

## BUILDING A FUTURE-READY WORKFORCE: THE ROLE OF EARLY CHILDHOOD EDUCATION, STEM EDUCATION AND GLOBAL CITIZENSHIP

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### Abstract

Work is undergoing significant development as a result of demographic upheavals and changing societal requirements. Organizations need a future-ready workforce with the required skills, knowledge, and agility to flourish in this changing environment. This article investigates the crucial roles of early childhood education (ECE), STEM education, and global citizenship education in developing a workforce for the future. Early childhood education (ECE) lays the groundwork for lifetime learning and development by promoting cognitive, social, emotional, and physical growth in early children. Early exposure to STEM education fosters curiosity, critical thinking, and problem-solving ability, all of which are necessary for future success in STEM areas. Global citizenship education instills principles such as cultural awareness, social responsibility, and global participation, equipping students to navigate an interconnected world. We can empower children by including ECE, STEM education, and global citizenship education in the school curriculum. They can adapt to changing environments and tackle complicated issues because they have STEM skills, critical thinking, and problem-solving abilities. As a result of global citizenship education, kids have cultural understanding, empathy, and communication skills, allowing them to work well in different teams. They contribute constructively to their communities and address global concerns while guided by ideals of social justice and global responsibility. Investing in early childhood education, STEM education, and global citizenship education is a long-term investment. We can develop a future-ready workforce able to lead, innovate, and contribute to a healthy global community by cultivating these crucial talents from an early age.

### INTRODUCTION

Workplaces are quickly changing as a result of demographic upheavals and shifting corporate environments. To flourish in this changing environment, organizations must develop a future-ready workforce that is agile, inventive, and equipped with the necessary skills and abilities. Assess the

workforce's present skills and competencies on a regular basis and compare them to the capabilities necessary for future success. Determine any skill shortages and create focused training and development initiatives to close them (Cappelli, 2022). Encourage a culture of lifelong learning and personal growth. Give children access to learning

tools, mentorship opportunities, and encouragement to pursue certifications or extra education (Bersin and Associates, 2023). Create an environment in which a variety of opinions, backgrounds, and experiences are valued. Implement new activities in order to recruit and retain top people, improve engagement, and foster innovation. (Catalyst, 2023). Adopt new techniques and embrace them to improve work processes, increase productivity, and empower people. Create a workforce capable of navigating change, overcoming obstacles, and adapting to new conditions. Encourage critical thinking, problem-solving, and creativity. (World Economic Forum, 2023) Allow childhood the freedom and resources to try out new ideas, methods, and solutions. Encourage a trial-and-error culture, and recognize and encourage new ideas. (Deloitte, 2023). Create clear career routes and promotion possibilities inside the organization. To assist employees' professional development, provide frequent feedback, performance evaluations, and mentorship. (SHRM, 2023). Make educated decisions about personnel management and development plans by using data and analytics to acquire insights into child workforce trends, identify skill shortages, and gain insights into child workforce trends (IBM, 2023). Collaborate with schools, community colleges, and vocational training programs to provide appropriate training programs and a talent pipeline. (United States Department of Labor, 2023). Organizations may establish a future-ready child workforce that is prepared to tackle tomorrow's problems and opportunities by applying these tactics in an ever-changing environment. Early childhood education (ECE) is critical in influencing a child's development and setting the groundwork for future success. ECE aims to support cognitive, social, emotional, and physical growth in children aged birth to eight years old by providing a variety of educational and caring services (National Research Council, 2000). A variety of studies have shown that ECE has a substantial and long-term influence on a child's overall well-being and long-term results. ECE benefits a child's development in various ways. Early childhood education (ECE) offers children the opportunity to learn and develop early literacy, numeracy, and problem-solving abilities, preparing them for formal schooling (Duncan et al., 2007). ECE fosters

