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Original Research Article

Selection of Developmentally Appropriate Technology in Early Childhood Education Environments, Serving Ages 4-6 in Nairobi County, Kenya

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Effective selection and use of technology in early childhood environments involve the application of developmentally appropriate tools and materials for enhancing learning, interaction, communication and collaboration. Since the influence of computers, iPods, mobile devices, digital cameras and video have increasingly found a way in Early Childhood Education (ECE) environments, teachers require guidelines for informed and intentional selection, use and evaluation of developmentally appropriate technology. However, gaps exist in research on parameters for selecting developmentally appropriate software for teaching and learning in pre-schools. Thus, the study assessed selection of developmentally appropriate technology in early childhood education environments serving ages 4-6 in Nairobi County. It was designed as a two-phase exploratory mixed methods study. The design allowed collection of data from two groups of ECE educators: case study and survey teachers. Case-studies of two ECE centres (low and high technology) involving 11 ECE teachers were compared in order to examine similarities and differences in selection of digital technologies. Similarly, teachers (n=508) in two education zones were surveyed and drawn in terms of similarities and differences in selection of technologies .Findings indicate that ECE teachers' selection of developmentally appropriate technology was influenced by professional training as well as type of ECE setting. The study recommends for further research and guidelines in selecting appropriate technologies for teaching and learning.

Keywords: Developmentally appropriate technology, Early childhood education, Selection, Teaching/learning environment.

INTRODUCTION

The role of developmentally appropriate technology in connection with curriculum offers children in Early Childhood Education (ECE) a medium of practicing and mastering skills essential for successful participation in school and in the entire society. Technology, when selected effectively is an effective tool for enhancing learning, social interactions, communication and collaboration. With technology becoming prevalent, the influence of computers, mobile phones, digital cameras and video has increasingly found its way in ECE settings raising questions on equity, access, affordability curriculum and pedagogy in Early Childhood programs.

However, according to according to National Association for the Education of Young Children (NAEYC), (2009), there are no guidelines for determining developmentally appropriate practices. Further still, Gravois, & Rosenfield, (2006) argues that selecting developmentally appropriate technology with educationally relevant content is challenging since the task of vetting pedagogical and developmental apparatus lies with ECE teachers whose pedagogy is weak in possessing a repertoire of skills in dealing with technology. Additionally, Kostelnik, Soderman, & Whiren, (2011), explains that the challenge of identifying developmentally appropriate software is broadened in the area of early childhood as the search for multiple content areas as mathematics, literacy, science and writing is an aggrieving task. In this context, there is need for teachers to take time in evaluating and selecting technological media for classroom carefully, observe children's use of the selected materials to identify opportunities and make appropriate adaptation, (Stevens, & Penuel, 2010).

While technology has broadened its scope, the challenge for teachers in ECE is in making informed choices on pedagogical principles, classroom practices and teaching strategies presented by informed child developmentally practice, Berk & Winsler, (2009). To this effect, analysis by Rennie Center for Education Research & Policy (2012) shows that, in selection process, teachers should consider allocation

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of limited resources and cost effectiveness, ongoing cost of updating hardware and software availability for effective use. In addition, Zimmerman, Christakis, & Metcalf (2007), insist that if ECE teachers are trained on how to select and utilize technology in correct ways there is a likelihood of positive impact on learning development. In support of this view, Wartella, *et al*,. (2010) opined that ECE educators who are grounded in Child developmental theory and developmentally appropriate practice are technologically and media literate have knowledge, skills and experience in selecting and using technology.

Besides, ECE teachers who lack technological literacy are at risk of making inappropriate choices which is likely to negatively impact children's learning and development. To address this challenge, ECE teachers require research that provides information on how to effectively select appropriate hardware and software while implementing technologies in classroom Moreover, teachers need to explore ways of promoting purposeful and intentional appropriate technology.

