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Concept Paper

STEAM Activities in the Inclusive Classroom: Intentional Planning and Practice

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Abstract: The promotion of equity and access for all children to learn science is critical in early childhood settings. Considering the benefits of teaching science, technology, engineering, arts, and mathematics (STEAM), it is important that educators embed this pedagogy across early childhood settings. In order to promote access in inclusive early childhood settings that include young children from birth to 8 years of age with or without disabilities to STEAM pedagogy, educators need to be intentional about their practice. This article provides a four-step approach to using an intentional framework, universal design for learning (UDL), to plan for and implement STEAM pedagogy in the inclusive classroom. Practical implications are illustrated through examples of an early childhood educator and a child with autism in an inclusive urban education setting.

Keywords: STEAM pedagogy; early childhood education; inclusion; UDL; early childhood special education

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1. Introduction

The term "STEM" and its variations have been widely used across educational settings [1,2]. In the classroom, STEM activities incorporate science, technology, engineering, and math concepts. The research on STEM education has gained attention as a result of the poor performance of children from the United States in international competitions in science, engineering, and mathematics, as well as the low number of children pursuing careers in these STEM fields [1]. Other countries such as the United Kingdom, Finland, Germany, and Canada have developed national strategies to promote STEM education of children [2,3].

STEM has demonstrated effectiveness in promoting engagement, persistence, problem-solving skills, and active learning through exploration, observation, and discovery [4–6]. STEM also promotes development in areas of language acquisition, comprehension, and communication skills [5]. Additionally, research supports the idea that engagement in the arts enhances children's learning skills, including creative and strategic thinking skills, and allows children to explore patterns, use measurement tools, and perform calculations [7]. Therefore, art has since been incorporated into traditional STEM pedagogy, and the acronym STEM has evolved into STEAM. Considering the benefits of STEAM, it is important that educators embed this pedagogy across early childhood settings by designing the environment, intentionally planning learning experiences, and providing necessary materials for STEAM activities.

The early stages of life are fundamentally important for establishing children's interest in science and fostering their science progress in subsequent years [1,8]. It is beneficial for young learners to become literate in science and obtain firsthand experience in science as early as possible so that educators maximize the benefit. Science-related activities foster children's science progress skills. Eshach and Fried (2005) articulate why science should be taught to young children and outline the reasons for teaching science in early childhood education. They report the following reasons: (a) children naturally enjoy

observing and thinking about nature, (b) exposing students to science develops positive attitudes towards science, (c) early exposure to scientific phenomena leads to a better understanding of the scientific concepts studied later in a formal way, (d) the use of scientifically informed language at an early age influences the eventual development of scientific concepts, (e) children can reason scientifically, and (f) science is an efficient means for developing scientific thinking. All of these reasons clearly align with research findings that children are capable of learning and engaging in science at young ages [1,9].

The National Research Council [10] emphasizes the promotion of equity and all children's capacity to learn science. In inclusive early childhood settings, settings that include children with and without disabilities from birth to 8 years of age, promoting equitable access to STEAM activities includes planning for the learning needs of children with disabilities. In inclusive early childhood settings, children with disabilities participate in the learning environment alongside typically developing peers as part of a free and appropriate public education (FAPE) guaranteed by the Individuals with Disabilities Education Act [11]. This means that children with disabilities may spend the entire instructional day in the general education setting or receive additional services for part of the day. Educators in inclusive settings may need support to implement STEAM activities in the classroom for all children [10].

One framework that is well suited to support the implementation of STEAM pedagogy within inclusive settings to meet the individual needs of learners is the universal design for learning (UDL). The three principles within the UDL framework include (a) providing multiple means of representation, (b) providing multiple means of engagement, and (c) providing multiple means of action and expression [12]. Children's motivation and well-planned instruction that is intentionally designed to promote active engagement of young children in learning activities is crucial to deliver effective STEAM pedagogy [13].

Early childhood educators should intentionally identify teaching opportunities when interacting with children to scaffold or extend their knowledge and skills. Intentional educators have a purpose for student learning (e.g., academic, or social goals), continuously monitor children' progress, and are able to explain what they are doing and why they are doing [14]. It is important for educators to allow and follow child-guided activities. How-ever, educators are not expected to take a passive role during these child-guided activities, intentional teaching is described as the combination of child-guided activities with adult-guidance to obtain optimal learning conditions in which neither children nor edu-cator takes passive role [14].

