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Discovering Early Childhood Educators' Perceptions of STEAM Education in the Saudi Context: A Qualitative Study

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Abstract

This qualitative study investigates attitudes toward Science, Technology, Engineering, Arts, and Mathematics (STEAM) education among early childhood educators in Saudi Arabia, in order to assess the strengths and obstacles to its implementation in this specific early learning context. STEAM education has gained global prominence for fostering creativity, critical thinking, and innovation—attributes that contribute significantly to the contemporary workforce and align closely with Saudi Arabia's goals for Vision 2030. Despite its acknowledged importance, the integration of STEAM into early childhood education is under-researched in the context of Saudi Arabia. Drawing on semi-structured interviews with six early childhood teachers from diverse regions, the study focuses on three areas of investigation: the factors that influence educators' perspectives on STEAM, how their knowledge of it influences their work, and the obstacles to effective implementation. To achieve these research goals, six early childhood educators were selected for participation in semi-structured interviews. Subsequent thematic analysis identified the crucial factors for successful STEAM education, including teacher preparedness, access to resources, professional development opportunities, and culturally relevant curricula, and the main obstacles, including time limitations, insufficient training, lack of administrative and parental support, and educational and infrastructural inequity between regions. The results demonstrate the necessity of continual, contextual professional learning; prioritization of interactive and innovative teaching methods; and enhanced co-operation between students and relatives, education professionals. And policymakers. This study contributes to the research by demonstrating the necessity for culturally responsive STEAM practices that are appropriate for early education. It also contributes by suggesting the following practical strategies for educational innovation in the Saudi context: differentiated teacher training; localized resource development; and systemic curriculum reform, for holistic implementation of STEAM from the early years onward.

Keywords: *STEAM Education, Early Childhood Education, Vision 2030 (Saudi Arabia), Qualitative Research, Barriers to STEAM Implementation.*

Introduction

Science, Technology, Engineering, Arts, and Mathematics (STEAM) education is a transformative pedagogical framework that combines a range of interdisciplinary knowledge to promote critical thinking, problem-solving, and creativity among learners (Pleasants, 2023; Makuvire et al., 2025). STEAM's inclusion of the arts into the STEM framework enables it to transcend the constraints of traditional educational boundaries and cultivate more explorative practices. This approach empowers students to acquire technical skills while also gaining creative insights that are crucial for addressing the complex problems facing the modern world (Belbase et al., 2022; Psycharis, 2018). In short, the STEAM approach creates flexible, tenacious, and co-operative thinkers who are adept at navigating a rapidly changing world (Adera, 2025; González-Pérez & Ramírez-Montoya, 2022).

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STEAM education has become a central component of numerous educational reform strategies worldwide, ameliorating such urgent issues as workforce readiness, economic inequalities, and disparities in technological literacy. By blending theory with practical application, STEAM fulfils the goals of innovation and educational relevance. For instance, it enables students to adopt a more holistic approach to projects involving the combination of design principles with scientific inquiry. Thus, it is particularly significant for learners working toward careers focused on creativity and technological innovation.

In the context of Saudi Arabia, STEAM education is awarded greater significance given its relevance to Vision 2030, the Saudi initiative to diversify the national economy and cultivate a society founded on knowledge (Maashi et al., 2022). Education is a fundamental component of Vision 2030, given its necessity for developing a multifaceted workforce capable of participating in the drive for national progress and competitiveness on the global scale (Brahimi et al., 2024). Through its emphases on crucial skills (e.g., technological fluency, cultural awareness, and innovation), STEAM education directly supports the objectives of Vision 2030.

However, regarding the execution of STEAM in Saudi Arabia, contextual consideration must be made given the country's unique pedagogy, institutions and culture. While the implementation of STEAM, particularly in the early childhood education (ECE) phase, is a promising opportunity, its complexities must not be overlooked. Early education serves as a crucial stage for cultivating essential skills in curiosity, creativity, and cognition. By implementing STEAM into national ECE curricula, Saudi Arabia can ensure learners are prepared to contribute to the Fourth Industrial Revolution from an early age while maintaining prioritization of societal aspirations and cultural values (Alghamdi, 2023).

Significance of Early Childhood Education in the Saudi Context

Previous research has demonstrated the crucial impact of early childhood education on people's social, emotional, and cognitive development. The skills acquired during the formative years, including creativity, emotional regulation, and problem-solving, are significantly influential for future learning and performance (Osher et al., 2021). Besides enhancing academic performance, early education can play a crucial role in contributing to the long-term development of beneficial factors such as socio-emotional well-being and resilience (Housman, 2017; Babineau, 2023). Therefore, it investment in early education is paramount, particularly in Saudi Arabia and other nations whose economic development is heavily reliant on human capital (Allmnakrah & Evers, 2020).

Implementing STEAM at the ECE level in Saudi Arabia can be uniquely advantageous in providing practical activities driven by exploration. Lessons can use children's innate curiosity to facilitate development of problem-solving and critical thinking skills, through activities such as making simple structures, using natural materials, or employing storytelling to build understanding of scientific concepts. By emphasizing innovation and inquiry, such methods enhance performance in later phases of education (Shernoff, 2024).

In Saudi Arabia, education traditionally places emphasis on rote learning; therefore, implementation of STEAM education is especially important in this context. Integration of cultural themes into STEAM curricula can enable development of lessons that resonate with pupils' cultural and social backgrounds, thereby increasing the meaningfulness and inclusivity of education. For instance, by including aspects of Saudi Arabia's heritage (e.g., unique traditional architecture or sustainable water management and infrastructure) in STEAM

education, teachers can engender children's pride in their culture and heritage while simultaneously enhancing their understanding of various artistic and scientific ideas (Al-Salamat, 2022; Maspul, 2024).

Moreover, focusing on STEAM implementation in the ECE context enables Saudi Arabia to tackle inequalities in access to STEM careers from the outset. Through the promotion of equal opportunities for all children, implementation of STEAM education can catalyze equity throughout society. This is of particular importance for a nation prioritization workforce diversification and equipping all citizens to participate in national innovation and development (Alghamdi & Ernest, 2019). The benefits of STEAM education at the ECE level can be further enhanced through the implementation of global best practices, which enable students to cement their theoretical learning through practical application and exploration. Adoption of such methods will enable Saudi Arabia to cultivate lifelong innovation and learning, thereby equipping the nation's workforce to navigate a knowledge-based society (Habeeb et al., 2024).

Significance of the Study

By investigating the implementation of STEAM education within Saudi Arabia's early childhood classrooms, this study fills a significant gap in the literature. While the beneficial impacts of STEAM education have been acknowledged in numerous global contexts, there is a dearth of research on its reception and implementation in Saudi Arabia. By addressing this gap, this study will enable policymakers and educators to develop impactful, culturally pertinent interventions (Margot & Kettler, 2019).

