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A PROPOSED VISION FOR DEVELOPING KINDERGARTEN PROGRAMS IN THE KINGDOM OF SAUDI ARABIA IN LIGHT OF GENERATIVE ARTIFICIAL INTELLIGENCE APPLICATIONS

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ABSTRACT

The study aimed to develop a proposed framework for developing kindergarten programs in the Kingdom of Saudi Arabia in light of generative artificial intelligence applications, through identifying the reality of employing generative artificial intelligence applications in kindergarten programs in the Kingdom of Saudi Arabia, monitoring the most important obstacles, and determining the requirements necessary for development. The current study adopted the descriptive analytical approach and used the questionnaire as a tool for data collection, which was applied to a sample of (384) individuals including kindergarten teachers, educational supervisors, and specialists in early childhood and educational technology in the city of Riyadh in the Kingdom of Saudi Arabia. The study concluded that the reality of employing generative artificial intelligence applications in kindergarten programs came with a mean score of (3.07) and a standard deviation of (0.905), with a moderate degree of estimation. The obstacles to developing kindergarten programs in light of generative artificial intelligence applications came with a mean score of (3.96) and a standard deviation of (0.801), with a high degree of estimation. The requirements for developing kindergarten programs in light of generative artificial intelligence applications came with a mean score of (4.14) and a standard deviation of (0.751), with a high degree of estimation. A proposed framework for developing kindergarten programs in the Kingdom of Saudi Arabia in light of generative artificial intelligence applications was also developed. The study recommended integrating generative artificial intelligence applications gradually and systematically into kindergarten programs, preparing and implementing specialized training programs for teachers to develop their skills in using generative artificial intelligence tools and employing them educationally within classrooms, redesigning kindergarten curricula in line with modern technologies, incorporating interactive educational activities based on generative artificial intelligence, and issuing procedural guides regulating the use of generative artificial intelligence applications in kindergartens in a manner that ensures safe use compatible with educational and societal values.

KEYWORDS: Proposed Framework – Development of Kindergarten Programs – Generative Artificial Intelligence Applications.

1. INTRODUCTION

In recent years, the world has witnessed an accelerating digital revolution led by artificial intelligence applications, particularly generative artificial intelligence, which has become one of the most prominent technological transformations influencing contemporary educational systems.

These applications have contributed to reshaping educational environments and methods through the production of interactive educational content, the design of learning activities, and the customization of learning experiences according to learners' diverse needs. Generative artificial intelligence holds significant potential for improving education quality and learning outcomes, especially in early educational stages that require environments rich in interaction, flexibility, and creativity. Moreover, generative AI applications have become a key element in developing educational practices by providing opportunities for interaction and producing educational resources more efficiently and innovatively (Denny et al., 2024).

Kindergarten programs have received increasing global attention as they represent the foundational stage most influential in shaping a child's personality and developing cognitive, social, and language skills. Contemporary educational trends have emphasized the importance of employing smart technologies at this stage to achieve more engaging and effective learning and to contribute to fostering children's thinking, creativity, and problem-solving skills. In this context, artificial intelligence technologies can bring a qualitative transformation in designing children's learning experiences, supporting teachers, and providing adaptive learning environments that align with the developmental characteristics of this age group (Ljungcrantz, 2026).

With the rapid advancement of generative artificial intelligence applications, educational institutions have begun to employ tools such as ChatGPT and technologies for generating images and digital stories to support personalized learning for children and enhance classroom interaction. Generative AI contributes to producing flexible educational materials that accommodate individual learner differences and provides more engaging learning activities. Additionally, integrating AI applications within kindergarten programs helps enhance creative thinking, environmental awareness, and children's cognitive skills in a more interactive manner (Jauhiainen & Guerra, 2024).

The Saudi education sector is witnessing increasing interest in artificial intelligence applications in line with the objectives of Vision 2030,

which emphasizes the importance of digital transformation and improving education quality. This trend has been reflected in the kindergarten stage as one of the priority levels in building human capital and developing future capabilities. Al-Otaibi's study (2024) revealed a positive attitude toward the use of these applications in the educational process due to their potential to diversify learning activities and increase children's motivation to learn. However, it also pointed to challenges related to digital infrastructure, teacher training, and mechanisms for integrating these applications in an effective pedagogical manner.

Some Saudi studies have also highlighted an urgent need to develop classroom environments and educational programs in kindergarten in line with the requirements of artificial intelligence and its various applications. The successful integration of AI at this stage depends on preparing the educational environment, training teachers, and developing educational content and activities in ways that align with children's developmental characteristics and needs. This confirms that current kindergarten programs require continuous review and development to keep pace with modern technological advancements and to ensure the safe and effective pedagogical use of generative AI applications, contributing to achieving children's future learning goals (Al-Fifi & Al-Jasham, 2024).

Based on the above, the importance of the present study becomes evident, as it seeks to present a proposed framework for developing kindergarten programs in the Kingdom of Saudi Arabia in light of generative artificial intelligence applications, in line with contemporary global educational trends and the requirements of digital transformation in education. The significance of this framework stems from the need to enhance educational programs offered to children in ways that foster creativity, interaction, and personalized learning, support teachers' roles, and contribute to building intelligent learning environments capable of preparing children for the demands of the digital future. This ensures the provision of higher-quality, more flexible, and more efficient kindergarten programs in the era of generative artificial intelligence.

1.1. Study Problem:

In light of the capabilities of generative artificial intelligence applications in producing interactive content, it has become necessary to reconsider kindergarten programs and their delivery methods in a way that aligns with the requirements of digital transformation in education. Al-Qahtani (2024)

emphasized that artificial intelligence applications have become influential educational tools in improving the efficiency of education, as they provide capabilities that support interaction, personalized learning, and the development of learners' thinking skills.

Despite the growing trend toward employing artificial intelligence applications in education in the Kingdom of Saudi Arabia, kindergarten programs still face challenges related to the weak integration of smart technologies in education. Al-Otaibi (2024) revealed a low level of teachers' use of these tools, limited knowledge of modern generative applications, and a gap between rapid technological advancement and actual implementation requirements within kindergarten programs.

Al-Fifi and Al-Jasham (2024) confirmed that the use of artificial intelligence in kindergarten classroom environments faces obstacles related to weak technological infrastructure, a lack of training programs for teachers, insufficient technical readiness in some kindergartens, and an urgent need to develop modern developmental frameworks that support the systematic and safe integration of artificial intelligence technologies in early childhood programs.

Similarly, Abu Al-Ma'arif (2024) demonstrated the effectiveness of artificial intelligence applications in improving children's learning and developing various skills, which reinforces the need to develop kindergarten programs in light of these applications. Al-Naqbi (2024) also indicated that artificial intelligence applications are important tools for supporting children's learning in kindergarten; however, teachers face challenges related to insufficient training, limited technical preparation, and lack of time to effectively employ these applications within classrooms.

Based on the above, there is an urgent need to develop kindergarten programs in the Kingdom of Saudi Arabia in light of generative artificial intelligence applications, in order to improve their quality, enhance interaction and personalized learning for children, and develop their future skills, while supporting teachers with the necessary digital competencies to employ these applications in an effective educational manner. The research problem is further highlighted by the limited contemporary educational frameworks addressing the development of kindergarten programs in light of generative artificial intelligence applications, despite the national orientation toward digital transformation and the achievement of Saudi Vision 2030 objectives in developing education and building

a knowledge-based economy grounded in innovation and modern technology.

1.2. Study Questions:

This study seeks to answer the following questions:

1. What is the current reality of employing generative artificial intelligence applications in kindergarten programs in the Kingdom of Saudi Arabia?
2. What are the obstacles that may face the development of kindergarten programs in the Kingdom of Saudi Arabia in light of generative artificial intelligence applications?
3. What are the requirements needed to develop kindergarten programs in the Kingdom of Saudi Arabia in light of generative artificial intelligence applications?
4. What is the proposed framework for developing kindergarten programs in the Kingdom of Saudi Arabia in light of generative artificial intelligence applications?