Given that the future of integrating technology into classroom is growing every day, increasing teacher's skills and knowledge in integrating technology into classroom is crucial. This can be through focusing on professional development aligned with features known to be effective in enhancing effective pedagogy. To this effect, Takanishi, & Kauerz, (2008) suggests that developmentally appropriate practice should guide the decision about when and how to integrate technological tools into program for ECE. Furthermore, analysis by Technology and Young Children Interest Forum, (2008) explains that appropriate use of technology and professional knowledge is required to determine if specific of technology is age appropriate.

Thus, ECE educators should continually monitor and assess research findings on emerging issues related to technology including eye health exposure to electromagnetic fields in physiological side effects. With focus on technology as an educational tool, Hudzik, & Stohl, (2009), advocates that teachers should use verifiable criteria based on good practices in addition to taking the time to evaluate and select technological tools and carefully observe children's use of learning materials to identify opportunity and make appropriate adaptations. Similarly, Yelland, (2001),explains that successful use of technology occurs when school policies are coherent, comprehensive and integrated with other policies for example language and equity policies.

In addition, integrations provide a framework for encouraging teamwork and strong leadership in technology use in ECE classrooms, (Mogharreban, & Bruns, 2009). For this to be successful children require mentoring on appropriate software. If teachers are trained on how to select and utilize technology in correct ways, learners are likely to achieve: autonomy, independence visualizing of ideas, sharing skills, selecting relevant information, making connections, and awareness of global matters.

Developmentally appropriate technology and learner interaction

Since children have become passionate users of technology, interaction and producing elaborated explanations are important for improving learning Wissman, *et al*., (2012.For example Schraw, Crippen, & Hartley, (2006), explains that developmentally appropriate technology facilitates effective interactions, characterised by sharing studying materials, joint problem solving and critical thinking skills. While putting technology in ECE classrooms may seem alarming, however, Cocking, (2009) points out that increasing use of technology offers opportunities for moral reasoning, positive interactions and expansions in social networks. Therefore, Bub, (2009) argues that through positive interactions, children develop social skills necessary for negotiating as well as problem-solving strategies necessary for success in life.

In addition, recognising that learning is an active process and that learning by doing rather than being told is vital, educationist have realised potential contribution of interactive technology to education, Siirtola, (2007). In line with this background, appropriate use of technology should be balanced with use of essential materials ,and activities in promoting interactive skills for enhancing learning.

*Developmentally appropriate technology and learner collaboration***.**

According to Schraw, Crippen, & Hartley, (2006), appropriate technology triggers collaborative learning and critical thinking skills such as coordination, conflict resolution, problem-solving and decision making. In this view, Schmidt *et al.,* (2007), argues that if technology is appropriately selected, children in ECE are likely to respond constructively to others during group discussions implying interaction in pro- social ways by encouraging and respecting the contribution of others. Hence, teachers need to align technology tasks in ways that support goals of collaboration including a high degree of negotiation, interactivity and interdependence.

Similarly, Egan & Judson, (2008), pointed out that developmentally appropriate technology can effectively enhance collaborative structures through shaping children's reasoning, controlling children's over thinking, enhancing learning skills and academic motivation in particular enjoyment of school learning. To achieve this, teachers should use developmentally appropriate technology in providing explicit instruction in collaborative activities such as teamwork and effective communication characterised by mastery orientation, curiosity, persistence and learning challenging tasks, Guay, (2010).More to the point, teachers need affordable, accessible and professional opportunities including hands-on technology training, financial support and access to latest technology.

Developmentally appropriate and learner communication

Communicating and navigating through technology sites exposes children in ECE to an array of skills including thinking, creativity, problem solving, questioning, critiquing, communication and making connection, NAEYC, (2009), Besides developmentally appropriate technology provides curiosity for children to take interest and be involved in learning, awareness of different audiences and increase in motivation through hands-on activities, Strickland et al., (2007), In order to achieve this, teachers need to select technology application that supports curriculum in addition to making decisions about which technology to use, for what learning, how to use it and how to judge its effective use in learning.

