

# **DIGITAL TRANSFORMATION AND EARLY CHILDHOOD EDUCATION OUTCOMES IN NAIROBI CITY COUNTY KENYA**

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## **ABSTRACT**

**Purpose:** This study examined the influence of digital transformation on the quality of Early Childhood Education (ECE) in Nairobi City County, Kenya. The study was motivated by the increasing importance of technology-driven learning environments in enhancing pedagogical quality, learner engagement, accessibility, and inclusiveness.

**Problem Statement:** Despite implementing the Competency-Based Curriculum (CBC) and the Digital Literacy Programme (DLP), digital technology integration in Kenya's ECE centres remains inconsistent due to inadequate infrastructure, limited teacher digital competencies, weak technology-supported pedagogy, and insufficient institutional support. Consequently, the influence of digital transformation on ECE quality remains inadequately understood.

**Methodology:** The study adopted a positivist philosophy and descriptive survey design, guided by the TPACK and UTAUT frameworks. A sample of 267 teachers and administrators was selected from 870 respondents using Fisher's formula. Data were collected through structured questionnaires and analyzed using descriptive statistics, correlation, multiple regression, and diagnostic tests to validate the model.

**Results:** The findings revealed that digital transformation significantly improved the quality of Early Childhood Education. Digital infrastructure, teacher digital competence, digital pedagogy integration, and leadership and policy support each had significant positive effects on ECE quality.

**Conclusion and Policy Recommendation:** The study concluded that digital transformation is a critical driver of quality ECE. It recommends increased investment in digital infrastructure, continuous teacher professional development, strengthened digital pedagogy, and supportive policy implementation to promote inclusive and sustainable technology-enabled early learning environments.

**Keywords:** *Digital transformation, Early Childhood Education, digital competence, digital pedagogy, educational quality, Nairobi City County.*

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## INTRODUCTION

Digital transformation had become a significant force reshaping education system globally by influencing how teaching, learning, assessment, and educational management were designed and implemented. The rapid advancement of digital technologies, including artificial intelligence, learning management systems, mobile technologies, and digital educational resources, had created new opportunities for improving access, quality, and inclusiveness within education systems. Unlike traditional ICT adoption, digital transformation had represented a broader institutional change process involving technological infrastructure, human capabilities, organisational culture, and pedagogical innovation aimed at improving educational outcomes (UNESCO, 2023). Early Childhood Education (ECE) had been recognised as a critical stage in human development because it established foundational competencies that influenced children's cognitive abilities, social development, creativity, and future academic achievement. Quality ECE had depended on effective teaching approaches, appropriate learning resources, child-centred pedagogy, qualified teachers, and supportive learning environments. Recent evidence had indicated that appropriately designed digital technologies could enhance early learning experiences by promoting interactive learning, creativity, personalised instruction, and learner engagement (OECD, 2021; UNESCO, 2023).

Globally, education systems had increasingly incorporated digital transformation strategies to improve learning quality and reduce inequalities in access to educational opportunities. The COVID-19 pandemic had accelerated digital adoption by demonstrating the importance of digital readiness and technology-supported learning environments. However, studies had shown that technology availability alone did not guarantee improved educational outcomes. Effective digital transformation required adequate infrastructure, teacher digital competencies, supportive leadership, appropriate policies, and pedagogical integration of technology into classroom practices (UNESCO, 2023). Teacher digital competence had emerged as a critical determinant of successful digital transformation in education. Teachers required not only technical skills but also the ability to integrate technology with appropriate teaching methods and subject knowledge.

The Technological Pedagogical Content Knowledge (TPACK) framework had emphasised that meaningful technology integration occurred when teachers effectively combined technological knowledge, pedagogical knowledge, and content knowledge (Koehler et al., 2022). In ECE settings, teacher competence had been particularly important because young learners required developmentally appropriate and interactive learning approaches. In Africa, digital transformation in education had gained increased attention due to its potential to address challenges associated with access, resource limitations, and quality improvement. However, many education systems had continued to experience barriers such as inadequate

digital infrastructure, unreliable internet connectivity, limited teacher training, and unequal access to technology between urban and rural institutions (World Bank, 2021). These challenges had affected the ability of schools to effectively integrate digital technologies into teaching and learning processes.