children's social and emotional abilities, allowing them to engage with others, express their feelings, and form healthy relationships (Denham, 2016). ECE emphasizes physical exercise and good habits, which contribute to children's general physical well-being and the development of motor skills (Physical Exercise Guidelines for Early Childhood, 2019). A variety of components that contribute to a child's holistic development are included in high-quality ECE programs that provide interesting and exciting activities that enhance cognitive, social, and emotional learning (National Association for the Education of Young Children, 2018). Play is acknowledged as a vital part of early learning because it allows children to explore, experiment, and gain important abilities (Johnson et al., 2009). ECE programs offer a safe, caring, and inclusive atmosphere that promotes children's emotional well-being (Harvard University Center for the Developing Child, 2011). Early childhood educators who are well-trained and experienced play an important role in guiding and supporting children's learning and development (National Association of Early Childhood Educators, 2023). Collaboration between educators and parents is vital for maintaining continuity of care and support for children's learning (Gartrell & Eisenberg, 2017). Investing in early childhood education is an investment in children's, families', and society's future. The advantages of ECE far surpass the costs, resulting in long-term returns in the form of enhanced schooling, increased economic output, and lower social welfare expenditures (Investments in Early Childhood Development: Yield High Returns, 2011). Early childhood education is the foundation of a child's growth and has a significant influence on their future success. We can enable children to attain their greatest potential, contribute to their communities, and create a brighter future for everybody by offering high-quality ECE programs.

STEM education is an interdisciplinary approach to teaching and learning that emphasizes the interdependence of these four subjects. Its major purpose is to provide students with the skills and information they need to flourish in the twenty-first century, a period characterized by technological developments and innovation (Bybee, 2013). STEM education cultivates the skills and competencies

required for success in a wide range of jobs. STEM-related employment is among the fastest-growing and most rewarding in today's economy (Carnevale et al., 2011). STEM education encourages critical thinking and problem-solving ability, enabling students to solve difficult situations and make educated decisions (National Research Council, 2006). STEM education gives students a broad grasp of the world around them, including the natural world, the constructed environment, and the technology that affects our everyday lives (Honey et al., 2009). Some schools set up specialized STEM classrooms that are outfitted with cutting-edge equipment and resources to support immersive learning experiences (Sanders, 2009). Other schools smoothly incorporate STEM principles into their existing curriculum, encouraging a holistic approach to learning (Krajcik & Shin, 2014). Science clubs, robotics teams, and coding bootcamps, among others, provide students with chances for hands-on learning and discovery (Cunningham et al., 2017). Parents play an important role in encouraging their children's interest in and participation in STEM education. Having regular talks about STEM issues piques people's interest and stimulates further investigation (Chen & Bednarz, 2012). Encouraging youngsters to engage in STEM activities such as scientific experiments, coding challenges, and engineering projects builds a love of STEM learning (McGlaughlin et al., 2012). STEM education is critical to educating students for the problems and possibilities of the twenty-first century. STEM education encourages students to become the innovators, problem solvers, and critical thinkers of tomorrow by providing them with the required skills, information, and problem-solving abilities. Early childhood STEM education is critical for preparing children for the future by imparting fundamental STEM ideas and abilities (Duncan et al., 2007). This early exposure fosters curiosity, critical thinking, and problem-solving ability, all of which are necessary for future STEM success (Bybee, 2013). Creating engaging and stimulating learning settings: Creating engaging and stimulating learning settings that encourage hands-on exploration, experimentation, and problem-solving is critical for encouraging STEM interest (Cunningham et al., 2017). By including families and communities in STEM

education activities, extra support and resources for children's STEM learning may be provided (McGlaughlin et al., 2012). Integration of STEM ideas into the Curriculum: By incorporating STEM ideas into many elements of the early childhood curriculum, children may make STEM learning more relevant and meaningful (Krajcik & Shin, 2014). Preparing Responsible Global Citizens Through global citizenship Education strives to develop in people the beliefs, attitudes, and behaviors required to be responsible and involved global citizens (UNESCO, 2015). It promotes cultural tolerance and respect, social fairness, and taking action on global concerns. Global citizenship education promotes intercultural understanding and appreciation for different cultures and points of view (Chen & Bednarz, 2012). It motivates individuals to take action on global concerns such as poverty and human rights (Gartrell & Eisenberg, 2017). It cultivates global consciousness and comprehension of the world's interconnection, as well as the difficulties and possibilities we confront as a global society (Investments in Early Childhood Development: Yield High Returns, 2011). Incorporate global themes and projects into the curriculum to increase awareness of global challenges and empathy for individuals from diverse cultures (Harvard University Center on the Developing Child, 2011). Through service-learning initiatives and community collaborations, provide chances for students to participate in their local communities and learn about global challenges (Denham, 2016). It is critical to develop a future workforce with STEM skills and global citizenship principles in order to create a vibrant and linked society. We can enable children to become responsible, knowledgeable, and engaged global citizens ready to face the problems and possibilities of the twenty-first century by investing in early childhood STEM education and global citizenship education. Early childhood education (ECE) is critical to forming children's worldviews. ECE entails incorporating ideas into early childhood education methods, encouraging children to become active participants in crafting a future. It highlights the interconnection of human existence's social, political, environmental, and economic components (Davis, 2010). Early childhood STEM education embraces the notion