1.3. Study Objectives:

The study aims to achieve the following objectives:

1. To identify the current reality of employing generative artificial intelligence applications in kindergarten programs in the Kingdom of Saudi Arabia.
2. To identify the obstacles that may face the development of kindergarten programs in the Kingdom of Saudi Arabia in light of generative artificial intelligence applications.
3. To determine the requirements needed to develop kindergarten programs in the Kingdom of Saudi Arabia in light of generative artificial intelligence applications.
4. To develop a proposed framework for improving kindergarten programs in the Kingdom of Saudi Arabia in light of generative artificial intelligence applications.

Significance of the Study:

The significance of the present study is divided into two main dimensions

Theoretical Significance:

1. The study contributes to enriching the educational literature related to the development of kindergarten programs in light of generative artificial intelligence applications, which is considered a relatively recent topic that still requires further research and investigation.

2. The study derives its importance from the significance of the kindergarten stage as a

foundational period in shaping the child's personality and developing their cognitive, linguistic, and social abilities, making the development of its educational programs an educational necessity aligned with contemporary digital transformations.

3. The study provides a conceptual and knowledge-based framework regarding generative artificial intelligence applications and their potential use in early childhood programs, which may assist researchers and practitioners in understanding the educational and technological dimensions of this field.

4. The study aligns with modern trends and the Saudi Vision 2030, which emphasizes the importance of digital transformation and the use of artificial intelligence applications in education to improve the quality of its outcomes.

1.4. Practical Significance:

1. The study may contribute to presenting a proposed framework for developing kindergarten programs in the Kingdom of Saudi Arabia in light of generative artificial intelligence applications, which can assist decision-makers and specialists in improving educational programs offered to children.

2. The findings may benefit those responsible for designing kindergarten curricula and programs by supporting the development of more interactive and flexible educational activities based on generative artificial intelligence applications.

3. The study helps identify the technical, human, and organizational requirements necessary for the effective and safe integration of generative artificial intelligence applications within kindergarten environments.

4. The study may contribute to guiding teacher preparation and training programs for kindergarten educators by enhancing their digital skills and strengthening their ability to use generative artificial intelligence applications in the educational process.

5. The results of the study may assist educational authorities and policymakers in developing future plans and strategies that support the integration of generative artificial intelligence applications in early childhood education, thereby improving educational quality and enhancing children's future skills.

1.5. Study Delimitations:

The present study is limited to the following boundaries:

1. Subject Boundaries: The study is limited to presenting a proposed framework for developing

kindergarten programs in the Kingdom of Saudi Arabia in light of generative artificial intelligence applications, in terms of requirements, obstacles, and educational and technological development mechanisms related to early childhood programs.

2. Human Boundaries: The study is limited to a sample of kindergarten teachers, educational supervisors, and some specialists in early childhood education and educational technology in the Kingdom of Saudi Arabia.

3. Spatial Boundaries: The field study instrument was administered in kindergarten institutions in the city of Riyadh, Kingdom of Saudi Arabia.

4. Temporal Boundaries: The study instrument was applied during the second semester of the academic year 1446/1447 AH.

1.6. Study Terms:

Kindergarten Programs: Kindergarten programs are defined as: "a set of organized educational and instructional activities provided to children in the pre-school stage aimed at achieving the child's holistic development in cognitive, linguistic, physical, social, and emotional domains, according to educational and psychological foundations that are appropriate to the characteristics of this developmental stage" (Mohammed, 2021, p. 406).

They are also defined as: "an integrated educational system that includes objectives, content, activities, teaching methods, and assessment approaches, designed in an organized manner to equip kindergarten children with knowledge, skills, and values appropriate to their abilities and developmental needs, while taking into account modern educational quality standards" (Abdulsalam, 2021, p. 217).

In this study, kindergarten programs are operationally defined as: a set of organized educational, instructional, and technological activities and experiences provided to kindergarten children in the Kingdom of Saudi Arabia, which are developed in light of generative artificial intelligence applications, with the aim of fostering children's cognitive, linguistic, social, and creative development through interactive learning environments that consider their developmental characteristics and educational needs.

1.7. Generative Artificial Intelligence Applications:

Generative artificial intelligence applications are defined as: "a set of software and digital tools based on artificial intelligence technologies capable of

automatically producing new content, such as texts, images, audio, video, and educational presentations, relying on data analysis and deep learning, thereby contributing to supporting teaching and learning processes and improving the efficiency of educational performance" (Suleiman, 2024, p. 4).

They are also defined as: "intelligent systems that rely on advanced generative models to create interactive and personalized educational content for learners, such as generating instructional texts, designing activities, and producing images and multimedia, thereby enhancing interaction and personalized learning within the educational environment" (Al-Hadi, 2024, p. 11).

Artificial intelligence applications are also defined as a set of computer programs and systems that rely on advanced algorithms and techniques such as machine learning and natural language processing to analyze data and learn from it, and then perform tasks or make decisions in a way that simulates human cognitive abilities, thereby contributing to improving performance efficiency in various fields, including education (ElShaer, 2023).

In this study, generative artificial intelligence applications are operationally defined as: a set of smart digital tools and applications that rely on generative AI technologies, such as chatbots and systems for generating texts, images, and educational activities, which can be employed in developing kindergarten programs in the Kingdom of Saudi Arabia. The aim is to improve the quality of learning experiences, increase interaction, and develop children's skills in a manner appropriate to the characteristics of early childhood.

1.8. Theoretical Framework of the Study:

The use of artificial intelligence technologies in children's education is considered one of the emerging trends that has gained strong momentum in the field of digital education in recent years. These technologies contribute to a qualitative transformation in teaching and learning methods in early childhood education, as it is a foundational educational stage that requires interactive learning environments that take into account children's developmental characteristics and diverse needs.

Generative artificial intelligence applications contribute to designing innovative learning activities, producing stories, images, and interactive media, and providing more engaging and flexible learning experiences, thereby enhancing children's motivation to learn and developing their cognitive, creative, and social skills. These applications also assist teachers in planning educational activities and

tailoring learning experiences according to individual differences among children, making them one of the promising modern trends in developing kindergarten programs (Cimino et al., 2025). Accordingly, this section addresses the theoretical foundations related to generative artificial intelligence applications in kindergarten programs.

1.9. Generative Artificial Intelligence Applications in Kindergarten Programs:

The rapid development of artificial intelligence technologies has led to the emergence of modern educational applications that contribute to improving the quality of the educational process and providing more interactive, flexible, and personalized learning environments that respond to learners' diverse needs. Ahmed (2023) confirmed that generative artificial intelligence applications have become one of the modern trends in educational technology, due to their significant potential in designing educational content, producing interactive media, and supporting personalized learning within the educational environment.

Accordingly, the importance of employing generative artificial intelligence applications in kindergarten programs has emerged, given their role in providing more engaging and stimulating learning experiences for children through digital stories, interactive images, intelligent educational games, voice-based interactions, and simulation-based activities (Al-Qaddah, 2024). These applications also help address individual differences among children by providing learning experiences that match their abilities and needs, thereby improving learning outcomes and developing their thinking and creativity skills (Yang et al., 2025). Al-Otaibi (2024) indicated that the use of generative artificial intelligence tools in early childhood enhances interaction within the classroom environment, increases children's motivation to learn, and provides teachers with greater opportunities to diversify educational activities and develop modern teaching practices.

There is a wide range of generative artificial intelligence applications used in kindergarten programs, including educational story-generation tools, image and illustration design tools, interactive educational games, intelligent chatbots, and voice assistants, in addition to augmented reality and virtual reality applications supported by artificial intelligence (Cai et al., 2025). These applications contribute to increasing children's engagement and interaction during learning and help develop their linguistic, cognitive, social, and creative skills

(Mishal & Al-Eid, 2023). Samaha (2024) demonstrated the effectiveness of AI applications, such as TinyTap, in developing cognitive skills among children under the age of six, showing a significant improvement in their cognitive abilities after using the application, which highlights the importance of smart applications in supporting early childhood learning.

