African Journal of Education Science and Technology (AJEST) Vol. 9 No. 1 (October, 2026)
University of Eldoret, Kenya, Mount Kenya University, Kenya, Chukwuemeka Odumegwu Ojukwu University, Nigeria, Kyambogo University, Uganda and University of Makeni, Sierra Leone

Influence of Teacher Digital Competency on Early Childhood Education of Pupils in Lurambi Sub-County, Kakamega County, Kenya

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Abstract

The use of digital technologies in early childhood education (ECE) is becoming a critical need, especially in the context of Kenya's Competency-Based Curriculum (CBC). This study focused on the effect of teacher digital competency on early childhood education of pupils in Lurambi Sub-County, Kakamega County, Kenya. The study used a mixed-methods design, with a sample of 152 ECE teachers in 96 schools. The number of teachers that were sampled was 123, which was determined by stratified and simple random sampling techniques and the Krejcie and Morgan formula. Questionnaires and interview schedules were used to collect data. The instrument was validated by experts and the reliability was tested by split-half and Cronbach's alpha ($\alpha = 0.823$) in a pilot study. The quantitative data were analyzed descriptively (mean and standard deviation) and inferentially (Pearson correlation and multiple linear regression) and the qualitative data were used to complement the quantitative data. Descriptive results showed that the internet and images/photographs were the most frequently used ICT resources, while teachers reported the lowest competency and experience in PowerPoint. The findings showed that teacher digital competency was positively and statistically significantly related to early childhood teaching and learning ($\beta = 0.412$, $p < 0.05$) and accounted for 39.2% of the variance in educational outcomes ($R^2 = 0.392$). Qualitative responses from teachers supported these results. The study concludes that teacher digital competency is an important factor in the effective delivery of ECE. It suggests the Ministry of Education and County Governments give structured ICT training and professional development programs greater priority to build digital skills of ECE teachers.

Keywords: *Teacher digital competency, Early childhood education (ECE), Competency-Based Curriculum (CBC), Educational outcomes, Professional development/ICT training*

Introduction

As an integral component of modern education, Information and Communication Technology (ICT) continues to transform pedagogical practices across all academic levels. In the context of Early Childhood Education (ECE), digital technologies present significant opportunities to foster interactive learning, stimulate cognitive development, encourage creativity, and widen access to varied instructional resources. Realizing these benefits, however, relies heavily on the availability of robust technological infrastructure, access to digital content, educators' digital literacy, and the seamless alignment of technology with age-appropriate teaching strategies. Digital technologies, when used in a developmentally appropriate and purposeful manner, and in relation to the curriculum objectives, have been found to have a positive impact on emergent literacy, numeracy, cognitive development, motor skills and social engagement in Early Childhood Education (ECE) (Blackwell et al., 2014; Nikolopoulou, 2014; Angeli & Valanides, 2020). The interactive tools like multimedia animation, digital storybooks, and learner-centered applications create dynamic learning environments that stimulate curiosity and maintain motivation for young learners (Wei, 2023). Yet, the use of ICT in early childhood settings in Sub-Saharan Africa is still uneven. Digital tools and technology are recognized as important in the ECE classrooms of countries like Senegal, Togo, Tanzania, and Zambia, but technology is not fully integrated or effectively used in classrooms (Lindsay, 2016). ICT resources are not fully utilised and are not always effectively integrated in classroom teaching and curriculum, partly as a result of low teacher ICT competencies and low pedagogical integration (Barasa et al., 2020). This disconnect is due to the continuous concerns of how to use digital technologies appropriately with young children and the lack of pedagogical preparation of early childhood educators in using ICT effectively in curriculum and teaching practices (Yang & Hong, 2022). The Kenyan government has acknowledged the transformative power of ICT in enhancing the quality of education and in contributing to the country's development objectives. The government has supported the use of ICT in education and learning through various programmes, including the Kenya Education Sector Support Programme (KESSP) and policy frameworks developed by the Ministry of Education (Republic of Kenya, 2012). The government has

