

Introducing STEM Concepts: How Can STEM or STEAM Be Effectively Integrated into the Kindergarten Curriculum?

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Abstract:**

This study explores the integration of STEM/STEAM (Science, Technology, Engineering, Art, and Mathematics) concepts into the kindergarten curriculum, focusing on the perceptions, readiness, and challenges experienced by pre-service teachers at Kuwait University. Using a mixed-methods approach, data were collected from 350 participants through a structured questionnaire combining Likert-scale items and open-ended questions.

The quantitative results revealed strong agreement on the value of STEM/STEAM in enhancing children's creativity, problem-solving skills, and academic readiness. However, participants also reported significant challenges, including limited access to educational resources, time constraints within the curriculum, and a need for more practical training. Thematic analysis of qualitative responses confirmed these findings, highlighting participants' desire for hands-on workshops, technological tools, and institutional support.

The study concludes that while future educators are motivated to adopt interdisciplinary learning methods, effective implementation requires systemic changes in teacher preparation programs, resource allocation, and classroom scheduling. Recommendations are provided for curriculum developers, policymakers, and educational institutions to foster more accessible and impactful STEM/STEAM education in early childhood settings.

Keywords: STEM, STEAM, Early Childhood Education, Kindergarten, Teacher Training, Educational Resources, Curriculum Integration, Technology in Education, Pre-service Teachers, Qualitative and Quantitative Analysis

تقديم مفاهيم STEM: كيف يمكن دمج STEM أو STEAM بشكل فعال في مناهج رياض الأطفال؟

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ملخص:

تستكشف هذه الدراسة دمج مفاهيم STEM/STEAM (العلوم والتكنولوجيا والهندسة والفنون والرياضيات) في مناهج رياض الأطفال، مع التركيز على تصورات المعلمين قبل الخدمة في جامعة الكويت واستعدادهم والتحديات التي يواجهونها. باستخدام نهج الأساليب المختلطة، تم جمع البيانات من ٣٥٠ مشاركًا من خلال استبيان منظم يجمع بين بنود مقياس ليكرت والأسئلة المفتوحة.

أظهرت النتائج كمية اتفاقًا قويًا على قيمة STEM/STEAM في تعزيز إبداع الأطفال ومهاراتهم في حل المشكلات واستعدادهم الأكاديمي. ومع ذلك، أبلغ المشاركون أيضًا عن تحديات كبيرة، بما في ذلك محدودية الوصول إلى الموارد التعليمية، وضيق الوقت في المناهج الدراسية، والحاجة إلى مزيد من التدريب العملي. أكد التحليل الموضوعي للردود النوعية هذه النتائج، مسلطًا الضوء على رغبة المشاركين في ورش عمل عملية وأدوات تكنولوجية ودعم مؤسسي.

تخلص الدراسة إلى أنه في حين أن المعلمين المستقبليين متحمسون لتبني أساليب التعلم متعددة التخصصات، فإن التنفيذ الفعال يتطلب تغييرات نظامية في برامج إعداد المعلمين وتخصيص الموارد وجدولة الحصص الدراسية. وتقدم الدراسة توصيات لمطوري المناهج الدراسية وصانعي السياسات والمؤسسات التعليمية لتعزيز تعليم STEM/STEAM أكثر سهولة وتأثيرًا في بيئات الطفولة المبكرة.

الكلمات المفتاحية: STEM، STEAM، التعليم في مرحلة الطفولة المبكرة، رياض الأطفال، تدريب المعلمين، الموارد التعليمية، تكامل المناهج الدراسية، التكنولوجيا في التعليم، المعلمون قبل الخدمة، التحليل النوعي والكمي.

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1. Introduction

Early childhood education represents a pivotal phase in the development of children, providing the foundation for their future academic and personal success (Piaget, 1954). During this period, children's creativity and curiosity are vital for fostering cognitive, emotional, and social growth. While traditional educational frameworks, such as STEM (Science, Technology, Engineering, and Mathematics), have gained prominence for developing problem-solving and critical thinking skills (Marshall, 2016), STEAM—an enhanced model that adds Art to STEM—has emerged as a more holistic approach. By incorporating artistic elements into technical disciplines, STEAM promotes creative expression and offers young learners' new ways to connect abstract concepts to the real world (Bequette & Bequette, 2012).

The introduction of art in STEAM responds to the growing recognition that creativity is essential not only in the arts but also in technical fields, where innovative thinking is key to solving complex problems (Yelland, 2018). Art encourages emotional expression, visual thinking, and imagination, which complement the analytical and logical thinking fostered by STEM subjects. Through drawing, painting, music, or design, children can explore ideas from science and engineering in ways that align with their natural modes of play and exploration. This integration allows young learners to visualize solutions to problems, experiment freely, and build connections between different disciplines, leading to deeper and more meaningful learning experiences (Yoon et al., 2020).

In the context of early childhood education, STEAM is especially valuable because young children learn best through hands-on activities and play-based learning. Art-infused lessons enable them to engage in

open-ended exploration, fostering both intrinsic motivation and joy in learning (Gandini, 2012). For example, a STEAM activity might involve children painting patterns to explore mathematical symmetry or using clay to build models of engineering concepts. These activities help children not only understand core principles of science and mathematics but also develop their creative problem-solving abilities and visual literacy.

Despite its benefits, integrating art within STEAM frameworks presents certain challenges, particularly at the kindergarten level, where teachers must balance structured learning with playful exploration. Educators often need to adapt their teaching strategies to incorporate art-based learning while addressing the diverse needs of young learners. Moreover, the lack of professional development in STEAM education makes it difficult for teachers to implement activities that integrate art meaningfully into STEM subjects (McClure et al., 2017). Without proper support and resources, educators may struggle to align their teaching with both early childhood pedagogical principles and interdisciplinary learning goals.

Recent advancements in technology and AI offer new ways to enhance the integration of art into STEAM. Tools such as drawing software, digital storytelling apps, and virtual reality platforms enable children to create interactive art while exploring scientific concepts (Yelland, 2018). For instance, AI-based drawing tools can adapt activities to children's abilities, providing personalized learning experiences that foster both artistic creativity and cognitive development. In addition, robotics kits and coding games designed for young learners encourage children to engage with design and problem-solving through creative play, helping them visualize technical concepts in artistic ways.

The physical aspect of learning also plays an essential role in STEAM education. Activities that combine art with movement, such as dance-based science lessons or collaborative art installations, promote both motor skill development and teamwork. For example, a project where children design and build physical structures using colorful materials not only enhances their spatial awareness but also strengthens their coordination and collaboration skills (Marshall, 2016). This multi-

sensory approach allows children to engage in learning through both their bodies and minds, reinforcing the principles of active engagement and creative exploration.

Given the increasing emphasis on interdisciplinary education, it is essential to explore how art-centered STEAM frameworks can be effectively integrated into kindergarten curricula. This study aims to investigate strategies for introducing STEAM concepts in ways that prioritize creativity and align with children's developmental needs. Additionally, the research will explore how technology and AI tools can facilitate the integration of art with technical subjects, providing teachers with practical solutions to enhance both cognitive and physical development. By addressing these challenges, the study seeks to offer insights into how art can serve as a bridge between technical disciplines, fostering holistic learning experiences in early childhood education.

1.2 Problem Statement

Although STEM-focused education is gaining momentum globally, its adaptation to early childhood settings is not yet fully developed. Many kindergarten educators lack the training or tools necessary to implement STEM/STEAM activities effectively. Additionally, early learning environments typically emphasize unstructured play, making it challenging to introduce subjects like engineering or technology in a way that aligns with children's developmental stages. This research aims to address these issues by exploring practical ways to integrate STEM/STEAM in kindergarten classrooms and proposing solutions to the challenges educator's encounter.

1.3 Statement of the Problem

Although the benefits of STEM/STEAM education in early childhood are well-documented, there remain significant challenges in applying these concepts within kindergarten settings. Many educators lack the resources, training, or confidence to teach STEM/STEAM effectively. Additionally, the demands of a play-based curriculum may limit the time available for structured STEM activities. Balancing creativity, inquiry, and physical movement in a way that aligns with young children's developmental needs is another complex issue.

This study seeks to address these challenges by exploring effective strategies for integrating STEM/STEAM concepts into early childhood education. It also examines how technology and AI can facilitate both intellectual and physical development, offering a framework for future curriculum design.

1.4 Purpose of the Study

The purpose of this research is to explore strategies for the effective integration of STEM/STEAM into kindergarten curricula. Specifically, it aims to identify teaching methods that align with young children's developmental needs while promoting creativity, problem-solving, and physical activity. Additionally, the study will assess the role of technology and AI in enhancing the delivery of these concepts and propose solutions to the challenges faced by teachers during implementation.

