



Vol.5 Special Issue No.2 (2022)

Journal of Applied Learning & Teaching

ISSN : 2591-801X

Content Available at : <http://journals.sfu.ca/jalt/index.php/jalt/index>

Transferring and sustaining technological innovations after professional development: Insights from school leaders and teachers in Sub-Saharan Africa

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Keywords

Capacity building;
professional development;
sub-Saharan Africa;
technology integration;
transfer of learning.

Abstract

Desiring technology-related change promotes reform-oriented technology integration to create a lasting impact on education. Nonetheless, most technology projects in Sub-Saharan Africa least achieved this target. Research points to quality professional development (PD) as a significant influence in achieving this. This follow-up study is on a cohort of 6,351 school leaders and teachers from six Sub-Saharan African countries who participated in a digital instructional PD targeted at building their capacity to embed ICT into school organisation and curriculum practices. The study sought to evaluate the impact of the PD programme in relation to the quality and the extent of the participants' transfer of the programme's ideas from capacity building to school organisation and classroom practices. A semi-structured survey instrument and diaries, kept to maintain records of activities and events during the period of implementation, were data channels. Findings revealed that stakeholder groups expressed general satisfaction with content and processes of the training programme; however, essential conditions to support transfer of the training's ideas to school level seemed inadequate during the period of implementation. Implications of the study for effective technology-related PD that have sustainable impact on educational practices particularly in Sub-Saharan regions and similar contexts are discussed in this article.

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Article Info

Received 14 November 2021
Received in revised form 8 August 2022
Accepted 15 August 2022
Available online 17 August 2022

DOI: <https://doi.org/10.37074/jalt.2022.5.S2.4>

Introduction

Much advancement has been seen in this field of ICT in education in a relatively short time across the globe and resulted in the expansion of ICT infrastructure. These improvements in technology are penetrating most African countries (even before the outbreak of COVID 19) and are bringing about conditions that are gradually turning into homes of emerging ICT hubs. These developments seem to compliment the majority of ICT initiatives in Sub-Saharan Africa in the immediate past that have often focused on creating ICT presence in schools. Such ICT initiatives form the basis of the bulk of ICT development and practices in most Sub-Saharan countries even though educators' and students' access to ICT is still limited. While these initiatives do not seem to create a broad or lasting impact on education, their inheritance remain important; they allow for setting up new computer laboratories or hubs in schools and thus, improving access as well as goodwill from donor partners. The obvious and most critical issue that needs to be addressed is the question of sustainability – Niederhauser et al. (2018) reports that the essence and utmost importance of ICT initiatives or research projects must be to foster effective adoption that will support the long-term goals of the education policy.

These arguments also point to the importance of effective professional development (PD) programme in implementing ICT initiatives. Fortunately, in recent times, Sub-Saharan governments at different levels are focusing on strategies that do not only seek to increase access, but also build capacity for educators and students to improve the quality of education through ICT (United Nations Economic for Africa (UNECA), 2005). While the process has previously been painfully slow (Ottevanger et al., 2007), the situation has been improving in the last few years. A case in point is the Africa Digital Schools ICT-project that was launched recently under the joint sponsorship of the British Council and Microsoft and in coordination with the Ministries of Education of six Sub-Saharan African partner countries: Kenya, Tanzania, Uganda, Ethiopia, Ghana and Nigeria. The ultimate goal of the project was to influence policy for ICT integration to build ICT competencies in school leaders and teachers in order to enhance and transform school practices.

Key to the envisioned project roll-out was a network of 80 digital hubs (also referred to as digi-hubs) installed and made to operate in the six Sub-Saharan African countries. Each hub was equipped with twenty terminals which acted as centres of excellence that supported other schools. Cascading from the digital hubs, digi-hub ambassadors (known as digital ambassadors) and master trainers were supporting schools and teachers in the project countries with ICT professional development and ongoing support during the 18 months long project implementation period. The PD training programme was meant to develop school leaders and teachers' capacity to integrate ICT to enhance their professional practices across the beneficiary schools of the project. Several months after this intervention, what remains to be done is a follow-up to see if the training programme has yielded the desired results in the way trainees who took part in the training implement the knowledge, skills and attitudes gained in the training

context in their practices. Fishman and Krajcik (2003) reported that in the space between originating context and broader applications or continuity, most innovations either disappear or become unrecognisable and as Fullan (2015) reported, a great majority of policies and innovations did not get implemented even when implementation was desired. This study is an independent one, carried out to explore how the project's PD programme was implemented in relation to the school leaders and teachers' development, school organisation, resource support, usage and changes.

Literature review

Transfer of learning

A number of studies have shown that though most research projects yielded valuable knowledge about the nature of cognition, teaching and learning, they failed to have a broad or lasting impact on education. These studies (e.g. Saks, 2002; Yamnill & McLean, 2001) point out that learning from a formal training programme is often not or in a limited way applied on the job. Questions raised normally centre around the degree to which trainees effectively transfer the knowledge, skills and attitudes gained in the training programme to a real world of work. Over the years, there have been studies and explorations of factors that thwart transfer, diffusion and implementation efforts. Prominent among those who have journeyed into this puzzling morass are Baldwin and Ford (1988). Baldwin and Ford (1988) identified a taxonomy of major conceptual factors influencing transfer. They divided these factors into three groups of characteristics which directly or indirectly influence trainees' learning and the transfer of training: trainee characteristics, training characteristics and work environment characteristics. Baldwin and Ford referred to work environment characteristics as external factors which directly and indirectly affect trainees' learning and transfer of training; trainee characteristics as internal factors (e.g. ability, personality, and motivation) and training characteristics as training design factors (e.g. principles of learning, sequencing, and training content). Bebell and O'Dwyer (2010) reported of other key factors to include the importance of leadership and support. The importance of administrative leadership in implementing and sustaining reform initiatives (see Niederhauser et al., 2018; Fullan, 2015) have also been reported in the literature – Fullan reiterated that effective school leaders are key to effective implementation of large-scale, sustainable education reform efforts.