This study offers important insights into the attitudes of early childhood educators toward STEAM implementation. The development of professional development programs can be facilitated by investigating the potential impediments faced by educators, such as cultural considerations, curriculum constraints, and limited financial and material resources. For instance, training aimed at addressing specific barriers, such as workshops focused on the embedding of arts into science classes or the modification of STEAM projects to align more closely with relevant cultural contexts, can strengthen implementation significantly (Almazroa & Al-Shamrani, 2015).

This study also provides insight into how global educational trends such as STEAM can be adapted to suit different institutional and cultural settings, and emphasizes the significant value of such adaptations. Thus, it demonstrates not only the efficacy of educational reforms but also their sustainability in various settings, providing valuable context for other countries implementing comparable developments (Aldhilan et al., 2024).

Need for a Qualitative Approach in Saudi Arabia

Effective implementation of STEAM education at the ECE level in Saudi Arabia relies on thorough exploration of the relationships between individual, institutional, and cultural aspects. Qualitative research methods enable in-depth investigation of subjects' practices and opinions; therefore, in the context of this study, they are crucial for obtaining adequate insight into educators' experiences and perspectives (Margot & Kettler, 2019).

Semi-structured interviews are an especially effective qualitative method for this research context. In particular, their flexible nature allows for in-depth examination of certain topics while ensuring participants can describe their experiences authentically and express themselves freely. For example, an educator might explain how they accommodate cultural expectations while

implementing STEAM education into classroom activities, or their approach to overcoming challenges related to resource limitations or inadequate training (Alghamdi, 2022).

Such qualitative studies can offer significant insight into STEAM implementation, which in turn can be used to inform evidence-based strategies for improving it. For instance, gaining an understanding of how education professionals modify STEAM activities to increase their relevance to local cultural contexts can inform the development of culturally responsive curricula. Similarly, findings highlighting systemic barriers (e.g., restrictive or inflexible education policies, or limited funding) can inform advocacy efforts aimed at creating more supportive environments for STEAM integration.

This study's focus on educators' experiences and perspectives ensures the authenticity and contextual relevance of its findings. The insights drawn from its qualitative methods can achieve the integration of local education needs with worldwide trends, thereby supporting Saudi Arabia's cultivation of an education system that is culturally relevant, equitable, and innovative.

Methods

Selection of Study Participants

Multi-faceted approaches are always necessary when deciding on an appropriate method, and especially in cases where study participants need to be representative of a diverse population. In this case, the eligibility of study participants was taken into account to help meet the requisites of participant relevance and qualification. This approach was deemed appropriate in helping select participants that could help investigate the phenomenon under study within the Saudi Arabian context.

Initial Contact and School Nomination

Given the need to draw study participants from different Saudi Arabian schools, I found it necessary to establish contact with influential individuals within each school. Consequently, I pinpointed administrators from several locations. These constituted Najran, Riyadh, and Jeddah. Subsequently, the administrators were provided with ample information concerning the purpose and scope of the study so they could help develop a list of ECE schools within their respective regions. According to researchers (Belbase et al., 2022), such a move is often expedient in ensuring that the institutions selected satisfy the need for resource as well as cultural diversity.

Following the nomination process, efforts were made to reach out to school principals. This was necessary in order to obtain permission to recruit teachers from their respective institutions. The principals were provided adequate information regarding the nature, objective, and scope of the study so they could aid in pinpointing teachers within their institutions that satisfied study requisites.

Teacher Nomination Criteria

It was essential for the institutional principals to follow a specific criterion. The researcher provided a set of instructions to ensure that the efforts made by the principals aligned with the study objective. Below are the pointers that the principals were required to utilize while helping recruit the teachers.

1. Professional Experience- Individuals teaching in the institution that have been providing ECE. This particular instruction was necessary to ensure that recruited individuals could provide relevant information regarding ECE teaching approaches.

2. Teacher involvement in STEAM- Teachers pinpointed for recruitment were required to have been involved in seminars and initiatives that reflected contributions towards STEAM.

3. Excellence in teaching- Given the need to recruit teachers that had an excellent record in the practical deployment of both teaching knowledge and updated pedagogical methods

Teacher Recruitment

Having obtained permission from the school principals, it was as well necessary to obtain permission from the teachers. This took place after each of the institutional leaders had provided their respective nomination lists. At first, the researcher contacted the nominated teachers and provided ample information concerning the nature of the study as well as underlying objectives. Following the advice of modern-day scholars (González-Pérez & Ramírez-Montoya, 2022), the teachers were also detailed concerning the process of obtaining data with emphasis on the pre-determined interviews. Further, they were made to understand that they would not be coerced into taking part in the study and that they could withdraw at will. The researcher took time to provide sufficient details concerning concerns raised by the teachers. After each potential participant was satisfied, they were required to sign the consent form.

Interview Procedures

According Lincoln and Guba (1985), when determining interview procedures that will be used to collect data from human participants, it is ethical to pay attention to the scheduling factor. Following this advice, the researcher liaised with each individual teacher to obtain information concerning their availability. Consequently, the interview scheduling process took on a flexible approach with each teacher being allowed to participate in the 20–30-minute interviews at their convenience. Additional information was provided to the participants regarding recording of the interview proceedings and the measures that will be undertaken to foster confidentiality and maintain the anonymity of their contributions.

Ethical Considerations

As is the requirement for every research process, and especially where human participants are involved, the researcher ensured that the entire exercise adhered to pre-determined ethical considerations. Following the advice of Lincoln and Guba (1985) concerning study trustworthiness, the researcher ensured that the participants were satisfied with the measures that would be used to ensure anonymity and confidentiality. Further, the component of informed consent was taken into account. Additionally, the researcher ensured that data collected from the participants would not be used for any other purposes besides the objectives dictated by the study and the information was relayed to each participant. Finally, the University's ERB was provided with the select study design for approval.

Summary

Methodological procedures require sufficient collaboration and communication. In this study, methodological rigor was facilitated by allowing the contribution of stakeholders such as heads of institutions, individuals wielding influence in Saudi's education sector, and ECE teachers in institutions within the region. Further, the structure of the method used for the study was designed around ethical principles.

Research Questions

The RQs guiding this study had been designed in such a manner as to help gather data through

the pre-determined semi-structured interviews. The questions are highlighted below.

1. What are the key factors shaping early childhood teachers' perceptions of STEAM education in Saudi Arabia?

2. How do teachers' knowledge and understanding of STEAM influence their instructional practices?

3. What barriers hinder the effective implementation of STEAM education in Saudi ECE settings?

Data Analysis

Specific approaches are required to analyse data depending on the nature of data that has been collected. Thematic analysis as proposed by Braun and Clarke (2006) was found most appropriate for this study. According to Braun and Clarke (2006), this approach helps researchers to gain comprehensive insights into the phenomenon being studied as it embodies the multi-faceted approaches of coding, pattern pinpointing, theme identification, and thorough synthesis. Following the recommendation by Clarke and Braun (2017) while deploying thematic analysis procedures the researcher also conducted triangulation combined with the principles of member checking to foster study trustworthiness. When conducting analysis, emergent software also comes in handy. In this case, the researcher relied on NVivo to foster rigor in the analysis process.