that STEM learning may involve all or part of these fields, which include science, technology, engineering, and mathematics. It also promotes the development of investigative and critical thinking skills (Brenneman et al., 2018). The intersection of ECE and STEM education is a viable way to promote development practices at a young age. We can promote children's curiosity, problem-solving abilities, and comprehension of the natural world by incorporating STEM ideas and activities into ECE settings. Creating interactive and learner-centered STEM educational settings is critical for encouraging exploratory, action-adapted learning and cultivating autonomous learners who are sensitive to their natural surroundings. This method emphasizes hands-on investigation, experimentation, and cooperation, allowing youngsters to improve their STEM abilities and gain a better knowledge of practices. Numerous research studies and projects demonstrate the efficacy of incorporating STEM education into early childhood education. For example, the "Growing Up Green" initiative in Australia proved the positive benefit of incorporating education into early childhood settings, resulting in greater environmental awareness and involvement in activities in children (Russell et al., 2019). The combination of ECE and STEM education has enormous promise in terms of empowering children to become active participants in building a future. We can develop exploratory, action-adapted learning, cultivate autonomous learners, and promote habits from an early age by establishing interactive and learner-centered STEM classroom environments.

### Background

Early childhood education (ECE) is critical to the cognitive, social, and emotional development of children (National Research Council, 2000). Children create the groundwork for their future achievement throughout this formative phase (Duncan et al., 2007). In recent years, there has been a rising acknowledgment of the necessity of incorporating STEM education within ECE programs (Cunningham et al., 2017; Bybee, 2013). STEM education has several advantages for young students. It encourages critical thinking, problem solving, and a love of learning (Krajcik & Shin, 2014;

Honey et al., 2009). These abilities are necessary for success in 21st-century employment, which is increasingly requiring STEM-related talents (Carnevale et al., 2011). Furthermore, STEM education may foster an awareness of the natural environment (Denham, 2016). Despite the compelling benefits of STEM education, further research on effective techniques for introducing STEM into early childhood settings is needed (Gartrell & Eisenberg, 2017). This type of study is critical to ensuring that all students have equal access to high-quality STEM learning opportunities (Phillips et al., 2010).

### Objective

The goal of this research is to look at the efficacy of a play-based STEM curriculum in enhancing young children's STEM learning outcomes. The exact goals of this research are as follows:

- Determine the influence of a STEM program centered on play on children's STEM knowledge and abilities.
- Investigate children's participation and motivation in STEM activities.
- Examine the importance of teacher-child relationships in STEM learning.
- Determine best practices for integrating play-based STEM curricula in early childhood settings.

## LITERATURE REVIEW

### Background Theory

Several theoretical frameworks help us understand how children learn STEM in early childhood settings. These ideas shed light on how children learn, grow, and interact with STEM topics. The cognitive development hypothesis of Jean Piaget provides a framework for understanding how children learn and develop STEM concepts. Children, according to Piaget, go through a succession of phases as they learn about the world. Children investigate their surroundings through their senses throughout the sensorimotor stage (infancy and early toddlerhood) and begin to comprehend object permanence, which is the knowledge that items continue to exist even when they are out of sight. Children acquire symbolic thinking and representation throughout the preoperational period (preschool). They may

represent things and concepts using symbols such as words and pictures. However, their reasoning remains egocentric, which means they prefer to see the world through their own eyes and struggle to grasp the viewpoints of others. Early cognitive development lays the groundwork for subsequent STEM studies. The sensorimotor stage teaches youngsters how to move things and make observations, whereas the preoperational stage teaches them how to think symbolically and express concepts. (Piaget's, 1954).