Professional development for ICT initiatives

According to Webb and Cox (2004), one of the reasons for the unenthusiastic response to ICT-based innovation amongst schools is that technological knowledge and skills is either absent or lacking in the processes that underpin school organisation and teachers' planning. Training is therefore considered an important influence on how technology can be embraced in the classroom (Baylor & Ritchie, 2002). If school leaders and teachers are not trained or prepared sufficiently for their new roles with technology, then it could be that they merely will try to transfer classroom

practices to the new environment (Redmond, 2011; Kelz, 2011). Additionally, Meloncon (2007) indicates that teachers need to redefine themselves when they are changing their teaching place, e.g., the change to a technology-based learning environment. This stresses the importance and the need for PD on learning how to teach with technology and transform school practices. In this respect, recent research emphasises the need for more studies on effective PD that implement instructional technology in ways that encourage integration (for examples, see Goktas et al., 2008; Kay, 2006; Philipsen et al., 2016) into school organisational and curriculum practices even after the training.

The professional development arrangement

Prior to the conduct of this study, a PD programme was organised to target Science, Technology, English and Mathematics (STEM) high school teachers and their school leaders from six countries that participated in the study. Preceding the PD programme, a first stage capacity building training of selected master trainers from the participating countries was organised. The "Master Facilitator Training Programme" was aimed at building the capacity of the trainers to enable them to train selected school leaders and teachers as well as to get them to familiarise with the content of a training manual that had been designed for the PD programme. In the following stage, the master trainers were to offer training programmes to the school leaders and teachers (using the training manuals) to be extended to the school communities of the various participating countries.

Table 1: Overview of the training programme manual.

Session	Content
1	Managing and Leading Change
2	Leading Effective Teaching and Learning
3	Creating and Communicating a Vision
4	Goal-Setting for Success
5	ICT Skill Development
6	The Benefits of the International Dimension and Technology
7	Building Teams
8	The Power of Coaching
9	Action Plan
10	Leading Effective Teaching and Learning
11	ICT Skills for Teachers – Word
12	ICT Skills for Teachers – PowerPoint
13	ICT Skills for Teachers – Excel
14	Using Microsoft AutoCollage
15	Using Microsoft Photo Story

The training manual was intended to be used to support teachers during the training sessions and, subsequently, to be used by the participants in their own local school settings. The training manual consisted of 15 sessions in all. The material also provided a facilitator manual with orientation for guiding participants through each session of the course. Strategies in the course delivery were focused on participatory methodologies with guidance orientation on an 80:20 rule in which 80% of talking and activities doing came from the participants and 20% of guidance and instruction from the facilitators. Table 1 gives an overview of the content of the training manual.

Conceptual framework

The Guskey model was adopted in the current study to examine the evidence of effectiveness of the PD programmes impact at each level of the model's influence from training to practice. Thomas Guskey is an educationist who has been writing for some time about the importance of seeking evidence of the effectiveness of PD models and programmes (see Guskey, 1985, 1986, 1990, 1991, 1998; Guskey & Sparks, 1996). According to Guskey (2002, 2017), effective PD evaluations require the collection and analysis of five critical levels of information: Level 1: Participants' Reactions; Level 2: Participants' Learning; Level 3: Organisation Support and Change; Level 4: Participants' Use of New Knowledge and Skills and Level 5: Student Learning Outcomes. With each succeeding level, the process of gathering evaluation information gets a bit more complex. The model also explains that success at one level is usually necessary for success at higher levels because each level builds on those that come before.

The present study sought to apply Guskey's model to explore the efficiency, effectiveness and relevance of the PD training programme. The evaluation focused on four levels of the model impact, namely:

- Level 1: School Leader and Teacher Reaction focused on general impressions about the digital training programme and its components (e.g., quality and effectiveness) in transforming school practices;
- Level 2: School Leader and Teacher Learning, focused on the quality of learning during the training (e.g. the change in competencies, self-belief of digi-hub use in teaching and school organisation);
- Level 3: Organisation Support and Change focused on schools' conditions and practices that underpin or support school leaders and teachers' implementation efforts and recognition of the digi-hub in teaching, learning and school organisation (e.g., things planned to do or changes after training, plans in place for ICT use);
- Level 4: School Leader and Teacher Use of New Knowledge and Skills focused on the use of the training programmes' ideas in practice. At this level, the emphasis is on whether school leaders and teachers were applying the knowledge and skills they had acquired during the training in their professional and teaching practices.

The relationship between PD and improvements in student learning in this setting was far too complex and difficult to measure, since the entire project spanned over a period of 18 months. In such a case, collecting good evidence about whether a PD programme has contributed to specific gains in student learning was a difficult task. Hence, level 5 of Guskey's model was not considered in this study.