Interview Questions and Validation

Without paying attention to the validation of questions that help obtain data during semi-structured interviews, researchers often lose focus and clarity. In this study, the researcher avoided this pitfall by subjecting the guiding research question, which were the same questions being used to sustain focus during data collection, to comprehensive assessment procedures and reviews to facilitate refinement. Particularly, the questions were reviewed with the help of five experts. These constituted 1 professor whose specialism is in the field of qualitative research and 4 PhD owners that specialized in ECE.

The experts provided the feedback below that was then incorporated into the research method and process.

1. Research focus and conciseness- After the review, the experts suggested that structural and content-based changes be made to ensure alignment of the questions to study objective. The researcher used this recommendation to streamline the questions for improved clarity. Questions that exemplified compound ideas were also re-designed to contain a single and concise idea.

2. Simplification and precision- The reviewers advised that question simplification was important to help collect precise and relevant information from the participants. Therefore, the researcher made the wording for each question easier and removed complex and ambiguous phrases that would confuse the study participants.

3. Study objectives and alignment- The positive response from the reviewers was encouraging as they affirmed the alignment of the questions to the overall study objective. However, I also ensured to follow their advice and removed tangential questions that could threaten attainment of the study objective.

4. Cultural sensitivity- Being aware of the cultural sensitivity surrounding the Saudi region, the

experts were keen to advice that the questions be adjusted to make them more appropriate for the interviewees. The researcher made the changes with specific attention being given to changing phrases that would make the interviewees uncomfortable.

5. Adherence to qualitative research requisites- Particularly, the reviewers noted that leading questions be eliminated from the interview protocols. I adhered to this reviewer comment by switching to open-ended questions that could facilitate establishment of the much-required rapport with the interviewees. Since the reviewers had also emphasized the need to ensure that the qualitative research questions could foster dialogue, I also made the changes accordingly by ensuring that each of the questions was able to trigger conversations with the participants.

6. Final refinements- After considering the comments made by the reviewers in their totality, I revisited and revised the interview guide. This led to the development of questions that were not only aligned to the study objective but were also able to retrieve comprehensive and relevant data from the participants. Overall, the changes made after paying attention to the feedback helped ensure that the interview process generated high quality data.

Trustworthiness

The element of trustworthiness is particularly expedient in studies whose findings impact the nature of service delivery. In this study, efforts were made to attend to this requirement in order to ensure that the findings obtained could be used to enhance pedagogical strategies used in STEAM. The various components captured in trustworthiness are addressed below.

Credibility

According to Amankwaa (2016), credibility in research studies has to do with the degree to which findings reflect the phenomenon being studied. Several measures were put in place to facilitate credibility. Following the advice of Mirhosseini and Pearson (2024), the researcher relied data from diverse sources with the aim of establishing informational consistency. These sources constituted observations made in the classroom environment. Notes taken by ECE teachers, and observations made during STEAM classes. Collaboration was also used to facilitate credibility. Particularly, the researcher involved powerful administrators during the process of institution nomination and as well collaborated with institutional heads when the need to recruit qualified teacher participants emerged. Another method that was used to foster credibility was the use of peer review and feedback. This involved elimination of researcher bias possibilities by having peers and a panel of experts review the study methods, procedures, findings, and interpretations. Credibility was also fostered by embodying the component of cultural sensitivity. This was done following the recommendations by the panel of experts that required question changes to reflect the prevalent cultural norms in Saudi Arabia.

Transferability

The notion of transferability has to do with the ability of obtained study findings to be usable in more general contexts rather than the specific area of focus. In this study, efforts were made to ensure that the findings could be applicable in settings beyond Saudi Arabia. First, efforts were made to cover the component of diversity and representation with the researcher facilitating broad usability of the study findings by recruiting teachers from different regions across Saudi. Secondly, the researcher ensured richness while describing the context within which the study was carried out. This involved provision of detailed information covering the setting within which the study was conducted as well as participant experiences with STEAM. The final

measure for ensuring transferability involved aligning the objectives of the study and discussion of the findings to Saudi's Vision 2030. Such an approach was aimed at making sure that the model resulting from this study can be replicated in other countries outside of the UAE.

Confirmability

In the opinion of Lincoln and Guba (1985), conformability fosters study trustworthiness when researchers are able to ground their arguments and findings on empirical data rather than personal opinions. To achieve confirmability, the researcher sustained a neutral stance when communicating reports concerning collected data. As such, responses obtained from the study participants were reported word-for-word and accurate analysis of gathered information was also deployed to justify the accompanying interview recordings and notes taken during the interview process. Following the advice of Amankwaa (2016), the researcher provide an accurate audit trail to enable other researchers trace the coding and analytical processes leading to the acquired findings. The researcher also followed the recommendation by Onwuegbuzie et al. (2009) by conducting member checking through a process that allowed study participants to confirm the accuracy of their contributions.

Dependability

When the findings of a study go past consistency and are able to be proven reliable after being subjected to the time factor, such a study is deemed DEPENDABLE. To foster trustworthiness by deploying this concept, the researcher utilized a systematic approach in which were embodied observation checklists and the protocols guiding the data collection process through semi-structured interviews. Further, the researcher followed the advice of Lincoln and Guba (1985 to ensure data consistency by cross-checking the responses obtained from study participants and merging coinciding information into themes that were relevant to the study objective. In addition, the use of NVivo enabled the researcher to achieve the kind of methodological rigor necessary for enhancing the study's dependability.

Findings/Results

The presentation of findings in this section follows keenly after the responses obtained from the six teachers that were interviewed. Headings to the findings are also presented in alignment with the three questions to help meet the objective of the study. A summary of the similarities and differences is also provided.

Question 1: What are the main factors shaping early childhood educators' perceptions of STEAM education in Saudi Arabia?

Teacher One

The responses provided by the first interviewed ECE teacher indicated that teacher's perceptions in relation to STEAM education. These constituted the nature of classroom milieu and preparation of teachers. Particularly, the first teacher stated that "the efficacy of pedagogical approaches associated with STEAM students is determined by the teachers ability to prepare lessons and positively influence classroom environments". The explanation provided by this teacher was that taking into account these two factors reflected proficiency in the utilization of teaching approaches. From such a perspective, it stands to reason that whereas materials are fundamental in fostering effective STEAM education, without the elements of teacher preparedness and recognition of the role played by the learning environment, the efforts of teachers can be frustrating when compared to student outcomes.

