

Assessing The Use of Technology in Education: A Study of Urban Schools in Zambia

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Abstract—The role of Information and Communication Technology (ICT) in the education systems of the world is becoming more central and Zambia is not an exception. Over the years, the successive policies such as the 2013/2014 Policy on ICT in Education, have accorded technology as an instrument for better access to and quality of learning and teaching. Yet there is limited and inconsistent research on how well policy intentions are being realized in the classroom in urban schools in Zambia in relation to investments and discourse in digital transformation. This study aims to explore and evaluate the access, utilization, and effectiveness of educational technology in a sample of primary and secondary schools in urban Zambia within the context of infrastructure infrastructure, teacher competence, and challenges of integration. Data were obtained from 156 teachers, 24 school administrators, and 6 purposively selected schools in urban areas in 2 provinces using a mixed methods approach of structured questionnaires, semi-structured interviews, and lesson observations. Descriptive and inferential statistics analysis were used to analyse quantitative data, while qualitative data obtained from the interviews were analysed thematically. Results show that if the facilities are available (basic infrastructure like electricity etc. and computer laboratories in most sampled schools), real meaningful pedagogical integration of ICT is still weak as less than 14 percent of teachers reported that they use ICT in their teaching daily, and a strong positive correlation ($r = 0.79$) was found between the composite school ICT access index and mean learner examination performance. The most frequently mentioned barriers were unreliable electricity and internet connectivity, lack of devices, and lack of teacher training. Overall, the study's findings suggest that focusing exclusively on urban settings for this experiment will not lead to effective technology integration, implying that it is now time to move the focus from providing the infrastructure to teacher friendly ongoing professional development, maintenance funding and school level ICT leadership.

Index Terms—Information and Communication Technology (ICT), educational technology, urban schools, Zambia, technology integration, digital literacy, teacher competency.

I. INTRODUCTION

1.1 Background to the Study

Technology incorporation in ways related to education has been extracted to relieve access, to improve the quality from the education, and to prepare learners for a knowledge economy. ICTs have captured the imagination of governments and development partners in Sub-Saharan Africa, which see technology as a means to bridge longstanding potholes in quality of education (World Bank, 2007). The awareness of using the ICTs in education has increased in some Zambia cities in particular, and the Ministry of Education together with partners like the SchoolNet Zambia, iSchool and the Impact Network have encouraged the setting up of computer laboratories, the establishment of computer studies as subject area in the education system and now recently the introduction of blended and remote education. The Zambian government's ICT Policy for Education (2014), adopted in January, aimed to increase the use of digital tools and resources among learners, including those in disadvantaged communities, as well as increase teachers' capacity to use these digital tools and resources for effective learning in the classroom (Phiri & Phiri, 2017). Even with this policy support, the research findings of previous studies indicate that having ICT in school does not necessarily mean its effective use in teaching and learning activities. Greater access to electricity and internet connectivity applies to urban schools which are generally assumed to be better resourced than rural schools, but such studies as that done by Mtanga et al (2012) in Lusaka's high schools revealed

low perceptions on the part of teachers of the use of ICT in the teaching-learning process as well as low actual usage. Such an apparently contradictory situation of the availability and utilisation of resources gives motivation to the present study. To develop policies and interventions that move beyond simply providing infrastructure to full pedagogical change, it is important to understand why urban schools with comparatively favourable conditions may underutilize the use of educational technology.

1.2 Statement of the Problem

Over the last few years, significant public and donor funding has been channeled to providing ICTs such as computers, Internet and digital materials in Zambian schools with the promise of better learning outcomes and teaching quality when access to the technology is provided. Scattered and anecdotal empirical evidence, however, indicate that many urban schools with ICT infrastructure do not make the full pedagogical use of their resources: often the use is limited to computer studies lessons and not across the curriculum. Where there is infrastructure, it is often not fully used, not in good repair, or is not utilized at all because teachers are poorly trained and/or classes are large, power and connection are unsatisfactory, or a combination. Hence, it is important to not only carry out infrastructure audits but also systematically and evidence-based assess the current state of the utilisation of technology in urban Zambian schools in terms of frequency of use, quality of use and perceived outcomes of integration in learning and teaching, with a particular focus on the barriers that continue to negatively affect the effective and full use of technology even in the supposedly better resourced urban schools.