The purpose of this article is to provide early childhood educators with practical steps to intentionally design the learning environment and intentionally plan for and implement STEAM activities in an inclusive education setting for all young children, including children with disabilities. Specifically, we provide four steps for early childhood educators: (a) establishing a relationship between the educator, child, and family; (b) intentionally developing STEAM activities; (c) including all children; and (d) assessing child engagement and learning. The steps presented are accompanied by a case study following an early childhood educator, Mr. Matt, and a child, Jeremy, with autism.

2. Setting the Scene: Introductory Case Study

To demonstrate the application of the steps provided throughout the remainder of this article, we provide a case study about one early childhood special educator, Mr. Matt, and a focus child, Jeremy, a young student with autism spectrum disorder. Mr. Matt is an early childhood special educator with 5 years of experience teaching in early childhood special education settings and is certified to teach young children from birth to 8 years of age. The setting for this case study is an inclusive early childhood preschool classroom in an urban elementary school. Excerpts from the case study are presented using italics.

Mr. Matt is teaching in an inclusive four- and five-year-old preschool classroom in an urban elementary school where he has been teaching for five years. Mr. Matt has ten children who come from diverse backgrounds culturally, linguistically, and socio-economically and have varying

educational needs (developmental delays, autism, etc.), with some students specifically receiving early intervention services. Ms. Mendez supports Mr. Matt as the assistant teacher. Mr. Matt is a strong advocate for inclusive environments where children with and without disabilities learn, play, and develop together. He believes that inclusive preschool environments allow children to develop critical skills such as social interactions, communication, play skills, and a sense of belonging, which enable children to become a part of the community they live in. Therefore, Mr. Matt strives to provide equitable learning opportunities for all children in his classroom and to meet young learners' needs.

Mr. Matt integrates individualized education plan (IEP) goals into lessons and embedded learning opportunities (ELOs). Upon reflection and observation, he noticed increased attention on STEAM practices and the way STEAM offers increased benefits in the areas of brain development, executive functioning, math, literacy, scientific inquiry, and social acquisition. As he began to read more articles and blogs about STEAM activities in the classroom, he began to think about how he could implement these within his setting, especially for children who may need more targeted support. He decided to first start this process with Jeremy, a student with autism spectrum disorder (ASD), as he was highly motivated by STEAM concepts.

3. Step One: Establishing a Relationship between the Educator, Child, and Family

In alignment with the Division for Early Childhood (DEC) Recommended Practices and developmentally appropriate practices (DAP), it is critical that educators develop a relationship with the child and family [15–17]. One way Mr. Matt practices this is by conducting home visits prior to the start of the school year. Conducting home visits is one way to strengthen educator relationships with children and their families by learning about the family within the context of their culture, which can support increased learning opportunities that support the success of the children in the classroom individually and collectively.

During Jeremy's home visit, Mr. Matt observed him playing with some of his favorite toys and interacting with his family. When asked, Jeremy's parents confirmed that his main interests during play at home were playing with blocks and animal toys, especially dinosaurs. The family expressed concerns about Jeremy's ability to join in play with other children in the classroom and maintain interest in learning activities. Mr. Matt left the home visit determined to plan new ways to include Jeremy in learning activities.

At the beginning of the school year, Mr. Matt used time prior to school starting to conduct home visits for each of his students. Prior to visiting Jeremy's family, Mr. Matt read Jeremy's IEP and met with the IEP team to discuss present levels of performance and learning goals. He noted that Jeremy had functional goals on his IEP related to increasing time on tasks and transitions in the classroom. Present levels of performance indicated that an area for growth during the school year included math and science tasks such as independent exploration, counting with one-to-one correspondence, and counting the total number of items in a group. It was during his visit with Jeremy and his family that Mr. Matt initially noticed Jeremy's interest in dinosaurs. They spent a few moments during the home visit playing with Jeremy's favorite dinosaur toys. Mr. Matt made a note to be sure he had dinosaurs available for Jeremy to explore throughout the classroom.