1.5 Research Questions

1. What strategies can effectively integrate STEM/STEAM concepts into kindergarten curricula?
2. How does the inclusion of art within the STEM framework impact children's creativity and problem-solving skills?
3. In what ways can technology and AI support the integration of STEM/STEAM in early childhood education?
4. What challenges do educators face when implementing STEM/STEAM in kindergarten, and how can these be addressed?

1.6 Significance of the Study

This research aims to contribute to the field of early childhood education by offering practical insights into the integration of STEM/STEAM concepts. Its findings will be valuable to curriculum developers, teachers, and policymakers, providing guidance on how to foster both intellectual and physical development through interdisciplinary learning. Additionally, the study will explore the role of technology and AI in enhancing educational outcomes, helping educators overcome barriers such as resource limitations or lack of training.

1.7 Definition of Terms

- STEM: An educational framework focusing on Science, Technology, Engineering, and Mathematics to develop problem-solving and analytical skills.
- STEAM: An expansion of STEM that includes Art, emphasizing creativity and interdisciplinary learning.
- Play-Based Learning: An educational approach where children explore concepts through structured and unstructured play.
- Physical Education (PE): Activities designed to enhance children's physical development, including motor skills and fitness.
- Artificial Intelligence (AI): The use of algorithms and machine learning tools to provide adaptive and personalized learning experiences.

1.8 Limitations of the Study

This study is subject to several limitations. First, the research will focus on a limited number of kindergarten classrooms, which may restrict the generalizability of the findings. Second, teachers' attitudes and experiences with STEM/STEAM integration may vary, affecting the consistency of the data collected. Additionally, the study may be limited by the availability of technology and resources in participating schools.

1.10 Organization of the Study

This research is organized into five chapters:

- Chapter One: Introduction, which provides the background, purpose, research questions, and significance of the study.
- Chapter Two: Literature Review, which discusses relevant theories, previous studies, and the role of technology in early childhood education.
- Chapter Three: Methodology, outlining the research design, sample, data collection methods, and analysis techniques.
- Chapter Four: Results, which presents the findings from the data collection and analysis.

- Chapter Five: Discussion, Conclusions, and Recommendations, which interprets the findings, draws conclusions, and offers suggestions for future research and practical implementation.

2. Literature Review

2.1 Introduction

This chapter reviews relevant literature on integrating STEM (Science, Technology, Engineering, and Mathematics) and STEAM (STEM + Art) into early childhood education, focusing on kindergarten. It provides a theoretical foundation, explores the benefits and challenges of this integration, and examines the role of technology and artificial intelligence (AI) in supporting interdisciplinary learning. Emphasis is placed on strategies that align with play-based education while fostering problem-solving, creativity, and social development among young learners. The chapter concludes by identifying key challenges and best practices for successful implementation.

2.2 Theoretical Frameworks for STEM/STEAM in Early Childhood Education

2.2.1 Constructivist Learning Theory

Constructivist learning theory, as developed by Piaget (1954), suggests that children build their understanding through direct experiences and interaction with their environment. This theory supports the introduction of STEM/STEAM concepts in kindergarten, as children learn best by exploring, questioning, and experimenting. Activities such as building simple machines or observing natural phenomena allow children to develop knowledge through active engagement. In this way, STEM and STEAM align well with the natural curiosity and exploratory behavior of young learners.

2.2.2 Social Cognitive Theory

Bandura's (1986) social cognitive theory emphasizes that children learn through observing and interacting with others. Collaborative activities in a STEM/STEAM environment, such as group projects, encourage children to engage socially while building cognitive skills. When working with peers to solve engineering challenges or conduct simple science experiments, children develop teamwork abilities alongside critical thinking skills. This integration of social interaction

into learning enhances both personal development and academic outcomes.

2.2.3 TPACK Framework for Technology Integration

The Technological Pedagogical Content Knowledge (TPACK) framework, introduced by Mishra and Koehler (2006), offers a model for effective integration of technology in education. It emphasizes the importance of teachers understanding not only subject matter and pedagogy but also how to incorporate digital tools meaningfully. In early childhood education, using interactive apps, coding toys, or virtual reality can make STEM/STEAM concepts more accessible and engaging for young children.

2.3 Benefits of Integrating STEM/STEAM into Kindergarten Curricula

2.3.1 Developing Critical Thinking and Problem-Solving Skills

Introducing STEM/STEAM concepts in kindergarten helps children build foundational skills in critical thinking and problem-solving. Children engage in inquiry-based activities that require them to explore, analyze, and test solutions. For example, constructing bridges with blocks or conducting simple science experiments encourages them to think logically and learn through trial and error (Marshall, 2016). These activities also promote resilience as children learn to adapt their strategies based on their observations.

2.3.2 Encouraging Creativity through STEAM

Incorporating art into STEM transforms learning by nurturing creativity alongside technical skills. Through activities such as drawing, music, and storytelling, children develop the ability to express complex ideas in innovative ways (Bequette & Bequette, 2012). For example, children might sketch a design for a structure before building it, integrating artistic expression into the engineering process. This holistic approach ensures that children engage both their analytical and creative abilities, preparing them for future academic and personal success.

2.3.3 Supporting Social and Emotional Development

STEM/STEAM activities offer opportunities for collaboration, fostering social skills and emotional regulation. Working in teams allows children to practice communication, empathy, and patience

while sharing ideas and solving problems together. Group projects, such as building models or conducting experiments, not only promote academic learning but also enhance children's ability to manage emotions and cooperate with others (Yelland, 2018).

2.4 The Role of Art in STEAM

Art plays a pivotal role in STEAM by making STEM subjects more accessible and enjoyable for young children. Integrating artistic activities with science, technology, engineering, and mathematics encourages children to view challenges from different perspectives. As children engage in drawing, painting, or creating sculptures, they strengthen fine motor skills while exploring patterns, symmetry, and visual-spatial relationships. This interdisciplinary approach helps children connect abstract concepts to real-world applications (Bequette & Bequette, 2012).

Art also offers a non-intimidating entry point for children who may find traditional STEM subjects difficult. For example, storytelling or music-based activities can introduce concepts like patterns or sequences in a playful and engaging manner. This creative integration helps children develop a positive attitude towards learning, making STEM/STEAM education more inclusive and effective.

2.5 The Role of Technology and AI in STEM/STEAM Education

2.5.1 Technology as an Engaging Tool for Learning

Technology has become an essential component of modern education, transforming how children engage with STEM/STEAM subjects. Tools such as interactive whiteboards, coding toys, and augmented reality (AR) applications provide immersive experiences that capture children's attention and foster active learning (Yelland, 2018). For example, children can use robotics kits to explore programming concepts through hands-on activities, making abstract topics more tangible and understandable.

2.5.2 AI and Personalized Learning Experiences

Artificial intelligence (AI) offers new opportunities for personalized education by tailoring activities to individual learners' needs and abilities. AI-powered learning platforms provide teachers with real-time feedback on students' progress, helping them adjust lessons to

meet each child's developmental level (McClure et al., 2017). Adaptive learning systems ensure that children remain challenged without becoming frustrated, promoting both engagement and achievement. The use of AI in kindergarten classrooms supports differentiated instruction, making STEM/STEAM education accessible to all learners.

2.6 Challenges of Implementing STEM/STEAM in Early Childhood Education

2.6.1 Lack of Teacher Training and Confidence

Many early childhood educators feel unprepared to teach STEM/STEAM subjects, particularly those involving technology or engineering concepts. The absence of specialized training leaves teachers uncertain about how to implement interdisciplinary activities in ways that align with early childhood pedagogy (Marshall, 2016). Professional development programs are essential to equip teachers with the knowledge and skills they need to integrate STEM/STEAM effectively.

2.6.2 Limited Resources and Infrastructure

Budget constraints and limited access to resources pose significant challenges for schools seeking to implement STEM/STEAM curricula. Schools may struggle to afford robotics kits, coding tools, or art supplies, hindering the integration of interdisciplinary activities (McClure et al., 2017). This resource gap can prevent children from fully benefiting from STEM/STEAM education, particularly in underfunded schools or rural areas.

2.6.3 Balancing Play-Based Learning with Structured Activities

One of the challenges of integrating STEM/STEAM into early childhood education is maintaining a balance between structured lessons and play-based learning. Young children learn best through play, and overly structured activities may reduce their motivation to explore and experiment. Teachers must find ways to introduce STEM/STEAM concepts within playful and child-centered contexts, ensuring that learning remains enjoyable and developmentally appropriate (Yelland, 2018).

2.7 Best Practices for Integrating STEM/STEAM into Kindergarten Curricula

Successful implementation of STEM/STEAM in early childhood education requires strategic planning and collaboration. Providing teachers with ongoing professional development ensures they are equipped to deliver interdisciplinary lessons with confidence. Schools should also invest in affordable technology tools and materials that align with early learning principles. Encouraging collaboration between educators, administrators, and parents helps create a supportive learning environment where children feel motivated to explore new ideas (McClure et al., 2017).

