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STEM EDUCATION IN EARLY YEARS: PRACTICES AND PROSPECTS IN SHARJAH SCHOOLS

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Abstract
This study explores the current practices, challenges, and prospects of integrating STEM (Science, Technology, Engineering, and Mathematics) education in early childhood classrooms in Sharjah, United Arab Emirates (UAE). Employing a quantitative descriptive design, data were collected from a sample of 350 early years educators using structured questionnaires. The findings reveal that while STEM implementation is gradually gaining momentum, it remains uneven across school types and curricula. Teachers in private schools and those following international curricula demonstrated higher levels of STEM integration compared to their counterparts in public schools. A significant factor influencing implementation was educator preparedness, which strongly correlated with access to STEM-specific professional development. Major challenges identified include a lack of training opportunities, insufficient resources, and restrictive curricula. Despite these barriers, teacher enthusiasm and institutional efforts suggest promising prospects for future STEM growth. The study concludes that enhancing teacher training, aligning curricula, and investing in infrastructure are essential for successful early STEM education, aligning with the UAE's vision for innovation and knowledge-based development.

INTRODUCTION

In the rapidly evolving landscape of global education, Science, Technology, Engineering, and Mathematics (STEM) have emerged as central pillars in preparing the next generation for a knowledge-driven economy. Recognizing the transformative power of early exposure to STEM concepts, educational policymakers worldwide have begun integrating STEM principles into foundational learning stages. This is especially true in the United Arab Emirates (UAE), where significant efforts have been initiated to embed STEM education within early childhood programs to foster a future-ready, innovation-driven generation (Aldhilan et al., 2024). The UAE's strategic vision, anchored in documents such as the National Innovation Strategy and Vision 2031, places STEM education at the heart of its economic and human capital development agenda. Central to this vision is the realization that instilling STEM competencies during the formative years of education is vital for cultivating curiosity, problem-solving abilities, and scientific literacy (Al Murshidi, 2019). Early childhood, characterized by rapid cognitive development and an innate tendency for exploration, provides a critical window of opportunity to establish a solid STEM foundation (Gallagher, 2019). The introduction of STEM in early years is more than just an academic shift; it represents a pedagogical transformation. Traditionally, early childhood education in the UAE was centered around language acquisition, social skills, and general cognitive development. However, recent reforms have pushed for the inclusion of hands-on, inquiry-based STEM experiences, supported by modern curricula and teacher training initiatives (Dickson et al., 2019). For instance, the Ministry of Education has launched initiatives to equip kindergarten classrooms with age-appropriate technology and manipulatives, fostering play-based learning environments that support engineering and computational thinking (Rafiq et al., 2024).

Despite these efforts, the implementation of early STEM education in UAE schools faces multifaceted challenges. These range from limited availability of qualified STEM educators in early childhood settings to curricular fragmentation and unequal access across public and private institutions (Forawi & Al Quraan, 2022). Furthermore, research indicates disparities in students' STEM engagement due to socio-cultural factors, gender biases, and inconsistencies in teacher preparedness (Lee et al., 2022). These issues underscore the importance of a holistic, culturally responsive, and inclusive approach to STEM integration in the early years.

Nevertheless, the prospects are promising. Studies have shown that early exposure to STEM increases children's future interest in science and technology careers and boosts academic achievement across disciplines (ElSayary, 2018). In response, UAE universities and government bodies are collaborating to develop specialized teacher training programs and community-based STEM enrichment activities (Chaya, 2024). Additionally, partnerships with international STEM bodies and private organizations have brought innovative labs, coding bootcamps, and robotics initiatives into UAE classrooms, even at the kindergarten level. As the UAE continues to transition from an oil-based to a knowledge-based economy, the emphasis on early STEM education may likely become more pronounced. This article explores the current practices in early STEM education across UAE schools, evaluates the systemic challenges involved, and identifies strategic opportunities for optimizing early learning environments to meet national development goals.