The educator, child, and classroom environment are all variables that contribute to the quality of developing educator–child relationships [18]. Where there are close educator–child relationships, children are likely to feel more comfortable and are able to learn [19]. Given this, early childhood educators should build meaningful relationships with the children they teach. In building these relationships, educators should seek to gain an understanding of each child's preferences, interests, background, and family culture. These are key elements that will assist educators with tailoring the learning environment so that there are engaging learning experiences to engage both the interest and learning needs of the child.

4. Step Two: Intentionally Developing STEAM Activities

Children's motivation and well-planned instruction that is intentionally designed to promote the active engagement of young children in learning activities are crucial to

delivering effective STEAM pedagogy [13]. Early childhood educators should intentionally identify teaching opportunities when interacting with children to scaffold or extend their knowledge and skills. Intentional educators have a purpose for student learning (e.g., academic or social goals), continuously monitor children's progress, and are able to explain what they are undertaking and why [14]. It is important for educators to allow and follow child-guided activities. However, educators are not expected to take a passive role during these child-guided activities; intentional teaching is described as the combination of child-guided activities with adult guidance to obtain optimal learning conditions in which neither children nor educators take a passive role [14].

Therefore, early childhood educators like Mr. Matt, who serves in an inclusive setting, should provide guidance when needed and balance child-led and adult-led activities (see Table 1). Adult-led activities are those activities in which the adult is in control of selecting and guiding the activity. Child-led activities allow the child to be in control, using their interests and passions to lead play. The provision of both adult-led and child-led activities is an important contributor to children's development [15]. Additional routines and activities that can be used to implement STEAM learning goals within the natural environment include transitions (e.g., transitioning activities or environments) and mealtimes (e.g., breakfast, lunch, and snacks). These are routines and activities that are a part of the typical daily schedule within an early childhood classroom and therefore provide multiple opportunities to embed opportunities to practice STEAM learning goals. The STEAM learning goals included as examples in Table 1 are from a statewide set of comprehensive standards for young children in a mid-Atlantic state in the United States.

Intentionally planning for instruction also includes identifying, with the family, the learning goals and interests of children. Incorporating these learning goals and interests promotes engagement and assists children to become socially connected and adaptive in inclusive settings as recommended by the DEC Recommended Practices [16].

Mr. Matt learns that one of the critical aspects of STEAM activities is the integration of science, technology, engineering, art, and math throughout the day. By implementing these aspects, he hopes that children will generalize STEAM concepts across activities and routines. He needs to approach already existing activities in a way that integrates science, math, engineering, technology, and arts. He decides to plan child-guided activities and to create an environment in which children explore and manipulate materials freely so that they learn and acquire skills through their experiences.

Table 1. Examples of STEAM Activities Across Routines.

STEAM Learning Goals	Adult-Led Activity	Child-Led Activity	Transition	Mealtime
One-to-one correspondence	Dinosaur footprint estimation: The teacher provides an outline of a dinosaur footprint on blank paper. Children are asked to estimate the number of hands they believe will fit in the dinosaur. Estimations are recorded on chart paper and saved for large group discussion. Children then choose a color of paint, dip their hands in the paint, and place their hands on an empty space in the footprint. Children are asked to count the number of handprints in the footprint so far.	Counting materials in any item they create (e.g., block structure, plates at dramatic play, etc.)	Counting friends in line	Counting how many napkins are at the table

Table 1. *Cont.*

STEAM Learning Goals	Adult-Led Activity	Child-Led Activity	Transition	Mealtime
Asking questions about the natural world related to observations	Virtual field trip: Children are given the opportunity to engage in a virtual field trip to the Smithsonian Natural History Museum to view an exhibit on dinosaurs. The SMART board provides a technology-enhanced experience that children can investigate and explore. The teacher and children will discuss the historical facts presented for each fossil or dinosaur exhibit and engage in ongoing conversation. Key vocabulary words from the books and items provided in the classroom should be highlighted. For example, if children look at a fossil, prompt them to answer questions such as "What is a fossil?" and "How do we find fossils?"	Adding natural materials or objects such as leaves, pinecones, or rocks to the dramatic play area	Pointing out different types of leaves and rocks when they transition to the playground	Discuss fossils of food items like fruits, berries, seeds, and nuts that might have been observed in the museum and compare to foods on the children's plates