However, NAEYC & the Fred Rogers Center for Early Learning and Children's Media at Saint Vincent College, (2012), explains that the challenges for teachers is how to make informed choices that maximize learning opportunities. Thus, professional judgement is vital in determining if specific use of technology is age appropriate, individually appropriate, culturally and linguistically appropriate.

STATEMENT OF THE PROBLEM

Providing developmentally appropriate technology requires an understanding of technology viewed through the lens of known child development theories, Snider & Hirschy, (2009). Likewise, technology can improve when teachers are intensively trained in making professional judgement about appropriateness of technology and needs of learners in ECE. However according to McCarrick, & Li, (2007), teachers in ECE are unable to provide children with developmentally appropriate technology. Furthermore, gaps existing in research leave little guidance and parameters for selecting developmentally appropriate software for enhancing pedagogical interventions.

If teachers are trained on how to select and utilize technology in correct ways, learners are likely to achieve: autonomy, independence visualizing of ideas, sharing skills, selecting relevant information, making connections, and awareness of global matters. Consequently, inadequate emphasis on technology as an instructional tool hampers realization of effective selection of relevant resource employed in teaching and learning.

PURPOSE AND OBJECTIVES

The purpose of this study was to determine teachers' selection of developmentally appropriate technology in enhancing teaching and learning. The outcome of this study is to provide ECE teachers with knowledge and potential strategies of selecting appropriate technology. Likewise, policy makers will benefit by addressing inadequate infrastructure policies by ensuring coherence in equity and successful use of technology. The objective of this study was to examine how ECE teachers select developmentally appropriate technologies in teaching and learning.

THEORETICAL FRAMEWORK

The study was grounded in social-cultural perspective on knowledge and learning, Dewey (1997), social constructivism perspective, Vygotsky, (1998) and socialization distribution perspective, Dysthe, (1997). Social cultural oriented perspectives view the construction of knowledge as essentially social and embedded in a community while Vygotsky's (1998) view focuses mainly on the role of language in learning process. Consequently, Dysthe, (1976) views knowledge and learning as situated, distributed, mediated and depended on learning and participation in communities.

As a consequence of these perspectives, digital technology is the paradigm for introducing information technology in ECE teaching and learning environments. Since ECE children have grown up in different social conditions from previous generations, mainly through saturation of digital technology, it is essential to search ECE teachers' grounding in the use of technology.

Teachers should perpetually keep each child's unique learning style, culture, interest and developmental ability in mind when selecting and embedding technology in ECE classrooms. With this in mind, Mohammad & Mohammad (2012) explains that ECE curriculum should directly relate to child development readiness, embedded in children's unique needs interest, developmental ages, as well as social and cultural environment.

CONCEPTUAL FRAMEWORK

The study was founded upon Aslan, & Reiguluth (2013) conceptual framework of systematic change. For purposes of implementing developmentally appropriate technology, systematic change process provides educators with a foundation for achieving sustainable change involving stakeholders in changing their attitude about education, need for resources in developmentally appropriate practices such as software, training and funding. Therefore, the desire for implementing change into ECE classrooms lies in increasing purposeful implementation of developmentally appropriate applications. In this context, a paradigm shift is necessary for implementing technology into ECE classrooms focusing on interaction, collaboration and communication. For success to be realized, teachers require significant re-organisation of social and physical organization of classrooms; engage technology specialists with curriculum and pedagogical mentoring arrangements between expert and non-expert teachers in technology.

Understanding the process of change provides ECE teachers with a better understanding of how to implement digital technology to cognitive, social, intellection and knowledge construction to learners. Media and technology tools such as mobile phones, computers, digital cameras printers and photocopiers utilized should capitalize upon children's innate interest to actively create knowledge as well as recognizing diverse challenging effects of digital technology. When technology is fully integrated into classrooms, it is likely to become a catalyst for changing pedagogical relation for learners to achieve; autonomy, independence visualizing ideas, sharing skills and ideas, selecting relevant information, making connections, and awareness of global matters.