Research questions and research design

This study aimed at evaluating the impact of an instructional digital PD programme on high STEM high school teachers and their leaders from the six Sub-Saharan African countries who participated in the study and was guided by two research questions.

(1) How did the participating school leaders and teachers perceive the contribution of the PD programme to developing their experiences of the instructional digital innovation to enhance their professional practices?

(2) To what extent did the PD programme promote transfer of learning among the school leaders and teachers?

In the study, 'transfer of learning' referred to whether new knowledge, skills and attitudes acquired by participating school leaders and teachers during the training programme were being applied or used in their professional and teaching practices. The study employed an embedded mixed method research design (Creswell et al., 2003), including the collection of quantitative and qualitative data.

Methods

Participants

6,351 participants consisting of 4,945 teachers and 1,406 school leaders from all the six countries responded to the survey. This constitutes a 90.1% response rate from the total of 7,050 participants who took part in the PD and were expected to respond to the survey sent to them. Table 2 gives the breakdown of the participants by country and gender. The highest number of 1,909, constituting 29.6 % of the total respondents was from Uganda.

Table 2: Distribution of respondents by country and gender.

Country	School Leaders	Teachers	Total	M (%)	F (%)
Ghana	233	688	921	87.9	12.1
Ethiopia	508	556	1064	86.9	13.1
Nigeria	92	545	637	53.0	47.0
Tanzania	138	1051	1189	41.7	58.3
Uganda	200	1709	1909	41.8	58.2
Kenya	235	396	631	34.3	65.7
Total	1406	4945	6451	61.1	38.9

The lowest (631) response was from Kenya and this constituted about 9.8% of the total respondents. Table 2 gives an overview of the distribution of the respondents by countries. The summary profile of the respondents' gender showed a higher male to female ratio of about 61: 39. With respect to age distribution, the majority (47.5%) of the total respondents fell within the age range of 25-34 years. About 47.3% were either within the age group of 35-44 or above 45 years. Only a small percentage fell within the lower age ranges of 16-20 (0.3%) and 21-24 (4.9%).

Data collection and analysis

Teacher questionnaire

This study adopted an online survey evaluation tool which was used previously for the data collection during the PD programme for the participants. The survey was made of a semi-structured questionnaire developed and used to collect data at the first four levels of Guskey's model. Items on the survey included perceptions of participants of the training programme and what they learned from the training. For these items, a five-point Likert scale (1 = strongly disagree, 5 = strongly agree) was used. The scores were interpreted as follows: 1 is the lowest possible score, which represents a very strong negative perception, while 5 is the highest possible score which represents a very strong positive perception. The questionnaire also contained an item in which respondents were required to make recommendations to other colleagues based on their own experiences with the training programme. They were to rate on a scale ranging from 0-10; where 0 = very unlikely to recommend and 10 = very likely to recommend. The survey also included an open-ended item which required respondents to explain three things they would like to do or change as a result of the training. The focus was to explore the potential influence of the digital hub post-training on practices and to verify the potential enabling conditions for supporting ICT implementation efforts in school organisation. In analysing the data, closed-ended items were analysed using descriptive analysis, t-test and analysis of variance test. For open-ended items, quantitative content analysis was used. This analysis focused on generating and coding themes or categories (Miles & Huberman, 1994) based on the school leaders' and teachers' responses followed by a systematic quantitative analysis of the occurrence of particular categories/themes.

Digital Ambassador diaries

Digital Ambassador diaries were used to maintain records of activities and events at the various hubs during the training programmes. Data collected referred mainly to the training content and processes of the training challenges encountered during the training programme. The information recorded and analysed qualitatively used data reduction techniques (Miles & Huberman, 1994).

Results

Using Guskey's framework for evaluating the PD programme, data were analysed at four levels of the training programme and its implementation. The following summary provides an overview of findings from the analyses.

School leader and teacher stakeholders reaction on the training

The first level of the evaluation focused on the school leaders' and teachers' views on the training programme. The purpose was to explore the level of quality of the

training programme and the extent to which the training met their expectations. The results showed overall highly positive perceptions for both teachers (M=4.36, SD= 0.57) (i.e. approximately 'agree') and school leaders (M=4.42, SD= 0.36) (i.e. approximately 'agree') of all the participating countries.

Table 3: Descriptive statistics of school leaders and teachers' views on the training programme.

Items	Ghana		Ethiopia		Nigeria		Tanzania		Uganda		Kenya	
	T	SL	T	SL	T	SL	T	SL	T	SL	T	SL
	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
	(SD)	(SD)	(SD)	(SD)	(SD)	(SD)	(SD)	(SD)	(SD)	(SD)	(SD)	(SD)
This event met my expectation	4.18 (.70)	4.34 (.62)	4.67 (.50)	4.64 (.54)	4.25 (.80)	4.04 (.80)	4.44 (.56)	4.55 (.54)	4.47 (.65)	4.41 (.62)	4.40 (.57)	4.49 (.59)
High quality event	4.22 (.62)	4.38 (.52)	4.49 (.63)	4.70 (.49)	4.31 (.67)	4.13 (.69)	4.41 (.57)	4.46 (.57)	4.44 (.68)	4.39 (.63)	4.09 (.92)	4.52 (.53)
Overall view on training	4.22 (.58)	4.36 (.48)	4.57 (.51)	4.67 (.42)	4.28 (.65)	4.09 (.64)	4.43 (.49)	4.51 (.50)	4.45 (.58)	4.40 (.52)	4.25 (.58)	4.51 (.49)

Note: 5 = strongly agree, 4 = agree, 3 = neither agree nor disagree, 2 = disagree, 1 = strongly disagree, T=Teachers, SL=School Leaders.