Background of Study

The integration of STEM (Science, Technology, Engineering, and Mathematics) education into early childhood learning environments has garnered global attention over the past two decades. As technological advancement accelerates and economies increasingly demand STEM-related skills, the imperative to begin STEM learning early, during the most cognitively malleable years, has become more evident (Lee et al., 2022). The early years are not only critical for foundational skill development but also for nurturing curiosity, problem-solving, and creative thinking, traits that underpin STEM disciplines (Gallagher, 2019). For countries like the United Arab Emirates (UAE), this early investment in STEM education is deeply aligned with broader national objectives centered on innovation, diversification, and global competitiveness. The UAE's Vision 2021 and subsequent strategies, such as the Centennial 2071 Plan, emphasize transitioning from an oil-based economy to a knowledge-based, innovation-driven society. Education is at the heart of this transformation, and STEM subjects are recognized as crucial drivers of future national progress. Within this policy context, early childhood education has become a strategic area for reform. The government prioritized improving science and math literacy at all levels of schooling, with early education receiving growing attention for its role in shaping lifelong learning pathways (Al-Gindy, 2024).

Despite ambitious policies and investment, early STEM education in UAE schools is still in its developmental phase. Research indicates that while many initiatives have been launched, such as STEM-friendly curricula, technology labs in kindergartens, and inquiry-based learning approaches, implementation remains inconsistent, particularly between public and private schools and across different Emirates (Al Murshidi, 2019; Forawi & Al Quraan, 2022). A lack of trained early childhood educators proficient in STEM methodologies further complicates the landscape. Many teachers are unprepared to integrate hands-on, interdisciplinary learning or to leverage digital tools in age-appropriate ways (Chaya, 2024; Rafiq et al., 2024). Another challenge lies in culturally adapting global STEM models to fit the UAE context. As ElSayary (2018) notes, imported frameworks may fail to align with the linguistic, religious, and socio-cultural characteristics of the Emirati population. This dissonance may affect both educator readiness and student engagement. Furthermore, societal perceptions of STEM, particularly around gender roles, can influence how early learners engage with STEM topics, especially girls (Houjeir et al., 2019). Yet, the opportunities are equally compelling. Studies show that children exposed to STEM during their early years are more likely to pursue related careers and demonstrate higher academic performance in later schooling (Kayan-Fadlelmula et al., 2022). UAE universities, educational councils, and international collaborators have begun to design programs that offer mentorship, resources, and curriculum support for early childhood STEM initiatives. The shift toward experiential learning, the use of AI-based education tools, and coding bootcamps in primary schools are indicative of this forward-thinking approach.

This study thus emerges from a dynamic intersection of policy ambition, educational reform, and pedagogical innovation. It seeks to explore the current practices, barriers, and opportunities related to STEM education in the early years within UAE schools. By examining how STEM is embedded in early learning environments and what factors influence its success, this research aims to contribute to the growing body of knowledge on educational transformation in the Arab Gulf region.

Problem Statement

Despite national policies emphasizing the importance of STEM education in the United Arab Emirates (UAE), its integration into early childhood education remains limited, uneven, and insufficiently studied. While early STEM exposure is known to foster long-term academic and professional success, many UAE schools, particularly in the early years, lack structured curricula, qualified educators, and culturally contextualized pedagogical models for effective STEM instruction. This is compounded by disparities between public and private sectors, urban and rural regions, and gender-based engagement levels. Although the UAE's strategic vision promotes innovation through education, there is a lack of empirical evidence about how STEM is currently implemented in early learning environments and how this aligns with national goals. The absence of a consolidated framework and evaluative studies makes it difficult for policymakers, educators, and curriculum designers to assess the effectiveness of current practices or identify actionable improvements.

Research Gap

Existing literature on STEM education in the UAE predominantly focuses on higher education and secondary schooling, with minimal attention to early childhood education. Very few studies provide systematic data on curriculum design, teacher readiness, and classroom practices specific to the early years. Moreover, the available research seldom explores the cultural and institutional factors that influence STEM implementation at the foundational level, leaving a critical knowledge gap in aligning educational practice with policy ambitions in the UAE context.

Research Objectives

1. To explore the current implementation of STEM education in early years classrooms in UAE schools.
2. To assess the preparedness and professional development of early childhood educators in delivering STEM education.
3. To identify key challenges faced by schools in integrating STEM education at the early childhood level.

Research Questions

1. How is STEM education currently implemented in early years classrooms across UAE schools?
2. What is the level of preparedness of early childhood educators in teaching STEM in the UAE?
3. What are the main challenges schools encounter when integrating STEM education in early childhood?

