African Journal of Science, and Technology Education (AJSTME), *12*(6). 13 - 18, Nov., 2026.
ISSN: 2251-0141 (Print), 2971-623 (Online) https://www.ajstme.com.ng

Predictive Impact of Emerging Technologies on Curriculum Implementation in Early Childhood Education in Calabar Municipality, Cross River State

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Abstract

The study explored the predictive impact of emerging technologies on curriculum implementation in early childhood education in Calabar Municipality, Cross River State. Four research questions and four null hypotheses guided the study, which adopted a predictive correlational survey research design. The population comprised 408 preschool teachers, from which a sample of 186 was drawn for the study using random and purposive sampling techniques. The Emerging Technologies Utilization Scale (ETUS) and the Curriculum Implementation Assessment Scale (CIAS) were developed by the researchers for collection of data. The instruments were face-validated by three experts and trial-tested to determine their reliability. Data collected from the trial-test were analysed using Cronbach Alpha, which yielded reliability coefficients of 0.79 for ETUS and 0.81 for CIAS. Data collected from the actual study were analysed using simple and multiple regression analyses. The results revealed that integration of digital tools ($r = .592$, $r^2 = .351$), augmented reality ($r = .613$, $r^2 = .376$), and virtual reality ($r = .661$, $r^2 = .436$) contributes significant ($p < .05$) to curriculum implementation in in early childhood education. The implication of these findings is that the use of emerging technologies cannot be undermined if effective curriculum implementation is to be achieved in early childhood education. Based on these findings, it is recommended, among others, that early childhood education centres should adopt emerging technologies in the curriculum implementation in early childhood education.

Keywords: Emerging technologies, Early-childhood education, Curriculum, Digital tools, Augmented reality, Virtual reality.

INTRODUCTION

Emerging technologies are having a growing impact on the ways in which learning content is presented, learning activities are structured and progress is evaluated. In early childhood education (ECE), new digital and technological tools that facilitate learning and teaching are Digital Tools, Augmented Reality (AR), and Virtual Reality (VR). Digital tools include devices, applications, including computers, tablets, educational software, and multimedia, which are used by teachers in curriculum planning, teaching, and assessment. AR is used to display digital information over top of the real world, like images, animation and 3-D models, and VR is used to create a computer-generated, immersive environment that allows children to interact with simulated objects and settings. The use of these technologies with the intent to support age appropriate learning activities and to meet curriculum goals has become inevitable. These resources can be used, if chosen and planned for, as aids to visualisation, exploration, interaction and differentiated learning. Their educational value is, however, contingent on other factors, such as their availability, the teachers' competence, and pedagogical appropriateness, and they ought to be used in addition to, not as a substitute for, hands-on activities, social interaction, and responsive teacher–child engagement.

The various technologies that have been considered relevant to the implementation of the curriculum align with the National Policy on Education (Federal Republic of Nigeria, 2013) and the National Policy on Information and Communication Technologies (ICT) in Education (Federal Ministry of Education, 2019). The National Policy on Education draws attention to the role of exploration, creativity and play in the early childhood care, development and education while the National Policy on ICT offers a decision-making framework for the use of ICT in the educational process. The policy directions highlight a need to consider the technological resources that schools have, and whether they are able to allow teachers to use these resources to enable students to experience meaningful learning of curriculum objectives. While policy commitment can mean nothing if a school lacks digital resources, electricity, internet and teacher training, it can mean everything if a school has all the necessary resources. There are notable implementation challenges in Nigeria's general educational system. UNICEF Nigeria (2025) noted that some of the challenges to digital learning were limited digital infrastructure, lack of access to electricity and broadband, and lack of ICT skills on the part of educators. Likewise, the Nigeria Education Fact Sheets 2023, by UNICEF, indicated that there was also a significant disparity in the access of children to computers and internet, depending on the socio-economic status of their households and level of education. While these national results give an overall sense of the importance of digital inequality, it is not

automatically anticipated that they are indicative of the situation of early childhood education centres in Calabar Municipality. Furthermore, findings from the broader Calabar Education Zone suggest that technology use in the school pedagogy is an issue that needs to be addressed. In this regard, Chiukpai et al. (2023) noted that the use of computers by teachers and the internet for lesson delivery in secondary schools was low. The results of secondary school, however, cannot be translated to early childhood settings because children's developmental needs, methods of instruction and technical needs vary.

