
| RESEARCH ARTICLE

Generative AI in Teacher Professional Development: A Literature-Based Review of Student Engagement and Academic Performance in Saudi Early Childhood Education

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| ABSTRACT

Globally, classroom practices and teacher professional development have been significantly impacted by the quick development of generative artificial intelligence (AI) (Chen et al., 2020; Kasneci et al., 2023; UNESCO, 2023). In Saudi Arabia's Vision 2030-aligned educational reforms, technological innovation and the integration of AI into educational systems are becoming increasingly significant, especially in early childhood education (Ministry of Education, Saudi Arabia, 2021; UNESCO, 2023). Focusing on student engagement and academic performance in nursery and early childhood settings, this literature-based evaluation contrasts classrooms led by teachers trained through generative AI-supported professional development with those trained through conventional professional development. Using a qualitative document analysis method, the study examined peer-reviewed journal articles, policy papers, conference proceedings, and educational research published between 2015 and 2025. Thematic analysis was used to identify recurring themes across instructional strategies, classroom interaction, student involvement, and early academic development. According to research, AI-assisted professional learning can improve classroom interaction, individualized learning, engagement-based pedagogies, and instructional flexibility (Holmes et al., 2019; Luckin et al., 2016; UNESCO, 2023). Adaptive activities, language-supportive engagement, and personalized feedback strategies were more common among educators who received AI-supported technology training. There is still little and conflicting evidence for a direct advantage in academic achievement, especially in early childhood environments where linguistic interaction and social-emotional development are crucial to learning outcomes (Fredricks et al., 2004; Parker et al., 2021). The review also emphasizes the importance of aligning AI integration with Saudi cultural norms, educational regulations, and teacher autonomy. By examining recent findings on generative AI, teacher development, and early childhood learning in the Saudi Arabian context, the work contributes to ongoing discussions on AI in education and provides recommendations for additional empirical and longitudinal research.

| KEYWORDS

Generative artificial intelligence; teacher professional development; student engagement; academic performance; early childhood education; Saudi Arabia; educational technology

| ARTICLE INFORMATION

ACCEPTED: 30 April 2026

PUBLISHED: 22 May 2026

DOI: 10.32996/ijllt.2026.5.1.14

1. Introduction

Artificial intelligence (AI) and recent developments in digital technology are fundamentally changing schooling globally. Generative artificial intelligence is one of the most significant new tools that is influencing teaching strategies, teacher development, and classroom engagement (Chen et al., 2020; Kasneci et al., 2023). AI systems that can produce human-like material, such as lesson plans, exercises, feedback, and language resources, are known as generative AI. According to research,

these resources can support individualized instruction, student-centered learning, and more effective teaching (Holmes et al., 2019; UNESCO, 2023).

Saudi Arabia's Vision 2030-related educational reforms prioritize innovation, technological improvement, and the modernization of teaching methods at all educational levels, including early childhood education (Ministry of Education, Saudi Arabia, 2021). Early reading abilities, social-emotional growth, and language acquisition are all developed in nursery and kindergarten classrooms. Consequently, children's educational experiences are greatly impacted by the caliber of instructors and their professional development (Darling-Hammond et al., 2017; Parker et al., 2021).

Workshops, seminars, lectures, and general training sessions have long been considered traditional methods of professional development. Critics contend that while these strategies are still crucial, they frequently fall short of meeting the unique needs of instructors in the classroom or provide ongoing assistance (Darling-Hammond et al., 2017; OECD, 2021). However, AI-supported professional development provides flexible, tailored, and data-driven advice that could help educators better serve a large number of students (Luckin et al., 2016; Holmes et al., 2019).

Despite increasing interest in generative AI in education worldwide, few studies have looked at the connection between student engagement in Saudi nursery classes and AI-supported teacher training. Furthermore, there is conflicting information about the impact of AI-supported professional development on young students' academic performance (Kasneci et al., 2023; UNESCO, 2023).

Therefore, the purpose of this literature-based study is to investigate the possible benefits of generative AI-supported professional development on academic achievement and student engagement in Saudi early childhood education, in comparison with traditional professional development methods.

2. Literature Review

2.1 Generative AI in Teacher Professional Development

The choices for teacher preparation and instructional support have increased due to recent innovations in generative AI. Instructional materials, classroom activities, formative assessments, and personalized feedback can all be produced by AI-supported systems (Chen et al., 2020; Kasneci et al., 2023). According to educational experts, these technologies could enhance instructors' reflective practices, instructional preparation, and pedagogical flexibility (Holmes et al., 2019; Luckin et al., 2016).