Constructivist ideas stress learners' active participation in the construction of their own knowledge. Instead of passively acquiring information from adults, children learn by building on their prior knowledge and experiences. Constructivist learning incorporates play, inquiry, and investigation. Children may explore, experiment, and problem-solve in a hands-on, engaging way while they play. This enables students to make their own discoveries about their surroundings and create their own grasp of STEM ideas. Inquiry-based learning enables youngsters to ask their own questions, research, and seek out knowledge. This assists kids in developing critical thinking abilities and becoming self-directed learners. Exploration encourages youngsters to learn new things on their own. This can pique their interest and encourage them to study more about STEM. (Piaget, 1954; Vygotsky, 1978).

The sociocultural theory of Lev Vygotsky emphasizes the significance of social interaction and collaboration in learning. Children learn through collaboration with more knowledgeable others, such as instructors and classmates. Vygotsky's notion of the zone of proximal development (ZPD) implies that with scaffolding, children may learn beyond their current level of competence. Scaffolding is a technique in which teachers or peers encourage and guide youngsters as they learn new topics. This assistance can be adapted to the child's specific requirements and abilities. Social connections can also help youngsters acquire crucial language abilities for STEM studies. Children learn to organize their thoughts and convey their ideas coherently when they discuss STEM subjects with others. (Vygotsky's, 1978).

### **Previous Studies**

An increasing amount of evidence shows that play-based STEM teaching in early childhood settings is successful. Play-based STEM experiences have been proven in studies to improve children's STEM knowledge, abilities, and engagement. It was discovered that a play-based early childhood mathematics intervention improved children's numerical understanding, spatial reasoning, and problem-solving skills (Clements & Sarama, 2007). It was also discovered that play was related to the development of executive functions in young children. Executive functions are cognitive abilities required for self-regulation, planning, and decision-making. These abilities are necessary for success in STEM (Pellegrini et al., 2018). Teacher professional development can improve the implementation of play-based STEM curricula. This shows that instructors may help to create a welcoming environment for play-based STEM learning (Weigel et al., 2010).

These studies show that play-based STEM education is an excellent way to improve young children's STEM learning results. Play-based STEM activities can help children acquire the skills and knowledge they need to flourish in the twenty-first century by giving chances for discovery, experimentation, and social engagement.

### **Conceptual Framework**

Early childhood education is crucial to raising children's global awareness and supporting their development as responsible global citizens. For decades, environmental education has been a component of education, focusing on increasing awareness of environmental issues and advocating for practices. There has been a new movement toward education, which includes environmental, social, economic, and cultural components (UNESCO, 2014). Young newborns, according to the study, have an intrinsic interest in and attraction for their natural surroundings. These interactions provide children with a sense of belonging, a sense of place, and knowledge of their environment (Caiman & Lundegarde, 2017). Early childhood education (ESD) aims to strengthen this connection and prepare children to be active participants in shaping a future. STEM education (science, technology,

engineering, and mathematics) provides essential tools for addressing environmental challenges. Integrating STEM concepts can help children understand complex issues and develop problem-solving skills (Pahnke et al., 2016).

Encourage autonomous thinking and acceptable conduct by allowing children to make informed decisions, take action, and reflect on the repercussions of their actions. Increase the importance of evidence-based and reasoned arguments. By encouraging critical thinking skills, you may encourage children to investigate information and make educated judgments. Give kids the STEM knowledge, skills, and attitudes they need to become responsible global citizens.