One of the main concerns, therefore, is the limited locally specific evidence available to determine which emerging technologies are accessible to early childhood educators in Calabar Municipality, how early childhood educators are using these technologies to implement curriculum content and whether the use of these technologies predicts curriculum implementation statistically. Availability, accessibility, teacher competence and pedagogical integration are not the same thing, but are related. For instance, a centre can have digital devices but teachers are not using them to the best of their ability to meet the curriculum goals. Furthermore, there is no evidence that the presence of a technology equates to improved implementation of a curriculum. These differences necessitate a study of the relationship between technology and the real delivery of the early childhood curriculum in the context of the local community. In view of this, the present study investigated the predictive impact of emerging technologies on curriculum implementation in early childhood education in Calabar Municipality, Cross River State. The following specific research questions were posed to guide the study:

1. To what extent does preschool teachers' integration of digital tools predicts curriculum implementation in early childhood education?
2. To what extent does preschool teachers utilization of AR predicts curriculum implementation in early childhood education?
3. To what extent does virtual reality (VR) predicts the level of curriculum implementation in early childhood education?
4. What is the extent to which integration of digital tools, augmented reality (AR), and virtual reality jointly predicts the level of curriculum implementation in early childhood education?

Hypotheses

1. Integration of digital tools does not significantly predict the level of curriculum implementation in early childhood education.
2. preschool teachers use of AR does not significantly predicts curriculum implementation in early childhood education
3. Virtual reality (VR) does not significantly predicts the level of curriculum implementation in early childhood classrooms;
4. Integration of digital tools, augmented reality (AR), and virtual reality jointly do not significantly predicts the level of curriculum implementation in early childhood education.

Literature Review

The use of emerging technologies in early childhood education has emerged as a key area of research in the field, as it has the potential to greatly improve engagement, cognition and inclusion. Plowman and McPake (2021) noted that there is an increasing use of technologies like digital applications, augmented reality (AR) and virtual reality (VR) and interactive whiteboards, which well suit the range of young children's learning needs. These tools offer interactive and immersive learning spaces that enable children to interact with content in ways that traditional programs cannot. Interactive technologies were shown as increasing classroom participation and holding students' attention in the foundational subjects of literacy and numeracy (Donohue & Schomburg, 2020; Zomer & Kay, 2021). In the same way, Alnfisah (2020) conducted a study in Saudi Arabia on the effect of AR-based learning tools on increasing the attention span and conceptual understanding of preschool students, and in Nigeria, Ibrahim, Yusuf, and Lawal (2021) carried out a study on the effect of AR-based learning tools on the attention span and conceptual understanding of preschoolers in the Nigerian context, obtaining similar findings. The results indicate that immersive technologies, when used in an effective pedagogical approach, can become a powerful tool for fostering cognitive development in early learners.

In the literature, the impact of AR and VR has been given a lot of attention, especially the latter. Stotz and Columba (2022) also showed that board games with AR increased numerical recognition in preschoolers, showing the versatility of the use of AR technology in mathematics education. The same applies to the use of AR, which has been proven to facilitate vocabulary acquisition by creating visual cues and interactive contexts that help enhance learners' understanding and memory of new vocabulary (Ibrahim et al., 2017; Alnfisah, 2020). In addition, Iorliam and Agbo (2021) suggest that the technologies are particularly effective for fostering the development of language and mathematics skills which are key areas of early childhood development. Although these new technologies are promising, there are a number of obstacles to their successful use in early childhood education. One of the difficulties mentioned by Adebanjo and Rasheed (2020) is the poor infrastructure, including a lack of continuous power and internet connection, especially in low-resource areas like many schools in Nigeria. This is exacerbated by

weak levels of technical support and access to devices, which restrict the use of digital tools.