prioritised the use of digital technology in all levels of basic education including EYE. The introduction of the Competency Based Curriculum (CBC) by the Kenya Institute of Curriculum Development (KICD) places digital literacy as a key competence. The CBC framework does not aim at using ICT as a standalone subject, but as a tool for supporting teaching and learning, building digital literacy, and providing learners with 21st century skills like communication and collaboration, critical thinking and problem solving, and creativity (Republic of Kenya, 2021). But the effective use of technology in ECE depends on the classroom teacher. In order to be able to effectively implement the CBC, ECE teachers need to have high digital competence, which includes knowledge, technical skills, pedagogical understanding, and confidence in selecting and appropriately using digital resources in teaching and learning (Dardanou et al., 2023; Su & Yang, 2024). The Kenyan government has invested in digital infrastructure and has formed policies to support the integration of ICTs, but systematic attention to the actual digital competencies of ECE teachers, and to their pedagogical integration, is a concern. There is recent evidence that digital competence of ECDE teachers is significant in the effective integration and use of digital resources in teaching and learning, and that targeted professional development is necessary to enhance digital skills of ECDE teachers (Oyieno et al., 2024; Murithi & Yoo, 2021). Uneven levels of digital competence among teachers threaten the effective rollout of the Competency-Based Curriculum (CBC) in Early Childhood Education (ECE), potentially undermining such as effective integration of digital technologies into teaching and learning. An empirical study is therefore needed to examine how teachers' digital proficiency affects such as effective integration of digital technologies into teaching and learning at the early childhood level.

Materials and Methods

This study adopted a convergent parallel mixed-methods design, in which quantitative and qualitative data were collected concurrently and subsequently integrated during the analysis phase (Creswell & Plano Clark, 2011) to explore the impact of teacher digital competency on early childhood development and education (ECDE). The target population for the study comprised 152 Early Childhood Education (ECE) teachers in Lurambi Sub-County, Kakamega County. From this population, a sample of 123 teachers was selected to participate in the study using simple random and stratified sampling techniques. Instruments for data collection included questionnaires, interview guides and observation schedule. Quantitative data were collected through questionnaires administered to classroom teachers, while qualitative data were obtained via interviews conducted with two programme officers. Experts determined face and content validity and piloting was carried out in Shinyalu Sub-County because the sub-county provides an appropriate context for investigating teachers' digital competency and its influence on Early Childhood Education. The reliability test yielded a Cronbach's alpha coefficient of 0.823, indicating good internal consistency among the questionnaire items. Since the coefficient exceeds the commonly accepted threshold of 0.70, the instrument was considered sufficiently reliable for use in the main study. Ethical approval was sought from relevant academic and national research institutions. The quantitative data were analyzed in SPSS through descriptive statistics and inferential statistical models, after satisfying the assumptions of the diagnostic. Qualitative data from the interviews were transcribed verbatim, read repeatedly for data familiarization, and systematically coded to identify recurring patterns. Related codes were grouped into broader themes, which were then reviewed and interpreted in alignment with the study objectives. Finally, these emerging themes were triangulated with the quantitative findings to contextualize and explain the statistical results.

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Results and Discussion

Frequency of Use of ICT Resources

Respondents were therefore asked to indicate how often they use (skills) the following ICT resources in your teaching and learning of ECD learners. Tick where necessary.

Table 1. Frequency of use of ICT resources

ICT resources	Not used (1)	Less used (2)	Rarely used (3)	Used (4)	Mostly used (5)	M	SD
CDs	24(21.2)	14(12.4)	23(20.4)	40(35.4)	12(10.6)	3.02	1.33
DVDs	30(26.5)	16(14.2)	18(15.9)	40(35.4)	9(8)	2.84	1.37
PowerPoint	33(29.2)	10(8.8)	27(23.9)	31(27.4)	12(10.6)	2.81	1.39
YouTube	25(22.1)	11(9.7)	18(15.9)	25(22.1)	34(30.1)	3.28	1.53
Animations	35(31)	2(1.8)	24(21.2)	34(30.1)	18(15.9)	2.98	1.49
Captions	21(18.6)	9(8)	32(28.3)	40(35.4)	11(9.7)	3.10	1.25
Internet	18(15.9)	3(2.7)	20(17.7)	37(32.7)	35(31)	3.60	1.37
Images/photographs	15(13.3)	5(4.4)	28(24.8)	26(23)	39(34.5)	3.61	1.35
Smart boards	24(21.2)	11(9.7)	35(31)	31(27.4)	12(10.6)	2.96	1.29