A two-tailed t-test performed between the perceptions of the teachers and school leaders did not show any significant difference between the two groups; an indication that the overall views with regard to the quality of the training and the training meeting participants' expectations were the same as perceived by teachers and leaders for all the participating countries. Similarly, an analysis of variance test showed no significant differences between the reported values across the countries; though the descriptive statistics showed that respondents from Ethiopia [T (Mean = 4.57, SD= 0.51) and SL (Mean = 4.67, SD= 0.42)] recorded the overall highest mean score whereas those from Ghana [T (Mean = 4.22, SD= 0.58)] and Nigeria SL [(Mean = 4.09, SD= 0.64)] had the least scores relatively for teachers and school leaders stakeholders respectively. Table 3 shows a summary of the results.

Data gathered from digi-hub ambassadors from the respective countries gave a better description of the nature of courses provided in the hubs during the project implementation period. Whereas some hubs achieved success in running most of the courses in the training manual, others focused on just a few of the courses. For example, in Ethiopia, all the 22 hubs focused on training on the theme "Basic ICT Skills and Microsoft Applications". Apart from two hubs which did extra courses in "Leadership Skills", the focus of all the other 19 hubs in Tanzania was on "Basic ICT Skills and Microsoft Applications". This pattern was similar in hubs in Kenya and Uganda. In Nigeria, apart from "Basic ICT Skills and Microsoft Applications", all the hubs focused on providing courses on "Professional Learning Networking" and "Using Internet Resources". The majority of the hubs in Ghana ran at least three or more courses in areas such as "Managing Change", "Leading Effective Teaching and Learning", "Goal setting for success", "Creating and Communicating a Vision", "Introduction to the Learning Suite – ICT Skills Development", "Team Working" etc. Thus, apart from "Basic ICT skills and Microsoft Applications" Ghana was the only country that appeared to have touched on all the courses proposed for the PD during implementation period.

A key observation made was that most hubs across the countries focused on training that equipped trainees with basic ICT skills acquisition and Microsoft applications. It is not too clear why the courses were limited to basic skills while a contributing factor reported by the digi-hub ambassadors was the issue of time. The digi-hub ambassadors' reports highlighted some challenges encountered during the training programme. Time for the training was generally limited in proportion to the package of training content for the training module. The quality of the internet connectivity was also heavily critiqued and frequent power failure was also detrimental to the overall quality of the training experience. In spite of these challenges, the training served as an eye opener as participants reported positive perceptions were also reflected in high ratings to recommend the programme to other colleagues (see Table 4). The overall ratings [T (Mean=8.91, SD= 1.98), SL (Mean=9.52, SD= 1.06)] were seemingly high for both teachers and school leaders.

Table 4: Teachers' ratings on recommendations of training programme.

Country	Teachers		School Leaders	
	Mean	SD	Mean	SD
Ghana	8.15	2.49	8.92	1.54
Ethiopia	9.52	1.06	9.57	0.87
Nigeria	9.00	1.82	8.71	0.92
Tanzania	9.09	1.50	8.99	0.68
Uganda	9.40	1.27	9.34	0.65
Kenya	6.58	3.17	9.54	1.50
Overall	8.91	1.98	9.31	0.56

Scale between 0-10; 0=very unlikely to recommend and 10= very likely to recommend

Professional learning

The second level of evaluation focused on the quality of the participants' learning in the training programme. Findings showed that school leaders' and teachers' perceptions about the impact of the training programme on their learning were positive. For example, all the participating countries reported an approximate mean (SL=3.74, T= 4.01) value of 4.0 (which is agree) for knowledge and skills acquired to integrate ICT in schools and teaching respectively (See Table 5); an indication that both school leaders and teachers had acquired the necessary knowledge and skills to use the digi-hubs in their professional practices. Similar trends were observed in knowledge and skills acquired by the trainees to support teachers and student learning (SL=3.76, T= 3.92) respectively and to promote or use the facilities in the digi-hubs (SL=3.75, T= 3.82). These findings bring into line the extent and quality of learning that took place by the trainees across the different participating countries.

Table 5: Knowledge and skills acquired from the training programme.

Lessons Learnt/ Acquired	Ghana		Ethiopia		Nigeria		Tanzania		Uganda		Kenya	
	T	SL	T	SL	T	SL	T	SL	T	SL	T	SL
	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
	(SD)	(SD)	(SD)	(SD)	(SD)	(SD)	(SD)	(SD)	(SD)	(SD)	(SD)	(SD)
Knowledge and skills to integrate ICT schools/ teaching	3.98 (.23)	3.79 (.18)	4.06 (.50)	3.58 (.23)	3.77 (.24)	3.58 (.22)	4.29 (.41)	3.16 (.33)	4.05 (.39)	3.72 (.19)	3.92 (.14)	3.97 (.33)
Knowledge and skills to support teachers/students learning	4.06 (.19)	3.70 (.22)	4.06 (.32)	3.79 (.30)	3.71 (.21)	3.57 (.20)	4.12 (.20)	4.05 (.15)	3.93 (.43)	3.62 (.15)	3.68 (.19)	3.91 (.18)
Knowledge and skills to promote/ use facilities in the digi-Hub	3.89 (.13)	3.65 (.16)	4.06 (.36)	3.78 (.33)	3.59 (.37)	3.39 (.21)	3.99 (.28)	4.03 (.13)	3.87 (.20)	3.72 (.17)	3.83 (.28)	3.91 (.20)

Note: 5= strongly agree, 4=agree, 3=neither agree nor disagree, 2= disagree, 1=strongly disagree, T=teachers, SL= School Leaders

The report on the overall means (see Figure 1) of the measures used in assessing the quality of the participants' learning also confirmed that school leaders and teachers acquired significant knowledge and skill through the training programme. From Figure 1, the overall mean scores ($SL=3.84$, $T=3.95$) of lessons learnt by respondents from all the countries seemed satisfactory and give an indication that the training programme impacted on both the school leaders' and teachers' learning.