Donohue and Schomburg (2020) conducted a study which revealed that those teachers who had high self-efficacy in using ICTs were more likely to use digital tools in an active inquiry-based manner. Zomer and Kay (2021) observed that teachers with no training and support used technology in a more passive manner, which further points to the need of teacher professional development programs supported by extensive training. A study by Plowman and McPake (2021) confirms that teachers' attitudes towards the integration of technology were one of the major factors that predicts successful implementation. According to Ololube and Egbezor (2020), the Nigerian government has shown its support for the integration of ICT, and policies have taken major emphasis in secondary and tertiary education; but, little emphasis has been placed on ECE, with the technological resources and teacher training lacking. This lack of understanding is evidenced by the difficulties teachers encounter in putting technology into practice.

In the implementation of curriculum in early childhood education, a number of factors are closely related, particularly teacher preparedness, which is important for the success of implementing early childhood education, especially in the process of integrating emerging technology. Zomer and Kay (2021) maintained that the integration of technology into early childhood curricula is a key factor that impacts successful technology integration, and teacher professional development is a primary factor affecting the successful integration of technology into curricula. Well-trained teachers in technology and pedagogy are more likely to be able to make learning environments interactive and child-centered, suited to the developmental needs of young learners. However, Donohue and Schomburg (2020) noted that teachers without adequate training and/or support tend to have challenges in effective implementation, which can negatively affect their use or the way they use technology.

To implement the curriculum in early childhood education, it is necessary to balance content presentation, student participation and observation of student outcomes, which can be greatly improved through the use of technology in the right hands. But an important constraint to this is the lack of professional development of teachers, especially in low-resource communities. Many teachers have access to digital tools, but not all have the deep pedagogical knowledge to be able to utilize technology in meaningful ways when teaching. Plowman and McPake (2021) found that technology self-efficacy among teachers was correlated with the extent to which the teacher implemented technology in the classroom, which in turn, was correlated with greater engagement and positive learning outcomes. Zomer and Kay (2021) point out that teacher training in the use of technology for active learning has been documented to have a positive effect on student engagement and academic outcomes. Also, Alnfisah (2020) reported that specialized training has a significant effect on students' attention, motivation, and concept, when teachers are trained to integrate technology into their teaching, and the use of technology in teaching and learning has been linked to students' cognitive development.

METHODS

The study employed a predictive correlational survey research design because it aimed at finding the direction and the strength of the variation in the dependent (criterion) variable that was due to the independent (predictor) variable(s). A total of 408 Early Childhood Education (ECE) teachers in Calabar Municipality, Cross River State formed the population. Cohen, Mannion and Morrison (2018) criteria for representativeness of the population was used to select a sample of 186 teachers. A multi-stage sampling procedure was used in drawing teachers from schools that integrated emerging technologies in their curricula. The instruments for data collection included the Emerging Technologies Utilization Scale (ETUS) which had 30 items structured in three clusters with 10 items each for assessing the utilization of emerging technologies such as the integration of digital tools, augmented reality (AR), and virtual reality (VR). While the Curriculum Implementation Assessment Scale (CIAS) which had 10 items was constructed to assess the extent to which the early childhood curriculum is implemented. The instruments were structured based on a modified four point Likert type scale with response options of Strongly Agreed (SA), Agreed (A), Disagreed (D) and Strongly Disagreed (SD) with numerical points ranging from 4-1, respectively.

The instruments were subjected to face-validation by three experts in Educational Technology, Early Childhood Education, and Measurement & Evaluation in the College of Education, University of Calabar, Calabar. Reliability testing was conducted through a trial-test of the instrument on 30 teachers, and data obtained were analysed using Cronbach Apha which yielded overall coefficients for integration of digital tools (0.77), augmented reality (0.80), and virtual reality (0.78) with an overall index of 0.79 for the ETUS while 0.81 was obtained for CIAS. This coefficients showed that the instruments were reliable for the study. Data collection was through direct administration of the questionnaires to the teachers, and retrieved immediately upon completion to ensure high response rates. Data analysis was done using simple linear and multiple linear regression analysis because the study involves the linear and multiple predictive relationships. The correlation coefficients (r) and coefficients of determination (r^2) obtained were used to answer the research questions while the Analysis of Variance (ANOVA) obtained were used to test the null hypotheses at 0.05 level of significance.