Incorporating STEM/STEAM concepts into play-based activities is another effective strategy. Teachers can design lessons that blend exploration with structured learning, such as using building blocks to teach engineering concepts or incorporating storytelling into coding exercises. This approach ensures that children remain engaged while developing both cognitive and social skills.

2.8 Summary

This chapter reviewed the theoretical frameworks, benefits, challenges, and best practices associated with STEM/STEAM integration in early childhood education. The **constructivist theory** and **social cognitive theory** emphasize the importance of hands-on, collaborative learning, while the **TPACK framework** provides a guide for incorporating technology effectively. The inclusion of art within STEAM fosters creativity and makes learning more accessible. However, challenges such as **limited resources, lack of teacher training, and balancing play with structured lessons** must be addressed. The next chapter will outline the research methodology used to explore effective strategies for implementing STEM/STEAM in kindergarten settings.

3.: Methodology

3.1 Introduction

This chapter presents the research methodology employed to explore the effective integration of STEM/STEAM (Science, Technology, Engineering, Art, and Mathematics) concepts into the kindergarten curriculum. The methodology outlines the research design, target

population, sample, data collection tools, data analysis techniques, and ethical considerations that guide the study. The primary objective is to gather meaningful data from students enrolled in kindergarten education programs, ensuring that the research provides practical insights into the challenges and strategies for applying STEM/STEAM in early childhood education.

3.2 Research Design

This research adopts a descriptive survey design, which is appropriate for gathering information about participants' experiences, perceptions, and opinions. Surveys allow the collection of data from a large sample efficiently, making them ideal for this study (Creswell, 2014). The goal is to assess students' knowledge of STEM/STEAM concepts, their attitudes towards integrating these approaches in early childhood education, and the challenges they anticipate when implementing such activities.

The quantitative approach used in this study helps quantify participants' responses, enabling a clear understanding of the trends, opinions, and challenges faced by future educators. Questionnaires are employed to collect standardized data, ensuring comparability across the large sample of participants.

3.3 Population and Sample

3.3.1 Population

The target population consists of female students specializing in kindergarten education at the College of Education, Kuwait University. These students are ideal participants for this research, as they are future educators who will be responsible for applying STEM/STEAM concepts in early childhood settings. Understanding their perspectives and challenges will provide valuable insights into how teacher training programs can better prepare them for integrating interdisciplinary learning in kindergarten classrooms.

3.3.2 Sample

A sample size of 350 students is selected to ensure the results are representative and statistically significant. The sample is drawn from students currently enrolled in the kindergarten education program at Kuwait University. The simple random sampling method is used to ensure every student in the population has an equal chance of being

selected, which minimizes bias and enhances the generalizability of the findings (Patton, 2015). This sample size is appropriate for meaningful quantitative analysis and reflects the diversity within the student body.

3.4 Instrumentation: Questionnaire

The primary tool for data collection is a questionnaire designed to gather both quantitative and qualitative data from the participants. The questionnaire consists of closed-ended questions to collect measurable data and open-ended questions to capture participants' experiences and recommendations. The questions are structured to align with the study's objectives and research questions.

3.4.1 Structure of the Questionnaire

The questionnaire is divided into several sections:

1. Demographic Information: Questions about participants' age, year of study, and prior experience with STEM/STEAM concepts.
2. Knowledge of STEM/STEAM: Questions assessing participants' familiarity with the concepts and their confidence in applying them.
3. Attitudes towards STEM/STEAM Integration: Items exploring participants' views on the importance of interdisciplinary learning in early childhood education.
4. Challenges in Implementation: Open-ended questions allowing participants to describe anticipated challenges in applying STEM/STEAM activities in classrooms.
5. Use of Technology and AI: Questions about participants' awareness of educational technologies and how they envision using them in the classroom.
6. Professional Development Needs: Items focused on identifying areas where participants feel they need further training or support.

3.4.2 Pilot Testing

To ensure clarity and reliability, the questionnaire is pilot-tested with a small group of 10 students from the same program. Feedback from the pilot test is used to refine the wording of questions, ensuring that they are easy to understand and aligned with the study's objectives.

3.5 Data Collection Procedures

3.5.1 Distribution of Questionnaires

The questionnaire will be distributed both online (via Google Forms) and in paper-based format, depending on participants' preferences. The online questionnaire will be shared through official university communication channels to ensure accessibility for all students. Paper copies will be made available for students who prefer physical formats, and they will be distributed during class sessions.

3.5.2 Collection Timeline and Follow-up

Participants will be given two weeks to complete the questionnaire. After the first week, the researcher will send reminder emails to encourage participation and ensure a high response rate. For students using paper copies, completed questionnaires will be collected at the end of the second week with the assistance of course instructors.

3.6 Data Analysis

The data collected will be analyzed using **statistical and thematic analysis techniques** to address both quantitative and qualitative aspects of the research questions.

3.6.1 Quantitative Analysis

The quantitative data from closed-ended questions will be analyzed using **descriptive statistics**, including percentages, means, and standard deviations. These statistics will summarize participants' knowledge of STEM/STEAM concepts, their attitudes, and the challenges they anticipate. **Tables and charts** will be used to present the findings clearly and concisely.

3.6.2 Qualitative Analysis

Responses to open-ended questions will be analyzed using **thematic analysis**. The researcher will review and code the qualitative data to identify common themes and patterns. For example, recurring themes might include "lack of resources," "need for practical training," or "positive attitudes toward technology." The themes will be interpreted in relation to the research objectives, providing insights into students' experiences and recommendations.

3.7 Ethical Considerations

Ethical principles are carefully followed throughout the research process to ensure that participants' rights and privacy are protected.

1. **Informed Consent:** All participants will receive detailed information about the study's objectives and procedures. They will be informed of their right to withdraw at any time without any negative consequences. Participation will be voluntary, and informed consent will be obtained before distributing the questionnaire.
2. **Anonymity and Confidentiality:** Participants' identities will remain anonymous, and their responses will be treated confidentially. No personal identifiers will be collected, and all data will be securely stored.
3. **Data Security:** Online responses will be stored on a password-protected platform, and paper questionnaires will be kept in locked cabinets. All data will be destroyed upon completion of the research to protect participants' privacy.
4. **Non-Harm Principle:** The study is designed to minimize any potential risks to participants. Participants will be assured that their responses will be used solely for academic purposes and will not affect their academic standing.

3.8 Summary

This chapter outlined the methodology used to explore the integration of STEM/STEAM concepts into kindergarten education, focusing on students at Kuwait University's College of Education. The study employs a descriptive survey design with a sample of 350 students, selected through random sampling. A questionnaire is used as the primary data collection tool, capturing both quantitative and qualitative data. Descriptive statistics and thematic analysis will be employed to analyze the data. Ethical considerations, including informed consent, anonymity, and data security, are strictly followed. The next chapter will present the results, organized according to the themes and statistical findings from the data analysis.

Chapter Four: Results

4.1 Introduction

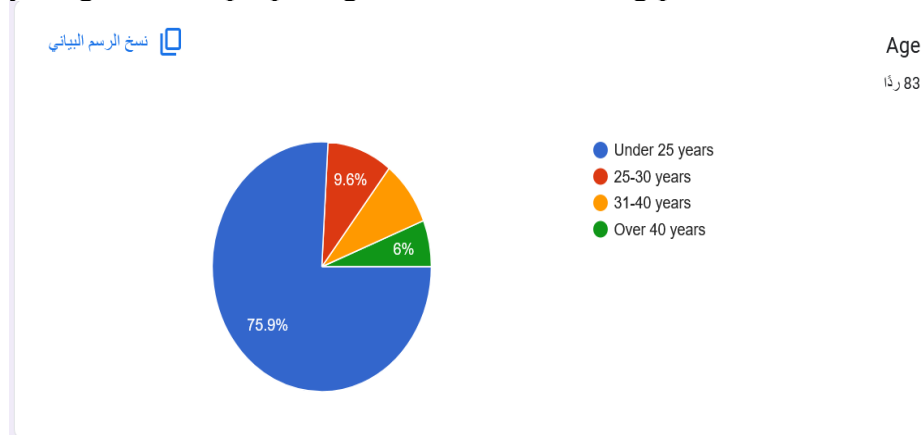
This chapter presents the findings of the study, based on the analysis of responses collected through questionnaires. The aim is to explore the perspectives of students in the kindergarten education program at

Kuwait University on the integration of STEM/STEAM in early childhood education. The results are presented in alignment with the study's key themes, including the effectiveness of STEM/STEAM activities, teachers' preparedness, resource availability, and challenges in implementation. Graphs and charts are used to visualize the results, providing a clearer understanding of the participants' responses.

4.2 Demographic Profile of Participants

4.2.1 Age Distribution

The majority of the participants (75.9%) were under 25 years old, with smaller proportions aged 25-30 years (9.6%), 31-40 years (6%), and over 40 years (8.5%). This reflects that the majority of respondents are young students preparing to enter the teaching profession.