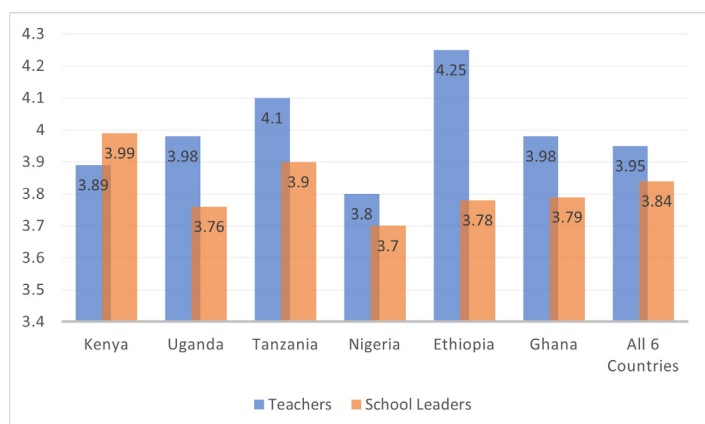


Figure 1: Country by country overall lessons learnt.

Interestingly, among the six countries, teachers ($T = 4.25$) in Ethiopia and school leaders ($SL = 3.99$) in Kenya reported the highest positive perceptions about knowledge and skills gained in the training programme, while Nigeria ($SL = 3.7$, $T = 3.8$) reported the least for both teachers and school leaders.

Organisation support or institutional conditions

To explore practices and school conditions that underpin or support teachers' implementation efforts and recognition of the digi-hubs in teaching, learning and school organisation, the survey required school leaders and teachers to determine if they have any plans in place of how they will use ICT in their professional practices in the future and explain three things they would like to do or change as a result of the training. Responses of the trainees showed highly positive perceptions on plans in place to use ICT in their teaching and school organisations. Averagely, all countries reported fairly high responses (see Figure 2). The average scores of 4.09 for teachers and 4.14 for school leaders indicate the participants' willingness to transform teaching, learning and organisation of schools with ICT in their respective countries.

Regarding what exactly participants will want to do or change as a result of the training programme, they enumerated various things. Table 6 presents the categories of teachers' responses on what they would want to do while Table 7 displays that of the school leaders. What was most popular among the teachers was the drive to motivate and help other teachers to integrate ICT in their teaching (17%). The next most popular was promoting curriculum reform and development (15%).

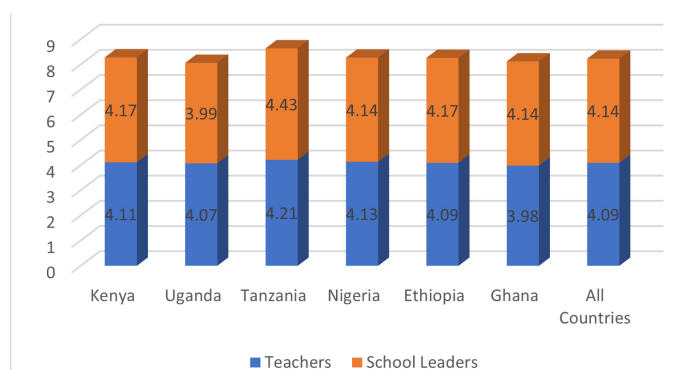


Figure 2: School leaders' and teachers' future plans to use ICT.

Table 6: Teachers' views on support of ICT implementation.

Description	% Response
Motivate and help other teachers integrate ICT	17
Curriculum reform/Development	15
Advocate for ICT facilities provision in schools to enhance T & L	14
Adopt new approach to teaching with ICT	12
Change personal attitude	10
Motivate students to use ICT	10
Promote student-centered approach of teaching	8
Networking	6
Advocate for training for teachers	1
Others	7

What was most popular among the leaders was a desire to motivate students to use ICT (18.5%) followed by improving their professional leadership skills (16.7%). Similar to the findings with the teachers, the school leaders also expressed a high desire to motivate teachers to use ICT to teach (12.6%). The distribution of responses by themes is shown in Table 7.

Table 7: School leaders' views on support of ICT implementation.

Description	% Response
Motivate students to use ICT	18.5
Improve my professional leadership skills	16.7
Motivate teachers to use ICT to teach	12.6
Improve schools' vision	11.0
Infrastructure development/support	10.2
Organisation of ICT-based in-service training for teacher	8.4
Involving teachers and all stakeholders in decision making	7.9
Promote commitment of teachers	6.8
Promote team work of teachers	4.4
Others	3.7

Use of new knowledge and skills

A major question dealt with in the study was whether the school leaders and teachers were able to transfer their knowledge and skills gained in the capacity building programme to school organisations and curriculum practices. Records from the digi-hubs provided evidence to this extent. The majority (37.6%) of teacher respondents used the hub to explore ICT applications such as presentations and spreadsheet while quite a good number (26.9%) also used it mainly for research work.