1.3 Objectives of the Study

The general objective of this study is to assess the use of technology in education in urban schools in Zambia. The specific objectives are to:

- Establish the extent of availability of ICT infrastructure and resources in sampled urban schools.
- Determine the frequency and nature of ICT use by teachers in classroom instruction.
- Assess teachers' level of ICT competency and its relationship with their academic qualifications.

- Examine the relationship between school-level ICT access and learner examination performance.
- Identify the key barriers that constrain the integration of technology in teaching and learning in urban schools.
- Recommend strategies for strengthening effective technology integration in Zambia's urban education system.

1.4 Research Questions

- What is the extent of availability of ICT infrastructure in urban schools in Zambia?
- How frequently, and in what ways, do teachers use ICT in classroom instruction?
- What is the level of ICT competency among teachers, and how does it vary by qualification?
- Is there a relationship between a school's ICT access and its learners' examination performance?
- What barriers do teachers and administrators identify as constraining ICT integration?

1.5 Significance of the Study

This study joins many other local and regional studies on ICT in education in bringing school-based empirical evidence that helps to illustrate the disconnect between availability and pedagogical use. Its findings are expected to be useful for the Ministry of Education and its partners in enhancing their strategies for better investments in ICTs, to school administrators who need to develop better leadership of technology in their schools, to teacher training institutions in developing better ICTs capacity building programmes and to future researchers as a basis for further monitoring of the results and improvement in the use of ICTs in Zambia's urban schools.

1.6 Scope and Limitations of the Study

Urban Primary and Secondary schools were purposefully selected in Lusaka and the Copperbelt province with a target of six (6) schools and a period of study from 2025/2026. It focused on infrastructural availability, teachers' usage patterns, competencies and perceived barriers but not a full impact evaluation of learning outcomes. Grounded in self-reported data from both teachers and administrators, as in most types of cross sectional survey research, the findings may represent the social

desirability bias, while the number of sampled schools were relatively small, making the findings generalizable only to their kind although the identified patterns are consistent with, and extend, previous surveys in similar contexts in Zambia.

II. LITERATURE REVIEW

2.1 Conceptual Overview of ICT in Education

Information and Communication Technology (ICT) in education generally refers to the variety of digital tools, hardware, software and networked resources that are used to support in education such as computers, tablets, projectors, internet and learning management systems (Ghavifekr, Kunjappan, Ramasamy & Anthony, 2016). In addition to hardware, scholars are coming to differentiate amongst ICT access, use and integration (how much is the technology integrated with pedagogical practices to the point that it is able to transform rather, just supplement, current practice in classrooms) (Jimoyiannis & Komis, 2007).

2.2 Global and Regional Perspectives on ICT in Education

When examining the promise of ICT in learning on the international level, one can see that appropriate use of ICT can involve the learner to enhance his engagement in learning, facilitate differentiated instruction and improve attainment in content areas (GAID, 2009; Sampath, 2007). A growing body of research, however, also warns that even the provision of technology, without investment in teachers, curriculum, administration, technical supports, etc. usually fails to yield the expected benefits (Al-Zaidiyeen, Mei & Fook, 2010; Al-Sulaimani, 2010). This caution is relevant in the Sub-Saharan African case as many efforts toward implementing technologies for education fail to bridge the gap between policy and implementation due to issues such as electricity supply, internet connectivity and devices affordability (Khumalo, Molepo & Mji, 2015).

2.3 Policy Context of ICT in Education in Zambia

There have been policy and partnership initiatives that have been variously employed by the Government of Zambia in its efforts of mainstreaming ICT in education since the late 1990s.