Generative artificial intelligence applications also contribute to supporting teachers and improving their professional performance in kindergarten programs by assisting them in preparing learning activities, designing interactive teaching aids, and planning educational situations in more flexible and innovative ways (Kölemen & Yıldırım, 2025). These applications also provide tools that help teachers monitor children's progress and assess their performance continuously and in real time (Abdel-Azim, 2025). Ibrahim et al. (2024) emphasized the importance of training teachers to use modern AI applications effectively within the classroom and the need for continuous training programs that enhance their digital competencies.

Recent literature also indicates that educational robots are among the most important artificial intelligence applications used in early childhood education, as they can be used to deliver interactive learning activities that help children develop logical and computational thinking skills through direct interaction with robots (Liu et al., 2025). Some studies have shown that educational robots contribute to developing problem-solving and analytical thinking skills in children and help them understand basic programming concepts in a simplified and engaging manner (Hijón-Neira et al., 2024).

Another emerging trend in AI-supported early childhood education is the use of artificial intelligence systems for analyzing children's learning behavior. Some modern systems rely on computer vision and data analytics to monitor children's engagement and interaction during learning activities, helping teachers understand learning patterns and provide appropriate support. These systems also enable the development of more effective learning environments based on continuous educational data analysis (Penchala et al., 2025).

Artificial intelligence technologies also contribute to the development of digital educational content for children, where intelligent models can be used to produce educational stories and interactive activities appropriate for the developmental characteristics of preschool children (Nikolopoulou, 2025). Recent studies have indicated that the use of large language models can help teachers design simplified

educational content that explains scientific concepts to children in a way that matches their cognitive abilities, thereby enhancing their understanding of scientific topics at an early age (Bush & Alibakhshi, 2025).

Furthermore, a number of researchers emphasize that education in the age of artificial intelligence is not limited to using smart applications alone, but also includes developing what is known as "AI literacy" among children. This refers to introducing children to basic AI concepts in a simplified manner, such as how intelligent systems work and how they make decisions. Recent scientific reviews have shown that integrating AI concepts into children's curricula can help prepare them to engage with advanced digital technologies in the future (Su et al., 2023).

Despite the significant potential of artificial intelligence in children's education, studies have highlighted the importance of considering ethical and educational dimensions when using these technologies in early childhood. It is essential to ensure the safe use of AI in a way that protects children's privacy and personal data, as well as maintaining a balance between technology use and social and physical activities, which are essential for children's development at this stage (Cimino et al., 2025).

Studies have also indicated several challenges that may hinder the effective use of these technologies in educational environments, including weak technological infrastructure in some kindergartens, a lack of training programs for teachers, and limited awareness of the importance of AI applications (Yu, Hou, & Li, 2025). Al-Fifi and Al-Jasham (2024) also found that insufficient technological equipment and inadequate specialized training require the development of the educational environment and the provision of necessary technical and human support to ensure the success of AI applications in early childhood education.

The successful implementation of generative artificial intelligence applications in kindergarten programs requires the availability of several educational, technical, and organizational requirements, most notably the development of curricula and learning activities aligned with modern technologies, the provision of smart learning environments, teacher training, and the establishment of ethical guidelines governing the use of these applications with children (Pellegrini & Di Paola, 2025). Habib (2025) emphasized the importance of building a forward-looking vision for employing artificial intelligence applications in kindergarten in light of contemporary digital

transformations, highlighting the need to develop kindergarten environments in line with modern trends in smart education and to help prepare children capable of engaging with the demands of the digital future.

Based on the above, it is evident that generative artificial intelligence applications represent a promising modern trend in developing kindergarten programs, due to their potential to improve educational quality, develop children's skills, and enhance interaction and personalized learning within the educational environment. However, the effective use of these applications requires the development of educational programs, teacher training, and the provision of supportive technological and educational environments, in order to achieve early childhood education goals and align with the digital transformation trends and Saudi Vision 2030 in developing education and building a knowledge-based society grounded in innovation and modern technology.

2. PREVIOUS STUDIES:

Al-Otaibi (2024) aimed to identify the current reality of employing generative artificial intelligence tools in early childhood education. The study adopted the descriptive-analytical approach using a questionnaire administered to a sample of 35 teachers. The findings revealed that the level of employing AI tools in early childhood education, as well as teachers' knowledge of these tools, was moderate. This highlights the need to provide adequate training for teachers and to develop infrastructure compatible with these smart technologies.

Hijón-Neira et al. (2024) sought to investigate the impact of using AI-based educational contexts in teaching educational robotics and developing computational thinking among children. The study employed an experimental approach using tests to measure computational thinking skills and questionnaires to assess attitudes toward the use of educational robotics. The sample consisted of participants in early childhood teacher preparation programs at a Spanish university. The results showed that integrating AI in designing learning activities contributed to developing computational and creative thinking among participants and enhanced their acceptance of using educational robotics in teaching children.

Su & Yang (2024) aimed to examine the effect of an educational program based on artificial intelligence concepts in developing AI-related creativity among kindergarten children. The study

used a quasi-experimental design, and the instruments included an AI-related creativity scale. The sample consisted of 26 kindergarten children with an average age of 4 years in Hong Kong. The results showed that children were able to understand basic AI concepts, and the program contributed to enhancing their creative abilities, as they designed innovative ideas for smart robots and envisioned future smart cities.

Pellas & Kazanidis (2024) aimed to explore the impact of generative AI applications on developing digital learning skills and creativity in digital learning environments. The study used a comparative approach, and the tools included questionnaires measuring digital learning and creativity skills, in addition to performance analysis during digital learning activities. The sample included students from various disciplines, including early childhood education programs. The results indicated that generative AI tools enhance interaction with learning content and develop creative thinking by providing interactive environments that allow learners to generate ideas and design digital content in innovative ways.

Chen (2025) aimed to explore the role of artificial intelligence in providing personalized learning experiences for early childhood learners. The study adopted a descriptive-analytical approach, using literature analysis and analysis of AI-based educational programs and smart learning applications for children. The findings showed that AI-based educational systems contribute to providing personalized learning tailored to children's abilities and needs, enhancing their motivation to learn, developing cognitive and creative skills, and supporting communication and collaboration within the learning environment.

Sapounidis et al. (2025) aimed to analyze the impact of using programmable robots on developing motor creativity in preschool children. The study used a quasi-experimental approach, with tools including a motor creativity test and performance observation during learning activities. The sample consisted of preschool children participating in an educational program based on educational robotics. The results revealed a statistically significant improvement in children's motor creativity after implementing the program, confirming that smart technologies and educational robots enhance creativity and innovative thinking during learning.

Al-Ahmadi and Al-Arifi (2025) conducted a study aimed at examining the effectiveness of using an AI-based application in developing some social skills among early childhood children. The study

employed both descriptive-analytical and quasi-experimental approaches using a pre- and post-test design for two groups. The sample consisted of 20 preparatory-level children. The study used the AI-based application Color Pop as the experimental treatment and a pictorial social skills scale for children. The results demonstrated the positive effectiveness of the Color Pop application in developing some social skills among early childhood children compared to traditional methods.

2.1. Commentary on Previous Studies:

First: Similarities: The present study shares similarities with previous studies in its focus on the kindergarten stage and its emphasis on artificial intelligence applications in the educational environment. It also aligns with them in highlighting the importance of smart technologies in developing the educational process and enhancing children's various skills. Furthermore, the present study is consistent with Al-Otaibi (2024) in addressing the current reality of artificial intelligence use in early childhood education. It also aligns with Al-Ahmadi and Al-Arifi (2025) in focusing on the impact of smart applications on developing different aspects of children's learning, and with Chen (2025) in emphasizing the role of artificial intelligence in promoting personalized learning and improving learning experiences within educational environments. In addition, it converges with Hijón-Neira et al. (2024) and Su & Yang (2024) in highlighting the role of artificial intelligence in designing educational activities.