Kenya had demonstrated commitment towards digital transformation in education through initiatives such as the Digital Literacy Programme (DLP), the National Digital Master Plan, and the implementation of the Competency-Based Curriculum (CBC). The CBC had emphasised learner-centred approaches, creativity, communication, collaboration, critical thinking, and digital literacy as essential competencies for learners in the 21st century (Ministry of Education Kenya, 2021). Consequently, digital technologies had become increasingly important in supporting curriculum implementation and enhancing learning experiences. Despite these policy initiatives, the integration of digital technologies within Early Childhood Education centres in Kenya had remained inconsistent.

Research had indicated that many ECE institutions continued to face challenges related to inadequate access to digital devices, limited digital learning resources, insufficient teacher preparedness, and weak institutional support structures (UNESCO, 2023). These challenges had been particularly relevant in ECE because young learners required carefully structured technology-supported experiences guided by competent teachers. Nairobi City County had represented an important context for examining digital transformation in ECE due to its high concentration of both public and private early learning institutions. Although the county had relatively better access to technological resources compared to many other regions in Kenya, disparities existed among ECE centres regarding availability of digital infrastructure, teacher competencies, and institutional capacity to support technology integration. The rapid growth of urban populations and increased parental expectations for quality education had further increased the need for innovative approaches to improving ECE outcomes.

Therefore, the study examined the influence of digital transformation on the quality of Early Childhood Education in Nairobi City County, Kenya. By focusing on digital infrastructure readiness, teacher digital competence, digital pedagogy integration, and leadership and policy support, the study sought to provide evidence that could guide education policymakers, county governments, and ECE institutions in developing effective digital transformation strategies.

## **RESEARCH OBJECTIVES**

- i. To examine the influence of digital infrastructure readiness on the quality of Early Childhood Education in Nairobi City County, Kenya.
- ii. To determine the effect of teacher digital competence on the quality of Early Childhood Education in Nairobi City County, Kenya.
- iii. To establish the influence of digital pedagogy integration on the quality of Early Childhood Education in Nairobi City County, Kenya.
- iv. To assess the effect of leadership and policy support on the quality of Early Childhood Education in Nairobi City County, Kenya.

## RESEARCH HYPOTHESES

**H<sub>01</sub>:** Digital infrastructure readiness has no significant influence on the quality of Early Childhood Education in Nairobi City County, Kenya.

**H<sub>02</sub>:** Teacher digital competence has no significant influence on the quality of Early Childhood Education in Nairobi City County, Kenya.

**H<sub>03</sub>:** Digital pedagogy integration has no significant influence on the quality of Early Childhood Education in Nairobi City County, Kenya.

**H<sub>04</sub>:** Leadership and policy support have no significant influence on the quality of Early Childhood Education in Nairobi City County, Kenya.

## THEORETICAL REVIEW

The study was anchored on two complementary theories: the Technological Pedagogical Content Knowledge (TPACK) Framework and the Unified Theory of Acceptance and Use of Technology (UTAUT). These theories provided a foundation for understanding how technological capabilities, teacher competencies, and organisational factors influenced digital transformation outcomes within Early Childhood Education.

### Technological Pedagogical Content Knowledge (TPACK) Framework

The Technological Pedagogical Content Knowledge (TPACK) framework was developed to explain the knowledge teachers required to effectively integrate technology into teaching and learning processes. The framework proposed that successful technology integration occurred through the interaction of three fundamental knowledge domains: technological knowledge, pedagogical knowledge, and content knowledge (Mishra & Koehler, 2006). Recent educational technology studies had continued to apply TPACK as an appropriate framework for analysing teachers' digital competencies and technology-supported instructional practices (Koehler et al., 2022). Technological knowledge referred to teachers' understanding of digital tools, software applications, learning platforms, and technological resources. In the context of ECE, technological knowledge included teachers' ability to operate digital devices, access online learning materials, use interactive applications, and incorporate digital resources into classroom activities. Pedagogical knowledge represented teachers' understanding of teaching methods, learner development, classroom management, and instructional strategies. In ECE settings, pedagogy was particularly important because young children required interactive, play-based, and developmentally appropriate learning approaches. Technology integration had to support rather than replace meaningful teacher-child interactions.