Table 8: Overall teachers' usage of the digi-hub.

Description	% Response
To use an application, e.g. spreadsheet, presentation	37.6
For research work or personal use	26.9
To communicate with others in another school via internet	17.4
To present something to my students in the digi-hub	7.4
For my students to research a subject on the internet	4.9
To find/create material to use with my students in the classroom	3.7
To find/create material to use with my students in the digi-hub	2.2

The use of new technology to support cross-curricular classroom practices comes out strongly as reported in relatively low percentage teacher responses for items such as: *To find/create material to use with my students in the classroom* (3.7%) and *To find/create material to use with my students in the digi-hub* (2.2% – see Table 8). The digi-hub records further showed the diverse ways the Hubs have been used by schools and their extended communities as reported by school leaders. They indicated using the Hubs to train community members to acquire basic ICT skills, accessing emails where there is connectivity and preparing reports. Some of the countries (Nigeria, Tanzania, Kenya) used the Hubs to train parents on ICT skill acquisition while others (Ghana, Kenya) used the Hubs as training centres for children from the community. Uganda had plans to train soldiers within the barracks on basic skills in computers. Ghana used the Hubs to train District Education officers while Ethiopia trained Educational Bureau Officials on ICT basic acquisition.

Thus, the results here seem to suggest that school leaders were most comfortable with aspects of digi-hub training linked to basic ICT skills acquisition because it promoted their own professional practices and helped them to extend the training to community members in diverse ways across the countries. Transfer of knowledge and skills by the teachers on the other hand required more than the mere inclination to use ICT tools; it needed more of an appreciation of the complex set of interrelationships between tools, users and teaching practices which was barely observed. Apparently, the training programme lacked dimensions for skill and knowledge development for exploring and examining how technology can be integrated with pedagogy and content to enhance teaching and learning strategies in their subject or classroom teaching. This could be the possible reason that explains the teachers' inability to transfer their acquired ICT competency from basic technology literacy to infusing level.

Discussion

The study followed up on a project in which digital hubs were installed and made operational in schools from six Sub-Saharan African countries, namely Kenya, Tanzania, Uganda, Ethiopia, Ghana and Nigeria. One major aim of the project was to build capacity of school leaders and teachers by providing PD or training courses in order to support them to embed ICT into school organisation and curriculum practices. This study reports on the impact of the PD programme: the quality and extent of transfer of the programmes' ideas from the school leader and teacher stakeholder's capacity building to school organisation and

classroom implementation. Results of the study showed that the majority of participants across the six countries expressed general satisfaction with training content and processes. The evidence as confirmed in the self-report data suggests that the training programme was of a high quality and developed the teachers' knowledge and skill mainly in applying and infusing ICT in their professional practices and learning networks.

It was encouraging to note that the participating school leaders and teachers appeared generally supportive and confident in wanting to use ICTs in their school organisations. Their overwhelming high perceptions to integrate ICT in innovative ways were not limited merely to developing their own personal practices and professional learning networks, but to improve teaching in their future lessons, enhance students' learning and promote curriculum reform and development as well are worth mentioning. What was most popular among the stakeholder groups was the drive to motivate and help other teachers to integrate ICT in their teaching; the respondents indicated that they will impart knowledge acquired to other teachers, share with colleague teachers what they have learnt and encourage fellow teachers in their schools to embrace ICT use. Thus, it suffices to say that the PD programme achieved some success in developing teachers' high positive perceptions and stimulating the participants' interest in ways that could encourage future uptake of ICT integration in spite of its limitation in providing adequate opportunity for the teachers to develop pedagogical integration of ICT experiences (cf. Webb & Cox, 2004). This finding seems to align with several studies (Meelissen, 2008; Paraskeva et al., 2008) which report positive attitude as a necessary condition for predicting teachers' future classroom integration and acceptance of technology (Agyei & Voogt, 2012). The finding can also be explained by the assertion of Todorova and Osburg (2009) that professional development programmes aiming to realise the sustainable uptake of ICT in teaching and learning can only be successful based on the two main factors. Thus, when participants involved develop positive attitudes and are satisfied with the programme and when the reason for using ICT to improve teaching and learning practices is accepted by the entire school organisation and not only by those who participated in the programme. Clearly, the result here suggests that the school leaders and teachers who participated in this study developed high tendencies of promoting and implementing ICT in their future classrooms since they seemed enthusiastic about plans and conditions they needed to put in place to support their ICT implementation efforts; an indication that the PD imparted positively on them.

Notwithstanding the positive high perceptions reported, participants faced some challenges during the training programme. Across all the countries, the critical area for improvement that was most commented on by participants during the training course was related to the issue of time. It appears the time for the training course was limited in proportion to the package of the training workshop modules. As a result, there was not enough time for practice of ICT basic skills for understanding, application and infusion of ICT concepts and resources in school and classroom practices. This confirms a number of studies which reiterate

that the adoption of innovation takes time (Agyei, 2013; Ebersole & Vorndam, 2003; Fullan, 2007). As Ely (1999) explained, implementers of an innovation must have time to learn, adapt, integrate, and reflect on what they are doing. It takes time for the people to understand the innovation and develop the abilities to adapt the innovation.