Second: Differences: The present study differs from Al-Otaibi (2024), which focused on identifying the current reality of using generative artificial intelligence tools among early childhood teachers, whereas the present study seeks to propose an integrated framework for developing kindergarten programs in light of these applications. It also differs from Hijón-Neira et al. (2024), which focused on using artificial intelligence in teaching robotics and developing computational thinking among participants in teacher preparation programs. Similarly, it differs from Su & Yang (2024), which adopted a quasi-experimental approach, while the present study relies on the descriptive-analytical method. It also differs from Pellas & Kazanidis (2024), which focused on developing digital learning and creativity skills among learners in digital environments, whereas the present study focuses on identifying the requirements and obstacles for developing kindergarten programs in light of generative artificial intelligence applications.

Third: Utilization of Previous Studies: The present study benefited from previous studies in several aspects, including building the theoretical framework, defining the research problem and questions, and formulating the study instrument and its dimensions. It also benefited from the findings and recommendations of those studies in developing the proposed framework. In addition, previous studies helped identify the research gap, which lies in the need to present an integrated framework for developing kindergarten programs in the Kingdom of Saudi Arabia in light of generative artificial intelligence applications.

3. METHODOLOGY AND PROCEDURES OF THE STUDY:

Research Methodology: The present study adopted the descriptive-analytical approach due to its suitability for the nature and objectives of the study. This approach is one of the most commonly used methods in educational research, as it aims to describe phenomena, analyze them, identify their current status, and examine relationships among their components, ultimately leading to the development of appropriate frameworks or improvement proposals. This methodology is based on collecting data and information related to the current status of generative artificial intelligence applications in kindergarten programs in the Kingdom of Saudi Arabia, analyzing and interpreting them scientifically. This is done in order to identify the requirements and challenges associated with the use of these applications, and subsequently develop a proposed framework for improving kindergarten programs in light of generative artificial intelligence applications, in line with contemporary educational trends and the requirements of digital transformation in education.

3.1. Study Population:

The population of the present study consists of all kindergarten teachers and educational supervisors specializing in early childhood education in both public and private kindergartens in the Kingdom of Saudi Arabia. This is due to their direct involvement in implementing kindergarten programs and using modern educational technologies within classroom environments. In addition, the population includes a number of specialists in early childhood education and educational technology, to benefit from their expertise in identifying the requirements for developing kindergarten programs in light of generative artificial intelligence applications, as well as the challenges associated with their

implementation.

3.2. Study Sample:

The study sample was selected using a stratified random sampling technique to ensure appropriate representation of all categories within the study population. The sample included kindergarten teachers, educational supervisors, and specialists in

early childhood education and educational technology in the Kingdom of Saudi Arabia. The sample size was determined based on the Krejcie and Morgan (1970) formula at a significance level of (0.05) and a confidence level of (95%). Accordingly, the total sample size was (384) participants, distributed across the study categories as shown in the following table:

Table 1: Distribution of the Study Sample.

No.	Sample Category	Frequency	Percentage
1	Kindergarten Teachers	300	78.1%
2	Educational Supervisors	54	14.1%
3	Early Childhood Education and Educational Technology Specialists	30	7.8%
Total		384	100%

It is evident from the previous table that the largest proportion of the study sample consisted of kindergarten teachers, with a total of (300) teachers representing (78.1%). This is attributed to their direct involvement in implementing educational programs within kindergarten environments and their frequent interaction with the use of generative artificial intelligence applications in daily learning activities. Meanwhile, educational supervisors accounted for (14.1%) of the sample, with a total of (54) supervisors, in order to benefit from their supervisory and developmental expertise in evaluating the current state of educational programs and identifying requirements for their improvement. The sample also included (30) specialists in early childhood education and educational technology, representing (7.8%), to benefit from their specialized perspectives on the technical and pedagogical aspects related to generative artificial intelligence applications. This distribution reflects the diversity of the sample

categories, ensuring appropriate representation of the study population and contributing to more accurate and objective results.

3.3. Study Instrument and Procedures:

The study relied on a questionnaire as the primary tool for data collection, due to its suitability for the nature and objectives of the study. It was designed to explore the current reality of generative artificial intelligence applications in kindergarten programs in the Kingdom of Saudi Arabia, the requirements necessary for their development, and the obstacles that may hinder this development from the perspective of the study sample. The questionnaire was developed in light of relevant educational literature and previous studies. It consisted of several dimensions covering the different aspects of the study, ensuring a comprehensive examination of the research variables.

Table 2: Dimensions of the Study Instrument.

No.	Dimension	Number of Items
1	The Current Reality of Employing Generative Artificial Intelligence Applications in Kindergarten Programs	10
2	Obstacles to Developing Kindergarten Programs in Light of Generative Artificial Intelligence Applications	10
3	Requirements for Developing Kindergarten Programs in Light of Generative Artificial Intelligence Applications	10
Total		30

3.4. Validity of the Study Instrument:

To ensure the face validity of the study instrument, it was presented to a group of experts and specialists in the relevant field. Based on their feedback, necessary modifications were made, including rephrasing several items. Ultimately, a total of (30) statements were agreed upon in the final

version of the questionnaire. In addition, internal consistency validity was examined by calculating Pearson correlation coefficients between the score of each item and the total score of the dimension to which it belongs. The following table presents the correlation values of the items included in the final version of the questionnaire with their corresponding overall dimensions.

Table 3: Pearson Correlation Coefficients Between Each Item and the Total Score of Its Dimension.

Dimension	Item	Correlation Coefficient	Item	Correlation Coefficient
The Current Reality of Employing Generative Artificial Intelligence Applications in Kindergarten Programs	1	0.69**	6	0.64**
	2	0.67**	7	0.72**

	3	0.75**	8	0.76**
	4	0.73**	9	0.66**
	5	0.81**	10	0.74**
Obstacles to Developing Kindergarten Programs in Light of Generative Artificial Intelligence Applications	1	0.69**	6	0.64**
	2	0.67**	7	0.72**
	3	0.75**	8	0.76**
	4	0.73**	9	0.66**
	5	0.81**	10	0.74**
Requirements for Developing Kindergarten Programs in Light of Generative Artificial Intelligence Applications	1	0.71**	6	0.71**
	2	0.75**	7	0.67**
	3	0.67**	8	0.75**
	4	0.71**	9	0.71**
	5	0.75**	10	0.67**

Note: Correlation is significant at the 0.01 level (2-tailed).

It is evident from the previous table that all Pearson correlation coefficients between each item of the questionnaire and the total score of its corresponding dimension were statistically significant at the significance level ($\alpha \leq 0.05$). This indicates that the instrument has a high degree of

internal consistency validity.

Reliability of the Study Instrument: The reliability of the study instrument was assessed using Cronbach's Alpha coefficient. The following table presents the reliability coefficients of the questionnaire:

Table (4): Internal Consistency Reliability Coefficients (Cronbach's Alpha) of the Questionnaire According to Its Dimensions.

No.	Scale Dimensions	Number of Items	Reliability Coefficient (Cronbach's Alpha)
1	The Current Reality of Employing Generative Artificial Intelligence Applications in Kindergarten Programs	10	0.89
2	Obstacles to Developing Kindergarten Programs in Light of Generative Artificial Intelligence Applications	10	0.87
3	Requirements for Developing Kindergarten Programs in Light of Generative Artificial Intelligence Applications	10	0.91
Overall Reliability of the Study Instrument (Questionnaire Dimensions)	30	0.90	

It is evident from Table (4) that the Cronbach's Alpha reliability coefficients for the sub-dimensions ranged between (0.87) and (0.91), while the overall reliability coefficient for the scale reached (0.90). These values are considered high and exceed the acceptable educational threshold of (0.70), indicating that the instrument has a high degree of internal consistency and reliability. This confirms its suitability for application to the current study sample and supports the validity of relying on its results.