Content knowledge referred to teachers' understanding of curriculum concepts and subject matter. Effective digital pedagogy required teachers to combine technological skills with curriculum knowledge to select appropriate digital resources that supported learning objectives. The TPACK framework was relevant to this study because it explained the importance of teacher digital competence and digital pedagogy integration as critical dimensions of digital transformation. The framework suggested that improved educational quality was achieved not simply through technology availability but through teachers' ability to integrate technology effectively with pedagogical practices. In relation to this study, TPACK supported the argument that ECE teachers who possessed stronger digital competencies were

more likely to utilise technology effectively, enhance learner engagement, and improve classroom experiences. Therefore, the framework provided theoretical justification for examining teacher digital competence and digital pedagogy integration as predictors of ECE quality.

### **Unified Theory of Acceptance and Use of Technology (UTAUT)**

The Unified Theory of Acceptance and Use of Technology (UTAUT) was developed by Venkatesh et al. (2003) to explain factors influencing individuals' acceptance and utilisation of technological systems. The theory proposed four major determinants of technology adoption: performance expectancy, effort expectancy, social influence, and facilitating conditions. Recent studies had continued to apply UTAUT in examining technology adoption behaviour among educators and institutions (Venkatesh et al., 2022). Performance expectancy referred to the extent to which individuals believed that technology would improve their performance. Within ECE, teachers were more likely to adopt digital tools when they perceived that technology improved lesson delivery, learner engagement, assessment, and classroom management. Effort expectancy referred to the perceived ease of using technology. Teachers who considered digital tools difficult to use were less likely to integrate them into their teaching practices.

Therefore, teacher training and continuous professional development were important in increasing confidence and reducing resistance to technology adoption. Social influence represented the extent to which individuals perceived that important stakeholders encouraged technology use. In ECE institutions, leadership commitment, government policies, and expectations from parents and education authorities could influence teachers' willingness to adopt digital technologies. Facilitating conditions referred to the availability of organisational and technical support necessary for technology use. These included access to digital devices, internet connectivity, technical assistance, and institutional policies supporting digital transformation. The UTAUT framework was relevant to this study because it explained how leadership and policy support and digital infrastructure readiness influenced successful technology adoption within ECE institutions. The theory demonstrated that digital transformation required not only individual willingness but also supportive institutional environments.

## **EMPIRICAL REVIEW**

### **Digital Infrastructure Readiness and Quality of Early Childhood Education**

Digital infrastructure readiness has been identified as a fundamental requirement for successful digital transformation in education. Infrastructure includes availability of digital devices, internet connectivity, digital platforms, and technical support systems. UNESCO (2023) reported that inadequate infrastructure remained one of the major barriers affecting equitable technology integration in education systems globally. Studies conducted in developing countries had established that schools with better digital infrastructure were more likely to implement technology-supported teaching practices effectively. The availability of reliable digital resources enabled teachers to access educational materials, utilise interactive applications, and create engaging learning experiences for children (World Bank, 2021). In Kenya, digital transformation initiatives had expanded access to educational technologies; however, disparities remained among institutions due to differences in resources and institutional capacity. The Ministry of Education Kenya (2021) noted that infrastructure

limitations continued to affect effective implementation of digital learning programmes, particularly in early learning institutions.

**Therefore, the study hypothesised that:** H01: Digital infrastructure readiness has no significant influence on the quality of Early Childhood Education in Nairobi City County, Kenya.

### **Teacher Digital Competence and Quality of Early Childhood Education**

Teacher digital competence had been recognised as one of the most important determinants of successful digital transformation in education. Digital competence extended beyond basic computer literacy and included teachers' ability to select appropriate digital resources, integrate technology into teaching practices, evaluate digital content, and use technology to support learner-centred instruction (UNESCO, 2023). In Early Childhood Education, teacher digital competence had been particularly important because young learners required carefully designed and interactive learning experiences. Teachers needed to understand how digital tools could complement play-based learning, creativity, communication, and social interaction. Research had indicated that teachers with higher levels of digital competence were more likely to adopt innovative teaching practices and create engaging learning environments compared with teachers who lacked confidence in using technology (OECD, 2021).

