradually increase their content knowledge and experience with STEM as they work through problem-solving with their students. Research on the effects of learning centers in early childhood education supports the idea that the use of learning centers helps educators gain understanding, confidence, and experience in subject areas while also providing opportunities to assess student learning in authentic environments (Aktulun & Kiziltepe, 2018; O'Donnell & Hitpas, 2010). Additionally, learning centers can potentially increase student engagement and enjoyment in the classroom (Stuber, 2007).

Process of Development

Early childhood educators should develop learning centers that meet the needs of the students and their own goals (Copple & Bredekamp, 2009). In addition, they should create problem-based STEAM learning centers using real-world problems from the students' viewpoints (Honey et al., 2020). The following section will describe the author's process of developing STEAM learning centers, shown in Figure 1, including the design aspects and the educator's role during implementation.

Figure 1

STEAM Learning Center Development Processes



Note. An illustration of the STEAM learning center development process.

STEAM Learning Center Development

Early childhood educators can use observational forms such as the Learner Analysis, Needs Analysis, and Learning Center Analysis created for classroom use by the author to develop STEAM learning centers with student interests and real-world problems in mind. For example, the Learner Analysis, shown in Figure 2, involves observing students over a week to determine interests, questions, and problems they encounter.

Figure 2

Learner Analysis

Learner Analysis: STEAM Learning Centers in Preschool

Observe students for a minimum of one week. Use the recording sheet below to note interests, questions asked, and problems they encounter in the classroom. Student interviews and parent questionnaires may also provide important information on student interests.

Interests – activities, colors, characters, games, sports, television shows, classroom materials, and music.

Questions – Any questions asked by students that the current classroom set-up cannot answer should be noted below in full. For example, "Why did the leaves change colors?" or "What happens to plants when we pick them?"

Problems Encountered – Note any problems that students encounter should below. For example, "Why does my block tower keep falling?" or "Why does his car move faster than mine?"

Student	Interests	Questions	Problems Encountered

Note. The Learner Analysis includes sections for student interests, questions, and problems encountered.

Next, to complete the Needs Analysis, shown in Figure 3, a document review of parent forms, notes from parent meetings, classroom assessments, and prior classroom observations should be conducted. A list of potential learning center topics will emerge while completing these analyses.

Figure 3

Needs Analysis

Needs Analysis: STEAM Learning Centers in Preschool

Identified Needs – List developmental or individual needs identified by the teacher or the student's family.

Accommodations/Adaptations – Use this section to note any accommodations that may need to be considered in the design of the learning center to meet each student's needs.

Student	Identified Needs	Accommodations/Adaptations

Note. The Needs Analysis includes sections for identified needs of each student and accommodations or adaptations.

Finally, appraise classroom learning centers using the Learning Center Analysis, shown in Figure 4. Each of these analyses should be ongoing as part of the iterative process of developing future learning centers.

Figure 4

Learning Center Analysis

Learning Center Analysis: STEAM Learning Centers in Preschool

Question or Problem – List possible questions or problems to use as the central focus for the problem-based STEAM learning centers here.

Material Availability – Note how materials in other classroom learning centers currently address this question or problem.

Needs – Note additional materials needed to address the question or problem in the classroom.