The results show that the most commonly used ICT resources by ECDE teachers were the internet (mean = 3.60, SD = 1.37) and images/photographs (mean = 3.61, SD = 1.35). The tools are probably preferred because they are accessible, easy to use, and provide support for visual learning, which is especially important for young children. More than 60% of teachers said they used the internet and images 'frequently' or 'most of the time', indicating that a high proportion of teachers are digitally engaged and comfortable with the use of images and the internet. The visibility of the internet may also be due to wider access to mobile data and devices for teachers, who are able to access information and plan lessons in a more diverse and creative way. YouTube also had relatively high scores, with a mean score of 3.28 (SD = 1.53), with 30.1% of respondents stating that it was used mostly in their teaching. This implies that videos are being incorporated into the ECDE classrooms, perhaps because of their engaging nature and the availability of a variety of age-appropriate educational content online. However, the high standard deviation indicates that there was a lot of variation in the responses, which could be due to variations in teacher skills or access to reliable internet connections. This distinction means that there are teachers who are very proficient in using video platforms, and others who may need more training or assistance from the infrastructure. The use of tools like DVDs (mean = 2.84), PowerPoint (mean = 2.81) and smart boards (mean = 2.96) was moderate to low. This could be due to the limited availability of the equipment, or the relatively high level of technical knowledge required to make effective use of these tools.

Level of Training

The table below shows the level of training that ECDE teachers in Lurambi Sub-County, Kakamega. For each of the tools such as CD/DVD, PowerPoint, YouTube, animation, captions, internet, images/photographs and smart boards, teachers were asked to rate their competency on a scale of 1 to 5, ranging from very low to very high.

Table 2. Teachers' competency in the use of ICT tools

Serial No	ICT resources	Very low	Low	Moderate	High	Very high	M	SD
1	CDs	30(26.5)	21(18.6)	50(44.2)	6(5.3)	6(5.3)	2.44	1.101
2	DVDs	30(26.5)	21(18.6)	50(44.2)	9(8)	3(2.7)	2.42	1.050
3	PowerPoint	36(31.9)	15(13.3)	53(46.9)	3(2.7)	6(5.3)	2.36	1.119
4	YouTube	22(19.5)	6(5.3)	41(36.3)	26(23)	18(15.9)	3.11	1.305
5	Animations	28(24.8)	14(12.4)	50(44.2)	9(8)	12(10.6)	2.67	1.235
6	Captions	28(24.8)	18(15.9)	42(37.2)	20(17.7)	5(4.4)	2.61	1.168
7	Internet	31(27.4)	15(13.3)	31(27.4)	18(15.9)	18(15.9)	2.80	1.415
8	Images/photographs	22(19.5)	9(8)	26(23)	30(26.5)	26(23)	3.26	1.413
9	Smart boards	27(23.9)	21(18.6)	47(41.6)	9(8)	9(8)	2.58	1.171

Teachers reported the lowest competency in PowerPoint (M = 2.36, SD = 1.119), followed by DVDs (M = 2.42) and CDs (M = 2.44). In contrast, images/photographs recorded the highest competency (M = 3.26, SD = 1.413), followed by YouTube (M = 3.11, SD = 1.305). The mean scores of competency in internet use were moderate (M = 2.80), and animations, captions, and smart boards had relatively low mean scores. The results show that there is a high degree of variation among teachers' ICT competency overall. Teachers seem to be more adept in the use of simple, easy-to-access resources, like images and YouTube, than structured or specialized technologies, like PowerPoint and smart boards. This indicates a need for professional development that includes both technical and pedagogical aspects. The authors Dardanou et al. (2023) highlight the need for digital competence in early childhood education to involve not only technical knowledge but also the use of technology in the right way in teaching. Likewise, Shikomera et al. (2023) and Oyieno et al. (2024) emphasize the need for teacher training and digital competence for effective integration of ICTs in Kenyan schools and ECDE settings.

Teachers' Level of Experience in Using ICT Resources

The table below shows the self-reported experience of the ECDE teachers in Lurambi Sub-County, Kakamega County in relation to use of different ICT tools in their teaching practices.