DATA AND METHODOLOGY

This was a two-phase mixed methods study that embraced a combination of both qualitative and quantitative approaches. Phase One was implemented within two ECE settings with 11 teachers as participants (N=11). The teachers' (N=11) experiences on access to digital technologies in the two settings were identified through a case study involving unstructured observations and semi-structured interviews. The main purpose of selecting two case study settings was to collect extensive and in-depth data (Baxter & Jack, 2008; Oldridge, 2010; Rowley, 2002) on ECE teachers' access to digital technologies. Yin (2009) defines a case study as an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident.

Sampling procedure

In this study, two ECE settings located in two education zones within the study district in Nairobi, the capital city of Kenya were selected to participate in the study. The two settings were selected with the assistance of the Ministry of Education on the basis of one being high and one being low in technology access. The criteria used in this selection included grouping ECE centres on the basis of the number of digital resources availed at the settings. The ECE settings with over ten digital resources were classified as 'high technology,' whilst those with less than ten digital resources were grouped as 'low technology'.

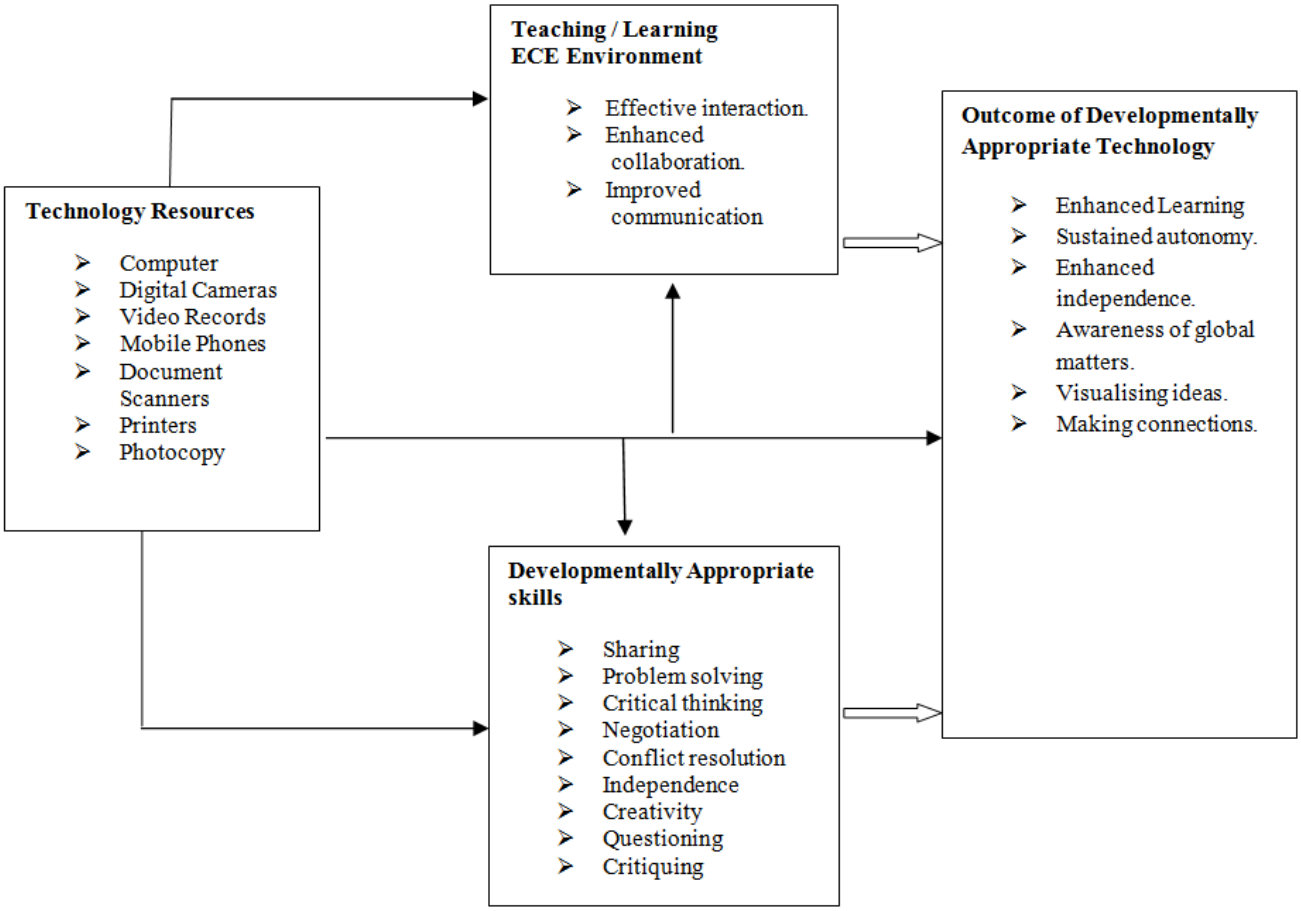

Figure 1. *Conceptual Framework*.

A combination of stratified and random sampling techniques (Teddlie & Yu, 2007) was employed to select the two ECE settings representing high and low access to technology.

Data collection and analysis

Unstructured observations and interview schedules were used to collect data on access to digital technologies in the case study for phase one. Leedy and Ormrod (2005) advocate the use of unstructured observations in qualitative. Phase Two of this study employed use of questionnaires. Analysis of Phase One data informed the design of the survey questions used in Phase Two. This strategy was selected for the purpose of gathering data from a larger sample of ECE teachers in one district (n=508).

Overall, qualitative data obtained through semi-structured interviews were transcribed and coded. A Census and Survey Processing System (CSPro), databases were developed and used to enter all data provided by respondents in data files and Serpro for entering, tabulating, and disseminating data from censuses and other surveys (Iris Center University of Maryland, 2010).