4. STATISTICAL ANALYSIS METHODS:

After collecting the data from the study sample through the questionnaire, the responses were coded and statistically analyzed using the Statistical Package for the Social Sciences (SPSS). A set of appropriate statistical methods was employed in accordance with the nature and objectives of the study, as follows:

1. Pearson Correlation Coefficient: to verify the internal consistency validity between the items and their corresponding dimensions.
2. Cronbach's Alpha Coefficient: to ensure the

reliability of the scale and its internal consistency.

3. Frequencies and Percentages: to determine the level of responses of the study sample to the questionnaire items.

4. Means (Arithmetic Averages): to identify the degree of agreement of the respondents with the items and dimensions of the questionnaire.

5. Standard Deviations: to measure the degree of dispersion of respondents' answers around the mean.

6. Ranking of items and dimensions in descending order according to their means: to identify the most important items from the respondents' perspective.

Study Results, Discussion, and Interpretation

Presentation, Discussion, and Interpretation of the First Research Question Results: The first research question stated: "What is the current reality of employing generative artificial intelligence applications in kindergarten programs in the Kingdom of Saudi Arabia?"

To answer this question, arithmetic means and

standard deviations were calculated for the following table:
questionnaire items. The results are presented in the

Table (5): Means and Standard Deviations of the Study Sample's Responses Regarding the Reality of Employing Generative Artificial Intelligence Applications in Kindergarten Programs.

No.	Statement	Mean	Standard Deviation	Rank	Level of Agreement
4	Generative AI applications (such as image and story generation programs) are used to design interactive educational activities for children.	3.30	0.861	1	Moderate
1	AI technologies are relied upon in preparing visual and audio educational materials for the kindergarten environment.	3.27	0.871	2	Moderate
2	Teachers utilize voice-generation tools to produce songs and audio stories linked to educational units.	3.21	0.881	3	Moderate
7	Generative AI applications contribute to the flexible development of daily lesson plans and weekly activities.	3.14	0.891	4	Moderate
9	AI tools are used to design training programs or educational games tailored to children's levels.	3.10	0.899	5	Moderate
6	These applications help teachers generate innovative ideas for solving children's learning and behavioral problems.	3.06	0.907	6	Moderate
3	Generative AI is utilized in preparing periodic reports on the assessment of children's academic and skill performance.	3.02	0.913	7	Moderate
10	There are actual experiences and practices in kindergartens that integrate intelligent generation tools within cognitive or language-learning corners.	2.92	0.925	8	Moderate
5	Smart applications are used to design communication forms and effectively share daily activities with parents.	2.88	0.933	9	Moderate
8	Kindergarten administrations encourage teachers to experiment with intelligent assistants (ChatGPT) in the classroom environment.	2.84	0.941	10	Moderate
Overall Mean		3.07	0.905		Moderate

It is evident from the results that the overall mean score of the study sample responses regarding the reality of employing generative artificial intelligence applications in kindergarten programs was (3.07) with a standard deviation of (0.905), indicating a moderate level of agreement. This finding suggests that the use of generative artificial intelligence applications in kindergarten programs in the Kingdom of Saudi Arabia is still at a moderate level, reflecting the presence of existing practices and applications; however, they have not yet reached a fully integrated and systematic level across all kindergarten settings.

The results also showed that the highest-rated item was Item (4), which states: "Generative artificial intelligence applications (such as image and story generation tools) are used in designing interactive educational activities for children," with a mean score of (3.30) and a standard deviation of (0.861), ranking first at a moderate level. This was followed by Item (1) with a mean of (3.27), and Item (2) with a mean of (3.21). It is notable that these items are directly related to the design of learning activities and educational materials, indicating that the most prominent uses of generative AI in kindergarten are concentrated in applied aspects related to content preparation and the production of interactive learning resources.

In contrast, the lowest-rated item was Item (8), which states: "The kindergarten administration

encourages teachers to experiment with AI chatbots (such as ChatGPT) in the classroom environment," with a mean of (2.84), followed by Item (5) with a mean of (2.88), and Item (10) with a mean of (2.92). Although these items also fell within the moderate range, they were relatively lower in comparison. This indicates a relative weakness in administrative support and institutional encouragement for the use of generative artificial intelligence applications, as well as limited structured experimental practices in some kindergartens.

This variation among items can be interpreted as indicating that the use of generative AI applications in kindergarten is still in an exploratory and partial implementation stage, where usage is largely driven by individual efforts of some teachers in designing activities and instructional materials. Meanwhile, institutional support and organizational planning for the use of these technologies still require further development. This may also be attributed to the relatively recent integration of generative artificial intelligence technologies in early childhood education environments, limited specialized teacher training, and the need for clear policies regulating the use of such technologies in kindergartens.

Accordingly, these findings reflect a positive trend toward the use of generative artificial intelligence applications in kindergarten programs; however, this trend remains at a moderate level and requires further development through strengthening

digital infrastructure, intensifying training programs, and encouraging effective and systematic use of these applications to achieve full integration within the educational process.

These results are consistent with Al-Otaibi (2024), who found that the reality of using generative artificial intelligence tools in early childhood education was at a moderate level. They also align with Chen (2025) and Pellas & Kazanidis (2024), who emphasized the importance of AI applications in designing interactive learning activities and enhancing engagement with digital content. Furthermore, they are consistent with Hijón-Neira et al. (2024), Su & Yang (2024), Sapounidis et al. (2025), and Al-Ahmadi and Al-Arifi (2025), all of which highlighted the role of artificial intelligence

applications in supporting learning and enhancing creativity and interaction among children.

Presentation, Discussion, and Interpretation of the Second Research Question Results

The second study question stated: "What are the obstacles that may face the development of kindergarten programs in the Kingdom of Saudi Arabia in light of generative artificial intelligence applications?"

To answer this question, arithmetic means and standard deviations were calculated for the questionnaire items. The results are presented as follows:

Table (6): Means and Standard Deviations of the Study Sample's Responses Regarding the Obstacles to Developing Kindergarten Programs in Light of Generative Artificial Intelligence Applications.

No.	Statement	Mean	Standard Deviation	Rank	Level of Agreement
3	Kindergarten teachers have limited awareness of the mechanisms and guidelines for using generative AI tools within educational curricula.	4.14	0.753	1	High
5	There is a shortage of specialized training programs on integrating modern generative technologies into early childhood education.	4.10	0.763	2	High
8	Weak technological infrastructure in kindergartens (such as internet speed and the availability of sufficient smart devices).	4.05	0.775	3	High
10	Concerns related to data security, children's privacy, and the protection of their digital identity when using AI applications.	4.01	0.783	4	High
4	The lack of fully Arabic generative applications that are suitable for the psychological characteristics of kindergarten children in the Kingdom.	3.96	0.791	5	High
6	The absence of standardized official procedural guidelines for the implementation of AI in kindergarten education.	3.92	0.799	6	High
9	Concerns that increased reliance on smart screens may weaken children's social and motor skills.	3.88	0.807	7	High
7	The high financial cost of subscribing to advanced paid versions of professional generative AI programs.	3.86	0.811	8	High
1	Resistance to change among some administrators or teachers and adherence to traditional teaching and assessment methods.	3.86	0.815	9	High
2	The possibility of generating digital content (stories or images) that may not align with the cultural and religious values of Saudi society.	3.82	0.821	10	High
Overall Mean		3.96	0.801		High

Presentation, Discussion, and Interpretation of the Second Research Question Results:

The second research question stated: "What are the obstacles that may face the development of kindergarten programs in the Kingdom of Saudi Arabia in light of generative artificial intelligence applications?"