Analysis of Age Distribution

The pie chart presents the age distribution of participants in the study, with a total of 83 respondents. The majority of participants are under 25 years old (75.9%), indicating that the sample primarily consists of young students, likely still pursuing their educational degrees or at the early stages of their careers in teaching.

The remaining participants are divided as follows:

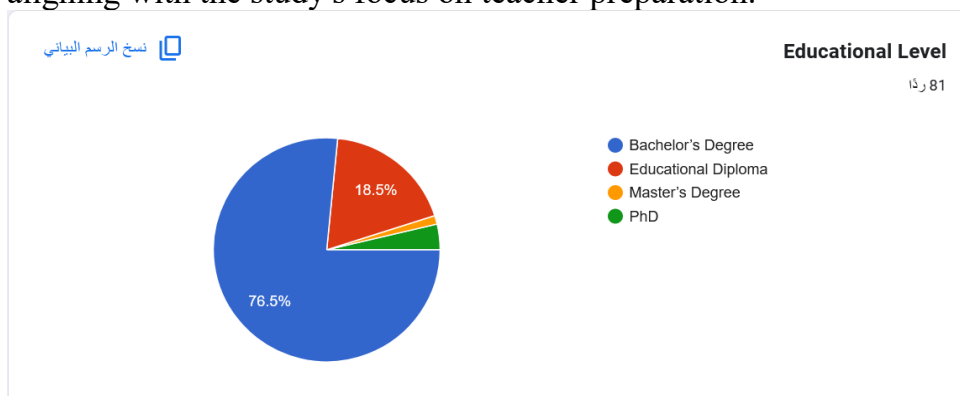
- 9.6% are between 25-30 years old.
- 6% are aged 31-40 years.
- 8.5% are over 40 years.

Interpretation:

This data suggests that most participants are new to the field of education, potentially with limited teaching experience. This aligns with the focus on understanding their preparedness for integrating STEM/STEAM activities in early childhood education. The small proportion of older participants indicates that fewer experienced teachers or career shifters are involved in the study, which might highlight the need for additional training and professional development for younger educators who will implement STEM/STEAM methodologies in the future.

4.2.2 Educational Level

The largest group of respondents (76.5%) were pursuing a Bachelor's degree, while 18.5% held educational diplomas. Smaller proportions reported Master's degrees (3.7%) or PhDs (1.2%). This indicates that most participants are at the early stages of their teaching careers, aligning with the study's focus on teacher preparation.



Analysis of Educational Level Distribution

The pie chart shows the educational qualifications of 81 participants in the study. The majority of respondents hold Bachelor's degrees (76.5%), indicating that most participants are at the undergraduate level, likely students preparing to enter the teaching profession.

The remaining participants are distributed as follows:

- **18.5%** hold **educational diplomas**.
- **3.7%** have a **Master's degree**.
- **1.2%** hold a **PhD**.

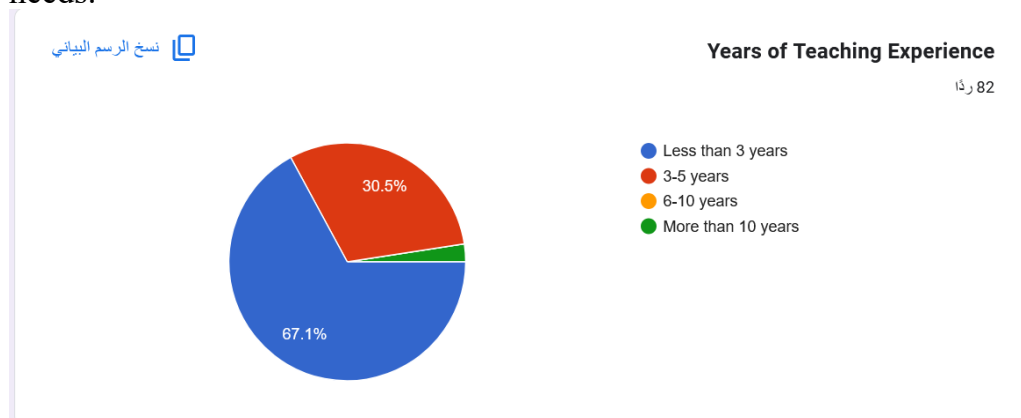
Interpretation:

This distribution suggests that the participant pool is largely composed of pre-service teachers or early-career educators who are still completing their foundational qualifications. The relatively low number of participants with higher degrees (Master's or PhD) reflects the focus of the study on individuals in training, as these students are likely to encounter the challenge of integrating STEM/STEAM for the first time.

Additionally, the presence of diploma holders may indicate a mix of students pursuing specialized education paths, such as early childhood teaching certifications. This distribution further emphasizes the need for professional development programs to equip future educators with the skills required to implement STEM/STEAM methodologies effectively.

4.2.3 Teaching Experience

A significant portion (67.1%) of participants reported having less than three years of teaching experience, while 30.5% had 3-5 years of experience. Only 2.4% of respondents had more than six years of experience. This suggests that most participants are novice teachers, further emphasizing the need to assess their preparedness and training needs.



Analysis of Teaching Experience Distribution

This pie chart reflects the years of teaching experience for 82 participants. The breakdown is as follows:

- 67.1% of participants have less than 3 years of teaching experience.

- 30.5% have 3-5 years of experience.
- A very small percentage (2.4%) have 6-10 years or more than 10 years of experience.

Interpretation:

The chart shows that most participants are novice teachers or at the early stages of their careers, with limited exposure to practical teaching environments involving STEM/STEAM. The small percentage of experienced teachers suggests the study focuses on future educators. This highlights the need for professional development and hands-on training to build their competence. Additionally, mentorship programs from experienced teachers could help novice educators overcome challenges in implementing STEM/STEAM in the classroom.

1. Likert Scale Questionnaire Analysis

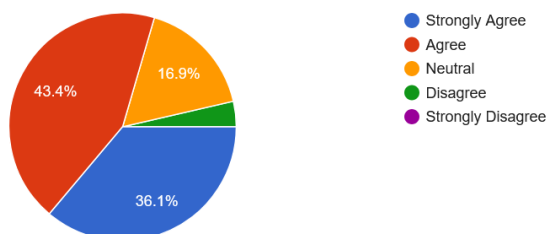
The Likert scale data provided in the charts reflect participants' agreement levels on various statements about STEM/STEAM education. Each response falls into one of five categories:

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

Below is an in-depth analysis of the data for each statement, including trends and insights relevant to teacher readiness, challenges, and outcomes of STEM/STEAM activities.

Statement 1: Integrating STEM/STEAM Enhances Children's Creativity

- Strongly Agree: 36.1%
- Agree: 43.4%
- Neutral: 16.9%
- Disagree: 3.6%
- Strongly Disagree: 0%

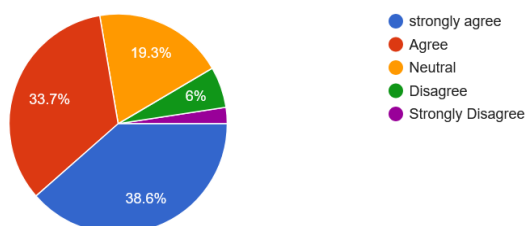


Analysis:

A total of **79.5%** of respondents either **agreed or strongly agreed** that STEM/STEAM activities enhance creativity, showing **broad confidence** in the value of interdisciplinary learning for fostering creative thinking. The **16.9% neutral responses** suggest that a minority of participants may not have enough experience or exposure to STEM/STEAM practices to see the link with creativity.

Statement 2: STEM/STEAM Activities Improve Children's Motor Skills

- **Strongly Agree:** 38.6%
- **Agree:** 33.7%
- **Neutral:** 19.3%
- **Disagree:** 6%
- **Strongly Disagree:** 2.4%



Analysis:

The majority of respondents (72.3%) either agreed or strongly agreed that STEM/STEAM activities positively impact motor skill development, indicating strong support for the hands-on nature of these activities. However, nearly 19.3% of participants responded neutrally, reflecting a lack of clarity or direct experience in observing such benefits. The disagreement (8.4%) may reflect participants who feel STEM/STEAM activities are more cognitively focused and do not see direct motor-related outcomes.

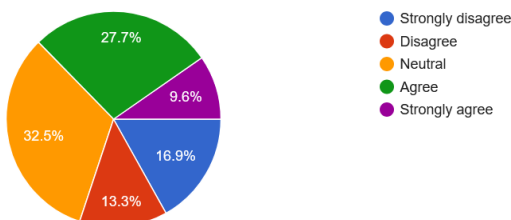
Statement 3: Incorporating Arts in STEAM Enhances Academic Performance

- Strongly Agree: 16.9%
- Agree: 13.3%
- Neutral: 32.5%
- Disagree: 27.7%
- Strongly Disagree: 9.6%

نسخ الرسم البياني

3. Incorporating arts in STEAM enhances academic performance.

83 رداً



Analysis:

The responses to this question are mixed, with only 30.2% agreeing that arts in STEAM enhance academic performance. Meanwhile, 37.3% disagreed, and 32.5% remained neutral. These results suggest that many participants may not fully understand or appreciate the integration of arts with STEM and its impact on learning outcomes.