STUDY FINDINGS

The study examined teachers' selection of technology resources in ECE settings based on zones Findings from Table 2, showed that total aggregates of technology resources selected by teachers in zones one and two were 2.34 and 2.31 respectively. This indicates that there were no significant differences between the two groups of teachers in the two zones in regard to selection of technology resources accessed in ECE settings [t (505) = 0.29, p >.05]. Additionally, both groups of teachers were more likely to be equal in regards to technology resources accessed in ECE settings.

Differences in access based on the type of ECE setting

Independent two-sample t-test analyses were performed to find out whether there were any significant differences between teachers in public ECE settings and those in private ECE settings in relation to selection of technology resources accessed at home (Table 3), and at their ECE centres (Table 4) The study sought to find out teachers' selection of technology resources accessed at home based on type of ECE settings.

Table 1. Number of Teachers and Participants in Each Educational Zone

Educational clusters	No. of teachers	No. of participants
Zone 1 – Public	110	106
Zone 1 – Private	168	150
Zone 2 – Public	90	61
Zone 2 – Private	195	191
Total number of teachers	563	508

Table 2. Independent T-Test Analysis for Teachers' Selection of Technology Resources in ECE Settings Based on Zones

			N=508			
Variable	**N**	**Mean**	**SD**	**df**	**t**	**p**
Zone One	256	2.34	1.48	505	0.29	0.773
Zone Two	252	2.31	1.51	505	0.29	0.773

Table 3. Independent T-Test Analysis for Teachers' Selection of Technology Resources Accessed at Home Based on Type of ECE Settings

			N=508			
Variable	**N**	**Mean**	**SD**	**df**	**t**	**Sig.(2tailed)**
Public Settings	167	1.94	1.19	395	- 4.04	0.000
Private Settings	341	2.43	1.46	395	-4.04	0.000

Table 4. Independent T-Test Analysis for Teachers' Selection of Technology Resources Accessed Based on Type of ECE Setting

			N=508			
Variable	**N**	**Mean**	**SD**	**df**	**t**	**p**
Public Settings	167	1.88	1.33	373	-5.00	0.000
Private Settings	341	2.54	1.53	373	-5.00	0.000