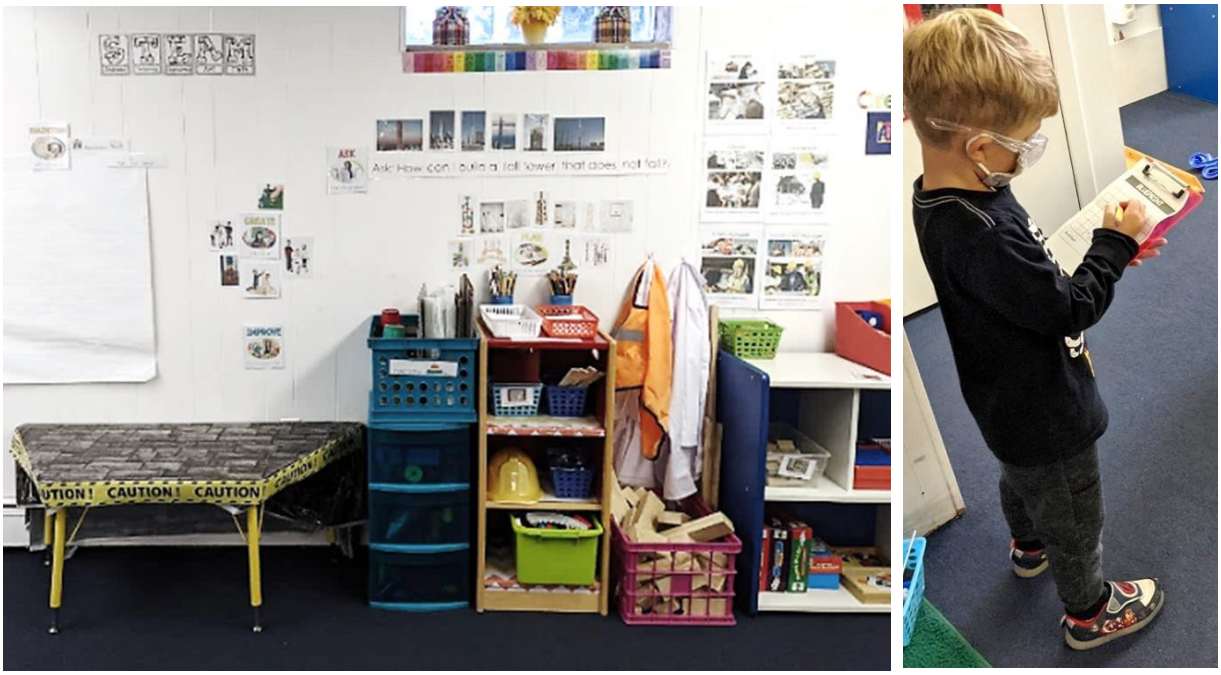
Question or Problem	Material Availability	Needs

Note. The Learning Center Analysis includes sections for the problem or question, the availability of materials in other learning centers related to solving the question or problem, and other needed materials.