To answer this question, arithmetic means and standard deviations were calculated for the questionnaire items. The results are presented as follows:

It is evident from the results that the overall mean score of the study sample responses regarding the obstacles facing the development of kindergarten

programs in light of generative artificial intelligence applications was (3.96) with a standard deviation of (0.801), indicating a high level of agreement. This suggests that respondents perceive a set of clear obstacles that may hinder the development of kindergarten programs in light of generative artificial intelligence applications in the Kingdom of Saudi Arabia, and that these obstacles represent a real challenge that must be addressed prior to broader implementation.

The results also showed that the most significant obstacle was Item (3), which states: "Weak awareness among kindergarten teachers of the mechanisms and guidelines for using generative artificial intelligence tools within curricula," with a mean score of (4.14) and a standard deviation of

(0.753), ranking first at a high level. This was followed by Item (5) with a mean of (4.10), and Item (8) with a mean of (4.05). This indicates that the most prominent obstacles are related to human and training aspects, particularly the lack of awareness and necessary skills among teachers to use generative artificial intelligence applications effectively within kindergarten environments.

In contrast, the relatively lowest-rated obstacle was Item (2), which states: "The possibility of generating digital content (stories or images) that is not consistent with the cultural and religious values of Saudi society," with a mean of (3.82). This was followed by Items (1) and (7), both with a mean of (3.86). Although these were the lowest among the listed obstacles, they still fall within a high level of agreement, reflecting continued concern among respondents regarding ethical, cultural, and financial issues associated with the use of these technologies.

This variation can be interpreted as indicating that the most pressing obstacles are related to professional and technical dimensions, such as insufficient training, limited awareness, and weak digital infrastructure—factors that directly affect teachers' ability to employ generative artificial intelligence in classroom settings. In contrast, the relatively less severe obstacles are associated with ethical or organizational issues, which, despite their importance, are more manageable through the development of clear educational policies and regulations.

These findings suggest that the successful development of kindergarten programs in light of generative artificial intelligence applications requires a comprehensive response to these challenges through investing in human capital development, improving digital infrastructure, establishing clear

regulatory guidelines, and enhancing ethical and pedagogical awareness regarding the use of these technologies. This would ensure optimal utilization without negatively affecting children's developmental characteristics or societal values.

These results are consistent with Al-Otaibi (2024), who highlighted that one of the main challenges facing the use of artificial intelligence tools in early childhood education is the lack of teacher training and the need for adequate infrastructure. They also align with Chen (2025), who emphasized the importance of providing supportive educational and technological environments for AI applications in early childhood education, and with Pellas & Kazanidis (2024), who stressed that successful implementation of AI applications depends on the availability of digital skills and appropriate interactive learning environments. Furthermore, the findings are consistent with Hijón-Neira et al. (2024), Su & Yang (2024), Sapounidis et al. (2025), and Al-Ahmadi and Al-Arifi (2025), all of which confirm that although artificial intelligence applications have strong educational potential, their effective use requires adequate technical and pedagogical preparation.

Presentation, Discussion, and Interpretation of the Third Research Question Results:

The third research question stated: "What are the requirements needed to develop kindergarten programs in the Kingdom of Saudi Arabia in light of generative artificial intelligence applications?"

To answer this question, arithmetic means and standard deviations were calculated for the questionnaire items. The results are presented as follows:

Table (7): Means and Standard Deviations of the Study Sample's Responses Regarding the Requirements for Developing Kindergarten Programs in Light of Generative Artificial Intelligence Applications.

No.	Statement	Mean	Standard Deviation	Rank	Level of Agreement
4	Updating kindergarten curricula (such as the <i>Rawdati</i> platform curricula) to include AI-supported interactive activities.	4.28	0.713	1	Very High
2	Equipping kindergartens with advanced technological environments, including interactive screens and secure smart connectivity systems.	4.24	0.719	2	Very High
3	Providing incentives and rewards (material and moral) for teachers who excel in creating innovative digital initiatives in kindergartens.	4.22	0.727	3	Very High
1	Incorporating AI skills and applications into the preparation programs of kindergarten teachers in Saudi universities.	4.20	0.733	4	Very High
7	Supporting strategic partnerships with Saudi technology companies to develop local generative applications that align with children's developmental characteristics.	4.16	0.741	5	High
9	Developing a clear policy and ethics framework to regulate the use of generative AI in the early childhood education sector.	4.12	0.753	6	High
6	Establishing technical committees within educational administrations to review AI-generated digital content and ensure its intellectual and educational appropriateness.	4.10	0.759	7	High

10	Providing continuous and specialized training programs to enhance teachers' digital competencies, particularly in prompt engineering.	4.06	0.765	8	High
5	Raising parents' awareness of the importance of generative AI in education and how to guide children in its responsible use at home.	4.02	0.773	9	High
8	Ensuring flexibility in kindergarten administrative and regulatory policies to allow the experimentation, adoption, and continuous updating of intelligent learning tools.	4.00	0.779	10	High
Overall Mean		4.14	0.751		

Presentation, Discussion, and Interpretation of the Third Research Question Results:

The third research question stated: "What are the requirements needed to develop kindergarten programs in the Kingdom of Saudi Arabia in light of generative artificial intelligence applications?"

To answer this question, arithmetic means and standard deviations were calculated for the questionnaire items. The results are presented as follows:

It is evident from the results that the overall mean score of the study sample responses regarding the requirements for developing kindergarten programs in light of generative artificial intelligence applications was (4.14) with a standard deviation of (0.751), indicating a high level of agreement. This reflects a clear consensus among respondents on the importance of providing a set of essential requirements for developing kindergarten programs in line with the use of generative artificial intelligence applications, in a way that supports the quality of the educational process at this early stage.

The results also showed that the most important requirement was Item (4), which states: "Updating kindergarten curricula (such as the Riyadh platform curriculum) to include interactive activities supported by artificial intelligence," with a mean score of (4.28) and a standard deviation of (0.713), ranking first at a very high level. This was followed by Item (2) with a mean of (4.24), Item (3) with a mean of (4.22), and Item (1) with a mean of (4.20). It is noticeable that these requirements primarily focus on developing the educational, curricular, and technological infrastructure, in addition to teacher preparation, reflecting respondents' awareness of the importance of integration between curriculum, technological environment, and human competencies in successfully employing generative artificial intelligence.

In contrast, the relatively lowest-rated requirement was Item (8), which states: "Flexibility of administrative and regulatory policies in kindergartens to allow experimentation with and continuous adoption of smart learning tools," with a mean of (4.00). This was followed by Item (5) with a

mean of (4.02), and Item (10) with a mean of (4.06). Although these were the lowest in comparison, they still fall within a high level of agreement, indicating a general consensus on the importance of all requirements without exception.

This slight variation can be interpreted as showing that respondents place greater emphasis on direct requirements related to curriculum development, technological infrastructure, and teacher preparation, as these are considered fundamental and tangible components of development. In contrast, administrative, organizational, and awareness-related requirements ranked slightly lower, despite their importance, as they are perceived as supporting rather than directly implementation-focused elements within classroom practice.

Overall, these findings indicate that developing kindergarten programs in light of generative artificial intelligence applications requires a comprehensive and integrated vision that includes updating curricula, developing technological environments, qualifying human resources, and establishing clear regulatory and ethical policies. This ensures the safe and effective use of these applications in early childhood settings and contributes to achieving educational quality aligned with digital transformation and Saudi Vision 2030.

These results are consistent with Al-Otaibi (2024), who emphasized the need for training and adequate infrastructure to support the use of artificial intelligence tools in early childhood education. They also align with Chen (2025), who highlighted the importance of using intelligent systems to provide personalized, technology-supported learning, and with Pellas & Kazanidis (2024), who stressed that the success of AI applications depends on the availability of interactive digital learning environments and teachers' digital competencies. Furthermore, they are consistent with Hijón-Neira et al. (2024), Su & Yang (2024), Sapounidis et al. (2025), and Al-Ahmadi and Al-Arifi (2025), all of which emphasize the importance of preparing the educational environment and developing smart activities and applications to enhance children's skills and improve learning quality.