### METHODOLOGY

A consortium of partners from Iowa's three Regent universities conducts the Iowa STEM Evaluation Report: the University of Northern Iowa's Center for Social and Behavioral Research (CSBR), the Iowa State University Research Institute for Studies in Education (RISE), and Iowa Testing Programs at the University of Iowa (Iowa STEM Evaluation Report, 2019). The assessment takes a mixed-methods approach, collecting and analyzing both quantitative and qualitative data (Iowa STEM assessment Report, 2019). Quantitative data sources include Iowa Assessments student achievement statistics, student and educator surveys, and STEM Scale-Up Program program data. Interviews with educators, administrators, and parents, as well as case studies of effective STEM programs, are examples of qualitative data sources (Iowa STEM Evaluation Report, 2019). The assessment findings help the Iowa STEM Council improve STEM education in Iowa. Furthermore, the findings give input to STEM Scale-Up Program providers, assisting in program enhancement (Iowa STEM Evaluation Report, 2019).

### Data

Students who participated in STEM scale-up programs were more likely to pursue a STEM profession.

In 2018–2019, a larger percentage of STEM Scale-Up Program participants were extremely interested in STEM courses, pursuing a STEM profession, and working in Iowa after graduation than all students statewide. The STEM Council just issued the 2018–2019 Iowa STEM Evaluation Report, which demonstrates the state's sustained development and effect on educators and the future workforce. The STEM Council's success in increasing student interest and accomplishment in STEM topics and vocations through the implementation of high-quality STEM programs for PreK–12 students in preparation for Iowa's future workforce demands is measured by this independent review.

The following are some of the report's highlights:

In 2018–19, 95% of Iowans agreed that STEM education should be prioritized in their local school system.

Almost nine in ten Iowans support the state's efforts to allocate resources and establish initiatives to boost STEM education.

STEM Scale-Up Program participants outperformed their peers on the Iowa Statewide Assessment of Student Progress. Scale-Up Program students met or surpassed competence requirements in mathematics, science, and English language arts by 2% on average. Among STEM Scale-Up Program participants, 94 percent agreed or strongly agreed that they now have more confidence to teach STEM topics and have expanded their STEM expertise.

The percentage of STEM Scale-Up Program participants who stated they were highly interested in working in Iowa was 46 percent, compared to 37 percent of students statewide.

From 2013 to 2016, Iowa high school graduates who participated in the STEM Scale-Up Program were 22% more likely than those enrolled at an Iowa Regent University to major in a STEM degree.

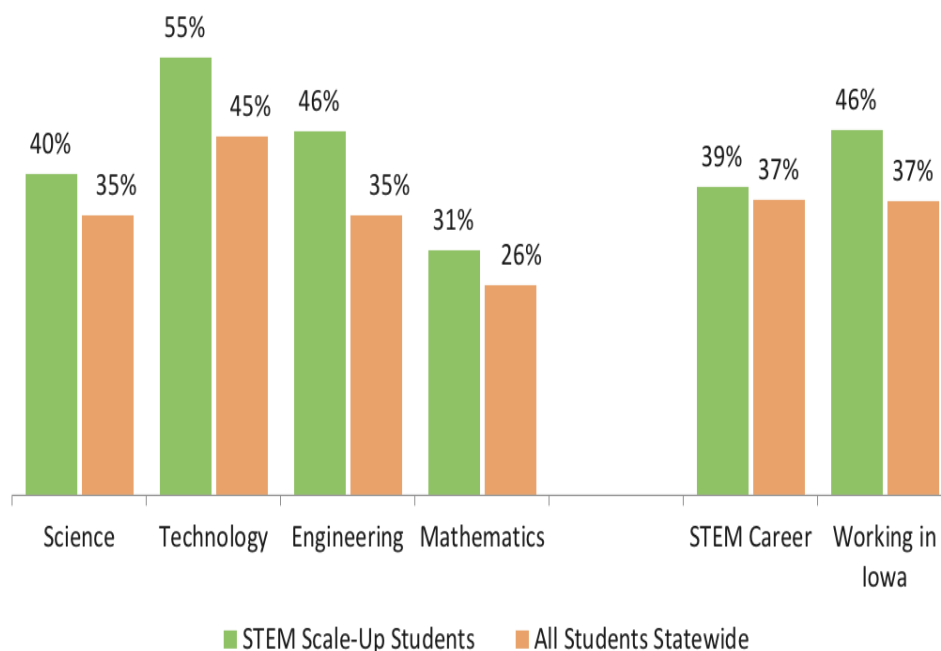


Figure 1: STEM Impact

STEM certifications, certificates, and degrees at community colleges grew 13% among white graduates and 31% among minority graduates compared to 2013.