RESULTS

The outcome of data analysis is presented below.

Table 1: Regression analysis of the extent to which integration of digital tools predict the level of curriculum implementation in early childhood education

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.592[a]	.351	.349	4.782	.351	214.085	1	184	.000

a. Predictors: (Constant), Integration of digital tools

Key: R = Correlation coefficient, R^2 = Coefficient of determination

The result in Table 1 shows that the correlation coefficient (r) and the coefficient of determination (r^2) values were 0.592 and 0.351, respectively. This coefficient of determination (R^2) of 0.351 denotes that 35.1% variation in level of curriculum implementation in early childhood education is attributable to integration of digital tools. This means that an increase in integration of digital tools lead to a moderate increase in the level of effective curriculum implementation in early childhood education. The result further revealed that integration of digital tools significantly predicts the level of curriculum implementation in early childhood education (F (1, 184) = 214.085, p = .000). Thus, the hypothesis was rejected because the significant value of 0.000 is less than the alpha value of 0.05. Hence, it is inferred that integration of digital tools significantly predict the level of implementation of early childhood education curriculum in Calabar Municipality, Cross River State.

Table 2: Regression analysis of the extent to which augmented reality (AR) predicts the level of curriculum implementation in early childhood education

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.613[a]	.376	.374	4.689	.376	238.372	1	184	.000

a. Predictors: (Constant), augmented reality (AR)

Key: R = Correlation coefficient, R^2 = Coefficient of determination

Result in Table 2 indicates that the correlation coefficient (r) and the coefficient of determination (r^2) values were 0.613 and 0.376, respectively. This coefficient of determination (R^2) of 0.376 denotes that 37.6% variation in level of curriculum implementation in early childhood education is predicted by augmented reality (AR). This means that an increase in augmented reality (AR) results to a moderate increase in the level of effective curriculum implementation in early childhood education. Furthermore, the result showed that augmented reality (AR) significantly predicts the level of curriculum implementation in early childhood education (F (1, 184) = 238.372, p = .000). Accordingly, the hypothesis was rejected because the significant value of 0.000 is less than the alpha value of 0.05. Thus, it was concluded that augmented reality (AR) was a significant predictor for the level of curriculum implementation in the early childhood education in Calabar Municipality, Cross River State.

Table 3: Regression analysis of the extent to which virtual reality (VR) predicts the level of curriculum implementation in early childhood education

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.661[a]	.436	.432	4.467	.436	101.677	1	184	.000

a. Predictors: (Constant), virtual reality (VR)

The result in Table 3 shows that the correlation coefficient (r) and the coefficient of determination (r^2) values were 0.661 and 0.436, respectively. This coefficient of determination (R^2) of 0.436 signifies that virtual reality (VR) predicts 43.6% changes in the level of curriculum implementation in early childhood education. In essence, an increase in virtual reality (VR) leads to a moderate increase in the level of effective curriculum implementation in early childhood education. Further result showed that virtual reality (VR) significantly predicts the level of curriculum implementation in early childhood education (F (1, 184) = 101.677, p = .000). Hence, the hypothesis was rejected

because the significant value of 0.000 is less than the alpha value of 0.05. Based on this, it was concluded that virtual reality (VR) was a significant predictor of the level of curriculum implementation in ECE in Calabar Municipality of Cross River State.