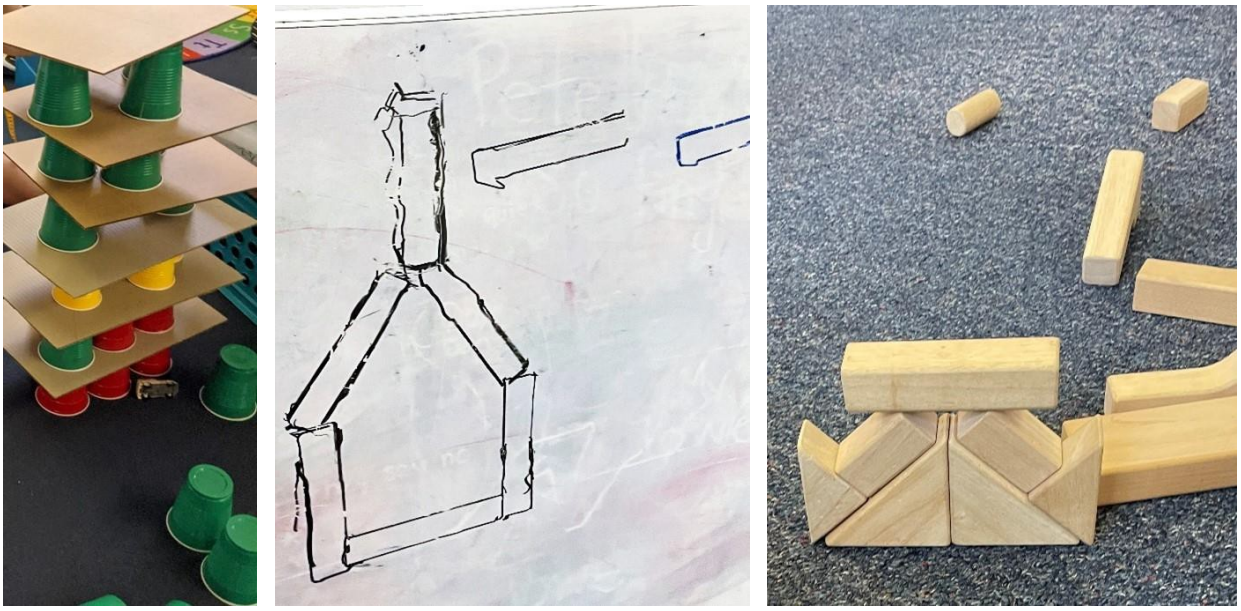
STEAM Learning Center Design

The data gathered from the analyses is then used to design multiple STEAM learning centers. Each center should include the same essential components: a focus question or problem to solve, related vocabulary with images to post on the wall, example images of people working on similar problems in real life, a visual of the engineering design process, a dress-up element, chart paper for students and educators to draw or write on while exploring the center, and a variety of materials needed to solve the problem. Many of these images and examples can be found online at no cost to educators. For example, Figure 5 depicts a STEAM learning center developed to explore the problem of falling block towers with the focus question: How can I build a tall tower that does not fall? Images and vocabulary were printed and laminated to hang on the classroom wall, and materials included common household and classroom items, such as cardboard, disposable cups, rulers, and blocks.

Figure 5



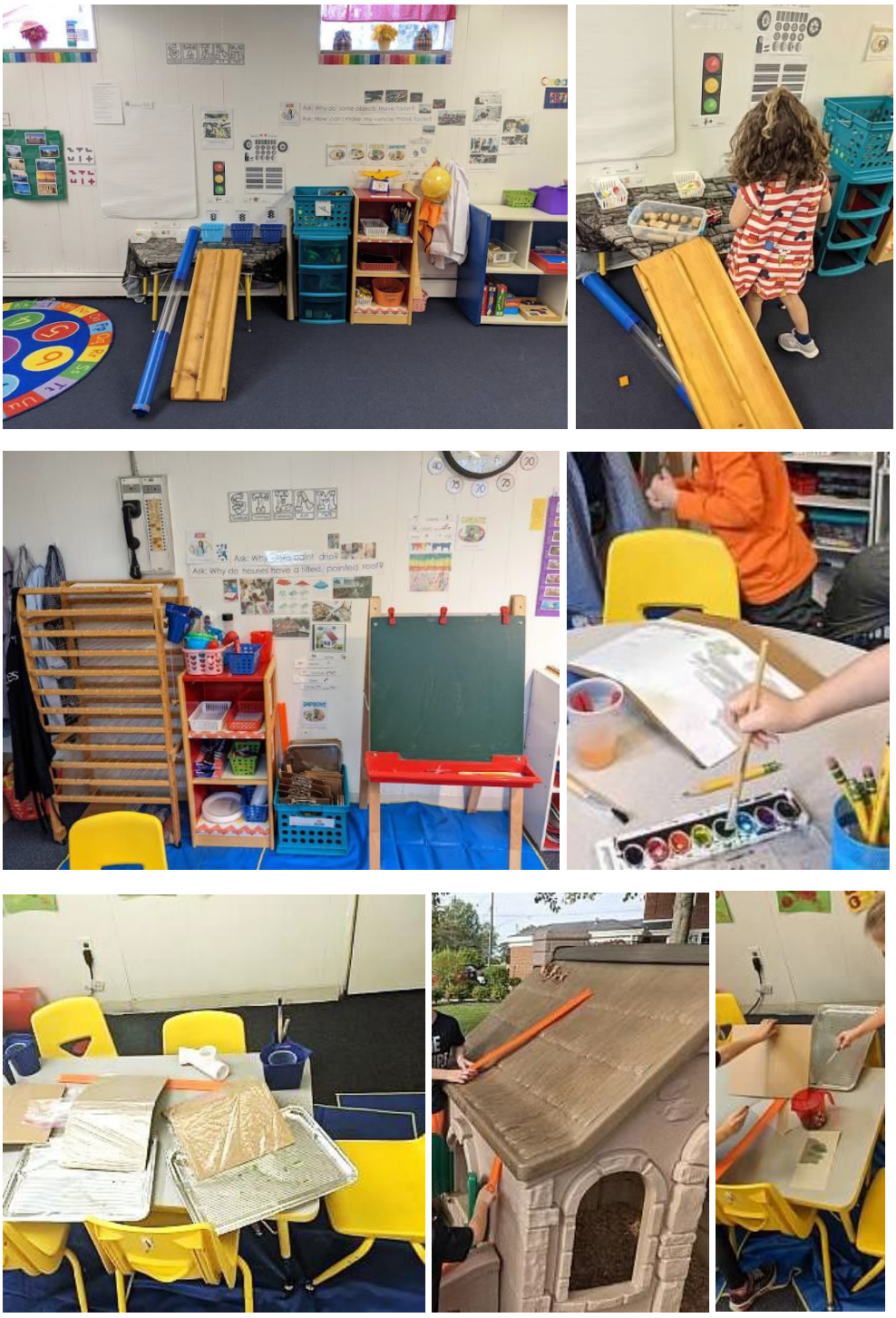
STEAM Learning Center: Tall Towers



Note. The images above depict the initial setup for a STEAM learning center exploring the building of tall structures that do not fall, a child drawing a blueprint of a tower, a tower made of cups and cardboard, a block tracing on a white board, and a block construction.