Additionally, by offering a range of instructional strategies, adaptive learning activities, and contextualized examples, generative AI systems can assist language-focused instruction. AI-generated activities could help teachers with vocabulary exercises, pronunciation support, reading comprehension assignments, and interactive class discussions while teaching languages (Schmidt, 1990; UNESCO, 2023).

The growing use of AI in professional development is consistent with learner-centered educational approaches that prioritize adaptability, personalization, and continuous instructional improvement (OECD, 2021). Teachers who have been trained with AI-supported systems may therefore be better able to adapt their teaching strategies to their pupils' cognitive and developmental demands.

2.2 Traditional Professional Development Approaches

Traditional professional development commonly includes workshops, seminars, lectures, conferences, mentoring, and peer observation. These approaches continue to provide important opportunities for teacher collaboration and institutional training (Darling-Hammond et al., 2017).

However, prior research suggests that typical professional development may have several disadvantages. Training sessions are frequently time-limited, uniform, and unrelated to the realities of teachers' everyday classrooms (Darling-Hammond et al., 2017; OECD, 2021). Teachers sometimes describe having trouble applying their theoretical knowledge in the classroom.

Moreover, traditional approaches may not adequately address the diverse learning needs present in early childhood classrooms. Young learners require highly interactive, language-rich, and developmentally appropriate instruction, which may not always be sufficiently emphasized in generalized professional development programs (Parker et al., 2021).

2.3 Student Engagement in Early Childhood Education

The development of student engagement is a critical aspect of the teaching and learning process. According to Fredricks, Campbell, and McColskey (2004), engagement is a multidimensional concept encompassing children's behavioral, emotional, and cognitive participation in educational settings. In nursery and kindergarten programs, engagement is typically seen as interacting with the classroom environment, including playing, conversing with classmates, and working with their teacher, language learning, and positive emotional outcomes (Parker, 2021).

Fredricks and others described the relationship between behavioral engagement and participation in academic settings and peer relationships, noting that higher behavioral engagement was associated with the greatest number of engagement items among students. Engagement comprises behavior, emotion, and cognition. Engagement can be thought of as children's visible activity, emotions such as joy, motivation, and interest in the classroom, as well as cognitive processes such as attention and curiosity that assist children in learning (2004).

Children's levels of engagement are significantly impacted by teacher attentiveness and classroom interaction, according to research. According to Vygotsky (1978) and Parker et al. (2021), teachers who foster a supportive, engaging, and communicative classroom atmosphere are more likely to facilitate young learners' language development and sustained participation.

2.4 Academic Performance in Early Childhood Education

In early childhood education, academic performance extends beyond results from traditional tests. Vocabulary progress, early literacy, phonological awareness, communication skills, and language comprehension are all included (Parker et al., 2021)

Although the use of AI - assisted instruction, for example, in adaptive learning technologies (Chen et al., 2020; Holmes et al., 2019) suggests potentially improved teaching through personalized experiences and detailed feedback, its influence on actual student achievement results is not consistently demonstrated, especially in preschool contexts in which age and other developmental factors vary between children (Kasneji et al., 2023; UNESCO, 2023).

Furthermore, researchers emphasize that social-emotional development and communicative competence are equally important indicators of learning success in preschool education (Fredricks et al., 2004; Parker et al., 2021).

2.5 Theoretical Framework

Several educational and language-learning theories pertinent to AI-supported instruction provide the foundation for this review.

Krashen's Input Hypothesis

Krashen's Hypothesis stresses the importance of intelligible input for language acquisition. AI-based teaching tools could give students access to personalized, on-demand, developmentally appropriate language.

Schmidt's Noticing Hypothesis.

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Vygotsky's Social Constructivism

Social interaction is crucial for cognitive development, according to Vygotsky's hypothesis (Vygotsky, 1978). AI-supported classrooms may facilitate interactive and collaborative learning experiences while preserving the teacher's primary role in guiding participation and communication.

3. Research Objectives

This literature-based review aims to:

1. Compare the levels of student engagement in classrooms taught by instructors trained through standard professional development methods against those trained through generative AI-supported professional development.
2. Examine the potential effects of AI-supported professional growth on academic achievement in early childhood teaching.
3. Examine the contextual elements influencing the application of generative AI in Saudi early childhood education.

4. Methodology

4.1 Research Design

Thematic document analysis was used in this study's qualitative literature review design. The review evaluated research on generative AI, teacher professional development, student involvement, and early childhood education, drawing on peer-reviewed journal articles, educational reports, conference proceedings, and policy papers (Chen et al., 2020; Holmes et al., 2019; UNESCO, 2023).