Table 3. Level of experience in using ICT resources

Serial No	ICT resources	Very little	Little	Moderate	Adequate	A lot	M	SD
1	CDs	31(27.4)	12(10.6)	44(38.9)	17(15)	9(8)	2.65	1.252
2	DVDs	31(27.4)	18(15.9)	35(31)	20(17.7)	9(8)	2.63	1.276
3	PowerPoint	45(39.8)	18(15.9)	29(25.7)	18(15.9)	3(2.7)	2.26	1.216
4	YouTube	31(27.4)	20(17.7)	23(20.4)	15(13.3)	24(21.2)	2.83	1.499
5	Animations	31(27.4)	12(10.6)	41(36.3)	17(15)	12(10.6)	2.71	1.307
6	Captions	33(29.2)	27(23.9)	24(21.2)	23(20.4)	6(5.3)	2.49	1.254
7	Internet	25(22.1)	18(15.9)	25(22.1)	18(15.9)	27(23.9)	3.04	1.476
8	Images/photographs	28(24.8)	15(13.3)	28(24.8)	18(15.9)	24(21.2)	2.96	1.466
9	Smart boards	30(26.5)	24(21.2)	33(29.2)	20(17.7)	6(5.3)	2.54	1.210

The lowest mean experience score (M = 2.26, SD = 1.216) was found for PowerPoint, with 39.8% of teachers indicating very little experience. Captions (M = 2.49) and smart boards (M = 2.54) had somewhat lower experience levels. In contrast, the highest experience was reported for the internet (M = 3.04, SD = 1.476) and images/photographs (M = 2.96, SD = 1.466), followed by YouTube (M = 2.83, SD = 1.499). The results suggest that teachers are more familiar with the easily available internet-based and visual resources than with the structured presentation and specialised technologies. This experience differential indicates that there is unequal exposure to ICT and highlights the importance of ongoing context-specific professional learning. Digital competence is not only a technical competence but also a pedagogical competence that is meaningful in the use of technology (Dardanou et al., 2023; Su and Yang, 2024). Oyieno et al. (2024) and Shikomera et al. (2023) also report teacher preparation, resource availability, and professional development as factors influencing the integration of ICTs in Kenya.

Learning Areas in Which Teachers Most Frequently Integrate ICT

Table 4 shows the learning areas in which ECD teachers felt comfortable in using ICT.

Table 4. Learning areas where teachers reported highest ICT integration

Comfortable learning areas	Frequency	Percent
Listening	65	57.5
Speaking skills	6	5.3
Reading skills	20	17.7
Writing skills	6	5.3
Literacy aspects	5	4.4
Number work	11	9.7
Total	113	100.0

Most teachers (57.5%) felt most comfortable teaching listening skills using ICT, followed by reading skills (17.7%) and number work (9.7%). The skills of speaking and writing each received 5.3%, and aspects of literacy 4.4%. The importance of listening skills might be related to the availability of audio-visual materials like songs, stories and videos appropriate for young learners.

The relatively low usage of ICT in speaking, writing, literacy and numeracy indicates a need for professional development on digital pedagogies that are relevant to the subject. UNESCO (2021) and OECD (2021) also highlight the need for digital resources to be readily available and for teachers to be trained in order to facilitate the effective use of ICT in the learning areas.

Frequency of ICT Integration

Participants were asked about the frequency of the use of ICT in teaching and learning. The results are shown in Table 5.

Table 5. How often teachers integrated ICT

Frequency of integrating ICT	Frequency	Percent
Always	25	22.1
Once a week	45	39.8
Twice a week	24	21.2
Never	17	15.0
Others	2	1.8
Total	113	100.0

The result indicates that 39.8% of the teachers were using ICT once a week, 22.1% of the teachers were always using ICT and 21.2% of the teachers were using ICT twice a week. Other frequencies (1.8%) and never using ICT (15.0%) were reported by a small proportion. Therefore, while most teachers reported that they integrated ICT to some extent, this was not the case for all teachers. The difference can be linked to the differences in ICT competency, access to digital infrastructure, professional development, and institutional support. Dardanou et al. (2023) and Oyieno et al. (2024) highlight the need for ongoing professional learning and access to suitable resources to ensure successful and consistent integration of ICTs in ECE.

