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Emerging e-learning technologies and Zambian education system: A focus on rural areas

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Abstract
This abstract is part of partial dissemination of research findings extracted from an on-going longitudinal study which commenced in 2016. Although comprehensive results are expected by end of 2021, these research results being released now have nevertheless high levels of reliability (Cronbach's Alpha Internal Reliability= 0.895). The main aim of the study was to establish the impact of e-learning emerging technologies on pupils' academic performance focusing on rural schools of Zambia. The study employed a correlation analysis to establish the relationship and its magnitude between use of emerging technologies in the teaching and learning processes and pupil's academic performance. The study followed grade six (6) pupils (Both treatment and control groups) for a period of four (4) years from rural Schools of Kapiri-Mposhi district, Central province, Zambia. Data were collected using observations of practical mathematics lessons in classrooms supplemented by semi-structured interviews and content analysis. Thematic and SPSS were used to analyse qualitative and quantitative data respectively. The study revealed that there was significant improvement in academic performance at 95% confidence interval (R = 0.967, R Squared = 0.935, Adjusted R Squared = 0.919 and std. Error of the estimate = 1.23. The academic improvement recorded was mainly because e-learning/ICTs provided blended teaching and learning environment, pupil-centred approach, interactive and engaging lessons.

Keywords: ICT education, e-learning, academic performance

1. Introduction

According to the Ministry of Labour (2016) [10] the latest population is estimated at 14.98 million and out of these 49.1 are males while females are at 50.9% and population growth rate stands at 2.88%. The majority (66.2%) being those aged less than 24 years while those aged between 25 and 54 are represented by 28.5%. These statistics do not just point to the fact that majority of the population are youths but also the numbers of young people keep on swelling each day thereby mounting pressure on the limited existing social amenities such as education and health. There are other challenges facing Zambia today such as early marriages and pregnancies, high poverty levels, alarming unemployment rates especially among the youths, disease burden such as HIV/AIDS, and lack of access to clean drinking water, quality education and health. Despite such distressing picture that lies ahead of Zambia, the government in partnership with private sector has identified education as one of the tools to significantly fight the above stated vices. What then is education? Perhaps the definition by Kelly (1999) [5] in Carmody (2004) [2] that 'education is unfinished business' would suffice in this paper. The government through Ministry of General Education (MoGE) also endeavours that this commodity called education should be of high quality, effectively and efficiently delivered. This is where e-learning which is one of the forms of Information and Communication Technology (ICT) comes into play.

As already alluded above, one of the modern ways in which education can be made available is through the use and implementation of ICTs and e-learning in the education sector. E-learning is a broad term that encompasses many teaching approaches, types of technologies and administrative practices (Olsno, Codde, DeMaagd, Tarkelson, Sinclair, Yook and Egidio, 2011) [12]. In this paper, a specific reference of an emerging e-learning tool is the use of the computer educational tablet. E-learning can therefore employ a range of pedagogical approaches and electronically supported technologies. According to Olson *et al*. (2011) [12] these technologies and approaches can take any of the following: One-to-many, One-to-one, One-alone, many-to-many, teacher training and school administration.

Koory (2003) [7] argues that the list of possible approaches using technology in learning and teaching must, be placed into an educational context. It must be acknowledged that the off-on line education tablet is designed in such a way that most of or all of the above approaches can be employed. This makes it to be one of the e-learning technologies suitable for rural schools. As observed by Means, Toyama, Murphy, Bakia and Jones (2010) [8] that both globally and locally, there are no conclusive research results that reveal that one type of e-learning approach is more effective than another. However, recent studies indicates that learning outcomes are somewhat improved with a 'blend' or hybrid of face-to-face learning with a teacher combined with technology-mediated learning

(Means, *et al*., 2010, Roblyer and Doeriay, 2009) [8, 14]. In fact e-learning is enhanced by giving pupils control of their interaction with the media, by embedding feedback mechanisms (Means, *et al*, 2010) [8]. All these could be made possible by using a tablet, mobile or smart phone and e-readers. In this paper, an educational e-learning tablet has been used to establish the impact of e-learning on pupils' academic performance in Mathematics in rural areas. According to Olson, *et al*. (2011) [12], a tablet is a personal computer similar to a laptop but with a touch screen and often a smaller hard drive and screen. Tablets have of late become very useful for e-learning especially in rural areas where other ICT facilities like internet are none existence.