The first teacher also reported that STEAM education requirements differed from the conventional teaching practices and required sufficient educator training for teachers to satisfy the dynamic children needs. According to her, the environment crated by educators in classroom settings was fundamental. She reported that since children found interacting practices more appealing, "it is the responsibility of teachers to create a suitable environment". In her opinion, STEAM teachers should look at the learning environment as not just a mere platform for delivering knowledge but rather as a platform that can be used to arouse student interests in learning and stimulate learning through interaction. Commenting on the aspect of critical thinking, she noted that the right learning environment promotes critical thinking and innovation making it possible for the learners to develop artistic, mathematical, curious, and scientific mind-sets. She did not hesitate to mention that she practices teaching in Najran. To this end, the interviewee noted that supportive materials were as well essential arguing that the Saudi government should make efforts to supply the required teaching materials.

She also noted the importance of knowledge and attitude reinforcement in STEAM classrooms. According to her, when designed properly, learning environments could be translated into avenues through which students could conduct scientific experiments and develop better insights into math-related concepts. In her opinion, "it is essential that emergent technologies be integrated into modern-day STEAM classrooms to foster interactive learning and help students relate with real-life concepts". Thus, she recognized the place of tech-based learning arguing that the approach was fundamental in enhancing student morale and augmenting their engagement.

Teacher Two

Unlike the first teacher that placed value on the classroom environment, teacher preparation, and tech-based learning, the second teacher opined that the most fundamental requisites for successful STEAM education constituted administrative support/resources and educator training. The interviewee stated that "although resources were essential, most teachers find STEAM teaching approaches burdensome because they lack sufficient training". The respondent added that although most institutions were keen to provide interactive and tech-based resources, STEAM education outcomes were still below average because teachers lacked the knowledge required to foster critical thinking and enhance learner engagement in classroom settings.

More importantly, the respondent noted the expedience of administrative support. However, she reiterated that institutions were much more focused on provision of teaching materials yet they had neglected the equally important regular training of educators concerning deployment of STEAM pedagogies. She believed that "institutions should pay attention to providing STEAM educators with interactive workshops so they can improve the learning experiences of students". Whereas she recommended institutions for having made efforts to provide learning materials, she believed that most of them were not up-to-date. Thus, she proposed that more emphasis be given to provision of emergent interactive tools. In her opinion, it is as well important for institutions to deploy "peer metnorship strategies so that weaker educators can benefit from interacting with their more proficient counterparts".

Teacher Three

To this third respondent, the most critical factor in fostering effective teaching was the ability of educators to gain comprehensive understanding of the concepts captured in STEAM education. In her own words, "without ample knowledge regarding the relationship between learner abilities

and associated approaches used in STEAM anticipated outcomes cannot be attained". On the other hand, she argued that efforts have not been made to foster the contribution of communities and to establish strategic partnerships that can help augment the efficacy of STEAM education. Therefore, she opined that institutions should partner with surrounding communities to ensure that parents are also involved through events designed to improve support for STEAM. Concerning classroom environments, the respondent cited the need for flexibility indicating that it is essential to help STEAM curricula attend to individual student needs.

The need to simplify and make changes to the pedagogical approaches was also reiterated by this interviewee. Particularly, she noted that simplicity measures when implemented through stories could help improve the engagement of learners. In her opinion, this is also important to ensure that learners can gain practical knowledge, which when gradually and thoughtfully developed can serve as effective stepping stones for their future careers. She also indicated that such changes when effected can change the perceptions of STEAM learners from an early age making it possible for them to harness critical thinking and eventually consider specializing in practical disciplines in future.

Teacher Four

This respondent identified two factors that impeded the efficacy of STEAM education. To her, limited awareness when coupled with challenges in classroom environments heightened the problem. The interviewee stated that "some of the teachers had not acquired ample knowledge concerning STEAM precepts and the insufficiently equipped classrooms contributed to implementation issues". In her opinion, the deficit in knowledge could have been addressed if emphasis had been given to the pre-educator training sessions. She also noted that the current classroom settings were incapable of fostering student engagement in engineering and science disciplines. Thus, the respondent cited that the improvement of classroom environments was essential in improving student attitude, teacher performance, and learner engagement. In addition, she advocated for the use of pedagogical strategies that by being embodied with emergent digital technologies can facilitate easier understanding among the learners.

Teacher Five

This respondent was particularly interested in the influences that STEAM curricula exert among the young learners. In the opinion of teacher five, "the unequal influences are worrying given the significant learner engagement and comprehension differences". She expressed concerns that the gap widens when it comes to students whose learning environments are marked by limited support and resource access problems. Commenting on potential ways through this inequality issue can be solved, the participant advocated that institutions focus on flexible and individualized service provision by educators. Further, she reiterated the importance of using technology to bridge the gap arguing that when merged with classroom activities that can promote equitable learner experiences the objective of outcome equity can be attained. The respondent also mentioned the necessity of pedagogical strategies that lean on teamwork among learners. From her perspective, collaboration can foster faster development of weaker learners helping them achieve the same outcomes as their more proficient counterparts. Further, the respondent reiterated the importance of learner competitions that are based on the curricula arguing that they can enhance critical thinking.

Teacher Six

This participant was quick to point out and discuss the challenges faced by educators involved

in STEAM. According to her, whereas time was a major factor, other factors like resource-related limitations and the absence of professional development opportunities also played significant roles. The interviewee reported that "resource insufficiency and inadequacies related to educator training impact negatively on STEAM delivery". On the other hand, she noted the need to make changes to the existing STEAM implementation approaches citing the need to focus on progressive learning. Nonetheless, the participant highlighted that even with such efforts being made towards restructuring, it would be expedient to carry out extensive teacher training so that they can be equipped to deliver effectively. Whereas she recognizes these moves as being useful, she also added that technologies that can help educators to deliver personalized content following flexible strategies should be considered. In her opinion, the use of digitalized platforms is both expedient for the learners and teachers enabling them to communicate and interact as determined by underlying classroom concepts.

Similarities in the Findings

The findings obtained and recorded after interviewing the six teachers exemplify significant similarities that are worth noting. For instance, it was evident that STEAM teachers require ample training to foster implementation improvements. Additionally, the respondents identified the resource issue noting that it impeded teacher efficiency and student learning. It as also astounding to discover that all the six respondents valued changes that could help improve classroom environments as well as student experiences. Similarly, the respondents anticipated that emergent technologies could improve STEAM education.

Differences in the Findings

Three key differences emerged from the participant responses. Challenges associated with STEAM awareness were discussed by the fourth participant/teacher whereas this issue was overlooked by respondent five whose emphasis was on manifest inequalities concerning comprehension of classroom concepts. Further, although other participants noted the element of resource insufficiency, teacher six mentioned that despite having such resources had to deal with issues that were related to administrative support and time. Another key difference is that whereas some participants were keen on pinpointing the need to establish appropriate learning environments, their counterparts believed that emphasis should be given to facilitating flexibility and interactivity.