Claro et al. (2024) found that although many schools had acquired digital technologies, teachers often lacked the pedagogical competencies required to integrate these technologies effectively into classroom instruction. Similarly, Althubyani (2024) reported that insufficient teacher digital competence remained a significant barrier to successful digital transformation in education systems. This challenge was particularly significant in Early Childhood Education (ECE), where technology integration required careful alignment with children's developmental needs. In Kenya, the implementation of the Competency-Based Curriculum (CBC) increased the demand for digitally competent teachers. However, the Ministry of Education (2021) reported persistent gaps in teachers' digital skills, access to professional development opportunities, and confidence in using technology for instructional purposes. The Technological Pedagogical Content Knowledge (TPACK) framework further explains that teachers improve learning outcomes when they effectively integrate technological knowledge with pedagogy and subject content (Koehler et al., 2022). Consistent with this view, Zhang et al. (2024) established that ECE teachers' technological pedagogical knowledge significantly influenced effective ICT integration and learner outcomes. Therefore, teacher digital competence was expected to contribute positively to ECE quality by improving teaching effectiveness, learner engagement, and access to diverse learning resources. **Therefore, the study hypothesised that:** H02: Teacher digital competence has no significant influence on the quality of Early Childhood Education in Nairobi City County, Kenya.

### **Digital Pedagogy Integration and Quality of Early Childhood Education**

Digital pedagogy integration referred to the effective incorporation of digital technologies into teaching and learning processes to enhance instructional quality and learner experiences. Unlike simple technology adoption, digital pedagogy focused on how teachers used technology to support learning objectives, improve interaction, and facilitate learner-centred approaches (UNESCO, 2023). In Early Childhood Education, effective digital pedagogy had involved the use of interactive applications, digital storytelling, multimedia resources, educational games, and virtual learning platforms to support children's cognitive, social, and

creative development. Research had indicated that technology-supported pedagogical approaches could improve learner motivation, engagement, and participation when appropriately implemented (OECD, 2021). However, studies had cautioned that digital technologies did not automatically improve educational outcomes.

The effectiveness of technology depended on how teachers integrated digital resources into learning activities. Excessive focus on technology without appropriate pedagogy could reduce meaningful interaction and negatively affect child-centred learning approaches (UNESCO, 2023). The TPACK framework had emphasised that successful digital pedagogy occurred when teachers were able to combine technological knowledge with pedagogical strategies and curriculum content. Therefore, teachers needed to understand not only how to use technology but also when and why specific digital tools were appropriate for particular learning activities. Within the Kenyan ECE context, digital pedagogy integration had become increasingly important due to the requirements of the Competency-Based Curriculum. The CBC had encouraged innovative teaching approaches that promoted creativity, problem-solving, and learner participation. Digital technologies had provided opportunities for teachers to develop richer learning experiences through multimedia resources and interactive activities. The study therefore tested the following hypothesis: H03: Digital pedagogy integration has no significant influence on the quality of Early Childhood Education in Nairobi City County, Kenya.

### **Leadership and Policy Support and Quality of Early Childhood Education**

Leadership and policy support had been identified as critical factors influencing the success and sustainability of digital transformation initiatives. Educational leaders played an important role in establishing digital strategies, allocating resources, supporting teacher development, and creating institutional environments that encouraged technology adoption (UNESCO, 2023). Institutional leadership influenced digital transformation by providing strategic direction, coordinating technology investments, and encouraging innovation among teachers. Schools with supportive leadership were more likely to implement digital initiatives successfully because leaders created enabling conditions for experimentation, training, and continuous improvement. According to the UTAUT framework, facilitating conditions significantly influenced technology adoption.

Teachers were more likely to use digital technologies when institutions provided adequate infrastructure, technical support, training opportunities, and supportive policies (Venkatesh et al., 2022). At the policy level, governments played an important role in establishing frameworks that guided digital transformation in education. In Kenya, policies such as the National Digital Master Plan and education sector digital initiatives had demonstrated government commitment towards technology integration. However, implementation challenges had continued due to resource constraints, uneven access, and limited institutional capacity (Ministry of Education Kenya, 2021). Leadership support was particularly important in ECE because early learning institutions required specialised approaches to technology adoption. School administrators needed to ensure that digital technologies supported child-centred learning rather than replacing essential teacher-child interactions.

**Therefore, the study hypothesised that:** H04: Leadership and policy support have no significant influence on the quality of Early Childhood Education in Nairobi City County, Kenya.