In Zambia, the government, parliamentary committee on education, Ministry of General Education in partnership with ischool.zm have approved and adopted the educational e-learning tablet to be used in all the schools (MoGE, 2015) [9]. Further, the Republican President while addressing the Fifth Session of the Eleventh National Assembly retaliated "...education is important to developing a skilled work force required for socio-economic development...I have approved an initiative for transforming the education sector through e-learning by using an innovation education tablet...it was expected that by 2017, 50% of our children in school could have hard access to the educational e-learning tablet..." (Times, 2015: 16) [16]. The ischool.zm is a comprehensive online multi-media e-learning package that is loaded on a simple tablet computer. The tablet has been designed to cover the whole of Zambian school curriculum for teachers and interactive learning for pupils. Currently, the project is being piloted in five primary schools in Lusaka with intentions of rolling out the programme to all the primary schools country wide (MoGE, 2015) [9].

Preliminary results from the five urban piloted schools indicate that the use of educational e-learning tablet has reduced absenteeism, increased academic performance, acquainting pupils to technology at a tender age and orienting pupils to the use of information technology (Kalila, 2015) [3]. Although it has been argued that ischool.zm is working in urban and rural schools by supplying equipment and ICT tools, the reality on the ground however is that rural schools have not received its full share of e-learning technologies later on the use of educational e-learning tablets. While the idea of piloting a few schools before rolling the programme to the whole country is good and welcome, it could have been more realistic if a few rural schools were piloted as well. Even though there are good indicators of the project being successful, are the research outcomes from a few urban schools being replicated in rural areas? Other than that, other critical questions still remain unanswered such as: In reality, do rural pupils have access to the educational e-learning tablet? Despite such tablets being taken to rural areas, will the parents who are already struggling with high poverty levels afford such tablets? All the above questions pose great concerns on the accessibility of these tablets by rural pupils. The impact of these tablets on pupils' academic performance particularly in rural schools needed to be established before replicating urban-based results to remote areas as these two settings have their own unique challenges. Furthermore, what about the sustainability of the tablets in rural schools? These are some of the concerns and problems being addressed in this paper.

2. Research Hypothesis

H_0: No association between teaching and learning Mathematics using emerging technologies (Educational Tablet) and academic performance of learners in rural areas

H_1: The association exist between teaching and learning Mathematics using emerging technologies (Educational Tablet) and academic performance of learners in rural areas

3. Statement of problem

Many studies have been done on ICTs and E-learning in general (Phiri, 2016; Bahufite, 2015) [13]. However much remain un-researched and not documented on the effectiveness of specific emerging technologies used in ICT and e-learning mode of teaching and learning in specific subjects such as Mathematics especially in rural Zambian schools. This study therefore sought to establish the impact of emerging e-learning technologies (a case of educational e-learning tablet) on pupils' academic performance in mathematics in rural schools.

4. Theoretical framework

The study was guided by the constructivist theory. Kalpana (2014) [4] suggests two types of constructivism of which one is individual and based on personal self-concept, belief system and experience and it was proposed by Jean Piaget. The other, which was proposed by levy Vygotsky (1978) [18], is based on social interaction and focused on views sharing among peers. Slavin (2006) [15] observes that learner-centred education is core in the teaching and learning processes. According to the constructivists' theory, the reality is a multitude in the learners' minds and each learner is unique. Learning therefore takes this into consideration and allows learners to explore and use their abilities to process information in order to create the personalised knowledge which makes more sense to them (Woolfolk, 1995) [19]. This can be done through the learners' interaction with peers and environment but based on their own experience. In this regard, learning could be better defined as meaning-making rather than memorising what was imposed by others (Nawaz, 2012) [11]. This sense making could be facilitated by the inclusion of e-learning and ICT in education as a way to apply the underlying principles of the constructivism. According to Kalpana (2014) [4], in the constructivist class, the environment is democratic and centred on the learner, where the curriculum is negotiated and not imposed. Learners participate freely in the creation of the knowledge either individually or through interaction with the peers or significant others (i.e. educational e-learning tablets) or even environment, but based on their prior experiences. The teacher in this environment just facilities the activity and guides the learners on their journey to discovery of new experiences. ICT and e-learning come in constructivism as a medium to facilitate the learning-how-to learn process by eliciting learners' curiosity which leads them into critical and analytical thinking, thereby resulting in discovery (Kharade and Thakkar, 2012) [6]. The principles underlying the constructivist theories, aim at promoting learner's activity in