Literature Review

STEM education, an interdisciplinary approach integrating Science, Technology, Engineering, and Mathematics, has gained global momentum as nations seek to cultivate critical thinkers and innovators from an early age. According to UNESCO (2017), early exposure to STEM nurtures inquiry, creativity, and cognitive flexibility, all of which are vital for 21st-century learning. In the context of the United Arab Emirates (UAE), the urgency for STEM adoption is reinforced by national strategies like Vision 2021 and Centennial 2071, which emphasize knowledge-driven development.

The early years are foundational for brain development, and research suggests that children as young as three can grasp complex scientific and mathematical concepts when taught through play-based, inquiry-driven models (Gallagher, 2019). The integration of STEM during these years fosters curiosity, improves problem-solving skills, and enhances school readiness (Kayan-Fadlelmula et al., 2022). However, while this global understanding has influenced curricular reforms, the UAE's early childhood education system has only recently begun integrating STEM in a structured manner. The UAE Ministry of Education has initiated curriculum updates and invested in technology-enhanced classrooms to promote STEM skills. Dickson et al. (2019) observe that early learning frameworks in some Emirates now incorporate robotics kits, coding tools, and science exploration activities. Despite these promising developments, implementation varies greatly across school types and regions. Public schools often lag behind private institutions in resources and teacher training (Chaya, 2024). One of the most cited challenges is the lack of educator readiness. Many early years teachers have limited training in STEM pedagogy and lack confidence in applying interdisciplinary methods (Forawi & Al Quraan, 2022; Rafiq et al., 2023). Al-Gindy (2024) emphasizes that while imported curricula may be rich in content, they often lack cultural adaptability, creating disconnects in both teacher delivery and student engagement. Multiple studies cite the absence of a unified national STEM curriculum for early childhood, insufficient teacher training programs, and limited parental awareness as key barriers (Lee et al., 2022; ElSayary, 2018). Cultural attitudes, particularly those influenced by gender norms, also affect how STEM is perceived and taught in early childhood classrooms. Houjeir et al. (2019) found that girls in some Emirati households were less encouraged to pursue science and technology subjects at an early age. Despite challenges, UAE schools have begun to experiment with innovative STEM practices. Partnerships between schools and local universities have led to community workshops and early science fairs (Dickson et al., 2024). Moreover, the growing use of educational technologies offers scalable tools for interactive STEM learning. As awareness increases, the UAE has the potential to become a regional leader in early childhood STEM education, provided that implementation becomes more systematic and inclusive.

Conceptual Framework

The conceptual framework of this study, as shown in the Figure, provides a structured lens through which the implementation of STEM education in early years across UAE schools is examined. It connects the research objectives, such as assessing educator preparedness and identifying classroom challenges, to clearly defined research questions. This framework is grounded in constructivist learning theory, which emphasizes experiential, hands-on learning as essential for early childhood development. It helps visualize the logical relationship between the study's goals and inquiry paths while ensuring coherence between policy context and classroom practices. Ultimately, the framework serves as a guide for data collection, interpretation, and the formulation of actionable educational strategies.