Question 2: How does teachers' knowledge and understanding of the STEAM concept affect their educational practices?

First Teacher

Responses obtained from the first teacher were also significant in helping address the second question. According to her, accurate insights into STEAM education were fundamental in fostering effective service delivery. Particularly, she noted that she had been "able to trigger the interest and engagement of learners having spent time to understand STEAM pedagogy concepts". Further, the participant added that "the ability to augment learning experiences for my apprentices was entirely depended on deployment of motivational aspects embodied in STEAM curricula". Commenting on how the knowledge helped attain these feats, she indicated that they have played a pivotal role in helping students establish the much-needed link between the diverse disciplines. The respondent also reiterated how utilizing different STEAM concepts helped her trigger student interest causing them to think creatively instead of relying on the conventional memorization approach to learning. Commenting on the role of technology, the

interviewee reiterated that technological approaches such as the deployment of virtual reality helped augment both student interest and creativity. More importantly, the participant recognized the usefulness of collaborative students in enhancing learner confidence and classroom participation.

Teacher Two

This second participant was more interested in pinpointing the necessity of STEAM basics with regards to the experiences of learners. Particularly, the interviewee pointed out that "concise insights into the basic requirements associated with delivery of STEAM education helped add meaning to the experiences of my students". The participant also noted that even in the presence of effective learning models, teachers find it difficult to improve service delivery and foster learning outcome improvements without proper and accurate STEAM knowledge. Adding to this comment, the teacher referred to her career as an educator indicating that accurate understanding helped her improve the outcomes of students that had seemed weaker in science and math-related disciplines.

Further, the participant highlighted the need for pedagogical strategies that rely on teamwork among students. In her opinion, "teamwork helps students develop the right attitude and also enhances their creativity". Noting that educators should take heed of the teamwork component, the participant reported her observations that educators have failed to achieve the desired student outcomes because they on focus on knowledge transmittance but fail to understand the necessity of collaboration in shaping the practical skills of students.

Teacher Three

The third participant when interviewed focused on the need for experience in STEAM education among educators and the influences such experience exerts on children. The teacher pointed out that "because of my understanding of the precepts captured in the curriculum i have been able to use the experience to improve the learning experience of children". In her opinion, having experience and knowledge helps address individual student needs by providing classroom activities that enable learners to connect STEAM principles to their daily lives. Further, the interviewee stated that motivation among STEAM learners depends extensively on the ability of educators to impart their knowledge and experience in classroom settings. The teacher also indicated that children are often interested in acquiring knowledge that can be applied in their daily lives, which makes teacher knowledge and STEAM experience fundamental. However, she pointed out that generating the anticipated levels of student engagement requires the input of parents and families and thus noted the importance of creating STEAM awareness at the community level. Without appropriate knowledge levels and experience, the interviewee noted that educators have difficulties promoting innovation and creativity among learners.

Teacher Four

This participant focused on providing information regarding the necessity of educator knowledge in fostering interactive classroom environments. She was quick to note how her knowledge concerning STEAM principles "helped trigger the curiosity of children to explore and think critically concerning the concepts learned in class". In her opinion, even with the availability of tech-based learning platforms it is almost impossible for educators to create learning environments that foster innovation if they are not sufficiently equipped with updated STEAM knowledge. The interviewee also reiterated how her STEAM knowledge had helped "utilize approaches that fostered educator-learner interactivity in classroom environments

through the use of simplified educational simulations". According to the interviewee, having the right information is essential in ensuring that teachers know how to promote student participation in classroom settings setting the stage for them to exercise independent and critical thinking at the personal level.

Teacher Five

This participant focused on the need for improved erudition experiences as well as the need for teachers to deploy their knowledge concerning STEAM ti transform learning experiences. The respondent indicated that the accurate understanding and experience she had gathered while dealing with STRAM students helped "transform classroom environments into places of fun and helped arouse the interest of learners". According to her, the efficiency of teachers was not only dependent on the ability to transmit knowledge but relied more extensively on their ability to help children relate classroom concepts to real-life issues. On the same note she argued for the necessity of classroom transformation reiterating how she was able to "trigger the interest of teachers in a manner that improved their curiosity and personal discovery". On the other hand, she noted that educators should be able to differentiate knowledge application stating that educators often failed to create enthusiasm among learners for failure to discern when to use interactive classroom challenges.

Teacher Six

The focus of this participant was on the aspect of fostering critical and creative thinking in STEAM classrooms. She noted that this was dependent on the levels of knowledge and experience among educators. The interviewee said that she had been able to "facilitate contusive classroom environments by using STEAM knowledge and experience to design aligned with the pre-determined curricula". However, she was quick to note that educators involved in STEAM should focus beyond practical activities to design pedagogy strategies that promoted analytical thinking. In her opinion, such a feat is possible in cases where pedagogy strategies are based on STEAM principles that seek to promote intellectual growth through the utilization of methods designed to foster creativity. In her opinion, "critical thinking can be stimulated by using approaches that allow students to make errors and creatively look for solutions". She reiterated that when such pedagogical strategies are in place it becomes possible for educators to impart practical knowledge.

Conclusion

The six participants revealed the necessity of STEAM knowledge in augmenting STEAM education delivery and improving student learning outcomes through knowledge-based implementation. Their responses also indicated that STEAM implementation has been failing to generate the anticipated levels of results because of misplaced emphasis on the practical aspects. Thus, their responses draw interest towards the need for pedagogical strategies to be focused on providing learners with the support that can help them acquire innovative, creative, and real-life skills. The aspect of technology usage in STEAM education also appeared to be a major contributor to successful implementation given the need to foster interactive learning. Moreover, critical thinking was mentioned as one of the core principles of facilitating successful STEAM implementation with respondents citing the necessity of approaches that improve analytical thinking in classroom environments.

Question 3. What are the barriers to the effective implementation of STEAM education in early childhood settings in Saudi Arabia?

Teacher One

The first teacher to be interviewed provided responses that were related to administrative and parental support as well as tools designed to aid in STEAM education. To her, these were the chief obstacles that impeded successful implementation. In her own words, she stated that "it has been increasingly challenging for STEAM educators to implement the pre-determined curricula without appropriate support". The respondent also stated that whereas teachers remained committed to successful implementation, the withdrawal of parental support when combined with insufficiencies in institutional support made the pursuit of successful implementation increasingly challenging. Reiterating on the importance of collaboration, the teacher also stated that families were unable to cooperate with institutions and STEAM teachers making procedural implementation intensively difficult. She also stated that the sustainability of successful STEAM curricula implementation relied heavily on the support received from parents, which in her opinion was "essential in fostering individualized student improvements".