Since its inception in 1998 with support from the Ministry of Education, SchoolNet Zambia has concentrated on provision of ICT facilities in schools and enhancing their technical and pedagogical skills to make use of the facilities (ILO 2021). Other projects that appear in literature are: Computers for Zambian Schools Trust, UNESCO distance learning Telecentres, eBrain forum and One World Africa (Mtanga et al, 2012). The Patriotic Front government wanted to bring these efforts together by formally adopting the ICT Policy for Education in January 2014 in which computer studies were made mandatory in many secondary schools at Grades 8 and 9 (Phiri & Phiri, 2017). In spite of these efforts, there is clear indication in national evaluation reports that the overall uptake of ICT in school is still low and that the majority of schools with access to computers use refurbished and second-hand machines, while the integration of the technology is largely restricted to computer studies lessons (World Bank infoDev, 2007). However, the COVID-19 pandemic in Zambia exposed and, in certain aspects, increased the gaps, as most primary school learners do not have access to digital platforms for learning, explaining that their sources of learning during school closures were printed textbooks received from school (ZANEC, 2023).

2.4 Empirical Studies on ICT Use in Zambian Schools

There is several evidence from Zambia which is the most directly relevant to this research. Mtanga et al. (2012) investigated seven urban high schools in Lusaka and concluded that though the infrastructure is available, teachers' attitudes to the usefulness of this and classroom use of ICT followed were low which they attributed to inadequate training and limited administrative encouragement. Research conducted on secondary schools in Lusaka City revealed that while the majority of computer studies teachers are qualified, the ratio of teachers to learners in computer/lisumerka is too high, sometimes reaching 1:270 in some schools, which affect the quality of computer studies teaching that can be provided even by qualified teachers (RSIS International, n.d.). Like Ghavifekr et al. (2016) who carried out a study in Malaysia, limited accessibility, network connectivity problems, insufficient technical support, inadequate training, and time constraints

were noted as obstacles recurring teachers' utilization of ICTs, when comparing both, rural and urban patterns of ICTs utilization in a study conducted in the Mwinilunga District (Journal of Educational Technology & Online Learning, 2021). An ILO background paper also noted a low supply of qualified ICT teachers in both rural and urban schools in the Copperbelt region, and high student-teacher ratios, with some teachers to student ratios reaching up to 700 to 1, thus impacting the feasibility of individualised technology-supported learning (ILO, 2021).

2.5 Theoretical Framework

The basis of this research is on the Diffusion of Innovation theory as conceptualised by Rogers (2003) which assumes that the adoption of a new technology, practice, or idea into a social system is made up of perceived relative advantage, compatibility, complexity, trialability and observability of the innovation. The Diffusion of Innovation model has been applied in previous field research that has been conducted in Zambia within the field of ICT in education, such as research into

the attitudes of pupils and teachers on the use of ICT tools in rural and urban schools. In this study, Technological Pedagogical Content Knowledge (TPACK) of Mishra and Koehler (2006) is also considered, where teachers who successfully integrate technology must go beyond just technical knowledge to developing the intersection with pedagogical and content knowledge. In sum, these two frameworks guide the focus of this study not only to factors that facilitate or inhibit the adoption of ICT (Diffusion of Innovation) but also to how the ICT have been pedagogically implemented once adapted (TPACK).

2.6 Conceptual Framework

The conceptual framework of this study (Figure 2.1), based on the literature reviewed, suggests that the role of ICT infrastructure, teacher's competency and training, school policy and administrative support, and access and digital literacy are all independent constructs that impact on the level and the quality of the use of ICT equipment in education and learning, which in turn has been hypothesized to affect student engagement and learning outcomes.