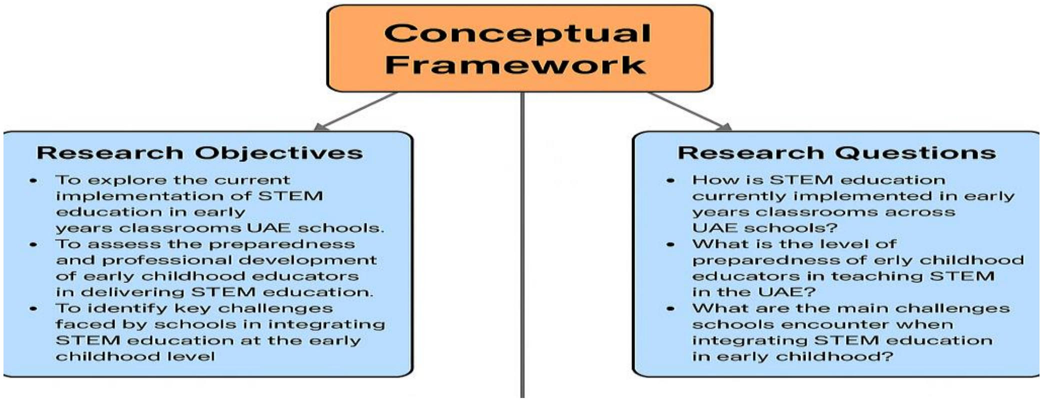

Figure 1: Conceptual Framework

Methodology and Procedure

Research Design and Method

This study adopts a quantitative research design to examine the current practices, challenges, and prospects of STEM education in early childhood classrooms in Sharjah, UAE. A descriptive survey method was selected to allow for a broad, statistical understanding of teacher perceptions and experiences with STEM integration (Creswell, 2014). This approach is appropriate for educational research when the aim is to gather numerical data to identify trends, measure frequencies, and make generalizations across a defined population (Gay, Mills, & Airasian, 2012). The design allows for standardized data collection from a large sample of teachers, ensuring reliability and validity of the results.

Population and Sampling

The target population for this study consists of all early childhood educators currently implementing STEM-related instruction in both public and private schools in Sharjah, UAE. Given the emphasis on early years (ages 3–6), this includes teachers in kindergartens and foundation stages following curricula such as the UAE Ministry of Education framework, British EYFS, or IB PYP, as long as they incorporate STEM activities.

A stratified random sampling technique was employed to ensure representation across different school types (public vs. private), curriculum models, and geographical zones within Sharjah. The sampling frame was developed using official lists of schools registered under the Sharjah Private Education Authority (SPEA) and the Ministry of Education. From this pool, schools were contacted, and eligible teachers were invited to participate. A final sample of 350 teachers was selected to represent this population, as shown in Table 1. This sample size was deemed statistically adequate based on Cochran's formula for determining minimum sample size in large populations (Cochran, 1977).

Table 1: Proportional Stratified Sampling of Early Childhood Teachers in Sharjah

Nursery Type	Number of Nurseries	% of Total Nurseries	Sample Size Allocation	Approx. Teachers per Nursery Sampled
Public Nurseries	39	52.7%	185	~4–5 teachers
Private Nurseries	35	47.3%	165	~4–5 teachers
Total	**74**	**100%**	**350**	

Data Collection and Analysis

Data was collected using a structured questionnaire designed by the researcher and validated through a pilot study with 30 early years teachers not included in the final sample. The instrument consisted of closed-ended Likert-scale items that assessed four major areas: (1) current STEM teaching practices, (2) teacher preparedness and training, (3) institutional support and infrastructure, and (4) perceived challenges and future prospects. The questionnaire was distributed physically and via secure online forms to participating schools with the assistance of school coordinators.

For analysis, descriptive statistics (mean, standard deviation, frequency, percentage) were used to summarize the responses. Inferential statistics, such as Chi-square tests and ANOVA, were applied to explore significant relationships between variables such as school type, curriculum, and years of teaching experience. Data was analyzed using SPSS version 26, and statistical significance was established at $p < 0.05$ (Field, 2018).

Ethical Considerations

This study strictly adhered to established ethical standards in educational research. Approval was obtained from the institutional research ethics committee and the relevant Sharjah education authorities. Participants were informed about the purpose of the study, their right to withdraw at any time, and the confidentiality of their responses. Written informed consent was secured before participation. No personal identifiers were collected, and all data were stored securely in password-protected files (BERA, 2018; Creswell & Creswell, 2018).

Data Analysis and Results

The data analysis reveals important insights into STEM implementation in early childhood classrooms in Sharjah. Descriptive statistics show moderate use of inquiry-based learning and technology, with less emphasis on cross-disciplinary planning. Chi-square and ANOVA results indicate significant differences in STEM practices across school types and curricula, with private and IB PYP schools demonstrating higher engagement. Teacher preparedness is significantly influenced by training, as shown by the t-test results. Key challenges include lack of training, limited resources, and curriculum rigidity, with Kruskal-Wallis results confirming variation in challenge severity across curricula.

Table 2: Descriptive Statistics for STEM Implementation (RQ1)

Implementation Indicator	Mean	SD	% Agree/Strongly Agree
Use of inquiry-based learning	3.89	0.78	72.5%
Availability of STEM materials	3.22	1.03	54.3%
Integration of technology (tablets, kits)	3.56	0.91	61.1%
Cross-disciplinary planning	3.10	1.02	49.8%

Table 2 shows that inquiry-based learning is the most widely implemented STEM practice in early years classrooms, with the highest mean score (3.89) and 72.5% of teachers agreeing. Integration of technology follows moderately (mean = 3.56), while the availability of STEM materials (3.22) and cross-disciplinary planning (3.10) are less commonly reported, indicating areas needing improvement.