any teaching-learning process through the use of e-learning facilities such as the educational e-learning tablets.

5. Literature review

Table 1

Author	Main Findings	Gap
Means, Toyama, Murphy, Bakia and Jones (2010) [8].	There are no conclusive research results that reveal that one type of e-learning approach is more effective than another	No reference is made to emerging technologies and rural areas
MoGE (2015) [9].	Approves use of tablets in all public schools	No concrete research-based evidence on how emerging technologies impacted on academic performance of learners in rural areas
Phiri (2017) [13].	Hybrid use of e-learning technologies improves learner's academic performance	Study was generic and did not specify kind of emerging technologies
UNESCO (2013) [17].	ICTs improves learner's academic performance	Emerging technologies and rural areas not cited in the study

6. Research methodology

A correlation and case study research designs were employed in conducting the study which targeted rural primary schools. Fifty-eight (58) participants (pupils) were drawn from grade six (6) classes as an 'experimental group' while forty-two (42) pupils from the same school formed a 'control group'. Although the school was purposively selected, the experiment group and control group were randomly chosen. The experimental group which received treatment (i.e. use of educational e-learning tablets) were directly observed during mathematics lessons for a period of two years or six full academic terms while the control group which did not receive experiment treatment provided a reliable baseline data. The Statistical Package for Social Sciences (SPSS, version: 20) were used to analyse data, generate Pearson Product of Correlation and independent t-tests which compared the means and standard deviations respectively.

7. Findings

As indicated in the abstract that these research findings were extracted from an on-going longitudinal study which commenced in 2016. Although comprehensive results are expected by end of 2020 or early 2021, these research results being released now have nevertheless high levels of reliability (Cronbach's Alpha Internal Reliability= 0.895).

7.1 Composition of participants

The study yielded 97% participation rate as two of the girls who were in the experiment group fell pregnant during the study and they left school. The participants in the experiment group consisted 43 (74%) male and 15 (26%) female. While for the control group, males accounted for 28 (67%) males and 14 (33%) females. The gender imbalance witnessed in both experiment group and control group was mainly attributed to early marriages and pregnancies among girls coupled with cultural beliefs that encourage mostly boys to continue with education while girls should remain home attending to household chores. Additionally, the 8 teachers who were interviewed comprised 6(75%) male and 2(25%) female.

7.2 Availability of e-learning facilities (educational e-learning tablets) in rural Schools

The study results revealed that there was only one (1) pupil edition educational e-learning tablet in the whole school against a total population of 406 pupils from grade one to grade seven. This represent a pupil- tablet ratio of (2 tablet-406 pupils) if the tablet was to be used by all the grades equally or 1tablet – 58 pupils) if only grade six pupils were considered. These are alarming ratios especially in this era where government policy on education has made ICTs and e-learning compulsory in all schools. Sadly, even the only tablet available in school was not functional and it was just kept in the head teachers' office. Therefore, in order to obtain reliable and valid results from the study, additional tablets were sourced and distributed to the experimental group.