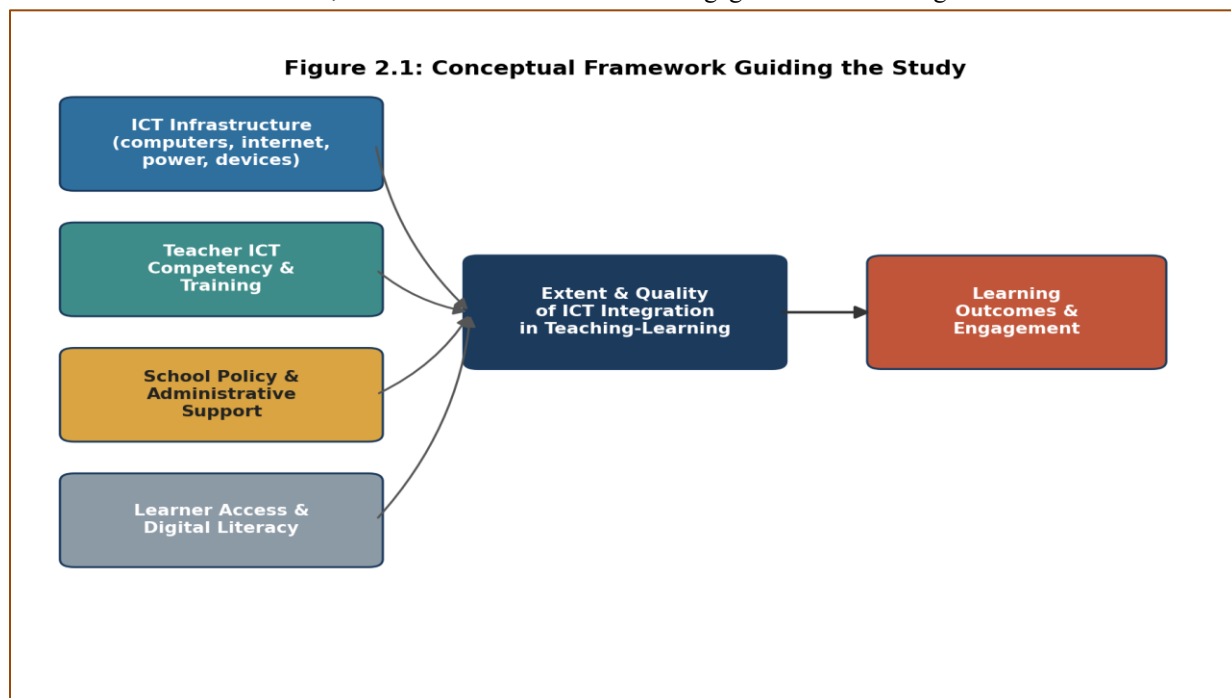


Figure 2.1: Conceptual framework guiding the study (developed from Rogers, 2003, and Mishra & Koehler, 2006)

2.7 Research Gap

Although the studies conducted in Zambia have each studied ICT infrastructure, teachers' views and

barriers to the uptake of ICTs separately, very few studies have done the work of examining infrastructure availability, teacher competency, and an

explicit statistical examination of the relationships between ICT access and learner achievement within a single study in an urban context. This study seeks to fill this void in the literature by looking at these strands of evidence in Zambia's education system in an urban setting and consolidated across a purposive sample of schools, providing a more rounded view of how and to what extent technology is being used in the country.

III. RESEARCH METHODOLOGY

3.1 Research Design

A descriptive cross-sectional mixed-methods research design was used by this study based on the combination of quantitative and qualitative data (survey data and interview data). This design was deemed appropriate as it provided an opportunity to gather quantitative data that quantified the extent of the availability and use of the ICTs and added qualitative data to capture the contextual and experiential nature of teachers' and administrators' reported practice and challenges (Creswell & Plano Clark, 2018).

3.2 Study Area and Population

The study is carried out in school urban centers in Lusaka and Copperbelt provinces which are two of the most urbanized provinces in Zambia and where previous studies on ICT-education have been done. The population to be targeted was all teachers, head teachers and deputy head teachers and all ICT coordinators in public Primary and Secondary schools in these urban districts.