Table 3: Chi-Square Test – STEM Implementation by School Type

Practice	School Type	Yes (n)	No (n)	Chi-square (χ^2)	p-value
Use of robotics kits	Public	58	127	12.46	0.0004
	Private	94	71		
Teacher collaboration on STEM	Public	76	109	3.78	0.052

Practice	School Type	Yes (n)	No (n)	Chi-square (χ²)	p-value
	Private	89	76		

Interpretation: Significant difference found in use of robotics kits across school types ($p < 0.05$)

Table 3 shows that there is a statistically significant difference in the use of robotics kits between public and private schools ($p = 0.0004$), with private schools demonstrating higher implementation. However, no significant difference was found in teacher collaboration on STEM activities across school types ($p = 0.052$), indicating relatively similar levels of collaboration between public and private institutions.

Table 4: ANOVA – STEM Implementation by Curriculum Type (RQ1)

Curriculum Type	N	Mean Implementation Score	SD	F	p-value
MOE	120	3.45	0.91	6.37	0.002
British EYFS	130	3.78	0.81		
IB PYP	100	4.01	0.74		

Conclusion: Significant difference between curricula in implementation levels ($p < 0.05$)

Table 4 shows that there is a statistically significant difference in STEM implementation levels across curriculum types ($p = 0.002$). Teachers following the IB PYP curriculum reported the highest mean implementation score (4.01), followed by British EYFS (3.78), while MOE schools had the lowest (3.45), indicating stronger integration of STEM in international curricula compared to the national one, as shown in Figure 2 below.

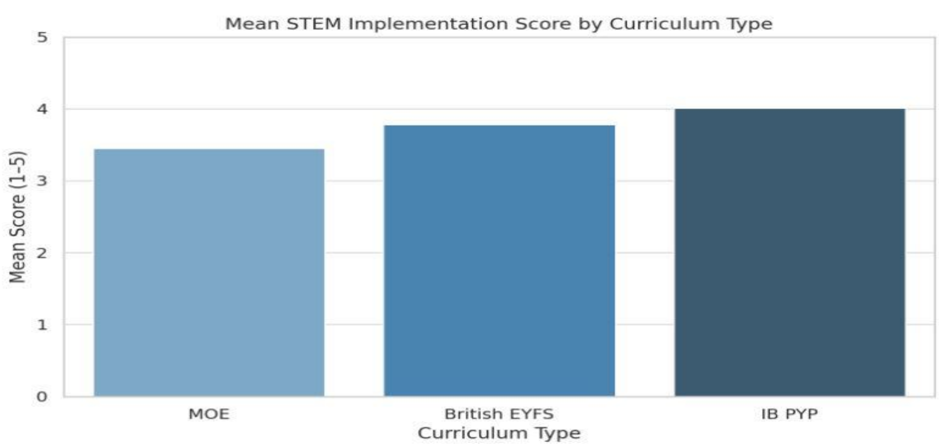

Figure 2: STEM Implementation Scores by Curriculum Type

Table 5: Teacher Preparedness (RQ2) – Descriptive Statistics

Preparedness Component	Mean	SD	% Reporting 'High Preparedness'
Knowledge of STEM pedagogy	3.66	0.85	59.1%
Confidence using STEM tools	3.42	0.91	52.4%
Training received in STEM	2.89	1.11	36.7%

Table 5 shows that teachers reported the highest level of preparedness in terms of knowledge of STEM pedagogy (mean = 3.66), with 59.1% indicating high preparedness. Confidence in using STEM tools was moderate (mean =

3.42), while training received in STEM scored lowest (mean = 2.89), with only 36.7% reporting high preparedness, highlighting a critical gap in professional development.

Table 6: t-Test – Preparedness by Training Received

Group	N	Mean Preparedness	SD	t-value	p-value
Received Training	160	3.88	0.72	5.29	0.000
No Training	190	3.22	0.89		

Interpretation: Teachers who received training are significantly more prepared than those who did not ($p < 0.01$)

Table 6 shows that teachers who received STEM training reported significantly higher preparedness (mean = 3.88) compared to those without training (mean = 3.22), with a *t*-value of 5.29 and a *p*-value of 0.000. This indicates a strong positive impact of professional training on teacher readiness to implement STEM in early years classrooms.