Apart from the self-reported data, a review of the training programme as recorded in reports by the Digital Ambassadors also showed some shortfalls which when corrected could enhance the quality and impact of the programme. Apparently, being novices in ICT use in education, the participating school leaders' and teachers' judgements on the impact of the training programme were limited to their understanding of what they believed was entailed in embedding ICT in school and classroom practices; this might have accounted for the high scores of their self-report data. Thus, though the study showed evidence that the training participants developed their knowledge and skill to use the digi-hubs across the participating countries, this was limited to using basic ICT applications to enhance their own practices and their professional learning networks as mentioned earlier, and not so much of teachers' classroom implementation of ICT which results when transfer of learning takes place from training to practice.

The findings here seem to suggest that the PD programme lacked more in-depth approaches in imparting knowledge and skills to participants to explore how technology can be integrated in school organisation and classroom practices. Baylor and Ritchie (2002) have indicated that training has an important influence on how well ICT is embraced in the classroom. Redmond (2007) and Kelz (2011) have also indicated that if teachers are not trained or prepared sufficiently for their new roles with technology, then it could be that they merely will try to transfer their classroom practices to the new environment. Thus, the study has shown that there is a need for governments in Sub-Saharan Africa to emphasise effective PD as key to implementing ICT initiatives, policies and curricula in an attempt to enhance teaching and learning with ICT. A PD arrangement in this regard, therefore, should seek to ensure that there are enabling conditions that will bring about ICT adoption and pedagogical change across component of school systems, curriculum and instruction. According to Fishman and Krajcik (2003), such PD approaches should seek to create a lasting change with technology that have sustainable impact on teaching and learning; thus, in designing effective professional training initiatives, designers should seek to incorporate innovations that function as part of systemic reforms. Fishman and Krajcik (2003) indicated that a fundamental goal of systemic reform is alignment across component of school systems (such as administration and management, curriculum and instruction, assessment and policy). The author, therefore, argues that for effective preparation of school leaders and teachers in order to transfer ICT knowledge and skill acquired, there is a need to include in training programmes contents that will build trainees' competency more incrementally from their own personal practices and professional learning networks into infusing ICT into the school organisation and curriculum practices even when the training is over.

Limitation

The study was not without limitations. The fact that the study did not make use of observed data to verify conditions of implementation of the training ideas at the school levels was a hindrance to the study. As a result, transferability of ideas of the training programme was limited to records of data collected at the various local hub settings and reported perceptions of what school leaders and teachers said they will do or have done. The author recognises that though self-report data provide important information about an individual's ICT knowledge and skill awareness, they are limited to measuring individuals' beliefs and not so much of what they can actually do or did. The limitation notwithstanding, this study allows for broad generalisations of the findings to Sub-Saharan African regions and similar context. Evidence from the study did not seem to differ significantly among the different stakeholder as well as the different participating countries; apparently, the contexts and conditions under which the study was conducted were similar across the participating countries.

Practical implications

The study has demonstrated that both school leaders and teachers increased their ICT proficiencies. However, it was limited to their own PD and learning networks and not so much on transfer of professional learning from training programmes to school and classroom implementation. Again, outcomes of the study showed that the participants expressed general satisfaction with training content and processes of the PD training programme; yet essential conditions to support transfer of the trainings' ideas to school level were seemingly not adequate during the period of implementation. Consequently, the study highlights areas that require further attention to enable school leaders and teachers infuse ICT into transforming school practices. In particular, elements of a PD scenario that will assist school leaders and teachers develop and transfer skills in ways to integrate ICT to bring about sustainable impact on teaching, learning and school organisation are discussed. In replicating such an arrangement, particularly in the Sub-Saharan region and similar contexts, programme designers should deliberately create professional learning experiences in which the following characteristics identified in the PD programme will be observed:

- Build a PD model into a more comprehensive framework that will assist school leaders and teachers to develop knowledge and skills about the use of ICT to support pedagogy, content and school organisation and management. The framework could incorporate a more systematic and graduated process for ICT competency development from basic ICT skills to technology literacy skills to skills for ICT infusion in school organisation and classroom practices.

- Build on the professional development activities to include – school level specific and subject specific elements that take into consideration the context of the stakeholder population of school leaders and teachers.
- Encourage modeling through demonstrations and exemplary materials on how to use technology as a component of the professional development. Exemplary curriculum materials are an important means as they can inspire both school leaders and teachers to learn and provide a better understanding of what ICT integration can look like in professional practice.
- Build in scaffolding and authentic technology experiences (such as teaching try-outs) as an integral part of the professional development programmes - Teaching try-outs have the tendency to reduce anxieties about ICT thereby increasing trainees' enthusiasm to use ICT in practice.
- Build in sufficient time in course delivery to ensure that school leader-teacher target populations have adequate time and opportunities to develop and apply their ICT competencies (e.g., from ICT basic to technology literacy to infusing levels).