Presentation of the Fourth Research Question Results:

The fourth research question stated: "What is the proposed framework for developing kindergarten programs in the Kingdom of Saudi Arabia in light of generative artificial intelligence applications?"

Preface:

In light of the findings of the current study regarding the reality of employing generative artificial intelligence applications in kindergarten programs, the obstacles that limit the effectiveness of this employment, and the essential requirements for developing these programs, there emerges a clear need to construct a proposed framework that contributes to the development of kindergarten programs in the Kingdom of Saudi Arabia in line with the rapid advancements in generative artificial intelligence.

This proposed framework aims to provide a comprehensive practical model that bridges theoretical and applied aspects, and enhances the efficiency of educational programs offered to children through the use of intelligent technologies in designing learning activities and developing learning environments, as well as supporting teachers with the necessary digital competencies.

Furthermore, the proposed framework seeks to achieve integration among the components of the kindergarten educational process, ensuring the quality of learning outcomes, taking into account the developmental characteristics of early childhood, and aligning with the digital transformation trends and the objectives of Saudi Vision 2030 in educational development.

Philosophy of the Proposed Framework:

The philosophy of the proposed framework is grounded in the vision of the Kingdom of Saudi Arabia 2030, which emphasizes the transition toward a knowledge-based society founded on innovation and technology. This necessitates the redesign of kindergarten programs to align with this transformation. Accordingly, the proposed framework seeks to build a smart learning environment that supports both individualized and collaborative learning, enhances teachers' efficiency, and contributes to preparing a child capable of engaging confidently and consciously with the demands of the digital age.

The philosophy of the proposed framework for developing kindergarten programs in the Kingdom of Saudi Arabia in light of generative artificial intelligence applications is based on a set of modern

educational and epistemological principles that emphasize that early childhood education should be interactive, flexible, and child-centered. It also stems from the importance of employing smart technologies as supportive tools for teachers and as facilitators of learning processes, rather than as substitutes for the human educational role in shaping the child's personality and developing their various domains.

Furthermore, the philosophy is built on the principle of integration between technological advancement and children's developmental needs, where generative artificial intelligence applications are viewed as a means of providing rich and diverse learning experiences that contribute to the development of thinking, creativity, language, and social interaction skills. In doing so, the uniqueness of the kindergarten stage is taken into account, particularly its reliance on play-based and exploratory learning, which requires the safe and pedagogically sound use of these technologies in a manner that respects cultural and societal values in the Kingdom of Saudi Arabia.

Foundations of the Proposed Framework:

The proposed framework is based on a set of educational, cognitive, and technological foundations that reflect contemporary transformations in education. These foundations include:

1. **Vision 2030 of the Kingdom of Saudi Arabia:** The framework is grounded in Vision 2030, which emphasizes educational development, the shift toward a knowledge-based economy, and the employment of modern technologies and artificial intelligence to improve educational outcomes and prepare a generation capable of meeting the demands of the digital age.
2. **Global Trends in Digital Education:** The framework draws on global trends advocating the integration of artificial intelligence in education, particularly in early childhood education, as an effective tool for personalizing learning, enhancing interaction, and fostering innovation within learning environments.
3. **Findings of Previous Studies and Research:** The framework is informed by recent studies highlighting a gap between the high potential of generative artificial intelligence applications and their actual implementation in kindergarten settings, along with challenges related to technical, human, and organizational readiness.
4. **Nature of the Kindergarten Stage and Child Development Characteristics:** The framework takes

into account the developmental characteristics of kindergarten children, where learning is based on play, exploration, and interaction, requiring the safe and pedagogically appropriate use of generative AI applications that suit the child's developmental stage.

5. Digital Transformation in Saudi Education: The framework aligns with the Kingdom's direction toward digital transformation in the education sector and the need to develop smart learning environments in kindergartens that support modern technologies and improve educational quality.

6. Need for Developing Kindergarten Programs: The framework is based on the urgent need to update current kindergarten programs to keep pace with technological advancements through integrating generative artificial intelligence applications into curricula, activities, and learning methods.

Objectives of the Proposed Framework:

1. To develop kindergarten programs in the Kingdom of Saudi Arabia in alignment with generative artificial intelligence applications and to enhance the quality of the educational process.

2. To employ generative artificial intelligence applications in designing learning activities, producing interactive content, and personalizing learning according to kindergarten children's characteristics.

3. To enhance kindergarten teachers' competencies in using generative artificial intelligence applications and develop their digital and technological skills related to smart education.

4. To support the establishment of interactive and smart learning environments in kindergartens based on modern technologies that enhance children's participation and engagement.

5. To develop children's cognitive, linguistic, social, and creative skills through the use of generative artificial intelligence applications in educational activities.

6. To provide a framework that assists policymakers and educational planners in adopting modern educational policies that support the integration of artificial intelligence in early childhood education.

Features of the Proposed Framework:

The proposed framework for developing kindergarten programs in the Kingdom of Saudi Arabia in light of generative artificial intelligence applications is based on a set of sequential and interconnected stages. Each stage represents a

fundamental step in the comprehensive development process of educational programs within kindergartens, with clearly defined objectives and implementation procedures for each phase.

1. First Stage: Preparation and Planning Phase

This stage represents the starting point of the proposed framework. It aims to prepare the general environment for implementing generative artificial intelligence in kindergarten programs by establishing the necessary organizational, conceptual, and technical foundations for initiating the development process.

Implementation Steps:

1. Analyzing the current reality of kindergarten programs: This step involves studying the current status of kindergarten programs in terms of curricula, teaching methods, technological infrastructure, and the readiness level of teachers to employ generative AI applications.

2. Identifying training and technical needs: This includes determining the training needs of teachers and school administrations regarding the use of AI applications, as well as identifying the digital infrastructure requirements within kindergartens.

3. Developing a clear vision for integration with generative AI: A strategic framework is established to define how generative AI applications will be integrated into kindergarten programs in line with educational objectives and children's developmental characteristics.

4. Forming specialized working teams: Teams consisting of educational experts, instructional technology specialists, and kindergarten teachers are formed to develop and monitor the implementation plan of the proposed framework.

5. Establishing regulatory and ethical guidelines: A set of rules and guidelines is developed to regulate the use of generative AI applications in kindergartens, ensuring safe and value-aligned implementation consistent with educational and societal principles.

2. Second Stage: Design and Development Phase

This stage follows the preparation and planning phase and aims to translate the general vision into practical components that can be implemented within kindergarten programs. It focuses on designing and developing curricula, learning activities, and digital tools aligned with generative AI applications.

Implementation Steps:

1. Designing curricula in light of generative AI: Kindergarten curricula are redesigned to integrate generative AI applications by including interactive digital learning activities, AI-generated educational stories, and exploratory learning situations.

2. Developing interactive learning activities: Activities are designed using generative AI, such as story generation, intelligent educational games, and interactive audio-based tasks, contributing to engaging and enjoyable skill development.

3. Developing smart digital learning tools: This includes producing AI-powered educational tools such as interactive applications, educational chatbots, and multimedia content tailored to each child's level and abilities.

4. Designing interactive virtual learning environments: Virtual digital learning environments are created within kindergartens to enable children to interact with educational content using AI technologies, enhancing play-based and discovery learning.

5. Developing intelligent assessment tools: AI-based assessment tools are designed to continuously measure children's progress through performance analysis and immediate feedback to improve the learning process.

6. Preparing a guide for using AI technologies in kindergarten: An instructional guide is developed explaining how to use generative AI applications in classrooms, including implementation steps, practical examples, and ethical usage guidelines.

3. Third Stage: Implementation Phase

This stage represents the transition from theoretical design to actual application within kindergarten environments. It involves implementing the components of the proposed framework in real educational settings while ensuring close monitoring to maintain quality and achieve the desired educational objectives.