Table 7: Top Challenges in STEM Implementation (RQ3)

Challenge	% Reporting Often/Always	Mean Severity (1–5)
Lack of training opportunities	71.2%	4.08
Limited STEM materials	64.6%	3.87
Curriculum rigidity	58.1%	3.55
Time constraints	52.4%	3.48

Table 7 shows that the most frequently reported challenge in implementing STEM education was the lack of training opportunities (71.2%, mean severity = 4.08), followed by limited STEM materials (64.6%, mean = 3.87). Curriculum rigidity and time constraints were also common issues, though reported slightly less often, indicating that both systemic and logistical factors hinder effective STEM integration in early childhood settings, as shown in Figure 3.

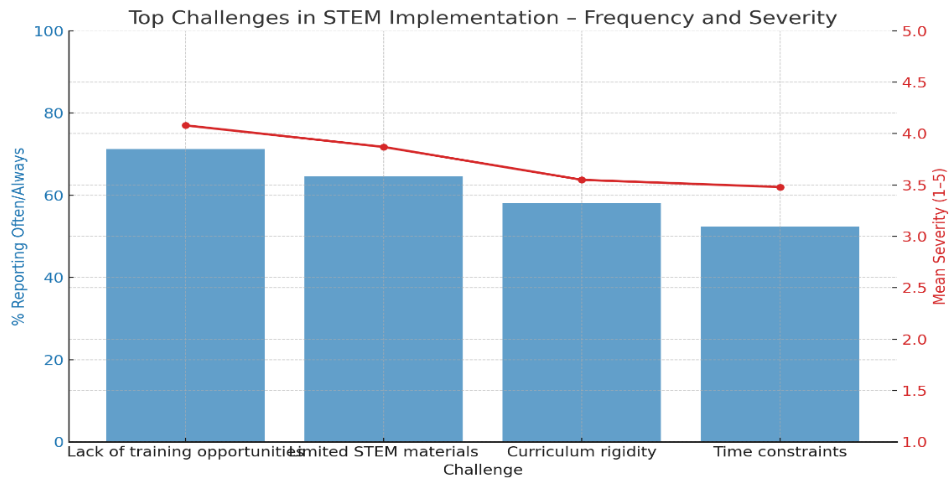

Figure 3: challenges in STEM implementation

Table 8: Kruskal-Wallis Test – Severity of Challenges by Curriculum

Challenge	χ^2	df	p-value
Lack of training opportunities	8.92	2	0.012
Curriculum rigidity	4.67	2	0.097

A significant difference in training challenge severity exists across curriculum types.

Table 8 shows that there is a statistically significant difference in the severity of the challenge related to lack of training opportunities across different curriculum types (p = 0.012). However, the perceived severity of curriculum rigidity does not differ significantly among the curriculum groups (p = 0.097), suggesting that training access varies more than curricular flexibility.

Discussion

The findings of this study reveal significant insights into the current state, preparedness, and challenges associated with implementing STEM education in early childhood classrooms in Sharjah, UAE. As the UAE positions itself as a leader in innovation and 21st-century learning, the foundational role of early years STEM education becomes increasingly pivotal.

The results indicate a moderate but uneven implementation of STEM practices across early years settings. Teachers reported frequent use of inquiry-based learning and technology integration, particularly in private institutions and schools following international curricula such as the British EYFS and IB PYP. These findings align with Gallagher (2019), who emphasized that well-resourced schools with global curriculum models tend to adopt STEM principles more fluidly. However, public schools, particularly those strictly following the MOE curriculum, showed lower engagement with hands-on tools like robotics kits (Aldhilan et al., 2025). This reflects previous research by Al Murshidi (2019), which found that a lack of infrastructure and rigid curriculum guidelines hinder practical STEM applications in public schools. Teacher preparedness emerged as a critical factor influencing successful STEM integration. The data revealed a clear gap in training and confidence levels between teachers who received STEM-specific professional development and those who did not. Those with training scored significantly higher in preparedness metrics, mirroring conclusions by Chaya (2024), who highlighted the strong correlation between teacher training and effective STEM delivery. Many respondents noted a lack of access to formal STEM training during their professional development, which resonates with findings by Forawi and Al Quraan (2022), who argue that early years educators in the UAE often lack subject-specific support and interdisciplinary teaching strategies (Afzal et al., 2022).