References

- Agyei, D. D., & Voogt, J. (2012). Developing technological pedagogical content knowledge in pre-service mathematics teachers through collaborative design. *Australasian Journal of Educational Technology, 28*(4), 547-564.
- Agyei, D. D. (2013). Analysis of technology integration in teacher education in Ghana. *Journal of Global Initiatives: Policy, Pedagogy, Perspective, 8*(1 & 2), 69-86.
- Baldwin, T. T., & Ford, J. K. (1988). Transfer of training: A review and directions for future research. *Personnel Psychology, 41*, 63-105.
- Baylor, A. L., & Ritchie, D. (2002). What factors facilitate teacher skill, teacher morale, and perceived student learning in technology-using classrooms?. *Computers & Education, 39*, 395-414.
- Bebell, D., & O'Dwyer, L. M. (2010). Educational outcomes and research from 1:1 computing settings. *Journal of Technology, Learning, and Assessment, 9*(1), 4-14.
- Creswell, J. W., Plano, C. V. L., Gutmann, M., & Hanson, W. (Eds.). (2003). *Advanced mixed methods research designs*. Sage.
- Ebersole, S., & Vorndam, M. (2003). Adoption of computer based instructional methodologies: A case study. *International Journal of E-Learning, 2*(2), 15-20.
- Ely, D. P. (1999). Conditions that facilitate the implementation of educational technology innovations. *Educational Technology, 39*, 23-27.
- Fishman, B., & Krajcik, J., S. (2003). What does it mean to create sustainable science curriculum innovation? *Science Education, 87*(4), 564-573.
- Fullan, M. (2015). *The new meaning of educational change* (5th ed.). Teachers College Press.
- Goktas, Y., Yildirim, Z., & Yildirim, S. (2008). A review of ICT related courses in preservice teacher education programmes. *Asia Pacific Education Review, 9*, 168-179.
- Guskey, T. R. (1985). *Implementing mastery learning*. Wadsworth.
- Guskey, T. R. (1986). Staff development and the process of teacher change. *Educational Researcher, 15*(5), 5-12.
- Guskey, T. R. (1990). Cooperative mastery learning strategies. *Elementary School Journal, 91*(1), 33-42.
- Guskey, T. R. (1991). Enhancing the effectiveness of professional development programs. *Journal of Educational and Psychological Consultation, 2*(3), 239-247.
- Guskey, T. R., & Sparks, D. (1996). Exploring the relationship between staff development and improvements in student learning, *Journal of Staff Development, 17*(4), 1-6.
- Guskey, T. R. (1998). The age of our accountability. *Journal of Staff Development, 19*(4), 1-9.
- Guskey, T. R. (2002). Does it make a difference? Evaluating professional development. *Educational Leadership, 59*(6), 45-51.
- Guskey, T. R. (2015). *On your mark: Challenging the conventions of grading and reporting*. Solution Tree.
- Kay, R. H. (2006). Evaluating strategies used to incorporate technology into pre-service education: A review of the literature. *Journal of Research on Technology in Education, 38*, 383-408.
- Kelz, A. (2011) "Bridging the gap - From teacher to e-teacher" In S. Greener, & A. Rospigliosi, (Eds), *Proceedings of the 10th European conference on e-learning* (pp. 363-369). Academic Conferences and Publishing International Limited, Brighton.
- Meelissen, M. (Ed.). (2008). *Computer attitudes and competencies among primary and secondary school students*. Springer.
- Meloncon, L. (2007). Exploring electronic landscapes: Technical communication, online learning, and instructor preparedness. *Technical Communication Quarterly, 16*(1), 31-53.
- Miles, M. B., & Huberman, A. M. (1994). *An expanded source book: Qualitative data analysis* (2nd ed). Sage Publications.

- Niederhauser, D. S., Howard, S. K., Voogt, J., Agyei, D. D., Laferriere, T., Tondeur, J., & Cox, M. J. (2018). Sustainability and scalability in educational technology initiatives: Research-informed practice. *Tech Know Learn, 23*, 507–523.
- Ottevanger, W., van den Akker, J. J. H., & de Feiter, L. (2007). *Developing Science, Mathematics and ICT education in Sub-Saharan Africa (SMICT): Patterns and promising practices*. World Bank Working Paper (101), pp. 1-84.
- Paraskeva, F., Bouta, H., & Papagianna, A. (2008). Individual characteristics and computer self-efficacy in secondary education teachers to integrate technology in educational practice. *Computer and Education, 50*(3), 1084–1091.
- Philipsen, B., Tondeur, J., & Zhu, C. (2016). Exploring digital didactics: An explorative case study on learning to teach online. In J. Novotná, & A. Jančařík (Eds.), *Proceedings of the 15th European conference on e-learning* (pp. 555-561). Charles University, Prague: Academic Conferences and Publishing International Limited.
- Redmond, P. (2011). From face-to-face teaching to online teaching: pedagogical transitions. In: *ASCILITE 2011: 28th Annual conference of the Australasian society for computers in learning in tertiary education: Changing demands, changing directions* (pp. 1050-1060). ASCILITE.
- Saks, A. M. (2002). So what is a good transfer of training estimate? A reply to Fitzpatrick. *The Industrial-Organizational Psychologist, 39*, 29–30.
- Todorova, A., & Osburg, T. (2009). *Factors for the sustainability of a teacher professional development programme for technology integration*. Paper presented at the London international conference on education, London.
- United Nations Economic Commission for Africa (UNECA) (2005). *Economic report on Africa 2005: Meeting the challenges of unemployment and poverty in Africa*. UNECA.
- Webb, M., & Cox, M. (2004). A review of pedagogy rated to information and communications technology. *Technology, Pedagogy and Education, 13*(3), 235-286.
- Yamnill, S., & McLean, G. N. (2001). Theories supporting transfer of training. *Human Resource Development Quarterly, 12*(2), 195–208.