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DIGITAL INEQUALITY AND THE USE OF TECHNOLOGY-BASED STRATEGIES BY CAREGIVERS IN EARLY CHILDHOOD EDUCATION IN UGANDA'S URBAN INFORMAL SETTLEMENTS

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Abstract

This study examines the influence of digital inequality on the adoption of technology-based learning strategies by caregivers in early childhood education (ECE) within Uganda's urban informal settlements, with a particular focus on Makindye Division, Kampala. While digital tools are increasingly recognized for enhancing early learning outcomes globally, their integration into low-resource ECE settings remains limited due to disparities in access, affordability, and digital competence. Rooted in Caregiver Identity Theory, the study explores how caregiver role mastery, self-efficacy, and environmental constraints shape the uptake and use of digital strategies in early learning contexts. Employing a quantitative correlational research design, data were collected from 70 caregivers using a structured questionnaire and analyzed using Pearson Product-Moment Correlation Coefficients. Findings reveal a statistically significant but modest positive correlation between technology-based strategies and learner performance ($r = 0.329$, $p = 0.005$), as well as a stronger correlation between digital access and technology use ($r = 0.412$, $p = 0.001$). These results confirm that while digital tools offer potential benefits for early learning, their effective use is constrained by limited infrastructure, high data costs, and caregiver digital illiteracy. The study concludes that addressing digital inequality is essential for advancing equitable ECE in Uganda and recommends increased investment in caregiver digital training, subsidized infrastructure, inclusive policy integration, and targeted community awareness initiatives to support the effective use of educational technology in underserved urban settings.

Keywords: Digital inequality, Technology-based learning, Early childhood education, Caregiver strategies, Uganda

Introduction

Digital technologies are changing educational delivery around the world, offering new possible ways to create access, engagement, and learning outcomes. It is a fact profoundly articulated in different versions of policy documents and theoretical discourses that children, particularly those who are nearly three years old, are gradually becoming more competent when the pedagogical content includes diverse types of educational apps, videos, and games (Zosh et al., 2023; OECD, 2022). In return, up to the youngest of the youngest learners, such tools will not only provide opportunities for individualized learning but also cultivate a sense of digital competence in them. This is, however, a fact profoundly articulated in different versions of policy documents and theoretical discourses that the use of technology-based strategies in early childhood pedagogy depends on context. While children from high-income settings have well-resourced and technologically literate teachers, children from the low-income strata of urban society, particularly in the Global South, face strong barriers in relatively less-endowed classrooms, characterized by a

lack of infrastructure, digital illiteracy, and socio-economic exclusion (UNESCO, 2021; Van Dijk, 2020).

Within sub-Saharan Africa, with a special focus on Uganda, there appears to be a digital divide in the early learning environment. The use of ICT has been promoted by the Ministry of Education and Sports of Uganda through its National Development Plans and Sector Strategies, but such plans mostly concentrate on the Primary and Secondary levels of education. This results in extremely under-resourced and non-prioritized early childhood education, especially in the urban informal settlements, left out from the nation's digital transformation agendas. The majority of caregivers at the forefront of such settings, particularly in Makindye, Kampala, face challenges of inculcating the use of technology due to lack of access to digital devices and unreliable internet, and even when available, they do not know how to use it for pedagogy (Khamis, 2022; UNICEF Uganda, 2021; APHRC, 2013). The challenges are more acute in the informal settlements of Makindye Division, Kampala, where households are below the poverty line, learning environments are overcrowded, under-resourced, and not supported by institutions.

Problem Statement

There is little empirical evidence in the context of increasing interest in educational technology on the role of caregivers in using digital tools for early childhood education in urban informal settlements of Uganda. In areas such as Makindye Division, caregivers associated with both public and private early childhood centers do not have electricity; they depend on shared and outdated devices and do not have internet access. Even when some are available, high costs of data and low digital literacy stand as barriers to using them for delivering instructional content or involving learners meaningfully. As a result, the empowerment of technology-based strategies is barely an implement within early learning programs that would otherwise bridge the educational gap between the children from unprivileged informal urban settlements and those from the relatively privileged formal settlements (Musisi, 2022; Angrist et al., 2021). They thus negate efforts towards the delivery of inclusive, equitable, and quality early childhood education despite the national and global commitments to attaining the SDGs.