Influence of Teacher ICT Competency on Teaching and Learning

Table 6. Influence of teacher ICT competency on teaching and learning

Model summary

Model	R	R^2	Adjusted R^2	Std. error of the estimate	ΔR^2	ΔF	df1	df2	Sig. ΔF
1	.648[a]	.420	.415	.37656	.420	80.407	1	111	.000

a. Predictors: (Constant), Teacher ICT competency

ANOVA

Source	Sum of squares	df	Mean square	F	Sig.
Regression	11.402	1	11.402	80.407	.000[b]
Residual	15.740	111	.142		
Total	27.142	112			

a. Dependent variable: Teaching and learning
b. Predictors: (Constant), Teacher ICT competency

Coefficients

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. error	Beta		
(Constant)	1.410	.082		17.289	.000
Teacher ICT competency	.312	.035	.648	8.967	.000

a. Dependent variable: Teaching and learning

The regression results show that there is a strong positive correlation between teacher ICT competency and teaching and learning (R = .648). The model accounted for 42.0% of the variance in the teaching and learning outcomes (R^2 = .420; Adjusted R^2 = .415). The regression model was statistically significant, $F(1,111) = 80.407$, $p < .001$.

Teacher ICT competency was a significant positive predictor of teaching and learning (B = .312, SE = .035, β = .648, t = 8.967, p < .001). This means that the greater the competency of teachers in the use of ICTs, the better the teaching and learning results.

Qualitative results corroborated quantitative results. One teacher stated, *"I only know how to use WhatsApp and Facebook, but I've never used PowerPoint in class."* Another said, *"I have been using YouTube for songs and stories since I took a workshop on how to use it, and I do so frequently in class."* A third teacher commented, *"I haven't been taught in college about ICT, I've learnt from my colleagues and by trial and error."*

The answers provided show the variation in teachers' exposure, confidence and training levels in ICT. They also argue that knowledge of the most popular digital platforms does not necessarily mean successful pedagogical integration. Therefore, teachers' professional learning needs should include technical skills as well as pedagogical skills so that they can choose and apply ICT to achieve particular learning goals.

The results align with the Professional Capital Theory of Hargreaves and Fullan which focuses on the knowledge, skills, professional judgement and collaborative capacity of teachers. In a similar study, Esmaeeli et al. (2024) discovered that few early childhood education programs offer sufficient opportunities for acquiring pedagogical knowledge needed for effective technology integration. Li et al. (2024) also stress the need to integrate technology into play-based, project-based, problem-based, and collaborative learning to make effective use of digital pedagogy, rather than just bringing technology into classrooms.

The teacher's self-efficacy and professional support are also significant. Paetsch et al. (2023) found that teachers' technology-integration self-efficacy was related to ICT literacy, self-efficacy, previous technology experience, and perceived support. Similarly, Zhang et al. (2023) connected SRL with teachers' ICT competencies, and Dai (2023) emphasized the role of collegial collaboration and institutional infrastructure in the development of digital competence.

The results overall show that teacher ICT competency is a key factor in effective teaching and learning in ECD. Enhancing technical and pedagogical skills of teachers and making digital infrastructure and peer-support more available would encourage more uniform and effective integration of ICTs.

Conclusion and Recommendations

The competency of the teacher in the use of ICT is an important factor in the successful teaching and learning in early childhood education in Lurambi Sub-County. Teachers who are more digitally fluent are more adept at selecting digital learning resources, designing lessons that are engaging and stimulating, and ensuring that pupils are involved, engaged and learning early. But the use of technology is still rather simple. Quarterly ICT professional development programmes should be introduced for ECDE teachers by the Ministry of Education through County and Sub-County Education offices; a peer-mentorship programme should be set up in each ECDE centre and the school should also have tablets, interactive whiteboards, reliable internet connectivity, projectors, and age-appropriate digital learning applications for interactive teaching and learning. School administrators should monitor the use of these technologies by teachers in lesson planning, delivery, learner engagement and assessment.

Acknowledgements

I would like to thank Masinde Muliro University of Science and Technology for allowing me to study for my Masters' degree. I would like to express my sincere gratitude to my supervisors Dr. Samuel Maragia and Dr. Edward Okaya for their invaluable guidance, constructive feedback and constant encouragement throughout the duration of this thesis. I also thank the entire Department of Educational Psychology for providing the basic research knowledge and skills that enabled this work. Thanks are due to Mr. Samuel Bulimo, Programme Officer for Lurambi Sub-County for his cooperation and to the administrators and teachers of the sampled schools without whose cooperation it would have been impossible to collect the data. I would like to express my gratitude to my mother, Catherene Anyango and immediate family for their moral and financial support throughout. Last but not least, I would like to thank my editorial team for their painstaking work in typesetting and editing. May God bless you all.

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