Teacher Two

This respondent identified factors that had been left out by her companions. She was very specific that whereas experiential knowledge mattered in fostering successful implementation, other factors that are time and budget-related when combined with resource insufficiency aggravated the difficulties encountered during the implementation process. The interviewee stated that "executing STEAM guidelines that necessitate the utilization of digital and interactive tools has remained challenging in the absence of resource sufficiency and administrative support". In her opinion, this is because successful and sustainable implementation of STEAM requires institutional administrators to provide specific learning materials. Further, the interviewee had observed during her years of experience that educators found it difficult to help students understand classroom concepts, and especially in cases where tangible learning materials were absent. Her final comment was related to the need for flexibility when it comes to scheduling extra classroom sessions.

Teacher Three

This respondent was more concerned with highlighting the need for STEAM educators to acquire in-depth knowledge regarding curricula principles. In her opinion, "successful implementation has been continuously hindered by insufficient knowledge among educators, which made planning increasingly challenging". In an attempt to explain the implications of lack of adequate professional training, the respondent reported that in the absence of sufficient skills the teachers were seldom able to make appropriate and relevant changes to their pre-planned classroom sessions. Based on her experience, she reported that she had observed the lack of in-depth knowledge demoralize STEAM educators making them incapable of arousing the levels of scientific curiosity required to foster successful teaching. The respondent also noted that "in the absence of sufficient resources educators dealing with foreign students did not effectively communicate the practicality of classroom concepts".

Teacher Four

Upon interview, this respondent highlighted the obstacles presented by classroom settings and minimal knowledge among STEAM educators. In her opinion, it has been increasingly challenging to implement the curricula effectively because learning environments are not sufficiently equipped". Further, the respondent noted that the classroom setting challenge when coupled with limited awareness of STEAM concepts heightened implementation challenges for

educators. According to her, these difficulties when combined made it challenging for students to enjoy learning experiences leading to poor performance. Particularly regarding the classroom settings, the interviewee noted that "implementation has remained an uphill task because teachers cannot trigger the curiosity required for students to practically explore classroom concepts. Therefore, she proposed continuous and regular educator training as well as the use of emergent mobile technologies in STEAM learning environments.

Teacher Five

The aspect of inequalities was the main focus of this interviewee. Noting that students experienced teaching differently, the respondent reported that "certain student groups, and especially those with ample resource access benefit more fin terms of classroom participation". In her opinion, the manifest differences in terms of student experiences and learning outcomes were closely tied to existing inequalities in resource distribution. Further, the teacher indicated that "intensive and individualized support should be provided in the form of resource provision to bridge the gap in learning experiences and outcomes". The interviewee also mentioned the aspects of educator workload and special student needs indicating that efforts should be made to improve the inclusivity of STEAM implementation approaches.

Teacher Six

This respondent started by noting that in her region of operation resource availability for STEAM educators and teachers was not a pressing challenge. However, she was keen to note that Riyadh STEAM educators were being plagued by time and training related issues. According to her observations, "teachers have been unable to deliver STEAM education as efficiently as is required being pressed by time and knowledge-related constraints". The respondent also added that implementation remained an uphill task because teachers did not have sufficient knowledge on how to improve classroom environments and help students relate concepts to real-world problems. Astoundingly, the participant despite having highlighted that she had years of experience in STEAM education also pointed out that she still looked forward to receiving advanced training so she could boost the morale of her students better. More importantly, she advocated for parental and administrative support arguing that these were fundamental in promoting successful and sustainable implementation.

Similarities and Differences in the Findings

Study participants pointed towards resource insufficiency, time limitations, challenges imposed by school schedules, and the absence of sufficient training as the main obstacles impeding successful implementation. Another major similarity that was pointed out by all the interviewees was that institutional administrators and parents should provide sufficient support to make the implementation process more workable. One of the chief differences that emerged in light of the participant contributions was that the absence of parental support was not a serious challenge as was the one presented by time and classroom equipping issues. Further, whereas some participants focused on individual student needs, others referred to teacher training inadequacies as the main implementation obstacle.

Recommendations

Based on the findings obtained and in relation to the guiding questions, the recommendations provided below are appropriate.

1. Allocation of additional class time for educators and students involved with STEAM

2. Provision of adequate resources through extra budgetary allocations

3. Encouraging parents to take part in the STEAM education of their children

4. Additional budgetary allocations to cater for the much-needed professional training of STEAM educators

5. Focus on resource translation to cater for the learning needs of Arabic students

Discussion

The Main Factors Shaping Early Childhood Educators' Perceptions of STEAM Education in Saudi Arabia

The Importance of Teacher Preparation and Professional Development

The essence of adequacy in matters related to teacher preparation was mentioned by the participants with their emphasis being the facilitation of progressive skill acquisition and educator development. The respondents referred to this concept indicating that it is fundamental when it comes to STEAM education, and especially in improving the interactive nature of student learning experiences. Such participant contributions align with the viewpoint of researchers (Permanasari et al., 2021) that pedagogical strategies utilized in STEAM education should be focused on teacher training to help teachers promote student interests as they take on the inter-related subjects. Other researchers have also corroborated this perspective indicating that without STEAM practices that are founded on adequate teacher knowledge, transmission of information becomes challenging because students are less interested in learning classroom concepts (Kelley et al., 2016). This implies that embarking on professional educator development is one of the keys that can help foster the attainment of better student outcomes.

The aforementioned findings have also been substantiated by other scholars. For instance, Vossoughi et al. (2021) noted the importance of consistent teacher training in improving the confidence of teachers involved in STEAM education. In similar fashion, Leung (2023) advocated for progressive training of STEAM educators after observing that it enhances their competence by approximately 23% and enables them to deliver individualized learning at the classroom level. Such scholarly sentiments would explain why the participants mentioned professional teacher development through regular training as one of the pillars of improving ECE by enhancing the involvement of students in practicals.

Whereas some participants only focused on the training component, researchers seem to pay more attention to progressive training that is designed based on educator and learner contexts. For instance, Darling-Hammond et al. (2017) noted that efforts to improve STEAM delivery have failed in the past because institutions only engage in one or two training workshops but do not recognize the need for progressive skill acquisition and educator transformation. Additionally, literature has indicated that training sessions should be carried out in the presence of assigned mentors to help achieve transformational changes in STEAM delivery (Cohen & Waite-Stupiansky, 2020). These sentiments have been attached to the need for professional partnership, which Darling-Hammond et al. (2017) indicated that are necessary to help educators improve pedagogical approaches through the utilization of novel instructional approaches. Referring to this as reflective training and supervision, researchers (Vossoughi et al., 2021) have noted that over 18% of STEAM educators fail to meet the pre-determined curricula delivery requirements because they lack sufficient mentorship and have been unable to establish a culture of collaboration.