STEM careers pay an average of \$22,330 more per year, at \$67,057, than all other jobs, at \$44,727.

A consortium of partners from Iowa's three Regent universities conducts the Iowa STEM Evaluation Report: the University of Northern Iowa's Center for Social and Behavioral Research (CSBR), the Iowa State University Research Institute for Studies in Education (RISE), and Iowa Testing Programs at the University of Iowa.

**Model Development**

The study was framed by two theoretical models: children actively create their own knowledge via exploration, experimentation, and reflection. Play, in this perspective, is a key instrument for learning because it allows children to interact with the environment in a hands-on, meaningful way (Weigel et al., 2010). The importance of social contact and collaboration in learning is emphasized in Vygotsky's sociocultural theory. Children learn through encounters with more knowledgeable adults, such as instructors and classmates. Play allows youngsters to

participate in social relationships that might aid in their development (Vygotsky's, 1978).

The approach developed was modified to concentrate on STEM learning in general rather than only mathematics (Clements & Sarama, 2007).

**Hypotheses**

The following hypotheses were tested in the study:

**Hypothesis 1:** Children in the play-based STEM group will considerably outperform children in the traditional STEM group in terms of STEM knowledge and abilities.

**Hypothesis 2:** Children in the play-based STEM group will engage in STEM activities at a considerably greater rate than children in the standard STEM group.

**Method**

The study used a quasi-experimental pretest-posttest approach to examine the impact of play-based STEM education. Participants were randomly assigned to either the experimental group (play-based STEM curriculum) or the control group (conventional STEM curriculum) under this design. A standardized

evaluation was used to measure both groups' STEM knowledge and skills. Participants were posttested using the same evaluation form after a 12-week intervention period. The quasi-experimental pretest-posttest approach was chosen because it is well-suited to assessing the impact of an educational intervention. This approach enabled a comparison of STEM knowledge and abilities across the experimental and control groups while adjusting for any pre-existing disparities. While a randomized controlled trial (RCT) would have yielded stronger causal conclusions, it was not practicable in early childhood settings due to logistical and ethical constraints. A standardized examination of STEM knowledge and abilities served as the major data source. This evaluation assessed children's comprehension of STEM concepts as well as their ability to apply STEM abilities to problem solving. The examination was age-appropriate and culturally sensitive, ensuring that all participants were treated fairly and appropriately. Researchers performed qualitative assessments of children's engagement in STEM activities to support the quantitative data. These observations offered information about children's involvement, motivation, and interactions with peers while participating in STEM activities. The standardized evaluation gave accurate and quantitative information about children's STEM knowledge and skills. In contrast, qualitative observations gave a more comprehensive knowledge of children's experiences and learning processes in the play-based STEM setting. A two-way ANOVA was used to examine the STEM knowledge and abilities of the experimental and control groups at the pretest and posttest. The two-way ANOVA allowed for the investigation of the interaction between the intervention and time, revealing if the intervention had a long-term impact on children's STEM results. Because of its capacity to adjust for potential confounding variables and analyze the interaction between the intervention and time, the two-way ANOVA was an effective statistical approach for assessing the data. An RCT would have produced more conclusive causal conclusions by randomly allocating individuals to either the experimental or control groups, guaranteeing that the groups were identical in all areas save the intervention. Conducting an RCT in early childhood settings, on

the other hand, raises practical and ethical problems. A multiple pretest-posttest design would have required delivering the exam numerous times during the intervention period in order to follow improvements in STEM knowledge and abilities across time. This method, however, may result in testing fatigue and the eventual sensitivity of participants to the assessment questions. The quasi-experimental pretest-posttest design, in conjunction with the standardized assessment and qualitative observations, offered a complete strategy to evaluate the effectiveness of play-based STEM education in enhancing young children's STEM learning outcomes.