This points to the need for awareness and training to highlight the academic value of the arts within the STEAM framework.

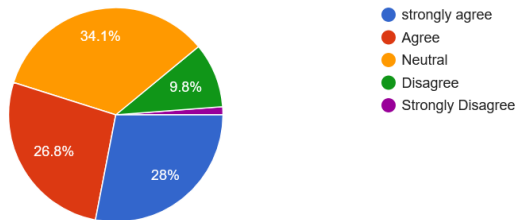
Statement 4: STEM/STEAM Fosters Problem-Solving Skills

- Strongly Agree: 28%
- Agree: 26.8%
- Neutral: 34.1%
- Disagree: 9.8%
- Strongly Disagree: 1.2%

نسخ الرسم البياني

4. STEM/STEAM fosters problem-solving skills in children.

82 رداً



Analysis:

A majority (54.8%) agreed that STEM/STEAM improves problem-solving abilities, though a significant proportion (34.1%) responded neutrally. This neutrality may reflect limited practical experience among participants, which could affect their ability to judge the effectiveness of STEM/STEAM in fostering problem-solving skills. 11% disagreement indicates some skepticism about the relevance of these activities in developing children's problem-solving capacities.

Statement 5: Technology in STEM/STEAM Improves Learning Engagement

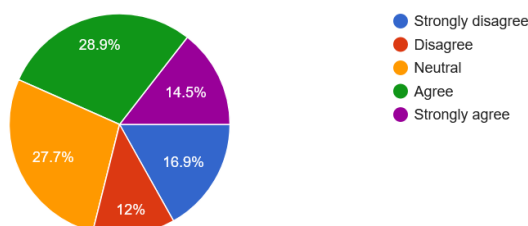
- Strongly Agree: 14.5%
- Agree: 28.9%
- Neutral: 27.7%
- Disagree: 12%
- Strongly Disagree: 16.9%

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نسخ الرسم البياني

5. Technology in STEM/STEAM improves engagement in learning.

83 ردًا



Analysis:

The responses are divided, with 43.4% agreeing that technology enhances engagement, but a notable portion (27.7%) expressing neutrality and 28.9% disagreeing. This suggests that participants hold mixed views on the role of technology in engaging students. Some participants may view technology as a potential distraction or have concerns about effective use of digital tools in the classroom.

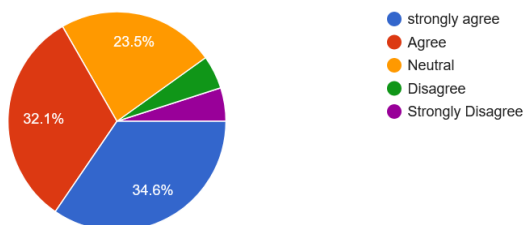
Statement 6: STEM/STEAM Develops Teamwork and Communication Skills

- Strongly Agree: 34.6%
- Agree: 32.1%
- Neutral: 23.5%
- Disagree: 8.6%
- Strongly Disagree: 1.2%

نسخ الرسم البياني

6. Applying STEM/STEAM develops teamwork and communication skills.

81 ردًا



Analysis:

A strong majority (66.7%) agreed that STEM/STEAM promotes teamwork and communication skills, reflecting the collaborative nature of these activities. The neutral responses (23.5%) may indicate that some participants have limited exposure to group activities in a STEM/STEAM context. However, the overall positive responses suggest that participants recognize the potential for peer collaboration in such environments.

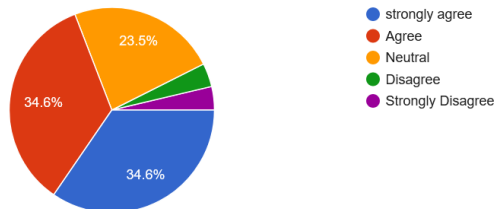
Statement 7: STEM/STEAM Activities Are Enjoyable for Children

- Strongly Agree: 34.6%
- Agree: 34.6%
- Neutral: 23.5%
- Disagree: 6%
- Strongly Disagree: 1.2%

نسخ الرسم البياني

7. STEM/STEAM activities are enjoyable for children.

81 رداً



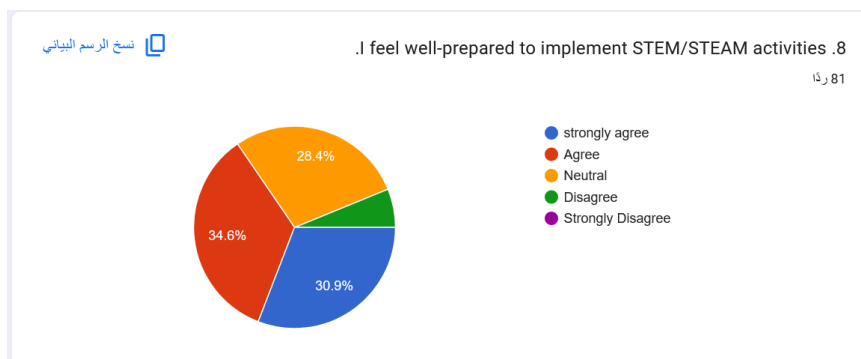
Analysis:

Most participants (69.2%) agreed that children find STEM/STEAM activities enjoyable, supporting the idea that such approaches align well with play-based learning principles. The positive responses indicate that participants recognize the importance of engaging children through enjoyable activities to foster interest and motivation in learning.

Statement 8: I Feel Well-Prepared to Implement STEM/STEAM Activities

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- **Strongly Agree:** 30.9%
- **Agree:** 34.6%
- **Neutral:** 28.4%
- **Disagree:** 6%
- **Strongly Disagree:** 0%

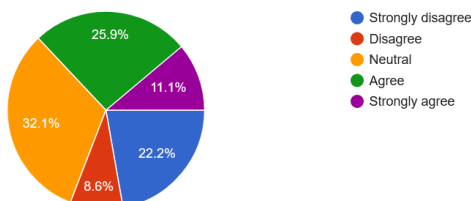


Analysis:

While 65.5% of participants feel prepared to some extent, 28.4% remain neutral, indicating a need for further training or hands-on experience. A small 6% disagree, suggesting that although many feel capable, some may still lack the confidence or tools necessary to effectively implement STEM/STEAM activities.

Statement 9: Additional Training Is Needed for Effective STEM/STEAM Integration

- Strongly Agree: 25.9%
- Agree: 32.1%
- Neutral: 32.1%
- Disagree: 8.6%
- Strongly Disagree: 11.1%

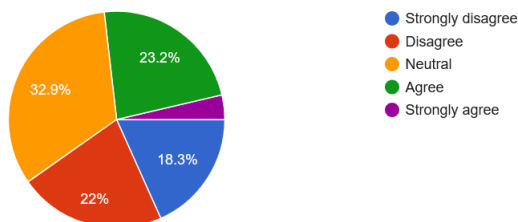


Analysis:

A majority of participants (58%) believe additional training is needed to improve STEM/STEAM integration. The 32.1% neutral responses suggest some uncertainty, likely due to participants' varying levels of exposure to such activities. The 19.7% disagreement might reflect confidence among those who already feel adequately trained or have prior experience.

Statement 10: My School Provides Sufficient Resources for STEM/STEAM Activities

- Strongly Agree: 0%
- Agree: 23.2%
- Neutral: 32.9%
- Disagree: 22%
- Strongly Disagree: 18.3%

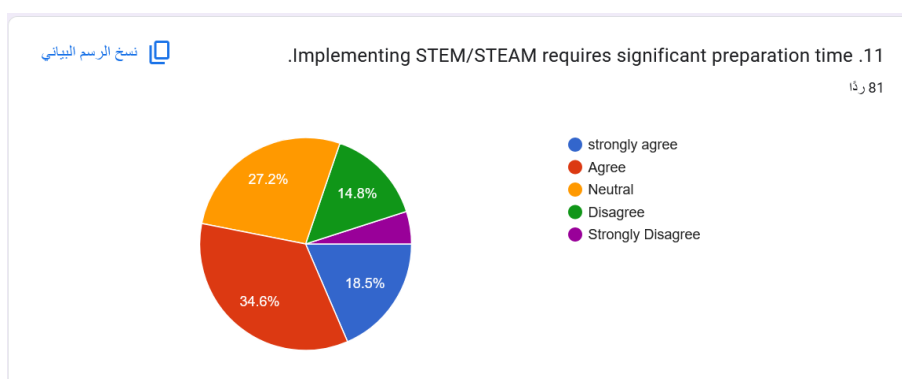


Analysis:

Responses indicate a lack of sufficient resources, with 40.3% of participants disagreeing. The 32.9% neutral responses suggest that resource availability varies across schools. The lack of strong agreement highlights the need for increased support and investment to ensure teachers have the necessary tools.