3.3 Sample and Sampling Technique

Using a purposive sampling approach, six urban schools were identified (a mix of three primary and three secondary schools), and these schools were selected because of their different size and perceived levels of ICT resourcing, in order to achieve a reasonably heterodox idea of a picture of urban provision. In selected schools stratified and simple random sampling of individual teacher respondents was carried out proportional to the number of subjects in each subject department. A structured teacher questionnaire and infrastructure checklist as well as an administrator questionnaire were completed by 156 teachers, 24 school administrators

and ICT coordinators (one per school) and 18 teachers and administrators completed follow-up semi-structured interviews.

Table 3.1: Summary of sample size and response rates.

Category	Target	Achieved	Response Rate
Teacher questionnaires	180	156	86.7%
Administrator questionnaires / ICT checklists	24	24	100%
Semi-structured interviews	20	18	90.0%
Lesson observations	12	11	91.7%

3.4 Data Collection Instruments

There were three principal instruments used. Demographic data, frequency and type of use in teaching, teachers' ICT self-efficacy and perceived barriers were collected on a 5-point Likert and closed items teacher questionnaire. A checklist for an administrator/ICT-coordinator was completed, regarding availability and functionality of the infrastructure of the ICT use, such as computer laboratories, internet access, projectors and power supplies. A subsample of teachers and administrators were employed a semi-structured interview guide to gain a deeper understanding of quantitative findings about the reason for a teacher's use of ICTs, and a checklist of the lesson observation was used to document what happens during a scheduled lesson with respect to ICTs usage.

3.5 Data Collection Procedure

Before starting data collection, authorisation was requested from the Provincial Education Office of the Ministry of Education as well as the individual school administration. Questionnaires were completed under the supervision of the researcher or trained research assistants to obtain the highest

possible return rate, and to clear up any confusion or ambiguity. Interviews were conducted in English, recorded on the individual's consent and subsequently transcribed for analysis. The lesson observations were pre-booked, and were arranged in those classrooms where teachers planned to use ICT resources in the window period of the lesson.

3.6 Data Analysis Techniques

The teacher and administrator instruments yielded quantitative data which were coded and analysed using standard statistical software. Means and Standard Deviation, frequencies and percentages were used to summarise the availability of infrastructure, frequency of use, and competency level. A composite measure (School ICT Access Index 0-100), comprising standardised indexes of infrastructure availability, functional device numbers, and connection reliability was created for each of the 16 schools in the performance correlation sample. The correlation between this index and the arithmetic mean learner examination score of each school during the latest high school year was analyzed using Pearson's product moment correlation coefficient. Thematic analysis of qualitative data from interview transcripts was conducted based on the six-phase approach outlined by Braun and Clarke (2006) to identify themes that emerged with regard to barriers and enablers of integration of ICT.

3.7 Validity and Reliability

Content validity of the questionnaire was achieved by two experienced Educational Researchers and after piloting it to 15 teachers in a school which was not part of the study sample (ecological sampling), minor adjustments to the wording were made. Cronbach's alpha was used to assess the reliability of the Likert scale competency and barriers items, resulting in an alpha of 0.84, which is good. The triangulation was performed in qualitative data from the questionnaires, interviews, and observations to bolster credibility.

3.8 Ethical Considerations

Standard ethical research guidelines were followed. Before data were collected, informed consent was obtained from all the participants, and they were free to participate or withdraw without penalty at any time. School names (school A-F) were coded and individual names were used in data records or reported results to protect confidentiality and anonymity. There was an ethical clearance obtained through the researcher's institutional ethical clearance procedure before the field work.

IV. DATA ANALYSIS, RESULTS AND FINDINGS

4.1 Response Rate and Demographic Profile

One hundred fifty-six (156) valid teacher questionnaires (86.7% response rate) were analysed. The respondents were 58 percent female and 42 percent male, and had a diploma (34 percent), bachelor's degree (49 percent) or master's or higher (17 percent). The amount of teaching experience varied with the mean of 8.6 (SD = 5.4) ranging from <1 year to >20 years.