Research Gap

Though recent studies assessed digital learning in Uganda's primary and secondary schools, the early childhood sector does not feature prominently in the discussion. Most of the studies are centered around access to digital devices or the impact of remote learning during COVID-19, rather than focusing on the integration of technology into the foundational learning process by caregivers, as stated by the UNICEF and Noor (2022; 2020). This literature does not also advance an exploration into how professional identities, self-efficacy, and training impact the use of technology-based strategies by the caregivers. Such localized evidence is conspicuously absent from the relatively better-studied informal urban communities of Uganda, where the education system is underfunded and where informal caregivers play a crucial role. This study seeks to bridge this gap by investigating how caregivers in Makindye Division use technology in early learning and the extent to which digital inequality affects learner outcomes.

Purpose of the Study

The study aimed to establish the relationship between technology-based strategies that caregivers apply and the performance of early childhood learners in the urban informal settlements of Kampala. It focused on the dimensions of digital inequality access, affordability, and literacy, and how these differentially shape and condition caregivers' capabilities in the implementation process. The study, guided by the Caregiver Identity Theory, inquires how the belief, confidence, and role of a caregiver relate to the adoption of digital tools in resource-constrained environments. By focusing on an under-researched population and context, the study will inform policymaking in education and caregiver training in Uganda, particularly on strategies for early childhood digital inclusion.

Theoretical Framework

This study utilizes Caregiver Identity Theory (CIT), as articulated by Montgomery and Kosloski (2022), which maintains that caregiving behaviors are dependent on the interaction of perceived role, self-efficacy, and social expectations of an individual. The key dimensions of the theory are described as follows: role commitment, role salience, and role mastery. Role commitment is the investment of the caregiver, both emotionally and morally, in the performance of the role; role salience refers to the degree to which the role is integral to the identity of the caregiver; and role mastery relates to the perceived competence and confidence of the caregiver in the execution of the caregiving task. In the area of early childhood education, these constructs create a perception through which the members see the desirability and feasibility of the use of the innovation, that is, technology in learning. Better mastered caregivers are inclined to have confidence in involving inventive tactics and, therefore, may embrace educational apps or online resources. Misinformed or under-confident caregivers may rather misuse such resources.

Applying CIT to this study gives a nuanced understanding of the reasons why caregivers in the urban informal settlements of Uganda respond diversely to the integration of digital systems. It explains why some caregivers will be enthusiastically using technology while others, even when accessibility is relatively similar, still show little interest. In low-resource settings such as Makindye Division and with limited formal training and support from the institution, the internal belief systems of the caregiver are what primarily determine whether digital strategies will be adopted and how they will be executed (Eifert et al., 2022). Therefore, by grounding the research in CIT, this study goes a step further than simply charting the usage patterns; it explores how the construct of caregiver identity interfaces with structural barriers in the digital realm to mark the ultimate outcomes of early learning. This theoretical approach facilitates the development of interventions that pool not only material resources but also confidence in agencies toward caregivers.

Review of Literature

The use of technology in the education of the youngest has become very popular around the globe. This occurred mainly because the COVID-19 pandemic created a huge demand for distance and technology-based learning. Studies from rich countries show that if used correctly, technology may help develop the cognitive, linguistic, and social skills of young children (Zosh et al., 2023; OECD, 2022). More access-oriented policies in digital learning are also advocated by scholars with the main focus on children living in underdeveloped localities; they feel left out of the educational process undertaken via the digital mode due to low availability of devices, connections, and prepared teachers (UNESCO, 2021). In this regard, the notion of digital equity has evolved, which emphasizes not only access but also skills, support, and infrastructure required for the proper use of digital tools. This overall literature creates a substantial argument showing that technology is not a neutral remedy but a socially embedded instrument that reflects and strengthens wider inequities.

In the African context, and Uganda in particular, very little research has gone into the area of the integration of technology into early childhood education. Most studies concentrate on upper primary and secondary education. While government policies support ICT in education, the policies do not include the caregivers in the informal ECE, who therefore operate outside the formal policy frameworks. Recent findings suggest that in urban informal settlements, some challenges have been experienced by the caregivers. These include low internet infrastructure, expensive data, and lack of pedagogical training, in digital pedagogy individually or collectively (Khamis, 2022; Musisi, 2022). All such barriers work towards misplaced contentions about the relevance of technology for preschool-age learners. Though some caregivers show great adaptability in improvising with basic tools or using phones to access learning content, it does point to the need for supportive structures that build on current practices. This paper tries to do so by looking at how digital inequality and caregiver identity interact, giving original evidence in an under-researched area of the Ugandan educational system.