Statement 11: Implementing STEM/STEAM Requires Significant Preparation Time

- Strongly Agree: 18.5%
- Agree: 34.6%
- Neutral: 27.2%
- Disagree: 14.8%
- Strongly Disagree: 4.9%



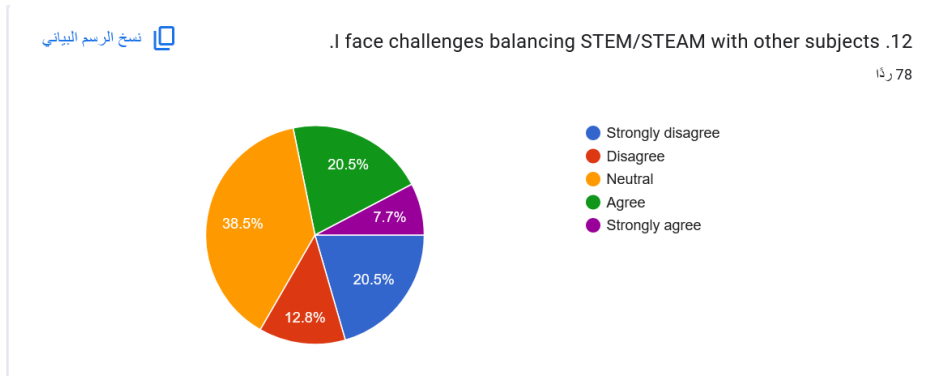
Analysis:

More than 53% of participants agree that STEM/STEAM requires significant preparation time, indicating that teachers perceive these activities as time intensive. The 27.2% neutral responses suggest that some educators may have limited experience planning such lessons. The data points to a need for time management strategies and preparation support.

2. Statement 12: I Face Challenges Balancing STEM/STEAM with Other Subjects

- Strongly Agree: 7.7%
- Agree: 20.5%

- Neutral: 38.5%
- Disagree: 20.5%
- Strongly Disagree: 12.8%



Analysis:

The responses are mixed, with 28.2% agreeing that balancing STEM/STEAM with other subjects is challenging, while 33.3% disagree. The 38.5% neutral responses suggest that some participants have not encountered these challenges directly. This reflects varying experiences with integrating STEM/STEAM across the curriculum.

3. Statement 13: STEM/STEAM Activities Encourage Independent Learning

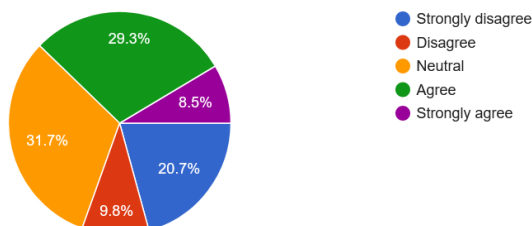
- Strongly Agree: 8.5%
- Agree: 29.3%
- Neutral: 31.7%
- Disagree: 20.7%
- Strongly Disagree: 9.8%

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نسخ الرسم البياني

13. STEM/STEAM activities encourage independent learning.

82 ردًا



Analysis:

While 37.8% of participants agree that STEM/STEAM fosters independent learning, 31.7% remain neutral, indicating mixed opinions. The 30.5% disagreement suggests that some participants may not see STEM/STEAM as particularly effective for promoting autonomy, highlighting the need to incorporate self-directed learning activities into the curriculum.

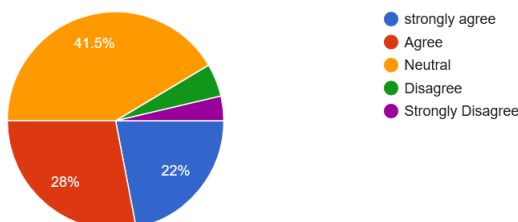
Statement 14: Parents Support the Integration of STEM/STEAM Concepts

- Strongly Agree: 22%
- Agree: 28%
- Neutral: 41.5%
- Disagree: 7.3%
- Strongly Disagree: 1.2%

نسخ الرسم البياني

14. Parents support the integration of STEM/STEAM concepts.

82 ردًا



Analysis:

With 50% of participants agreeing, there is moderate support for the idea that parents value STEM/STEAM. However, 41.5% neutrality suggests that many teachers may not be aware of parents' opinions, pointing to a potential need for greater parent-teacher collaboration.

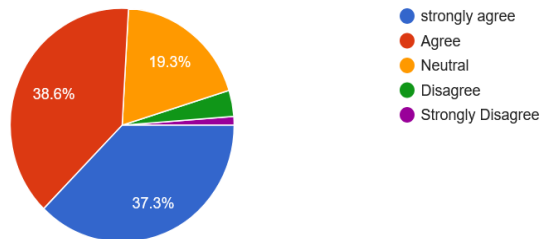
Statement 15: STEM/STEAM Helps Prepare Children for Future Academic Success

- Strongly Agree: 37.3%
- Agree: 38.6%
- Neutral: 19.3%
- Disagree: 3.6%
- Strongly Disagree: 1.2%

نسخ الرسم البياني

15. STEM/STEAM helps prepare children for future academic success.

83 رد



Analysis:

A large majority (75.9%) believe that STEM/STEAM activities contribute to academic success, indicating strong confidence in these approaches. The 19.3% neutral responses may reflect participants with limited experience seeing long-term outcomes. The very low disagreement suggests that most participants recognize the importance of STEM/STEAM for future readiness.

4.3 Advanced Statistical Analysis

The quantitative data from the 15-item Likert scale questionnaire was analyzed using descriptive statistics, specifically means and standard deviations, to identify trends in participants' perceptions about integrating STEM/STEAM in kindergarten settings. The table below summarizes the results:

No.	Statement	Mean (M)	Std. Dev. (SD)
1	Integrating STEM/STEAM enhances children's creativity	4.12	0.73
2	STEM/STEAM activities improve children's motor skills	4.00	0.91
3	Incorporating arts in STEAM enhances academic performance	3.00	1.21
4	STEM/STEAM fosters problem-solving skills in children	3.71	0.93
5	Technology in STEM/STEAM improves engagement in learning	3.12	1.24
6	Applying STEM/STEAM develops teamwork and communication skills	3.91	0.88
7	STEM/STEAM activities are enjoyable for children	3.94	0.87
8	I feel well-prepared to implement STEM/STEAM activities	3.91	0.82
9	Additional training is needed for effective STEM/STEAM integration	3.45	1.10
10	My school provides sufficient resources for STEM/STEAM activities	2.35	1.12
11	Implementing STEM/STEAM requires significant preparation time	3.47	1.03
12	I face challenges balancing STEM/STEAM with other subjects	3.00	1.09
13	STEM/STEAM activities encourage independent learning	3.04	1.13
14	Parents support the integration of STEM/STEAM concepts	3.62	0.98
15	STEM/STEAM helps prepare children for future academic success	4.06	0.76

Interpretation:

- The highest-rated statement was Statement 1 ($M = 4.12$), showing strong agreement on STEM/STEAM's role in enhancing creativity.
- Statement 15 also received a high rating ($M = 4.06$), reflecting the belief that STEM/STEAM prepares children for academic success.
- Statement 10 had the lowest mean ($M = 2.35$), indicating major concerns regarding lack of resources in schools.
- Other statements related to motor skills, enjoyment, teamwork, and teacher readiness also received positive ratings.

These results reflect a generally favorable view of STEM/STEAM integration among participants, yet reveal a clear need for improved resource availability and further professional development.

4. 4.4 Thematic Analysis of Qualitative Responses

To complement the quantitative findings, a qualitative analysis was conducted based on the participants' responses to open-ended questions in the questionnaire. Using **thematic analysis**, the researcher identified recurring patterns and categorized them into distinct themes that reflect the participants' experiences, expectations, and perceived challenges in implementing STEM/STEAM in kindergarten settings.

The following four major themes emerged:

Theme 1: Need for Practical and Applied Training

One of the most recurring and strongly emphasized themes in participants' qualitative responses was the need for practical, experience-based training in STEM/STEAM integration. While many pre-service kindergarten teachers acknowledged the importance of interdisciplinary learning, they expressed a noticeable gap between their theoretical knowledge and their ability to apply it in real classroom settings.

Several participants mentioned that their current academic coursework includes lectures and reading materials on STEM/STEAM concepts but lacks sufficient exposure to hands-on activities, real-life demonstrations, and classroom simulations.

"We know the names of the STEM fields and their goals, but we never practiced applying them with children in a real or even simulated

environment.”

— Participant #14

“Workshops or demo lessons would help us see how STEAM works in practice. It’s hard to imagine how to combine science, math, and art without examples.”