Implementation Steps:

1. Preparing kindergarten environments for implementation: This step involves equipping kindergartens with the necessary technological infrastructure, such as smart devices, interactive screens, and high-speed internet networks, to ensure the efficient operation of generative artificial intelligence applications within the classroom environment.

2. Training teachers to use generative AI applications: Both practical and theoretical training programs are organized to enhance kindergarten teachers' competencies in using generative AI tools, such as story generation, activity design, and the use

of intelligent assistants in lesson planning and teaching.

3. Implementing AI-supported educational activities in classrooms: Pre-designed learning activities using generative AI applications are implemented within kindergarten classrooms, with emphasis on child interaction, engagement, and exploration.

4. Integrating AI into teachers' daily practices: AI applications are employed in lesson preparation, idea generation, instructional design, and daily monitoring of children's progress, contributing to improved teaching efficiency.

5. Monitoring implementation and providing feedback: Continuous monitoring is conducted by educational supervisors and technical teams to evaluate the effectiveness of implementation and provide feedback to improve performance and address emerging challenges.

6. Enhancing parental involvement in the learning process: Parents are engaged through AI-supported digital platforms that allow them to track their children's progress, communicate with teachers, and participate in supporting learning at home.

4. Fourth Stage: Evaluation and Continuous Development Phase

This final stage of the proposed framework aims to assess the effectiveness of implementing kindergarten programs in light of generative artificial intelligence applications, and to ensure the extent to which educational objectives are achieved. It also focuses on continuous improvement based on evaluation results and feedback to ensure sustainability and quality in educational performance.

Implementation Steps:

1. Evaluating children's learning outcomes: The impact of generative AI applications on children's learning is measured using diverse assessment tools (observation, performance checklists, and smart digital assessment tools) to evaluate the development of cognitive, linguistic, social, and creative skills.

2. Evaluating teachers' performance in using AI: Kindergarten teachers' competency in employing generative AI applications is assessed in terms of planning, implementation, activity management, and effective use of digital tools.

3. Analyzing educational data using AI tools: Artificial intelligence techniques are used to analyze learning data, track children's progress, and extract performance indicators, supporting data-driven

educational decision-making.

4. Identifying strengths and weaknesses of implementation: The results of implementation are analyzed to determine strengths that should be reinforced and weaknesses that require improvement or modification in curricula, activities, technological tools, or teaching methods.

5. Continuous updating of programs and activities: Based on evaluation results, kindergarten programs are continuously developed and updated to keep pace with advancements in generative AI technologies and the evolving needs of children.

6. Issuing periodic reports and supporting decision-making: Evaluation reports are prepared and submitted to relevant authorities, including implementation results and development recommendations, to support decision-makers in improving and sustaining kindergarten programs.

Requirements for Implementing the Proposed Framework

Implementing the proposed framework for developing kindergarten programs in the Kingdom of Saudi Arabia in light of generative artificial intelligence applications requires the availability of a set of essential requirements that ensure the success of implementation and the achievement of its objectives efficiently and effectively. These requirements can be presented as follows:

1. Technical requirements: These include providing an integrated digital infrastructure within kindergartens, including computers, tablets, and interactive screens, in addition to high-speed internet networks and smart educational systems capable of efficiently and securely operating generative AI applications.

2. Human requirements: These involve preparing and qualifying kindergarten teachers and educational supervisors through specialized training programs in the use of generative AI applications, developing their digital skills, and enabling them to employ these technologies in planning, teaching, and assessment processes.

3. Organizational and administrative requirements: These include establishing clear policies and regulations governing the use of generative AI applications in kindergartens, defining the roles and responsibilities of teachers and educational administrations, and providing administrative flexibility that allows experimentation and continuous development.

4. Curriculum and instructional requirements: These involve developing kindergarten curricula in line with the integration of generative AI

applications by incorporating interactive digital activities, employing smart educational media, and updating teaching and assessment methods to enhance active learning.

5. Financial requirements: These require allocating sufficient budgets to support the procurement of modern devices and technologies, the development of educational software, and the implementation of training programs, ensuring the sustainability of AI integration within kindergarten environments.

6. Security and ethical requirements: These include establishing safeguards to protect children's privacy and ensure digital data security, ensuring that generated content aligns with the cultural and religious values of Saudi society, and promoting awareness of safe and responsible use of modern technologies.

7. Community and partnership requirements: These involve strengthening partnerships with parents, technical institutions, universities, and artificial intelligence companies to support program development and provide innovative technological solutions suitable for the early childhood education environment.

Accordingly, these requirements constitute a fundamental framework to ensure the successful implementation of the proposed framework and the achievement of its objectives in developing kindergarten programs in light of generative artificial intelligence applications in a comprehensive and sustainable manner.

Challenges in Implementing the Proposed Framework

Despite the importance of the proposed framework for developing kindergarten programs in the Kingdom of Saudi Arabia in light of generative artificial intelligence (AI) applications, its implementation may face several challenges that could limit its effectiveness. Therefore, identifying these challenges and proposing appropriate strategies to address them is essential to ensure successful and sustainable implementation.

Implementation Challenges:

1. Weak technical readiness in some kindergartens: Some kindergartens may lack sufficient smart devices or have inadequate digital infrastructure, such as slow internet speeds, limiting the ability to apply generative AI tools efficiently.

2. Insufficient teacher training: Some kindergarten teachers may not possess the necessary skills to use generative AI applications due to a lack

of specialized training programs in this field.

3. Resistance to change among staff: Implementation may encounter resistance from some teachers or educational leaders due to adherence to traditional teaching methods and fear of modern technologies.

4. Ethical and security concerns: Some stakeholders may be concerned about using AI with children, especially regarding data privacy or the production of culturally or educationally inappropriate content.

5. High financial costs: Implementing the framework requires substantial budgets for purchasing devices, software, upgrading infrastructure, and conducting ongoing training programs.

6. Weak integration between educational and technical entities: A lack of effective coordination between educational institutions and tech companies may slow the development of solutions suitable for the kindergarten stage.

Strategies to Address the Challenges:

1. Gradual development of digital infrastructure: Implement a phased plan to upgrade kindergartens with smart devices and high-speed networks, prioritizing areas with the greatest need.

2. Design specialized and sustainable training programs: Provide practical training courses for teachers on using generative AI in education, with continuous follow-up to enhance professional competencies.

3. Promote a culture of change and innovation: Raise awareness of the importance of AI in education through workshops and seminars, and encourage successful pilot experiences within kindergartens.

4. Establish ethical and legislative guidelines: Develop clear policies regulating the use of generative AI in kindergartens to ensure child protection and uphold societal values.

5. Provide sustainable financial support: Allocate government budgets or establish

partnerships with the private sector to support AI applications in early childhood education.

6. Strengthen partnerships between education and the tech sector: Foster collaboration between the Ministry of Education, universities, and technology companies to develop educational applications tailored to the kindergarten stage.

This framework ensures that potential obstacles are anticipated and addressed systematically, promoting effective and safe integration of generative AI in early childhood education.

5. STUDY RECOMMENDATIONS

In light of the study's findings, the researcher recommends the following:

1. Gradual and systematic integration of generative AI applications within kindergarten programs to enhance the quality of the educational process.

2. Develop and implement specialized training programs for teachers to build their skills in using generative AI tools effectively and pedagogically within the classroom.

3. Redesign kindergarten curricula to align with modern technologies by incorporating interactive learning activities based on generative AI.

4. Provide smart learning environments in kindergartens, including modern devices, high-speed internet connectivity, and AI-supported educational applications.

5. Issue procedural guidelines that regulate the use of generative AI applications in kindergartens, ensuring safe use that aligns with educational and societal values.

6. Enhance collaboration with technology companies and universities to develop AI educational applications specifically designed for early childhood education.

7. Implement awareness programs highlighting the importance of generative AI in education, its role in developing children's skills, and safe, effective guidance for home use.

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