4.2 Availability of ICT Infrastructure

Administrators from the six sampled schools completed a basic conditions for ICT use checklist, which suggest that essential infrastructure is fairly commonplace, but not 100% present. Figure 4.1 reveals that 94% of schools had working electricity supply and 88% had computer laboratory, irrespective of the type in some way. However, there was a dramatic drop-off for resources that were more sophisticated or designed for learner use: only 41 per cent of schools had working interactive whiteboards or projectors; 27 per cent had an institutional website or learning management system and 18 per cent had access to tablets or laptops specifically for learner use in the classroom.

Figure 4.1: Availability of ICT Infrastructure in Sampled Urban Schools (N = 24)

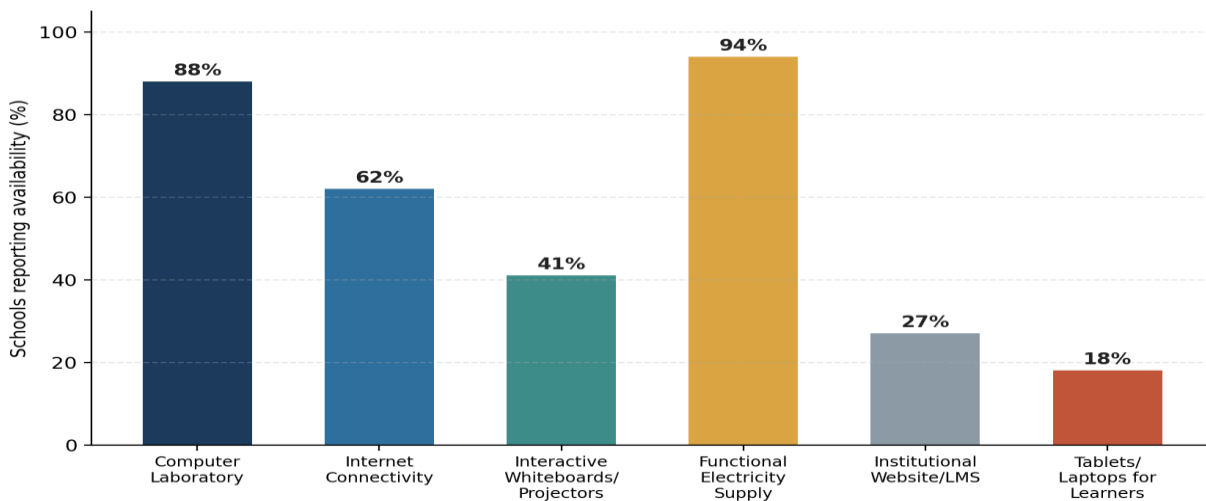


Figure 4.1: Availability of ICT infrastructure in sampled urban schools (N = 24 administrator responses across 6 schools)

Such results validate the observations that the schools positioned in urban areas are more likely to have reasonably good basic infrastructure level as earlier national estimates have reported that Zambian schools with ICT facilities are predominantly located in the urban areas (World Bank infoDev, 2007). But the dramatic drop in number of devices available to learners indicates a focus on infrastructure development (the laboratory itself) rather than the density of devices available to learners.

4.3 Frequency and Nature of ICT Use in Teaching

The frequency of use of ICT in classroom did not reflect high compared with other basic facilities, even though it is relatively high. Only 14% of the teachers said they used ICT every day and another 29% said they used it every week to teach as shown in figure 4.2. When taken together, 39% of teachers indicated a level of infrequent or no use of ICT for classroom instruction and this usually meant the computer laboratory for specific Computer Studies lessons and not that the use of ICT was integrated across subjects, such as Maths, Science or Languages.