CONCEPTUAL FRAMEWORK

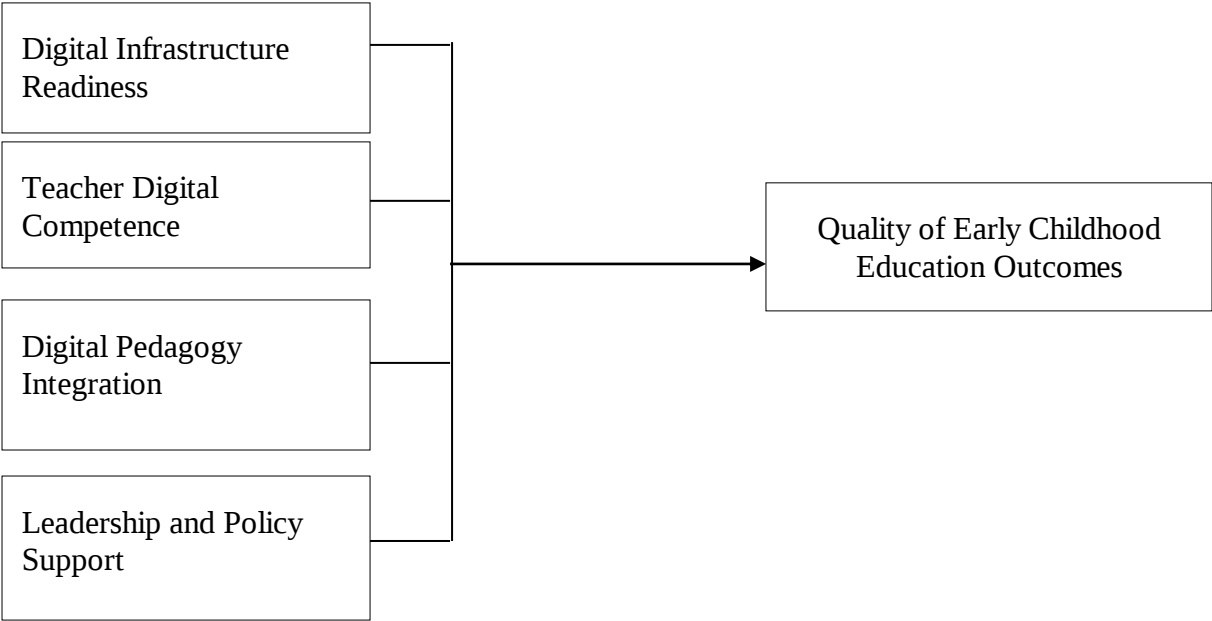


Figure 1: Conceptual Framework

RESEARCH METHODOLOGY

The study adopted a positivist research philosophy and a descriptive survey research design to examine the influence of digital transformation on the quality of Early Childhood Education (ECE) in Nairobi City County, Kenya. The positivist approach was appropriate because the study sought to measure relationships among observable variables using quantitative methods. The target population comprised 870 ECDE teachers and administrators from selected public and private ECE centres in Nairobi City County. Using Fisher’s formula for finite populations, a sample size of 274 respondents was determined, and 267 respondents were targeted after considering data completeness and response rates. A multistage sampling technique was employed, where ECE institutions were stratified by sub-county and ownership category, followed by random selection of teachers and purposive selection of administrators. Primary data were collected using a structured questionnaire developed from the study objectives, conceptual framework, and reviewed literature. The instrument measured four dimensions of digital transformation: digital infrastructure readiness, teacher digital competence, digital pedagogy integration, and leadership and policy support, alongside ECE quality outcomes. Measurement items were rated on a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

The validity of the research instrument was established through expert review and pilot testing among respondents from ECE institutions outside the study sample. Construct validity was enhanced by grounding the measurement items on the TPACK framework and UTAUT model. Reliability was assessed using Cronbach’s Alpha coefficient, with values of 0.70 and above considered acceptable (Hair et al., 2022). Data collected were coded, cleaned, and analysed using descriptive and inferential statistics. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarise respondent characteristics and digital transformation practices. Pearson correlation analysis was

conducted to establish relationships between study variables, while multiple regression analysis was employed to determine the predictive influence of digital transformation dimensions on ECE quality. Before regression analysis, diagnostic tests including normality, linearity, multicollinearity, and heteroscedasticity tests were conducted to confirm compliance with statistical assumptions and ensure the reliability of the regression model.