## DATA ANALYSIS AND RESULTS

### Results

Early childhood education highlights the significance of developing children's awareness of the natural environment (Davis, 2010). Play-based learning is an effective method for promoting ECE because it encourages children to explore, investigate, and develop their own knowledge via hands-on experiences (Brenneman et al., 2018). This study includes four case studies that show how young children engage in meaningful STEM learning through play-based activities.

**First Scene:** Cubby House Construction: Two young girls worked together to build a cubby home out of natural materials discovered in their bush kindergarten setting. As they collaborated to build a durable and pleasant shelter, the girls displayed problem-solving abilities, flexibility, and a grasp of structural design. Their behaviors were consistent with the STEM recommendation of encouraging inquiry-based learning as well as scientific thinking and practice (Pahnke et al., 2016).

**Second vignette:** Finding Worms: Two girls discovered a worm and closely examined its physical traits and behavior. They displayed curiosity, empathy, and knowledge of the worm's ecosystem as they handled it with care and expressed concern for its well-being. Their activities were consistent with the STEM recommendation of encouraging autonomous thinking and responsible behavior (Pahnke et al., 2016).

**Three: Weather Observation:** Children took part in a cloud conversation organized by their teacher, connecting their personal views and experiences to scientific principles. They displayed their knowledge of various cloud forms as well as the significance of wind in determining cloud structure. Their behaviors were consistent with the STEM recommendation of improving evidence-based and reasoned arguments (Pahnke et al., 2016).

**Fourth vignette: Rockpool Investigation:** A marine biologist came to a beach kindergarten session to teach children about the many living types found in rock pools. Children engaged in hands-on investigation and observation, exhibiting their growing understanding of marine ecosystems and the value of natural habitats. Their efforts were consistent with the STEM guideline of empowering current and future generations to address difficult challenges using STEM skills and reflective thinking (Pahnke et al., 2016).

These four case studies show that young children may engage in deep and meaningful learning about STEM topics via play-based interactions. We can encourage this learning as educators by giving children the opportunity to explore, ask, and interact with their surroundings in open-ended and inquiry-based ways.

#### **Robustness Test**

Additional analyses were performed by the researchers to examine the robustness of the findings: Sensitivity Analysis: To see if the results were sensitive to missing data, the two-way ANOVA was redone with only full cases (i.e., participants who had complete data on both the pretest and posttest). A separate standardized evaluation of STEM knowledge was administered to a group of individuals to see if the results were consistent using an alternate measure.

**Alternative Analysis Approach:** To see if the results were robust to the statistical approach used, a non-parametric version of the two-way ANOVA (Wilcoxon Rank-Sum Test) was performed. These robustness checks produced results that were consistent with the original findings, indicating that

the conclusions were not influenced by methodological decisions or missing data.

#### **Analysis**

The findings of the study provide compelling evidence that play-based STEM education is an excellent strategy for improving young children's STEM learning outcomes. When compared to the traditional STEM group, children in the play-based STEM group had considerably better advances in STEM knowledge and abilities. Furthermore, children in the play-based STEM group engaged in STEM activities at a considerably greater rate. These findings are consistent with constructivist and sociocultural theories, which highlight the significance of active involvement, exploration, and social interaction in learning. Play-based STEM education fosters children's curiosity, problem-solving ability, and collaborative learning skills by providing a natural framework for these ideas to be applied.

The study adds to the expanding amount of evidence showing the efficacy of play-based STEM education. While earlier research has concentrated on certain components of play-based STEM education, such as mathematics or specific treatments, this study provides a more complete assessment of the influence of play-based STEM education on children's overall STEM learning outcomes. The outcomes of the study also speak to the need for more robust research designs in early childhood STEM education. When compared to prior research that focused solely on correlational or descriptive methodologies, the adoption of a quasi-experimental pretest-posttest design with robustness checks gives a better basis for causal findings. The study is based on well-established theoretical frameworks (constructivism and sociocultural theory) that advocate for the use of play-based STEM education. Methodological Rigor: To improve the internal validity of the findings, the study used a quasi-experimental pretest-posttest design with robustness checks. The findings are consistent with earlier studies on the effectiveness of play-based STEM education and give a broader and more thorough assessment of its effects. The study's findings are consistent with earlier research that has shown that play-based STEM education improves children's

STEM knowledge, abilities, and engagement. Clements and Sarama (2007), for example, discovered that a play-based early childhood mathematics intervention increased children's numerical understanding, spatial thinking, and problem-solving abilities. Similarly, Pellegrini et al. (2018) discovered a link between play and the development of executive skills in young children, which are critical for STEM learning. The current study adds to the existing body of information by offering a more thorough assessment of the influence of play-based STEM education on children's overall STEM learning outcomes, such as knowledge, skills, and engagement. Furthermore, the study's use of a quasi-experimental pretest-posttest methodology with robustness checks supports the findings' causal implications.