7.3 Impact of E-learning using the educational e-learning tablets on pupils' academic performance in mathematics

7.3.1 Pupils' performance in mathematics before introduction of e-learning facilities (educational e-learning tablets)

Table 2: Pupils performance before use of educational e-learning tablets

	N	Mean score	Std. Deviation	C.V
Experiment Group	58	59	13.12	22.237%
Control Group	42	58.8	13.79	23.45%

***Source*:** On-Going Longitudinal Study 2016-2021

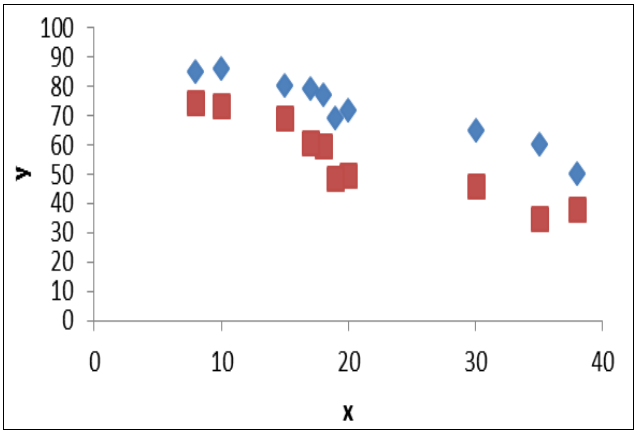

Fig 1: Scatter Plot Indicating Insignificance in Academic Performance between Experimental and Control Group

It is evident from the mean and standard deviation for both the experiment and control group that there was no statistically significance difference in the pupil's academic performance in mathematics. One possible explanation could be that both classes were being taught by the same teacher under similar classroom environmental conditions without any special treatment such as the use of e-learning facilities. The results on the scatter plot further demonstrate statistically

insignificance difference in academic performance between the experimental and control group.

7.3.2 Pupils performance in Mathematics after the experiment group used the educational e-learning tablets

Table 3: Pupils academic performance in mathematics after using educational e-learning tablets

	N	Mean score	Std. Deviation	C.V
Experiment Group	56	67.4	10.02	14.87%
Control Group	42	60.3	15.43	25.59%

***Source*:** On-Going Longitudinal Study 2016-2021

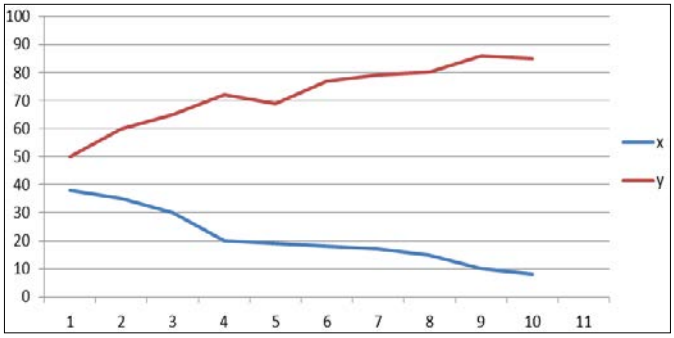

Fig 2: Academic Performance between Experimental group (Red) and Control group (Blue)

The mean score of pupils in the experiment group increased from 59 to 67.4 representing 14.24% while the standard deviation dropped from 13.12 to 10.02 which further suggest a significance improvement in pupil's academic performance in mathematics generally. Although the mean score for the control group equally posted an increase, the improvement however was very minimal (2.55%). The Coefficient Variations (CV) equally increased from 14.87% to 25.59%. Therefore the academic performance in mathematics by pupils in the control group was not as impressive as that of the experiment group. This is confirmed by an increase in the standard deviation of pupil's academic performance in mathematics from the control group.

7.3.3 Hypothesis testing

Refer to Research Hypothesis in 2.0 (H_0: No association between teaching and learning Mathematics using emerging technologies (Educational Tablet) and academic performance of learners in rural areas)

According to the findings from an independent t-test presented in table 3, the probability value (Pv = 0.0005) is less than level of significance ($\alpha = 0.05$), that is ($Pv < \alpha$), the null hypothesis is rejected. The findings therefore suggest that using e-learning facilities and in this case, the educational tablets helped improve pupils' academic performance in mathematics. What remains is to determine how strong the association is between using e-learning educational tablets and pupils' academic performance in mathematics, hence the Pearson product of correlation (r) as shown in table 4 below.