Classroom Environment and Resource Availability

The aspect of classroom environment appropriateness was also mentioned repeatedly by the study participants. Most of them emphasized on the need for institutions to equip classrooms with materials and resources that can help improve educator delivery and student learning experiences. These findings are consistent with the results obtained by Quigley, et al. (2016) after they explored the influences of resource provision on STEAM education. The researchers found that without the use of digital and emergent technologies, it was difficult for teachers to promote exploratory learning. In similar fashion, other scholars have reiterated the necessity of equipping classes with technological tools arguing that such efforts help improve STEAM students learning experiences.

Classroom milieu and resource sufficiency were also linked by the study participants to enhancements in student understanding and classroom participation. As indicated in existing literature (Gavari-Starkie et al., 2022), STEAM delivery benefits the most from such improvements because students are able to relate scientific concepts to real-life. Referring to this as multi-sensory exploration, Leavy et al. (2023) suggested that science and math-related subject teaching when merged with interactive tech-materials such as robotics helps augment cognitive development and allows students to relate classroom concepts to real-life situations. Whereas these are vital considerations, it is expedient to note the equity concerns raised by the participants. Particularly, the participants reported having observed that students in areas where resource and material availability is an issue do not develop the same as those with access to resources. This explains why Nong et al. (2022) noted that educational equity, and especially when it comes to the experiences of STEAM students can be improved by fostering equitable access to learning materials.

Provide Interactive Environments to Reinforce Learning Experience

The interviewed teachers were keen to point out the need for experimentation in STEAM education with emphasis on how appropriate classroom environments could help satisfy the need. As indicated in recent literature (Johnston et al., 2022), as opposed to conventional classroom environments, STEAM education demands that the dynamism of learning environments be sustained to foster integrated learning. Other researchers have corroborated this point of view. For instance, researchers have noted that when such dynamism is sustained, it becomes possible for educators to facilitate enhanced student participation as well as speedy acquisition of cognitive abilities (Vossoughi et al., 2021). Such scholarly sentiments could explain why the interviewed teachers attached student motivation and memory retention could be achieved in STEAM learning environments that fostered hypothesis testing and teamwork. In the opinion of Lee (2021) when classroom-related measures are in place, STEAM implementation becomes easier due to the corresponding increases in student interest and curiosity as well as the consequent developments among students in relation to critical thinking. Further substantiating the findings, Nzayisenga et al. (2023) noted that dynamic STEAM learning environments improve educator service delivery through heightened student interest and participation.

The Importance of Integrated Temporary Technology to Teach STEAM

Interviewed participants repeatedly mentioned the need for technology to be integrated into STEAM classrooms. In the opinion of Vossoughi et al. (2021), such a measure is fundamental in fostering improved abilities among educators to deliver educational services in cases where

learning institutions are characterized by limited infrastructure. Further, Leavy et al. (2023) highlighted the need for using emergent technologies in STEAM classrooms indicating that emergent digital platforms help introduce flexibility and simplify classroom concepts for learners. These scholarly sentiments align with the statements made by the interviewees that emergent and digital platforms play a significant role in helping students develop computational and critical thinking. Commenting on the same, scholars have indicated that it is easier for educators to satisfy educational and curricula objectives when digital technologies are introduced because students can not only relate with classroom concepts but can as well take on experimentation exercises.

How Does Teachers' Knowledge and Understanding of the STEAM Concept Affect Their Educational Practices.

It was astounding that all of the interviewed study participants associated the acquisition of adequate STEAM knowledge with significant enhancements in the quality of learning received by students. Despite this consensus, researchers (Herro & Quigley, 2017) have argued that knowledge is not the only contributing factor given that its implementation by the possessors is always determined by individual educator objectives, institutional objectives, and personalized student needs. On the other hand, literature (An, 2020) has indicated that the over-emphasis on knowledge and the role it plays in augmenting learning experiences stems from the misconception of STEAM with most educators and school administrators believing that it only embodies practicality. This would explain why the study participants also mentioned the contributions of supportive learning environments. With regards to support, Allina (2018) indicated that institutions should provide progressive educator training to foster skill improvements and enable STEAM teachers to help students harness their critical thinking skills and innovative reasoning.

The Barriers to the Effective Implementation of STEAM Education in Early Childhood Settings in Saudi Arabia

Availability of Resources and Teacher Preparation

The participants were keen to note the contributions of resource insufficiency and lack of appropriate teacher preparation as the major barriers when it comes to the implementation process. Affirming the validity of these findings, researchers (Herro et al., 2019) have noted that successful implementation often proves challenging for educators in cases where they face issues related to resource access and professional training. Further, literature has indicated that in the absence of specialized training, teachers are left to wonder around decisions related to STEAM service delivery causing most of them to provide irrelevant or untimely instruction to students (Johnston, 2022). This would explain why the participants cited the unavailability of educational materials and lack of professional development as some of the chief factors impeding successful STEAM implementation. These findings were corroborated by Sullivan and Bers (2019) after they explored STEAM teaching pedagogies. Findings by these researchers indicated that without appropriate training teachers lacked the confidence required to facilitate successful teaching.

Time Constraints

Whereas some participants focused on issues related to resource availability and training sufficiency, others were quick to note the impacts of time constraints. In the opinion of Herro et al. (2019), such findings are reliable given that 28% of STEAM teachers have repeatedly complained regarding scheduling and timing. In addition, Mirhosseini and Pearson (2024)

indicated that the comprehensive and demanding nature of STEAM education requires teachers to have ample preparation and teaching time to help students relate the concepts they learn in class to real-life issues through experiments and constant practice. As such, the prevalence of the time constraint explains why students face difficulties when it comes to developing creative skills and analytical problem-solving skills.

Support from School Administration and Parental Involvement

Participants that were interviewed in this study highlighted the obstacles presented by inadequate parental and administrative engagement in STEAM education. Particularly, they indicated that whereas parents have failed to develop interest in the learning of their children, institutions and accompanying administrators as well seemed to play hands-off. Affirming the point of view captured in these revelational findings, Permanasari et al. (2021) indicated that lack of involvement among parents demoralizes STEAM teachers causing them to be weighed down by the demands of the attached curricula. On the same note, Leung (2023) observed that in the presence of diminishing parental involvement and school administrators that pay little attention to the support required by STEAM educators, the consequent and manifest socio-educational disengagement causes teachers to limit their commitment towards successful implementation. From such a perspective, diverse stakeholders should be encouraged to contribute if STEAM implementation is to become successful. Such an assertion would explain why researchers such as Sullivan and Bers (2019) reported that teachers have been unable to help achieve the anticipated levels of STEAM student performance results because parents and administrators have failed to participate fully.

Differentiated Learning and Equity in STEAM Access

The participants also raised concerns regarding inequalities stemming from STEAM education. Such concerns have also been highlighted by Moore et al. (2014) with the researchers noting that STEM and STEAM education generates educational inequalities that are based on factors that influence resource availability. On the same note, Sullivan and Bers (2019) indicated that student engagement levels under the STEAM curricula have continued to vary depending on the ability of institutions to provide required learning materials. This would explain why the study participants highlighted the need for adaptive and flexible teaching approaches stating that they could prove useful in lessening associated educational experience inequalities. These scholarly contributions also bring to light the aspect of individualized learning. The participants noted that the diverse needs of students demand that institutions provide adequate resources to help foster personalized STEAM education. Moore et al. (2014) mentioned the need for individualized learning relating the differences in educational experiences among STEAM students to consistent use of strategies that do not promote teamwork and scaffolding of classroom instructions.