5. Step Three: Including All Children

Implementing STEAM activities in the inclusive early childhood classroom requires the use of universal design for learning (UDL) principles in order to engage all children in meaningful learning experiences. Educators should intentionally consider the classroom environment in the planning process for including all children in STEAM activities [16]. These three UDL principles are representation, engagement, and expression. After making sure the classroom environment has materials and space for all children to engage in learning, it is time to create meaningful learning activities (see Table 2). This section includes the addition of accommodation as a practice to include all children. While the use of UDL principles can support most children's needs, there may still be some children who require additional accommodations to access materials and engage in the learning environment.

Table 2. Principles of Universal Design for Learning.

STEAM Concept	Representation	Engagement	Expression
One-to-one correspondence	Reading a counting story (i.e., How Do Dinosaurs Count to Ten? by Jane Yolen and Mark Teague)	Count how many peers are at school that day;	Point and count;
	Playing a song about counting (i.e., Counting Bananas by Super Simple Songs)	Count how many pretzels they have left to eat during lunch;	Write the total number on a piece of paper;
	Showing a counting video (i.e., Count to Ten by ABCmouse.com (accessed on 1 August 2023))	Count how many steps it takes to reach the playground.	Use technology and select the appropriate number.

One morning, Mr. Matt observes Jeremy building roads and playing with dinosaurs in the small sandbox area in the classroom. He thinks that this is a great opportunity to integrate math. Mr. Matt: Jeremy, how about we draw a straight line on my paper every time a dinosaur comes to the bridge. Sometimes people pay money for using bridges. We need to record how many dinosaurs are using our bridge. Mr. Matt and Jeremy continue playing by making lines each time a dinosaur comes to the bridge. After a few minutes, Mr. Matt and Jeremy count the lines using one-to-one correspondence.

While planning for STEAM activities and focusing on one-to-one correspondence, Mr. Matt reflects on what he knows about his students. Taking into consideration the high engagement Jeremy showed while playing with dinosaurs during the home visit, he considers designing activities around

a dinosaur theme. Mr. Matt noticed that other children in the class enjoy playing alongside Jeremy and interacting with him in the block center with dinosaur toys or while looking at books in the book center related to dinosaurs. He plans two activities around a dinosaur theme focused on the STEAM concept of one-to-one correspondence and incorporating UDL.

5.1. Representation

Providing multiple means of representation can easily be incorporated into learning experiences in inclusive settings. For example, educators can represent or share information in many different ways. In Mr. Matt's classroom project on dinosaurs, he is focusing on the skill of one-to-one correspondence. Information is provided through the use of books, PowerPoint presentations, models and manipulatives in the block center, and games provided on iPads. By incorporating these materials into the classroom, Mr. Matt is providing multiple representations of the concepts that he is focusing on.

Mr. Matt finds stories that are focused on dinosaurs such as "You Can't Count on Dinosaurs! An Almost Counting Book" by Philip Ardagh and Elissa Elwick. While reading the stories, Mr. Matt models one-to-one correspondence by counting the dinosaurs in the story on a few different pages. He also creates a PowerPoint presentation by finding pictures online and placing them within slides with animations and their names to share with the class. On each slide, he adds an additional dinosaur so that as he shares the presentation with the children, he can model counting dinosaurs on each slide.

5.2. Engagement

Within everyday activities and routines, educators can use multiple means of engagement to provide multiple opportunities and ways in which children engage in STEAM concepts. Educators can engage children in child-led activities, adult-led activities, transitions, and mealtimes. For example, if focusing on the math and STEAM concept of one-to-one correspondence, children can count how many peers are at school that day, count how many dinosaurs are in the habitat they created in the block center, count how many pretzels they have left to eat during lunch, and count how many steps it takes to reach the playground. By providing opportunities to engage in the concept, children receive multiple opportunities to practice one-to-one correspondence in different ways, which promotes skill acquisition and generalization.

Mr. Matt also adds dinosaur figures to the block center. As children play with the dinosaurs, Mr. Matt models counting each of the dinosaurs that are part of the structure that they build. He also looks up applications and adds Dino Numbers Counting Games to the classroom iPads. By incorporating these materials into the classroom, Mr. Matt can represent one-to-one correspondence with a variety of materials within the dinosaur project.