Table 5. Independent T-Test Analysis for Teachers' Selection of Technology Resources Accessed at Home, Based on Gender

			N=508			
Variable	**N**	**Mean**	**SD**	**df**	**t**	**p**
Females	445	2.24	1.39	79	-1.13	0.261
Males	63	2.46	1.43	79	-1.13	0.261

Table 6. Regression Analysis of Teachers' Access to Technology Resources in ECE Settings with Multiple Predictors

Predictor	Coef	Std. Error	T	B	P (Sig.)
(Constant)	1.603	0.915	1.751		0.081
Gender	0.013	0.181	0.071	0.003	0.943
Age	-0.007	0.010	-0.671	-0.037	0.502
Education	-0.043	0.047	-0.906	-0.043	0.365
Profession	0.039	0.051	0.765	0.033	0.445
Place trained	0.069	0.072	0.960	0.043	0.338
Experience	0.001	0.017	0.043	0.002	0.966
Setting type	-0.372	0.130	-2.861	-0.780	0.004
ECDE Class	-0.066	0.085	-0.780	-0.31	0.436
Role	0.156	0.121	1.283	0.055	0.200
Home Access	0.485	0.043	11.304	0.454	0.000

From table 3, averages for total aggregates of technology resources selected by teachers in public and private ECE settings were 1.94 and 2.43 respectively. This suggests that there was a significant difference between teachers in public and private settings (in favour of those in private settings) in regard to selection of technology resources accessed at home [t (395) = -4.04, p < .05]. This data suggests that teachers in private ECE settings were likely to be accessing technology resources at home more frequently when compared to their counterparts in public ECE settings. The study observed teachers' selection of technology resources accessed based on type of ECE settings.

Data from Table 4 revealed that means for total aggregates of technology resources selected by teachers in public and private ECE settings were 1.88 and 2.54 respectively. This suggests that there was a significant difference between teachers in public and private settings (in favour of those in private centres) in regard to selection of technology resources accessed in ECDE settings [t ($373_{)}$ = -5.00, p < .05]. This data suggests that teachers in private ECE centres were likely to be accessing technology resources in ECDE settings more frequently compared to their colleagues in public ECDE settings. This finding did not match the findings in the case study centre in Phase One which indicated that none of the participating teachers at the low technology setting (private) accessed digital technologies while at this setting.

Differences in access based on teachers' gender

Independent two-sample t-test analyses were performed to determine whether there were significant gender-based differences in regards to teachers' selection of technology resources accessed at home as well as at ECE settings. Results of the analysis are presented in table 5 and 6 respectively.

The study ought to find out teachers' selection of technology resources accessed at home, based on gender.
From findings in Table 5, mean scores for ECE female and male teachers on selection of technology resources accessed at home were 2.24 and 2.46 respectively. This indicates that there was no significant difference between female and male teachers in regards to selection of technology resources accessed at home [t(79)= -1.13, p > .05].

***Relationships between teachers' demographic variables and selection of technology in ECE* settings**

Using multiple regression analysis, this study attempted to find out whether there were any relationships between teachers' selection of technology resources in ECE settings (as dependent or response variable) and a number of multiple independent variables (as predictors) related to teachers' demographic information (see Appendix B). The independent variables included gender, age, highest education attained and professional background; place of training, teaching experience, type of ECE setting, and ECE classes in which teachers practiced; responsibilities held and access to technology resources at home.

Findings from table 6 emanating from the regression test indicate that a multiple squared correlation coefficient (R^2) of 0.256 was obtained. This suggests that 25.6% of the variability in teachers' selection of technology resources accessed in EDE settings was accounted for by variability in the ten variables related to teachers' demographic information analysed simultaneously. This means that selection of technology resources by participating teachers was influenced by gender, age, highest education attained and professional background in EDE; place of training, teaching experiences, type of EDE setting, and ECE classes where the teachers practiced; the role or position held and access to technology resources at home.