— Participant #27

This concern highlights a major weakness in teacher preparation programs—theory-heavy instruction without active modeling or guided practice. As a result, many participants reported feeling unconfident and underprepared to implement STEAM-based activities despite understanding their value.

Supporting Quantitative Data

The concern regarding practical preparedness is supported by responses to **Statement 8** in the Likert scale:

“I feel well-prepared to implement STEM/STEAM activities.”

Out of all participants:

Response Category	Percentage
Strongly Agree	30.9%
Agree	34.6%
Neutral	28.4%
Disagree	6%
Strongly Disagree	0%

While 65.5% of respondents felt at least somewhat prepared, a significant portion (28.4%) chose Neutral, indicating uncertainty, likely due to lack of applied experience. Moreover, 6% disagreed, further confirming that practical readiness remains a point of concern for many.

Table 1:

Key Issues Related to Practical Training Identified in Open-Ended Responses

Sub-Theme	Example Responses	Frequency
Lack of model lessons or demonstrations	“We need to observe actual lessons using STEAM in early childhood.”	High

Insufficient workshops	hands-on	“More workshops or labs would help us feel confident in designing activities.”	High
Unclear how to apply concepts practically		“It’s hard to apply what we learn without examples or real scenarios.”	Moderate
Desire for simulations	classroom	“We would benefit from trying out activities in a simulated environment.”	Moderate

Interpretation and Implications

The findings suggest that bridging the gap between theory and practice is essential for building future educators' confidence and competence. Participants are eager to learn, but they need structured opportunities for:

- Microteaching and peer feedback
- Observation of expert-led STEM/STEAM lessons
- Interactive workshops with practical examples
- Mentorship from experienced kindergarten teachers

Without such interventions, theoretical knowledge risks remaining abstract and underutilized.

Theme 2: Limited Access to Educational Resources

Another major theme that emerged from the participants' responses was the **lack of adequate resources**—both physical and digital—necessary for effective implementation of STEM/STEAM activities in kindergarten classrooms. While participants were motivated and open to applying interdisciplinary learning, many expressed frustration about the **absence of essential teaching tools**, including:

- Technological devices (e.g., tablets, smartboards)
- Robotics and coding kits
- Basic science tools (e.g., magnifiers, measuring instruments)
- Art supplies (e.g., clay, paint, recycled materials)

“Even if I plan a STEM activity, I can’t execute it without tools. We don’t have any resources beyond books and pencils.”
— Participant #11

“I’ve never seen a robot kit or a digital learning device in our school. It’s hard to apply STEM when you don’t even have basic materials.”
— Participant #36

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This shortage reflects systemic challenges in resource allocation, especially in underfunded schools or training environments. As STEM/STEAM relies heavily on hands-on and inquiry-based learning, the lack of resources makes these approaches difficult to implement meaningfully.

Supporting Quantitative Data

The perception of insufficient resources is strongly reflected in **Statement 10** from the Likert-scale data:

“My school provides sufficient resources for STEM/STEAM activities.”

Response Category	Percentage
Strongly Agree	0%
Agree	23.2%
Neutral	32.9%
Disagree	22%
Strongly Disagree	18.3%

Combined, 40.3% of participants disagreed or strongly disagreed, confirming the critical lack of resources. The 32.9% who responded neutrally may reflect students who have not yet experienced actual teaching contexts and thus cannot assess resource availability.

Table 2:

Resource-Related Challenges Cited in Responses

Sub-Theme	Example Responses	Frequency
Lack of basic STEM tools	“There are no science or math tools in our school.”	High
Absence of technology kits	“We need coding kits or simple robots, but we don’t have any.”	High
Inadequate art materials	“Even crayons and paper are limited—we can’t do STEAM properly.”	Moderate
No access to digital content	“We need apps or software, but there are no tablets or screens.”	Moderate

Interpretation and Implications

The responses reveal that material shortages pose a major barrier to translating theory into practice. Without the necessary equipment and supplies:

- Creative projects become limited
- Student engagement decreases
- The interdisciplinary nature of STEAM is undermined

These findings underline the need for:

- Investment from educational institutions
- Resource-sharing models
- Government or NGO-funded STEM/STEAM toolkits for early education

Future curriculum design must consider not only *what* to teach but also *how* educators can access the tools they need to deliver it effectively.

Theme 3: Time Constraints and Curriculum Pressure

A recurring concern among participants was the difficulty of integrating STEM/STEAM activities into the existing kindergarten schedule. Many felt that the daily curriculum is already overloaded, leaving little room for creative, interdisciplinary, or exploratory learning.

Participants noted that STEM/STEAM lessons often require:

- Additional preparation time
- More flexible scheduling
- Extended periods for experimentation and group work

These requirements often clash with the structured and time-bound nature of the early childhood curriculum.

“There’s not enough time in the day to include STEAM. We are already struggling to finish the regular subjects.”

— Participant #22

“Planning a STEM activity takes time, and in reality, we only get a few minutes per lesson.”

— Participant #5

The time constraints reflect **system-level issues**, where creativity and innovation are often sacrificed in favor of completing pre-defined academic objectives.

Supporting Quantitative Data

Two Likert statements relate closely to this theme:

Statement 11: “Implementing STEM/STEAM requires significant preparation time

Response Category	Percentage
Strongly Agree	18.5%
Agree	34.6%
Neutral	27.2%
Disagree	14.8%
Strongly Disagree	4.9%

Over 53% of respondents agreed, clearly indicating that time investment is a perceived barrier.

Statement 12: “I face challenges balancing STEM/STEAM with other subjects.”

Response Category	Percentage
Strongly Agree	7.7%
Agree	20.5%
Neutral	38.5%
Disagree	20.5%
Strongly Disagree	12.8%

While agreement is lower than for the previous statement, **over 28%** acknowledged difficulties in balancing STEM/STEAM with other academic demands. A significant **38.5% neutral** response may reflect uncertainty or lack of real teaching experience.

Table 3:

Time-Related Challenges Identified

Sub-Theme	Example Responses	Frequency
Overloaded curriculum	“We already have too much to cover in the day.”	High
Lack of time for planning	“STEAM activities need extra planning time I don’t usually have.”	High

Short activity periods		“Most activities must be done in 20 minutes or less, which is limiting.”	Moderate
Conflict with standardized pacing		“It’s hard to keep up with the curriculum and do STEAM at the same time.”	Moderate

Interpretation and Implications

Time limitations emerge as both a logistical and pedagogical obstacle to effective STEM/STEAM integration. Without adjustments in:

- Daily scheduling
- Curriculum pacing guides
- Lesson length flexibility

Teachers may remain unable to adopt creative and interdisciplinary approaches, regardless of motivation or training.

To mitigate this, institutions should:

- Provide scheduled STEAM blocks
- Allow teachers autonomy to integrate subjects
- Offer ready-made activity templates to reduce planning time

This will not only alleviate teacher stress but also encourage meaningful, inquiry-based learning.

Theme 4: Positive Perception of Technology and Innovation

Despite the reported challenges related to resources, time, and training, participants expressed a **remarkably positive attitude toward the use of technology and AI** in early childhood education. They believed that digital tools could **enhance engagement, personalize learning**, and offer creative ways to deliver STEM/STEAM content.

Several participants highlighted that children respond enthusiastically to interactive tools such as:

- Tablets and educational apps
- Smartboards
- Simple coding games
- AI-based learning platforms

Participants also recognized that digital tools can **compensate for the lack of traditional materials** by offering virtual labs, drawing platforms, and simulation-based storytelling.

“Children love using technology. If we had tablets or smartboards, it would be easier to teach science or math in fun ways.”

— Participant #8

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“AI can help adapt activities to the child’s level. I think it’s the future of education, especially in STEM.”

— Participant #29

This theme reflects a forward-thinking mindset and a strong willingness among future teachers to adopt innovation, provided that infrastructure and training are in place.

Supporting Quantitative Data

This theme aligns closely with **Statement 5:**

“Technology in STEM/STEAM improves engagement in learning.”

Response Category	Percentage
Strongly Agree	14.5%
Agree	28.9%
Neutral	27.7%
Disagree	12%
Strongly Disagree	16.9%

While a total of 43.4% agreed that technology enhances engagement, a substantial 28.9% expressed disagreement, likely due to their limited direct exposure to tech-based teaching. The large neutral group (27.7%) suggests uncertainty—again reinforcing the need for more practical digital integration training.

Table 4:

Technology-Related Opportunities and Perceptions

Sub-Theme	Example Responses	Frequency
Children enjoy using technology	“They are always excited when we use screens or tablets.”	High
AI can personalize learning	“AI tools can adjust the activity to each child’s level.”	Moderate
Lack of devices, but high interest	“We don’t have them, but I really want to use technology in class.”	High
Belief in future relevance	“Tech is the future of teaching—it helps connect with kids better.”	Moderate

Interpretation and Implications

Participants' responses point to strong enthusiasm for integrating educational technology into STEM/STEAM, but this enthusiasm is often not matched by actual experience or access.