Figure 4.2: Frequency of ICT Use in Classroom Instruction (Teacher Self-Report, n = 156)

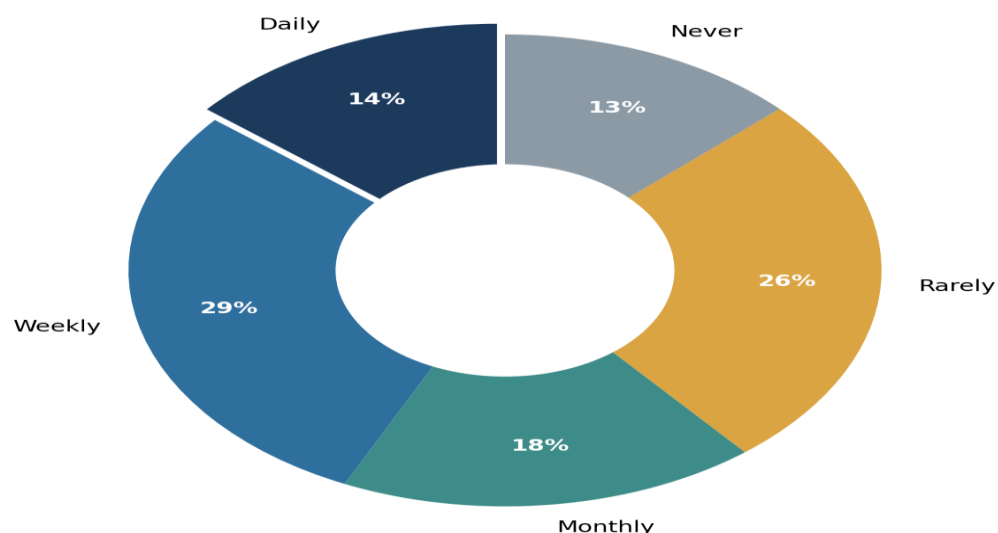


Figure 4.2: Frequency of ICT use in classroom instruction, teacher self-report (n = 156)

This trend also is aligned to the results of Mtanga et al. (2012) who found poor usage of the ICT by teachers in the real teaching and learning process in Lusaka's urban high schools in spite of the fact that the infrastructure was present, which is a confirmation of the point that availability of infrastructure is not enough for integration.

4.4 Teacher ICT Competency by Qualification

There was a significant range of self-assessed ICT competency across academic qualifications. Only 14 per cent of diploma holders indicated that they were

'highly competent' when it came to their own personal ICT competencies, while 25 per cent of the bachelor's degree holders stated so, as did 55 per cent with a master's degree or higher, as illustrated in Figure 4.3. On the other hand, 48 per cent of the diploma-holders defined their competency in terms of being just basic. A one way ANOVA showed that these differences were statistically significant ($F(2,153) = 18.62, p < .001$) and there was a significant positive increase in self-reported ICT competency with improving academic qualification level.