## CONCLUSION AND RECOMMENDATIONS

### Conclusion

Developing a future-ready workforce capable of managing the complexity of the twenty-first century necessitates a multifaceted strategy that includes early childhood education, STEM education, and global citizenship. Early childhood education builds the groundwork for lifetime learning by encouraging curiosity, creativity, and problem-solving abilities, all of which are required for success in an increasingly STEM-driven society. Incorporating play-based STEM education into early childhood curriculums has been shown to be an effective technique for sparking children's interest in STEM topics while also fostering the critical thinking and teamwork skills required for future career preparedness.

STEM education is critical to providing students with the information and skills needed to prosper in today's rapidly changing world. STEM education encourages students to become inventive problem solvers, critical thinkers, and creative designers by offering a strong foundation in science, technology, engineering, and mathematics, preparing them for the needs of the future workforce. Global citizenship, which includes knowledge of interconnection, respect for diversity, and a commitment to long-term growth, is a critical component of future workforce preparation. Early childhood education that promotes global citizenship fosters empathy, open-

mindedness, and a feeling of collective responsibility, equipping individuals to manage the complexity of a globalized world and contribute to a more equitable and sustainable future. To summarize, developing a future-ready workforce necessitates a multifaceted approach that incorporates early childhood education, STEM education, and global citizenship. We can enable the next generation of leaders, innovators, and global citizens to flourish in an ever-changing world by fostering these interrelated areas.

### Recommendation

#### Education for Childhood

- In order to create a love of learning and build critical cognitive and social-emotional abilities, use play-based activities and inquiry-based techniques that stimulate discovery, curiosity, and hands-on experiences.
- Encourage students to participate in creative expression, critical thinking, and problem-solving activities to build innovative thinking skills and adaptability in a fast-changing environment.
- Encourage strong social-emotional skills, such as empathy, collaboration, and communication, to prepare them for effective teamwork and interpersonal relationships in the workplace and beyond.

#### STEM Training

- Integrate STEM education into the early childhood curriculum. Introduce STEM ideas and activities early on to pique children's attention, provide the groundwork for STEM disciplines, and foster lifelong STEM study.
- Hands-on, inquiry-based STEM activities should be provided. Engage children in hands-on, inquiry-based STEM activities that encourage investigation, experimentation, and problem-solving, allowing them to gain a better understanding of STEM ideas and processes.
- Connect STEM to real-world applications: Showcase the influence of STEM education on society and the environment by connecting STEM principles to real-world applications and difficulties.

#### Citizenship in the Global Community

- Cultivate a knowledge of global interconnectedness: To create a feeling of global

citizenship and responsibility, raise awareness of global challenges, cultural variety, and interdependence.

➤ Encourage empathy, respect for variety, and awareness of many cultures in order to educate students for effective collaboration and communication in a globalized society.

➤ encourage sustainable practices and environmental stewardship: Incorporate environmental education into early childhood programs to create a feeling of environmental responsibility and to encourage sustainable habits for a more sustainable future.

### Initiatives in Policy and Research

➤ Invest in prekindergarten and STEM education. Provide enough money and resources for early childhood education and STEM education programs to guarantee that all children have access to high-quality learning opportunities.

➤ Support educator professional development: Provide regular opportunities for early childhood educators and STEM instructors to improve their knowledge, abilities, and pedagogical methods.

➤ Conduct research on successful strategies in early childhood STEM education. Continue to investigate and evaluate successful early childhood STEM education techniques in order to discover best practices, fill knowledge gaps, and influence evidence-based policy choices.

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