## RESULTS AND DISCUSSION

The study targeted 267 respondents comprising Early Childhood Education teachers and administrators from selected public and private ECE centres in Nairobi City County. A total of 241 questionnaires were successfully completed and returned, representing a 90.3% response rate, which was considered adequate for statistical analysis. The respondents were diverse in terms of gender, age, academic qualifications, and teaching experience, providing a broad representation of ECE practitioners. The descriptive findings indicated that digital transformation had been implemented at a moderate level across ECE institutions. Specifically, digital infrastructure readiness recorded an overall mean score of 3.31 (SD = 1.07), indicating moderate availability of digital devices, internet connectivity, learning platforms, and technical support. Teacher digital competence recorded a mean score of 3.60 (SD = 1.01), suggesting that teachers possessed basic digital skills but required further professional development to enhance advanced technology integration. Digital pedagogy integration recorded a mean score of 3.58 (SD = 1.02), while leadership and policy support recorded a mean score of 3.61 (SD = 1.01), demonstrating that institutional support and technology-supported teaching practices were gradually being adopted within ECE centres.

Correlation analysis established that all dimensions of digital transformation had positive and statistically significant relationships with the quality of Early Childhood Education. Digital infrastructure readiness showed a significant positive correlation with ECE quality ( $r = 0.612$ ,  $p < 0.01$ ), indicating that improved access to digital resources contributed to better learning environments and teaching effectiveness. Teacher digital competence had a stronger relationship with ECE quality ( $r = 0.674$ ,  $p < 0.01$ ), demonstrating the importance of teachers' ability to effectively utilise digital technologies. Digital pedagogy integration recorded the strongest correlation ( $r = 0.701$ ,  $p < 0.01$ ), suggesting that technology had the greatest impact on ECE outcomes when embedded within appropriate instructional practices. Leadership and policy support also demonstrated a significant positive relationship ( $r = 0.638$ ,  $p < 0.01$ ), confirming that institutional commitment and supportive policies enhanced successful technology adoption.

Multiple regression analysis was conducted to determine the combined influence of digital transformation dimensions on ECE quality. The regression model was statistically significant and revealed that digital transformation dimensions explained 61.2% ( $R^2 = 0.612$ ; Adjusted  $R^2 = 0.605$ ) of the variation in the quality of Early Childhood Education. The results indicated that digital pedagogy integration was the strongest predictor of ECE quality, followed by teacher digital competence, leadership and policy support, and digital infrastructure readiness. The findings confirmed that technology improved educational outcomes when supported by competent teachers, effective instructional practices, and institutional commitment. Diagnostic tests confirmed that the regression assumptions were satisfied, with no significant concerns relating to normality, multicollinearity, linearity, or heteroscedasticity.

## RECOMMENDATIONS

The study recommended increased investment in digital infrastructure within ECE centres, including access to digital devices, reliable internet connectivity, digital learning platforms, and technical support to enable effective technology integration. It further recommended continuous teacher professional development programmes to strengthen digital competencies, with emphasis on digital pedagogy, content development, technology-supported assessment, and effective use of digital tools in early learning environments. ECE institutions were encouraged to focus on meaningful digital pedagogy integration by using technology to enhance creativity, collaboration, learner engagement, and child-centred learning rather than merely acquiring digital resources. The study also recommended strengthening leadership and policy support through the development of institutional digital transformation strategies, improved resource allocation, teacher support mechanisms, and coordinated government policies. Finally, it recommended inclusive digital transformation approaches that address inequalities among ECE institutions by considering differences in resources, location, and socio-economic conditions to ensure that technology contributes to equitable access and improved quality of Early Childhood Education.

The study recommended further research to explore the specific effects of digital transformation on child development outcomes, including creativity, language development, cognitive abilities, and social interaction among ECE learners. Future studies should also consider longitudinal approaches to assess the long-term sustainability of digital transformation initiatives and their impact on education quality over time. Comparative research between public and private ECE institutions was recommended to establish differences in technology adoption and implementation outcomes. In addition, future researchers should investigate the contribution of emerging technologies such as artificial intelligence, adaptive learning systems, and virtual learning environments in enhancing teaching effectiveness and improving early childhood education outcomes.

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