Methodology

Research Design

This study used a quantitative correlational research design to assess the link between technology-based learning strategies used by the caregivers and the performance of early childhood learners in the urban informal settlements of Uganda. A correlational design was considered apt since it would help measure the strength and direction of relationships between variables without any form of manipulation. Precisely, the study determined the frequency for which caregivers used digital tools for activities in the early learning process and whether or not this use had any effects that could be seen on the learners. This design further looked into how digital access to the resource affected the ability of the caregivers to embrace technology-based strategies and thus provided an understanding of how digital inequality shaped the teaching practice in early childhood education.

Research Hypotheses

The following null hypotheses were tested in line with the objectives of the study:

H_{01} : There is no significant relationship between technology-based learning strategies and early childhood learner performance in urban informal settlements.

H_{02} : There is no significant relationship between caregivers' access to digital tools and their use of technology-based learning strategies in early childhood education.

Population and Sampling Strategy

The study population included 415 caregivers drawn from 83 early childhood centers, comprising both public and private institutions, in Kampala's Makindye Division. This is one of the largest and most socioeconomically diverse divisions within the capital of Uganda. A random sampling technique was stratified to ensure fair representation from both public and private institutions. From this population, 70 caregivers were selected as the sample. The stratification was based on the institution's type (public or private) to factor out structural disparities that could influence the incorporation of digital tools and resources accessibility.

Instruments for Data Collection

Data for this study were collected through a structured and researcher-developed questionnaire, further refined by expert opinion. Professionals in early childhood education and educational technology conducted a detailed analysis for clarity, pertinence, and alignment with the study goals. A final three-section thematic questionnaire emerged. The first section captured the use of technology-based strategies and the frequency of digital tools used by the caregivers in teaching children, such as mobile phones, educational applications, and digital video content. The first section captured the use of technology-based strategies and the frequency of digital tools used by caregivers in teaching children, such as mobile phones, educational applications, and digital video content. The second section captured learning performance indicators based on observations of children by the caregivers, including classroom engagement and cognitive responsiveness, and the ability to undertake and complete tasks. The third section captured digital access and barriers and started to indicate the availability of tools, reliability of the internet, cost of data services, and the level of digital literacy among the caregivers. All items in the questionnaire were worded to be on a 5-point Likert scale of "strongly disagree" to "strongly agree," so as to make them quantifiable and easy to analyze. This therefore enabled the researcher to capture systematically in a format amenable to statistical correlation analysis all caregiver experience and perception.

Validity and Reliability

For content validation, the questionnaire was shared with two lecturers in early childhood education and one specialist in ICT pedagogy. Their responses helped ready the items for a pilot test, which was then tried on 10 parents outside the sample to check the tool's reliability. The responses were used to calculate the internal consistency found by Cronbach's Alpha to be 0.873, hence high reliability.

Method of Data Analysis

The data, quantitative in nature, were analyzed with the Pearson Product-Moment Correlation Coefficient, a statistical technique most appropriate for determining the degree and direction of relationship between two continuous variables. It was carried out using the Statistical Package for the Social Sciences (SPSS) software. All hypotheses were tested at a 0.05 level of significance. Results were tabled, interpreted according to the strength and statistical significance of the observed correlations. It set a solid foundation for the scholar to critically measure how technology-based strategies influenced learner performance and to analytically think about the ramifications of digital inequality in urban early childhood education.

Results Presentation

Analysis of Hypothesis 1

H_{01} : There is no significant relationship between technology-based learning strategies and early childhood learner performance in urban informal settlements.

Table 1: Correlation Between Technology-Based Strategies and Learner Performance

Variable	N	Mean	Std. Deviation	Pearson Correlation (r)	Sig. (2-tailed)
Technology-Based Strategies	70	3.84	0.72		
Learner Performance	70	4.01	0.66	0.329	0.005

The results show a positive but modest correlation ($r = 0.329$, $p = 0.005$), indicating that caregivers who implement more technology-based strategies tend to report slightly higher learner performance. However, the modest strength of this correlation suggests that digital inequalities such as lack of access to devices and poor internet connectivity may be undermining the full potential of technology-enhanced learning. These findings highlight both the promise and limitations of ed-tech in low-resource early childhood settings.

Analysis of Hypothesis 2

H_{02} : There is no significant relationship between caregivers' access to digital tools and their use of technology-based learning strategies in early childhood education.