7.3.4 An association between using e-learning educational tablets and academic performance of pupils in mathematics

Table 4: E-learning educational tablets and pupil's academic performance

N	**56**
Sig. (2-tailed)	0.000
Pearson Product of Correlation (**r**)	0.892

***Source*:** On-Going Longitudinal Study 2016-2021

Table 4 indicates that there was a very strong association (**r** = 0.892) between using e-learning educational tablets and pupils' academic performance in mathematics. The findings therefore, suggest that the educational tablets positively impacted on pupils' academic performance in mathematics.

7.4 Sustainable measures of implementing e-learning in rural schools

In order to ascertain what sustainable measures that government and private sector should employ to promote the use of e-learning educational tablets in the teaching and learning of mathematics, the common views of the eight (8) teachers who were interviewed indicated the following as depicted in Table 5 below:

Table 5: Sustainable measures of implementing e-learning in rural schools

Sustainable Measure	No of Teachers	%
Establishment of special education fund (Home grown solutions)	4	50%
Government subsidising educational tablets	2	25%
Parental/community involvement	1	12.5%
Adoption of e-learning educational tablets by private companies	1	12.5%
Total	8	100%

***Source*:** On-Going Longitudinal Study 2016-2021

The majority 4(50%) of the respondents were of the view that government through the act of parliament should establish a special education fund specifically meant for implementing e-learning in rural schools. Those who felt that government needed to subsidise the cost of educational tablets were two (2) representing 25%. Others were for the idea of private companies adopting e-learning activities in communities where they operated and those who felt parents and communities had to buy the educational tablet for their children shared 12.5% each respectively.

8. Discussion and Implication of Findings

The discussion and implications of the findings was presented according the emerging themes and subthemes in line with the objectives of the study.

8.1 Availability of e-learning educational tablets in rural schools

The importance of ICTs and later on e-learning facilities in

schools cannot be overemphasised. This is so because e-learning promotes learner-centred teaching and learning methodologies, encourages interactive learning and engages pupils throughout the learning process (MoGE, 2015) [9]. This is further argued and supported by the constructivist theory that in the constructivist classroom, learners are allowed to explore and use their abilities to process information in order to create personalised knowledge which makes sense to them through interaction and experiences (Woolfolk, 1995; Vygotsky, 1978) [19, 18]. Furthermore, Slavin (2006) [15] equally observes that learner-centred education is critical in the teaching and learning process as it promotes critical thinking and reasoning among pupils. The educational tablets performs similar functions and does help pupils improve in acquiring pedagogical skills later on improve in academic performance. Despite numerous benefits that come along the use of educational tablets, this study has brought to light that these tablets are not available in most rural schools. Some of the factors contributing to non-availability of educational tablets in rural schools are but not limited to the following: High poverty levels, high cost price, erratic or no funding to rural schools by government and generally ICTs and e-learning activities may not be a priority by school administrators in rural schools.

8.2 Impact of using e-learning educational tablets on pupils' academic performance in Mathematics

This study which compared the academic performance in mathematics by pupils from the experiment group which were using educational tablets revealed a remarkable improvement as compared to those who were taught using traditional methods and approaches. The study also indicated a very strong association (r = 0.892) between the use of e-learning educational tablets and academic performance especially in mathematics. This outcome is in agreement with the research conducted by Ministry of General Education that revealed that the use of educational tablets in piloted few urban schools helped in reducing absenteeism, increased academic performance, acquainted and oriented pupils to technology at a tender age (Kalila, 2015) [3]. Other factors that contributed to the educational tablets use and improved academic performance in mathematics are that the tablets were highly interactive, engaging, had multiple languages of instruction, provided self-taught tutorials to pupils, all the preloaded educational materials and lessons were voiced, encouraged pupils develop critical and logic thinking and reasoning. This is in line with the observation made by Koory (2003) [7] who argued that technology being used in learning and teaching must be placed into an educational context. Such gains that pupils from rural schools could benefit immensely were being eroded by the challenges faced by rural schools as already discussed above. Unless these challenges are addressed with the seriousness they deserve, the dream of using e-learning and ICTs will continue just being on paper but not transformed into tangible results.