Implications include:

- The need to incorporate digital literacy into teacher training.
- Investing in classroom tech infrastructure.
- Developing guidelines for age-appropriate tech use in early childhood.

This optimism presents an opportunity for educational leaders: if equipped with the right tools and training, these educators are ready to innovate and help lead a new generation of tech-enhanced early learning.

5. Chapter Five: Discussion, Conclusions, and Recommendations

6. 5.1 Introduction

This section discusses the main findings of the study in light of the research questions and relevant literature. The goal is to interpret the significance of the quantitative and qualitative results and to understand how they reflect the preparedness, perceptions, and needs of future kindergarten educators regarding the integration of STEM/STEAM in early childhood education.

1. Perceptions Toward STEM/STEAM Are Generally Positive

The findings revealed that participants hold a favorable attitude toward STEM/STEAM integration, particularly in terms of its potential to enhance creativity, problem-solving, teamwork, and future academic success. For instance, over 79% agreed that STEM/STEAM promotes children's creativity (Statement 1), while 75.9% believed it supports future academic achievement (Statement 15). These results align with research by Anderson (2018) and Bequette & Bequette (2012), which emphasized STEAM's role in developing both cognitive and creative capacities.

The qualitative responses reinforced this enthusiasm, with participants expressing interest in making learning more engaging and enjoyable through hands-on, interdisciplinary approaches.

2. A Clear Need for Practical Training

Despite the positive perceptions, a major theme that emerged was the lack of practical training. Although 65.5% of participants felt prepared (Statement 8), 28.4% expressed neutrality, and many open-ended responses indicated a gap between theory and real classroom application. This reflects findings from Park & Park (2019) and Wilson & Lee (2019), who argued that teacher training programs often fall short in preparing educators for interdisciplinary, play-based STEM/STEAM teaching.

Participants specifically requested:

- More workshops
- Demo lessons
- Classroom simulations

This suggests that strengthening teacher preparation with experience-based learning is critical for successful implementation.

3. Resource Shortages Remain a Structural Barrier

The study found significant concern regarding the availability of materials and infrastructure. Only 23.2% agreed that their school provides sufficient resources (Statement 10), while over 40.3% disagreed. Qualitative responses echoed this, with many participants mentioning the lack of essential tools such as robotics kits, science equipment, and even basic art supplies.

This barrier, widely documented in literature (Smith & Karr, 2020; McClure et al., 2017), is particularly impactful in early childhood education where hands-on exploration is fundamental. Without materials, even the most enthusiastic and well-trained teachers may be unable to deliver effective STEM/STEAM experiences.

4. Time Constraints and Curriculum Pressure Are Significant Challenges

Participants also reported difficulty balancing STEM/STEAM with existing curriculum demands. Over 53% agreed that such activities require significant preparation time (Statement 11), while 28.2% acknowledged difficulty balancing them with other subjects (Statement 12). In open-ended responses, many participants described a lack of

time for planning and execution, due to rigid schedules and academic pressure.

These findings support prior studies (Moore et al., 2014; Mustafa & Rahman, 2018), which warned that overly structured educational systems can hinder innovation in early childhood settings. To overcome this, schools need to allocate dedicated time blocks and reduce curriculum overload.

5. Openness to Technology and Innovation Is High, But Not Fully Utilized

While only 43.4% agreed that technology improves engagement (Statement 5), qualitative responses painted a more optimistic picture. Participants expressed enthusiasm for integrating AI, apps, and digital tools to personalize learning and enhance student interest. However, the neutral and disagreeing responses suggest that many lack hands-on experience or access to classroom technology.

This echoes Yelland (2018) and McClure et al. (2017), who argue that while early childhood educators are willing to innovate, they need training and resources to do so effectively.

Summary of the Discussion

- Future kindergarten educators are **motivated and receptive** to STEM/STEAM integration.
- However, practical barriers such as **insufficient training, lack of resources, and time constraints** significantly hinder implementation.
- There is a clear need for structural support—through improved teacher preparation, investment in classroom materials, and more flexible scheduling—to ensure that the benefits of STEM/STEAM are realized in practice.

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Appendix

Survey Title:

"The Effectiveness of Integrating STEM/STEAM Concepts into Kindergarten Curriculum"

Survey Introduction:

Hello,

This survey aims to gather your opinions on the effectiveness of applying STEM (Science, Technology, Engineering, Mathematics) or STEAM (with the addition of Arts) concepts in the kindergarten curriculum. Your responses will help us improve the curriculum and teaching methods.

Thank you for your time and cooperation!

Main Sections of the Survey

Section 1: Demographic Information

(General information about the respondents)

1. Age

- Under 25 years
- 25-30 years
- 31-40 years
- Over 40 years

2. Educational Level

- Bachelor's Degree
- Educational Diploma
- Master's Degree
- PhD

3. Years of Teaching Experience

- Less than 3 years
- 3-5 years
- 6-10 years
- More than 10 years

Questionnaire: Evaluating the Integration of STEAM (Science, Technology, Engineering, Art, and Mathematics) in Early Childhood Education

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. Integrating STEM/STEAM enhances children's creativity.	☐	☐	☐	☐	☐
2. STEM/STEAM activities improve children's motor skills.	☐	☐	☐	☐	☐
3. Incorporating arts in STEAM enhances academic performance.	☐	☐	☐	☐	☐
4. STEM/STEAM fosters problem-solving skills in children.	☐	☐	☐	☐	☐
5. Technology in STEM/STEAM improves engagement in learning.	☐	☐	☐	☐	☐
6. Applying STEM/STEAM develops teamwork and communication skills.	☐	☐	☐	☐	☐
7. STEM/STEAM activities are enjoyable for children.	☐	☐	☐	☐	☐
8. I feel well-prepared to implement STEM/STEAM activities.	☐	☐	☐	☐	☐
9. Additional training is needed for effective STEM/STEAM	☐	☐	☐	☐	☐

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integration.

10. My school provides sufficient resources for STEM/STEAM activities.	☐	☐	☐	☐	☐
11. Implementing STEM/STEAM requires significant preparation time.	☐	☐	☐	☐	☐
12. I face challenges balancing STEM/STEAM with other subjects.	☐	☐	☐	☐	☐
13. STEM/STEAM activities encourage independent learning.	☐	☐	☐	☐	☐
14. Parents support the integration of STEM/STEAM concepts.	☐	☐	☐	☐	☐
15. STEM/STEAM helps prepare children for future academic success.	☐	☐	☐	☐	☐

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Table: Likert Scale Results for the 15-Question Questionnaire
Below is the requested table summarizing the results of the 15 Likert-scale questions based on the provided percentages:

Question	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
1. Integrating STEM/STEAM enhances children's creativity.	36.1%	43.4%	16.9%	3.6%	0%
2. STEM/STEAM activities improve children's motor skills.	38.6%	33.7%	19.3%	6%	2.4%
3. Incorporating arts in STEAM enhances academic performance.	16.9%	13.3%	32.5%	27.7%	9.6%
4. STEM/STEAM fosters problem-solving skills in children.	28%	26.8%	34.1%	9.8%	1.2%
5. Technology in STEM/STEAM improves engagement in learning.	14.5%	28.9%	27.7%	12%	16.9%
6. Applying STEM/STEAM develops teamwork and communication skills.	34.6%	32.1%	23.5%	8.6%	1.2%
7. STEM/STEAM activities are enjoyable for children.	34.6%	34.6%	23.5%	6%	1.2%
8. I feel well-prepared to implement STEM/STEAM activities.	30.9%	34.6%	28.4%	6%	0%
9. Additional training is needed for effective STEM/STEAM integration.	25.9%	32.1%	32.1%	8.6%	11.1%
10. My school provides sufficient resources for STEM/STEAM activities.	0%	23.2%	32.9%	22%	18.3%

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11. Implementing STEM/STEAM requires significant preparation time.	18.5%	34.6%	27.2%	14.8%	4.9%
12. I face challenges balancing STEM/STEAM with other subjects.	7.7%	20.5%	38.5%	20.5%	12.8%
13. STEM/STEAM activities encourage independent learning.	8.5%	29.3%	31.7%	20.7%	9.8%
14. Parents support the integration of STEM/STEAM concepts.	22%	28%	41.5%	7.3%	1.2%
15. STEM/STEAM helps prepare children for future academic success.	37.3%	38.6%	19.3%	3.6%	1.2%

Summary of Results:

- **Highest Agreement:**
 - *STEM/STEAM enhances creativity* (79.5% combined agreement).
 - *STEM/STEAM helps prepare children for future academic success* (75.9% combined agreement).
- **Key Challenges:**
 - *Lack of resources* in schools (40.3% disagree/strongly disagree).
 - *Need for additional training* (58% agree/strongly agree).

This table provides a clear overview of the **distribution of responses** and highlights key areas of strength, as well as challenges in **STEAM education integration**.