Institutional and curricular challenges further compounded implementation difficulties. The most frequently reported issues included insufficient materials, limited planning time, and unclear curriculum frameworks for STEM. These obstacles are consistent with Lee et al. (2022), who noted that even in countries with strong STEM policies, early years classrooms often lack clear guidance and resource allocation. The lack of training opportunities, identified as the most severe challenge, highlights a structural issue that must be addressed at the policy level. Gallagher (2019) suggests that without continuous teacher training and localized instructional materials, early STEM efforts risk being superficial or tokenistic. Despite these challenges, the prospects for STEM in early education remain promising. Many teachers expressed enthusiasm for STEM learning, especially when they had access to peer collaboration and innovative tools. This suggests a strong foundation on which to build capacity. Partnerships with local universities and education councils, such as those observed by Dickson et al. (2019), could play a transformative role in offering structured training, mentoring, and hands-on support. While the UAE has made commendable progress in prioritizing STEM education, particularly through its national vision documents, there is a pressing need to institutionalize STEM training for early childhood educators, develop age-appropriate curricula, and ensure equitable access to resources. Addressing these gaps may help align early years STEM practices with national goals and unlock the full potential of young learners in shaping a knowledge-based future.

Conclusion

This research confirms that while the UAE has laid policy groundwork for STEM education, its application in early years classrooms remains fragmented. Implementation varies by school type, curriculum, and teacher readiness, with private institutions generally leading in STEM integration. The preparedness of teachers emerged as a crucial determinant of success, underlining the urgent need for targeted professional development programs. The most pressing challenges identified, lack of training, limited resources, and rigid curricular structures, must be addressed to enable effective STEM practices. Encouragingly, the enthusiasm of early years educators presents a valuable asset, suggesting that with appropriate support, STEM in early childhood can evolve into a robust contributor to the UAE's vision of a knowledge-based economy.

Recommendations

Based on the findings of this study, several key recommendations are proposed to enhance the implementation and impact of STEM education in early childhood settings across Sharjah, UAE. First and foremost, there is a critical need to develop and mandate national STEM-focused professional development programs tailored for early years educators. These programs should be continuous, practical, and aligned with pedagogical principles suitable for young learners. Integrating explicit STEM objectives into early childhood curricula is equally important, particularly within MOE-regulated schools, where curriculum rigidity currently limits interdisciplinary instruction. Ensuring that STEM content is developmentally appropriate and culturally relevant may promote deeper engagement and consistency across different school types and curricula.

Additionally, increased investment in infrastructure and teaching resources is essential. Schools, especially those in the public sector, should be equipped with age-appropriate STEM kits, digital tools, and manipulatives that allow young learners to explore science, technology, engineering, and mathematics through hands-on, play-based experiences. To support this, the UAE Ministry of Education and local educational authorities could collaborate with universities and private institutions to establish school-university partnerships. These collaborations can facilitate STEM fairs, coding clubs, workshops, and mentoring initiatives that build both teacher capacity and student enthusiasm.

It is also recommended that a formal monitoring and evaluation framework be introduced to assess STEM implementation across early years institutions. Such a system would enable education policymakers to track progress, identify gaps, and design responsive interventions based on empirical data. Finally, efforts should be made to engage parents and the wider community in the promotion of early STEM learning. Awareness campaigns, community events, and parent-child STEM activities can extend learning beyond the classroom and help build a strong culture of innovation starting from the earliest stages of education.

References

Afzal, A., & Rafiq, S. (2022). Impact of Teachers' Instructional Techniques on Students' Involvement in Class: A Case Study. *UMT Education Review*, *5*(2), 184-204. https://doi.org/10.32350/uer.52.10

Al Murshidi, G. (2019). STEM education in the United Arab Emirates: Challenges and possibilities. *ResearchGate*. https://www.researchgate.net/publication/338672014

Aldhilan, D., Rafiq, S., & Afzal, A. (2024). Enhancing Early Childhood Education in Saudi Arabia: Utilizing Gamification for Engaging and Effective Learning. *Gomal University Journal of Research*, *40*(1), 21-35. https://doi.org/10.51380/gujr-40-01-03