8.3 Sustainable measures to promote e-learning in rural schools

Admittedly, Zambia has done very well in terms of policy formulation in the education sector. For example, the country has a national ICT policy, Sixth National Development Plan, Vision 2030, ICT policy for education and the newly revised curriculum which puts emphasis on e-learning and ICTs (MoGE, 2015) [9]. Despite having such progressive policy documents, the implementation aspect has been a problem for a long time now because of financial constraints and lack of prioritising ICTs as a vehicle for quality education delivery and national development among others. In other words, the Ministry of General Education remains toothless as most of its robust planned projects lack financial injection for them to kick off of which one of the them is the implementation of ICTs and e-learning especially in rural schools. Therefore, a suggestion for government to enact a law for the creation of special education fund to go towards implementing ICTs in rural schools is a welcome move. The only drawback with this measure is that only the already overtaxed civil servants would bear the whole load on their shoulder.

As regards parental and community involvement in the purchase of the educational tablets would work very well in urban areas. In rural areas however, this may not be a viable measure in that most parents cannot afford to raise K1, 500 to purchase a tablet for the child. Although community and parental involvement factors in the sense of ownership in a project, the reality on the ground is that most parents who leave on less than a dollar a day don't have the capacity to find such kind of money. Moreover, it is not uncommon is rural areas to hear some parents withdrawing their daughters from school in order to help them fetch for money for their living. The proposal to engage private businesses to adopt schools within the communities they operate and sponsor e-learning activities cannot be relied on because most business entities would rather setup their enterprises along the line of rail (urban areas) leaving rural areas neglected. Further, companies operate in market segments where they are profitable of which rural areas attract very little investment from both local and international investors.

By the way, according the existing laws, a business organisation is not mandated to take part of its proceeds to a school, but instead some companies do so under the corporate social responsibility. The only entity that can go to the remotest part of the country to provide a service is government hence the need for our political leaders to show commitment and walk the talk by realistically mobilising resources for policy implementation. We need as a nation to set our priorities right and invest heavily in our education sector of which implementation of e-learning and ICTs should take a centre stage. We are not denying the fact that some companies like Lumwana cannot invest in schools within the area they operate, but it is the role of government and all citizens to take up this challenge of providing our youths with quality education through ICTs. BETUZ (2016:15) [1] laments:

> ...Time is now for government to start procuring computers for ICT studies especially for rural schools which need them the most...more ICT teachers to be recruited so as to equip all the pupils countrywide with ICT knowledge and skills...our pupils in rural schools shouldn't just come to know computers when they come to town...

While this call is timely and a noble one procuring computers alone is not the answer as most of our rural schools neither have electricity or solar. For now, the e-learning educational tablets are the answer for rural schools because they come with a small solar panel for re-charging. These tablets do not only provide interactive, engaging learning and teaching environment but also they help pupils develop critical thinking depending on how effectively and efficiently they are integrated in everyday classroom activities. This is in line with what constructivist theory promotes to create a learning environment that is interactive, engaging and learner-centred. In a nutshell, while implementing long term solutions is vital, the educational tablets are the solution in the short term.

9. Conclusion and Recommendations

Based on the findings of the study, it came to light that E-learning facilities and IT infrastructure were still not available in most rural schools. Both the independent t-test ($Pv < \alpha$; i.e. $0.0005 < 0.05$) and the Pearson product of correlation (**r** = 0.892) confirmed that learners who used interactive computer tablets performed better than the control group which did not. However, such gains were being reversed by lack of e-learning IT facilities in rural areas. In light of the above stated challenges, the research team has instituted the following short and medium term practical measures:

- Adoption of a zone centre and supplying educational tablets using locally mobilised resources
- Putting up IT infrastructure so that neighbouring rural schools could be accessing ICT facilities from the established zone centre. This is made possible by individual research account funds.

Long-term sustainable interventions included the research team in collaboration with other stake holders engaging policy legislators, government, academicians and practitioners to invest in sustainable home grown ICT innovations suitable for rural schools.

10. The following recommendations emerged from the study

- Universities and colleges should adopt home-grown ICT/e-learning innovations during training process suitable for rural areas
- Parliament through ministry of Higher Education and General Education should introduce special fund levy for ICTs implementation
- ICT budgetary allocations should be part of institutional budgets

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