Table 4: Regression analysis of the extent to which integration of digital tools, augmented reality (AR), and virtual reality (VR) jointly predicts the level of curriculum implementation in early childhood education

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.683[a]	.467	.466	5.764	.467	346.821	3	182	.000

a. Predictors: (Constant), integration of digital tools, augmented reality (AR), and virtual reality (VR)

Key: R = Correlation coefficient, R^2 = Coefficient of determination

The result in Table 4 shows the correlation coefficient (r) and the coefficient of determination (r^2) values were 0.683 and 0.467, respectively. This coefficient of determination (R^2) of 0.467 implies that integration of digital tools, augmented reality (AR), and virtual reality (VR) jointly predicts 46.7% changes in the level of curriculum implementation in early childhood education. This means that an increase in virtual reality (VR) leads to a moderate increase in the level of effective curriculum implementation in early childhood education. Further result showed that integration of digital tools, augmented reality (AR), and virtual reality (VR) significantly predicts the level of curriculum implementation in early childhood education (F (3, 182) = 346.821, p = .000). Thus, the hypothesis was rejected because the significant value of 0.000 is less than the alpha value of 0.05. In this regard, it was determined that the use of digital tools, augmented reality (AR), and virtual reality (VR) are important predictors of the implementation of the curriculum in the early childhood education.

DISCUSSION

The study found that the integration of digital tools had a significant predictive impact on curriculum implementation in early childhood education. This result aligns with previous research, such as the work of Donohue and Schomburg (2017), which emphasized that the thoughtful incorporation of digital tools into early childhood curricula enhances engagement and learning outcomes. The moderate increase in curriculum effectiveness with digital tools supports findings by Zomer and Kay (2021), who noted that teachers with higher levels of ICT self-efficacy are better equipped to create interactive, child-centered learning environments. This finding also echoes Plowman and McPake (2021), who highlighted the potential of digital tools to foster greater participation in early learning settings when used effectively.

The study showed that augmented reality (AR) was a significant predictor for the level of curriculum implementation in the early childhood education in Calabar Municipality, Cross River State. This finding is consistent with Alnfisah (2020) and Ibrahim et al. (2021), who reported that AR-based learning tools significantly improve attention, motivation, and conceptual understanding among young learners. AR's immersive nature enables young children to visualize abstract concepts, making learning experiences more engaging and interactive (Stotz & Columba, 2022). The positive impact of AR on curriculum implementation, as found in this study, is further supported by research from Hsin and Wu (2018), who showed that AR technologies deepen comprehension in areas such as literacy and numeracy by offering multimodal learning opportunities.

The study also found that virtual reality (VR) was a significant predictor of the level of curriculum implementation in ECE in Calabar Municipality of Cross River State. This finding aligns with the work of Spiteri and Azzopardi (2019), who demonstrated that VR promotes spatial awareness and problem-solving skills in early learning environments. The ability of VR to create immersive experiences that facilitate deeper learning is consistent with the results from Stotz and Columba (2022), who found that VR significantly improved numeracy recognition and subitizing skills in preschoolers. The finding of VR's positive predictive effect on curriculum implementation underscores its potential in fostering interactive and context-rich learning environments, particularly in teaching complex concepts.

Finally, the study found that the use of digital tools, augmented reality (AR), and virtual reality (VR) are important predictors of the implementation of the curriculum in early childhood education. This finding suggests that a holistic approach to technology integration, incorporating multiple emerging technologies, has a more substantial impact on curriculum delivery than any single technology alone. This result supports the view of Donohue and Schomburg (2017) and Manches and Plowman (2020), who argued that the effective use of digital tools should not be isolated but rather integrated into a comprehensive and developmentally appropriate curriculum. Moreover, the positive correlation between the joint use of these technologies and enhanced curriculum implementation reflects the findings of Plowman and McPake (2021), who emphasized that the synergy of various technologies can

maximize engagement, foster creativity, and support differentiated learning.

CONCLUSION

This study concluded that emerging technologies, particularly digital tools, augmented reality (AR), and virtual reality (VR), significantly contribute to effective curriculum implementation in early childhood education in Calabar Municipality, Cross River State. Thus, emerging technologies fosters a more interactive, and engaging learning environment, thereby enhancing effective curriculum implementation in early childhood education.

Recommendations

It was recommended that:

1. Early childhood education centres should adopt integration of digital tools in the curriculum implementation in early childhood education.
2. Schools should prioritize the adoption of AR technologies to improve engagement and conceptual understanding, particularly in areas like literacy and numeracy.
3. Childhood educators should incorporate VR into early childhood curricula to promote spatial awareness, problem-solving, and deeper learning experiences for young learners.

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