Curriculum Integration and Structural Barriers

Study participants also reiterated the influences of curricula fragmentation as well as time limits and tight schedules on STEAM implementation. Ascertaining the reliability of these findings, Caton (2021) noted that the existence of such structural and systemic issues makes it impossible for educators to successfully implement STEAM education owing to the resultant influences of educational policy misalignment and misalignment with existing curricula. Literature has also indicated that regions such as the UAE have been keen to foster successful implementation by proposing educational strategies that align with Vision 20230 to help overcome existing

structural barriers that are related to STEAM curricula integration (Maashi, 2022). This would explain why teacher six was keen to point out the need to re-design and contextualize curricula in a manner that would propagate the utilization of more competent implementation models. On the same note, Caton (2021) noted that contextualization should be focused on prevalent cultural norms as well as languages to foster improve learning experiences and educational outcomes.

Synthesis and Broader Implications

This research activity has revealed an astonishing, yet, a profound discovery regarding ECE and the implementation of STEAM education. Notably, the information availed from the analysis of gathered data and available literature has pointed towards the need for a multi-faceted approach. Particularly, institutions involved in STEAM delivery and the accompanying members of staff should be focused on a more collaborative outlook and strategy of STEAM implementation is to be augmented. According to researchers (Gavari-Starkie et al., 2022), this means that it will be essential for policymakers, school principals, and other stakeholders such as parents and surrounding communities to pursue transformational change from a comprehensive systemic point of view. Suh a comprehensive approach will be particularly useful in the Saudi Arabian context where the availability of learning materials is remarkably unequal and cultural diversity requires complex approaches. Given these combined perspectives, the current study will hopefully facilitate the development of STEAM development models that will produce a generation of practical, critical, and innovative individuals.

Generally, the findings of this study are fundamental in that they highlight the following critical essentials.

1. The need for the government, policymakers, institutions, and school administrators to invest heavily in the professional development of STEAM educators.

2. The need for the government of Saudi to ensure adequacy of STEAM learning resources

3. The need to pursue a collaborative approach to STEAM implementation that facilitates barrier removal through the involvement of various stakeholders.

7. Variations in Responses by Geographic Region and Teaching Experience

The individuals interviewed to generate data for this study provided varying responses that seemed to be determined by their working experience as well as their location within Saudi Arabia. Borrowing from the opinion of Herro and Quigley (2017), these differing opinions are reflective of existing issues in resource distribution within Saudi Arabia as well as the underlying developmental needs associated with teachers within the region. This would explain why Riyadh STEAM educators pointed towards the existence of significant systemic and structural barriers amidst adequate resource provision while those from the Najran region were more cognizant of barriers associated with parental and institutional support. In addition, interviewees from Najran reiterated that teachers required individualized professional training to improve their awareness regarding STEAM principles whereas those from Riyadh advocated for measures that would help eliminate schedule-based and time challenges. Given these variations, it is important to refer to the opinion of Sullivan and Bers (2019) that a comprehensive re-designing of existing STEAM models would be more efficient rather than relying on a single approach to successful implementation.

The notion of working experience influencing service delivery among STEAM teachers was also evident among the interviewees. Particularly, the interviewed teachers indicated that the

years they had spent working with STEAM students determined their proficiency in using interactive approaches and instructional materials to improve student learning experiences and outcomes. Corroborating the findings associated with working experience, Clements and Sarama (2014) observed that in the absence of mentorship and training programs that can improve the ability of teachers to deliver, the implementation of STEAM will most likely remain an uphill task. Nonetheless, even teachers that had gained experience in STEAM education reported to have faced difficulties associated with autonomy as well as accompanying institutional barriers. On the same note, Desimone & Garet (2015) argued that paying attention to the precept of augmented teacher experience can help educators to enhance STEAM learning outcomes.

One thing is clear from the notable variations. According to Maashi (2022), such differing observations and findings are indicative of the need to deploy a comprehensive and holistic approach to STEAM implementation. Adding value to this assertion, Nzayisenga et al. (2023) indicated that respect should be paid to the growing and diverse teacher needs to ensure that they are able to implement STEAM curricula in a manner that fosters enhanced student results. This also implies that measures designed to foster successful STEAM implementation should as well be focused on existing institutional infrastructures, educator experiential gaps, and the geographical context within which suggested models will be implemented.

Limitations and Recommendations for Future Research

This study is marked by significant limitations. Given that this study was focused on the Saudi context and has provided insightful information regarding ECE educators in relation to STEAM, the findings may not be generalizable to regions beyond Saudi Arabia. Additionally, the select approach to collect data that relied on a qualitative approach brought on board limitations that cannot be ignored. Chiefly, this is because the data obtained through semi-structured interviews despite being detailed imposes limitations when it comes to study generalizability. As such, it is recommended that quantitative and mixed-method approaches be considered by future researchers to facilitate the acquisition of empirical data and enhance generalizability.

The number of participants utilized in a study can also impose notable limitations. For instance, the researcher opted to collect data from 6 female teachers. Whereas this provided adequate information regarding the phenomenon under study, the demographic reach of the study was limited to the six individuals, which also exerts negative impacts on study generalizability. Further, the study perspectives were void of contributions from the male gender and also failed to capture viewpoints from other important stakeholders such as policy makers. Thus, it is vital that future studies in this area be carried out with a larger sample while simultaneously taking into account contributions from different genders and STEAM stakeholders. More importantly, classroom observations were not included while collecting data. Consequently, future studies should be designed in such a manner as to go past the perceptions of STEAM teachers with emphasis being given to collecting observation-based data to help capture the cognitive and creative aspects associated with STEAM education.

Conclusion

The objective of this study was to investigate the perceptions of early childhood educators in Saudi Arabia regarding the integration of STEAM (Science, Technology, Engineering, Arts, and Mathematics) in early learning environments. The study revealed diverse and useful findings. One of the chief findings was that STEAM plays a significant role in promoting critical thinking among young learners and as well prepares them to undertake science and math-related careers

having been equipped with the ability to solve real-life problems. Unfortunately, the students do not experience STEAM education delivery the same way as their experiences are governed by resource availability depending on institutional commitment towards implementation success. The study has also helped identify the need for collaboration when it comes to STEAM education. Chiefly, the contributions of policymaker's parents, school administrators, communities, and families have been extensively discussed. Further, the study has underscored the need to ensure equitable STEAM student experiences with emphasis being on the provision of teacher training and adequate resources.

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