5.3. Expression

Early childhood educators can create a variety of ways in which children can express their knowledge. It is important to provide learners with multiple means to express their knowledge. For example, if focusing on the STEAM concept of one-to-one correspondence, children can point and count, they can hold up the total number with their hands, they can write the total number on a piece of paper, or they can use technology and select the appropriate number. The educator can prompt children to count the dinosaurs on a page in the book, on the PowerPoint slide, or in their structure, and the educator can prompt them to show the number with their fingers, write the number on paper, and/or say the number with their words. The educator's prompt should be specific to the child and the way in which the child will most accurately express their knowledge. For example, if a child is non-verbal or has a shy temperament, they may express their knowledge more accurately through writing or showing the number with their fingers.

5.4. Accommodations

Throughout these STEAM experiences, the level of support and accommodation needed for individual children will vary. For example, some children may need support to use one-to-one correspondence. This can look like an educator providing hand-over-hand assistance while counting aloud each item and repeating the total number. Some children may need other ways to communicate information such as an application on an iPad. The intensity of support needed will depend on the developmental needs of each student and should relate to steps one and two. Providing guidance and scaffolding throughout these activities is also important in order to avoid misunderstanding STEAM concepts.

6. Step Four: Assessing Child Engagement and Learning

Assessment is a natural part of the teaching and learning process. Assessing children's engagement and learning in STEAM can be accomplished through formative and summative approaches, which can be quantitative or qualitative in nature. Formative approaches are those that educators can use on a frequent (e.g., daily, weekly, etc.) basis and can be qualitative or quantitative. For example, educators can use observations. Observations of children should occur daily, including observations of children over multiple parts of the day. Educators can develop and use less structured observational measures by recording a date and time and recording what they observe. They might also consider developing something more structured that includes the specific skills they are watching for through measures such as checklists, which may include choices such as yes, no, or not yet in relation to the skill they are observing. These assessments rely primarily on qualitative approaches to measuring children's learning. A summative assessment is typically conducted less frequently (e.g., annually, biannually, etc.), and the type and frequency are typically determined by the school system. These tend to be a formal assessment. This form of assessment can provide useful information for educators by summarizing what a child has learned over a period of time. For example, a system may adopt a specific curriculum-based measure to identify which skills or standards a child has mastered across the year. These summative assessments are more likely to rely on quantitative approaches to measuring children's learning.

A combination of approaches might be something else that educators consider, where they include both a checklist for specific items and an area to take additional notes as needed. Observations of children's engagement in STEAM activities can assist educators in getting to know the child more to build stronger educator–student relationships. Observations give educators more information about what children know in order to support instructional planning as well as contribute to the development of stronger IEP goals. Finally, observations give educators information on how children are progressing in meeting curriculum-based goals as well as goals identified in the IEP.

7. Conclusions

Early STEAM education has substantial impacts on the future success of individuals. Research supports that the introduction of science concepts at early ages is age-appropriate for preschool children [1,20,21], and early exposure to scientific activities will promote young learners' analytical thinking skills and help them understand the connection between living organisms and the environment. All of these skills are necessary for individuals with special needs as well; therefore, STEAM activities should be designed well and implemented in a way that is inclusive and meets the needs of diverse learners in early childhood settings.

Effective STEAM education is more likely to occur when early childhood educators follow the main principles of UDL: (a) providing multiple means of engagement, (b) providing multiple means of representation, and (c) providing multiple means of action and expression [12]. More specifically, the steps included in this article, (a) developing an educator–child relationship, (b) intentionally developing STEAM activities, (c) including

all children, and (d) assessing child engagement and learning, can assist early childhood educators to implement STEAM activities effectively in the inclusive classroom.

Like all children, children with special needs enjoy and learn through exploring, drawing, playing music, dancing, and gaining firsthand experiences related to their environment. Research shows that children with special needs have the capacity to learn and engage in hands-on STEAM activities, and general or special education educators in early childhood education should use effective teaching strategies [22]. Early childhood educators are encouraged to carefully plan and implement intentional teaching strategies and design the learning environment according to their purpose in mind and their children's needs.

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