Figure 6

STEAM Learning Center Designs



Note. The images above depict the initial setup for three STEAM learning centers. The first two images show the movement center setup and a student with wooden balls and a ramp. The third

and fourth images show a paint exploration center and a student painting with watercolor paints. The final three images show a center exploring water and the shape and angle of a roof.

The Role of the Early Childhood Educator

The educator's initial role in this process is to observe the students during the analysis phase and use the information gained to design a STEAM learning center focused on one of the real-world problems or questions students encounter. The educator then introduces the center to the students, states the question, describes all images and materials within the center, and announces any relevant safety rules associated with the center. Each learning center can remain in place until students have solved the problem or lost interest.

When students use the centers, the educator's role is to facilitate student exploration by asking open-ended questions and commenting on the engineering design process, vocabulary, and related images on the wall. Students should be encouraged to immerse themselves in problem-solving and exploring related STEAM careers (Hachey, 2020). Including dress-up items like hard hats, lab coats, and safety goggles can aid this immersion. Additionally, as students explore the learning center, educators should be careful to use language that helps to develop student identity as scientists, mathematicians, and engineers.

When students have shown a shift in interest or solved the focus problem, a group discussion to debrief should occur. During this debriefing, students can share their learning, including possible answers, comments, and thoughts, before moving on to the next problem to solve. Educators can also use the debriefing to generate ideas for future centers or expand on the previous center's focus.

Conclusions

Considering the rapidly increasing growth of STEM jobs, with 10% job growth in STEM compared to 4% growth in other fields, it is essential to introduce students to STEM in early childhood (Honey et al., 2020; Okrent & Burke, 2021). This article has guided early childhood educators on using learning centers to bring STEM/STEAM learning into their classrooms in a low-stress manner, allowing them to build experience and develop confidence in implementing STEM. Early childhood educators are familiar with using learning centers in their classrooms. They are well-versed in developing and implementing learning centers and their roles during this time. These learning centers allow educators to learn alongside their students and build a deeper understanding of the concepts, making them the perfect opportunity to gain a better understanding of the use of STEM in their classrooms.

In addition, educators can create problem-based STEAM learning centers using materials already in the classroom and recyclable materials without any added expense. Repurposing classroom materials allows STEAM learning centers to be utilized in schools without a need for added funding resources in already tight budgets, providing an opportunity to introduce STEM to students in low-income districts. Furthermore, Buchter, Kucskar, Oh-Young, Welgarz-Ward, and Gelfer's (2017) review of the need for STEM in early childhood suggested that introducing students to STEM at an earlier age may help underrepresented students develop an interest in

related careers, increasing the potential for more representation in science and engineering in the future.

Implications

The guidance within this article will help early childhood educators and administrators implement STEM/STEAM within their schools in a budget-friendly manner using methods and tools with which they are already familiar. In addition, implementing STEAM learning centers may provide early childhood educators with experience in STEM that will increase their confidence in their ability to develop future STEM activities and lessons. Finally, educators and administrators can include descriptions and photos of the current STEAM learning centers and focus problems within newsletters and home connections. This inclusion will help connect students' real-world problem-solving in the classroom to their home environments, potentially encouraging an expansion of the use of STEAM problem-solving in the home as well. Additionally, educators should consider whether families or guardians may be able to be resources for STEAM learning within the classroom; bringing in members of the STEM workforce may help students see themselves in those positions in the future.

Future research should consider STEAM learning centers' effect on early childhood educator confidence in implementing STEAM and student development of 21st-century skills. Finally, a longitudinal study to follow students and see how these centers might impact future scores in science and mathematics is needed. These learning centers could be a valuable tool for educators to introduce STEM to students, build confidence in implementing STEM, and increase interest in STEM careers.

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