Aldhilan, D., Rafiq, S., & Afzal, A. (2025). Saudi Arabian preschool teachers' perceptions, positive and negative experiences of play-based robotics activities. *Cogent Education*, *12*(1), 2516375. https://doi.org/10.1080/2331186X.2025.2516375

Al-Gindy, A. (2024). *New paradigm shift to STEM education in the United Arab Emirates*. In S. A. Omran (Ed.), *Education and Development in the UAE* (pp. 145–162). Springer. https://doi.org/10.1007/978-3-031-65996-6_10

British Educational Research Association. (2018). *Ethical guidelines for educational research* (4th ed.). https://www.bera.ac.uk/publication/ethical-guidelines-for-educational-research-2018

Chaya, H. (2024). Investigating students' perceptions of STEM education in private elementary schools in Abu Dhabi. *Research in Science & Technological Education*. https://doi.org/10.1080/02635143.2024.2381113

Cochran, W. G. (1977). *Sampling techniques* (3rd ed.). John Wiley & Sons.

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). SAGE Publications.

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications.

Dickson, M., Fidalgo, P., & Cairns, D. (2019). Integrating science and technology in education in the UAE. In K. Gallagher (Ed.), *Education in the United Arab Emirates: Innovation and transformation* (pp. 67–87). Springer. https://doi.org/10.1007/978-981-13-7736-5_6

Dickson, M., McMinn, M., Bradley, C., & Grenon, M. (2024). The impact of university-based science workshops on UAE school students: A pilot study. *Research Square*. https://assets-eu.researchsquare.com/files/rs-4108415/v1_covered.pdf

ElSayary, A. (2018). Young Emiratis' exposure to STEM and future career expectations. *Academia.edu*. https://www.academia.edu/download/63662174

Field, A. (2018). *Discovering statistics using IBM SPSS statistics* (5th ed.). SAGE Publications.

Forawi, S., & Al Quraan, E. (2022). Status and trends of STEM education in the United Arab Emirates. *ResearchGate*. https://www.researchgate.net/publication/364690721

Gallagher, K. (2019). Education in the United Arab Emirates: Innovation and transformation. In K. Gallagher (Ed.), *Education in the United Arab Emirates* (pp. 1–18). Springer. https://doi.org/10.1007/978-981-13-7736-5_1

Gay, L. R., Mills, G. E., & Airasian, P. (2012). *Educational research: Competencies for analysis and applications* (10th ed.). Pearson Education.

Houjeir, R., Al-Kayyali, R. A. A., & Alzyoud, S. (2019). UAE females in STEM higher education: Challenges and opportunities. *IEEE Global Engineering Education Conference (EDUCON)*, 1238–1241. https://doi.org/10.1109/EDUCON.2019.8725063

Kayan-Fadlelmula, F., Sellami, A., & Abdelkader, N. (2022). A systematic review of STEM education research in the Gulf Cooperation Council (GCC) countries. *International Journal of STEM Education*, *9*(1), 1–19. https://doi.org/10.1186/s40594-021-00319-7

Lee, Y. F., Lee, L. S., & Nguyen, H. B. N. (2022). A comparison of STEM education status and trends in ten highly competitive countries. *ResearchGate*. https://www.researchgate.net/publication/387755244

Rafiq, S., Iqbal, S., & Afzal, A. (2024). The Impact of Digital Tools and Online Learning Platforms on Higher Education Learning Outcomes. *Al-Mahdi Research Journal (MRJ)*, *5*(4), 359-369. https://ojs.mrj.com.pk/index.php/MRJ/article/view/342

Rafiq, S., Kamran, F., & Afzal, A. (2023). Enhancing Professional Motivation in the Early Childhood Teacher Education: Unraveling Issues and Challenges. *Journal of Social Sciences Development*, *2*(1), 26-43. https://doi.org/10.53664/JSSD/02-01-2023-03-26-43

Rafiq, S., Kamran, F., & Afzal, A. (2024). Assessing Environmental Awareness Integration in the Curriculum: A Case Study of Lahore's Private Schools. *Al-Qudwah*, 02(04), 86-100. https://al-qudwah.com/index.php/aqrj/article/view/36

UNESCO. (2017). *STEM and gender advancement (SAGA) project: A policy guide.* United Nations Educational, Scientific and Cultural Organization. https://en.unesco.org/saga.