The ten predictive variables included in the regression analysis showed variations of influence on teachers' selection of technology resources accessed in ECE settings. More specifically, gender was not a statistically significant variable in the teachers' selection of technology resources accessed in ECE settings (β = 0.003, *p* = 0.943), nor was teachers' age (β = -0.037, *p* = 0.502). Additional variables that were not statistically significant in influencing teachers' selection of technology resources accessed in ECE settings included highest education (whether primary, secondary or university education) attained by teachers (β = -0.043, *p* = 0.365); professional training of teachers (untrained, trainee, certificate, diploma or degree) (β = 0.033, *p* = 0.445); places where teachers received training (Government ECE colleges, Private ECE colleges, Public and Private Universities) (β = 0.043, *p* = 0.338); teaching experience (β = -0.002, *p* = 0.966); class taught (baby, nursery or pre-unit) (β = -0.31, *p* = 0.436); and teachers' position held at various settings of practice as per head of ECE section, class teacher or assistant class teacher (β = -0.055, *p* = 0.200).

Whether or not teachers had access to technology resources at home produced a statistically significant difference (β = 0.454, *p* = 0.000). This means that teachers' selection of technology resources accessed at their ECE settings did vary as a function of the teachers' access to technology resources at home. This means that teachers' access to technology resources at home was a critical factor that could influence selection technology integration at the ECE settings.

Though statistically significant, the regression coefficient for the type of ECE settings (public or private) teachers worked in was negative but large ((β = -0.780, *p* = 0.004). This shows that a negative association existed between teachers due to the type of ECE settings as well as access to technology resources at their ECE settings. This suggests that the type of ECE setting teachers worked in determined selection of technology resources.

CONCLUSIONS

Further, this study found no significant differences between teachers in the two zones in relation to selection of digital technologies accessed at home and ECE settings; selection of digital technologies accessed at home and ECE settings between male and female teachers. However, the current study found a significant difference between teachers in public and private settings (in favour of those in private settings) in regard to selection of digital technologies accessed at home and ECE settings.

Additionally, the current study found that that 25.6% of the variability in teachers' selection of technology resources accessed in ECE settings that was accounted for by variability in the ten variables related to teachers' demographic information analysed simultaneously. These variables include gender, age, highest education attained and professional background in ECE; place of training, teaching experiences, type of ECE setting, and ECE classes where the teachers practiced; the role or position held and access to technology resources at home. However, this study noted that certain variables were not statistically significant in the teachers' selection of digital technologies accessed in ECE settings.

These included gender, teachers' age, the highest education attained by teachers and professional training; places where teachers received their training; teaching experience; class taught; and teachers' position held at the ECE setting. However, this study noted that teachers' selection of technology digital technologies at their ECE settings did vary as a function of the teachers' access to technology resources at home.

If ECE teachers, both pre-service and in-service are to enhance their professional daily practice, then exposure and use of varied digital technologies is essential. Early childhood teachers can enhance children's learning through access and use of varied digital technologies in their daily practice including planning and documentation of children's learning. In view of this, more research work is needed to determine factors contributing to non-availability of varied developmentally appropriate digital technologies in ECE teaching and learning environments and especially in non-Western countries.

RECOMMENDATIONS

Professional development for Early Childhood educators has lagged behind; as a result, the study recommends the following;

- Teachers require a set of guidelines for informed and intentional selection, use and evaluation of technology tool, learn about appropriate use of technology and gain knowledge and skills in implementing technology effectively.
- Teachers should recognize technology tools as valuable in supporting hands-on activities and authentic engagements in the learning process. Thus, features of effective professional development in technology should align with features of professional development known to be effective in enhancing pedagogy and learning in ECE settings.
- Teachers should develop institutional strategies for Supporting and understanding of technology that connect with existing philosophy and pedagogical views. This entails teachers own aspirations, skills, knowledge and understanding of learning context.
- There is need to focus on development of policy integration and practice across whole education sector.

Education sector should focus on development of technology policy integration in curriculum.

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