Table 2: Correlation Between Caregivers' Digital Access and Use of Technology-Based Strategies

Variable	N	Mean	Std. Deviation	Pearson Correlation (r)	Sig. (2-tailed)
Digital Access	70	3.67	0.81		
Technology-Based Strategies	70	3.84	0.72	0.412	0.001

The second hypothesis (H_{02}) proposed that there is no significant relationship between caregivers' digital access and their use of technology-based learning strategies. To test this, Pearson Product-Moment Correlation analysis was conducted using responses from the structured caregiver questionnaire. The analysis examined the relationship between caregivers' access to digital tools (e.g., availability of devices, internet access, data affordability) and the frequency with which they used technology-based instructional strategies.

The correlation results reveal a moderate positive relationship ($r = 0.412$, $p = 0.001$) between digital access and the use of technology-based learning strategies among caregivers. The significance level ($p < 0.05$) indicates that the correlation is statistically significant, leading to the rejection of the null hypothesis. This suggests that caregivers who have better access to digital tools and infrastructure are more likely to integrate technology into early childhood learning activities. These findings reinforce the idea that structural digital inequality including limited access to devices, unaffordable data, and unreliable internet remains a major barrier to the consistent and effective use of

educational technology in Uganda's urban informal ECE settings. Therefore, efforts to expand the use of digital learning in early childhood must prioritize both technological access and caregiver empowerment through training and support.

Discussion

It is based on the results of this study. Therefore, it can be firmly established that there is a positive though modest relationship between learner performance in Uganda's urban informal settlements and the integration of technology-based strategies implemented by caregivers in early childhood education. The Pearson correlation between the two variables-technology-based strategies and learner performance-is equal to 0.329, with a P-value of 0.005, therefore showing a statistically significant relationship; children exposed to technology-based strategies tend to perform better in terms of engagement as well as task and cognitive responsiveness. Mobile tools include educational apps, videos, and all forms of m-learning, etc. However, the strength of the correlation is modest, indicating that there are underlying structures impediments to the maximum use of technology in such areas.

Most importantly, the study found a stronger and statistically significant relationship between caregivers' digital access and their use of technology-based strategies ($r = 0.412$, $p = 0.001$). This confirms that digital inequalities, such as the lack of affordable devices and unreliable internet, and limited digital literacy directly impede the extent to which caregivers can implement technology-enhanced pedagogies. This has been indicated in the general and regional findings of research works, which emphasize the effect of digital access on educational equity. For example, some by UNESCO (2021) and Van Dijk (2020) show that digital divides in low-income setting regions do not provide equity of education, affecting educators rather than learners. For example, that of Angrist et al. (2021) and Khamis (2022) is that they are not able to harness technology for learning and thus perpetuate the educational disparities that are entrenched from the very earliest periods by the low-resource African setting caregivers.

This study fills a major gap in educational research in Uganda by focusing on caregivers who work in early childhood centers in informal urban settlements. This area has largely been overlooked in the discourse of digital education. While previous studies considered the integration of technology in primary and secondary schools, very little empirical work has considered how digital inequality impacts the early childhood educators and the children they serve. The study applies the Caregiver Identity Theory to assess not only external digital access but also how confidence, mastery, and commitment of the roles lead to the adoption of digital strategies. Such a theoretical framing would give more insight into the findings obtained and emphasize that the practice should focus on developing the identity of the caregivers alongside investing in infrastructure.

The results of the study support the study's rationale that technology-based learning has the potential to improve outcomes of early learners, but with limitations, as there are already existing digital inequalities. The results add to the secondary objective of the study, which is to assess how technology use relates to learner performance and to understand how digital access influences the integration of technology by caregivers. This research, therefore, is capable of informing and influencing actual actions for the policymakers, planners, and NGOs in reducing the digital divide in early childhood education.

Conclusion

This study proves that technology-based learning strategies have a positive effect on the performance of the early childhood learner, though they are not freely implemented due to unequal or uneven access to digital tools and infrastructure. Linking the caregiver digital access to the instructional practices sets a critical barrier to equity in the early learning sector of Uganda. The study bridges the major empirical literature gap by concentrating on the early childhood caregivers in the informal urban settlements and stresses the need to move above the infrastructure by investing in the empowerment of the caregivers, digital literacy, and inclusive policy reform to truly harness the benefits of educational technology for all learners.

Recommendations

- 1) Invest in affordable and accessible digital infrastructure for early childhood centers, especially in urban informal settlements.
- 2) Train caregivers in digital literacy and pedagogical integration of technology to enhance their confidence and competence in using educational tools.
- 3) Include caregiver-led ECE programs in national digital education strategies, ensuring that early childhood is not excluded from innovation agendas.
- 4) Promote public-private partnerships to provide subsidized digital devices, internet access, and locally relevant content tailored for early learners.

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