4.2 Data Collection and Selection Criteria

My search included academic sources such as Scopus, ERIC, ScienceDirect, Google Scholar, and Web of Science for scholarly articles published between 2015 and 2025, and I looked for literature on generative AI, education, Saudi Arabia, early childhood education, student engagement, teacher professional development, and AI-supported instruction. Inclusion criteria included only peer-reviewed articles on AI in education, early childhood, or language acquisition research, written in English, or on educational policy in Saudi Arabia or the GCC region.

Excluded were studies that had nothing to do with education or that had no impact on student learning or teacher development.

4.3 Data Analysis

There are common and distinct themes. My investigation examined academic results, student individualization, classroom dynamics, teaching strategies aimed at student engagement, teacher adjustments/adaptations in class, and the effectiveness of teachers' interactions with their classes. Academic achievements were highlighted, in large part, to show the impact of artificial intelligence on students' math performance.

5. Findings and Discussion

5.1 Student Engagement

The reviewed literature indicates that lecturers trained through AI-supported professional development exhibit greater instructional flexibility and engagement-focused classroom practices (Holmes et al., 2019; Luckin et al., 2016). These educators more commonly employed interactive storytelling, language games, adaptive exercises, and personalized support.

5.2 Academic Performance

Increased student participation, emotional engagement, and sustained attention in the classroom seem to be promoted by AI-supported teaching methods. More learner-centered classroom settings were also facilitated by quick feedback and personalized learning techniques (Chen et al., 2020; Kasneci et al., 2023).

On the other hand, previous approaches to professional development frequently focused on theoretical education without ongoing classroom support. Because of such factors, teachers occasionally found it difficult to continue using engagement-oriented teaching strategies (Darling-Hammond et al., 2017; OECD, 2021).

5.3 Saudi Arabian Context

Saudi Arabia's Vision 2030 places strong emphasis on modernizing education by fostering technological advancements and innovative practices. (Ministry of Education, Saudi Arabia, 2021). These technological shifts and reforms present both potential pathways and significant impediments to the effective incorporation of AI into teacher development programs, especially when they fail to prioritize cultural beliefs, educational goals, and current classroom settings.

With technology now playing such a major role in the classroom and the introduction of AI in education, Saudi educators would greatly benefit from programs that embrace AI without encroaching on their professional freedom, allowing them the final say in instructional choices and decisions. (UNESCO, 2023). Therefore, Saudi Arabian early childhood education teachers must continue to embrace culturally appropriate teaching approaches when integrating AI to uphold educational standards while remaining mindful of important social norms.

6. Implications for Practice

Conclusions reveal that more interactive, engagement-focused instructional methods in early childhood education may be supported by incorporating generative AI into teacher professional development (Holmes et al., 2019; UNESCO, 2023).

Therefore, blended professional development models that mix traditional teacher training with AI-supported instructional guidance may be adopted by educational institutions and policymakers (Darling-Hammond et al., 2017; OECD, 2021).

Additionally, digital literacy skills, ethical advice, and culturally relevant methods for integrating AI-supported learning technologies should be taught in teacher training programs (UNESCO, 2023).

7. Limitations and Future Research

One major drawback is that the study relies solely on existing literature and lacks primary data collection. In fact, only a small number of studies focus on the use of generative AI in Saudi nursery schools. Studies included in this review differ greatly in how they define both student engagement and academic performance, making it difficult to compare findings (Fredricks et al., 2004). Therefore, future research should employ an empirical, longitudinal design incorporating classroom observations, teacher interviews, and student assessments in Saudi early childhood settings. Other research could investigate how AI is used, teachers' beliefs about its role in early childhood education, and parents' views on its use.

8. Conclusion

This paper comprises a literature review that assesses the effects of generative artificial intelligence-supported teacher professional development on student engagement and academic outcomes in Saudi early childhood education. The surveyed literature indicated that such training enhanced classroom interactions, increased instructional variability, and supported greater learner participation (Chen, H. et al., 2020; Holmes, W. et al., 2019; Kasneci, E. et al., 2023). Studies have further suggested that educators trained with AI-enhanced systems are more adept at using adapted methods that meet learners' specific requirements and at developing student-centered learning approaches. However, the extant literature has failed to provide consistent evidence of improvements in academic outcomes for nursery education programs designed to support social-emotional development and communication skills (Fredricks, J. A. et al., 2004; Parker, M. E. et al., 2021). Finally, the article pointed out that the appropriate implementation of AI within Saudi classrooms depends heavily upon the relevant educational and cultural frameworks, individual teacher discretion, and national policies associated with Saudi Vision 2030, an initiative aimed at developing a modern workforce and diversifying the country's economy (Ministry of Education, Saudi Arabia, 2021; UNESCO, 2023). Generative AI may serve as an assistive tool for teacher growth and classroom progress. However, research needs to address the long-term effects of AI use in Saudi early childhood education settings.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

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