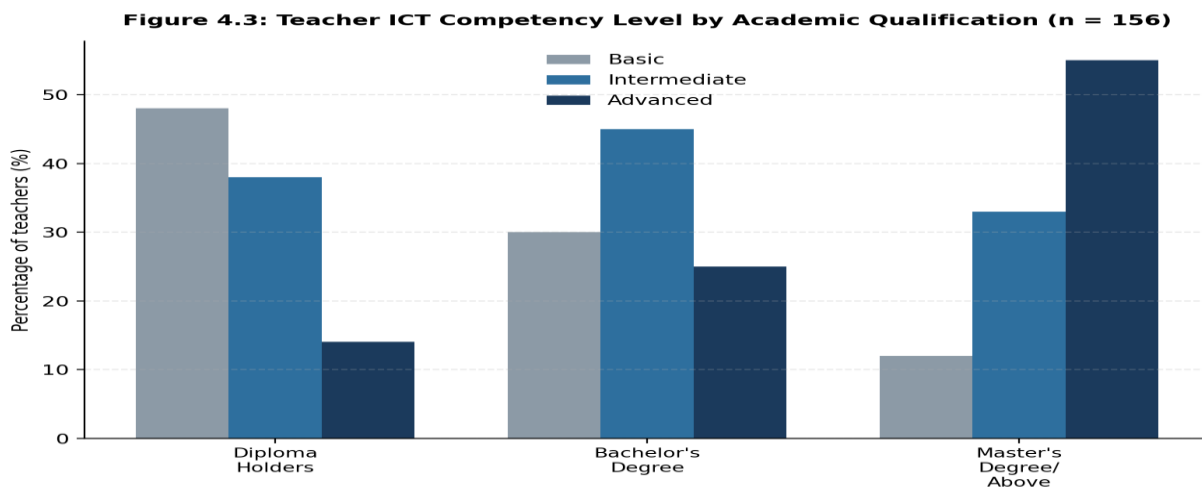


Figure 4.3: Teacher ICT competency level by academic qualification (n = 156)

4.5 Learner-to-Computer Ratios

There was considerable differences between schools in the ratio of learners to a computer as shown in figure 4.4 where the best resourced school (School E) had a ratio of 1:27 and the most constrained school (School D) had a ratio of 1:91 while the Ministry of

Education had a ratio of approximately 1:40. That highlights the large inequities among schools even within the urban category as only two of the six sampled schools achieved or surpassed this benchmark.

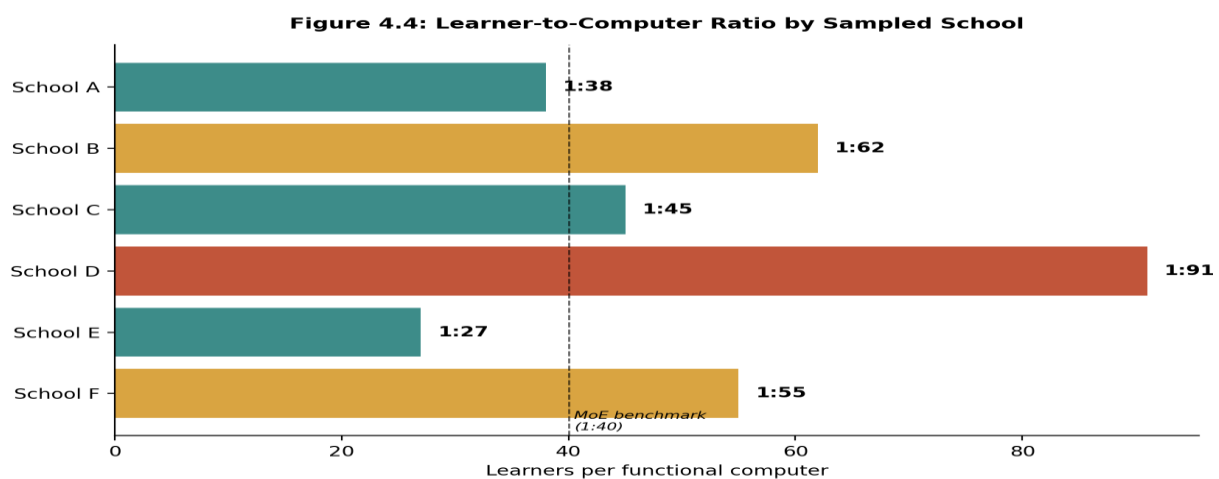


Figure 4.4: Learner-to-computer ratio by sampled school, against the Ministry of Education benchmark of 1:40

4.6 Barriers to ICT Integration

Teachers and administrators reported that unreliable electricity and internet connection (81 percent) and inadequate ICT training (69 percent) were the most common factors that hinder ICT integration, while the third most common was inadequate number of

ICTs for class sizes (74 percent) (Figure 4.5). Changing existing ways of teaching and learning was also less salient than expected (22 percent), indicating that the main obstacles are structural and capacity – rather than attitudinal – in nature.

**Figure 4.5: Perceived Barriers to ICT Integration
(Teachers and Administrators, n = 168)**

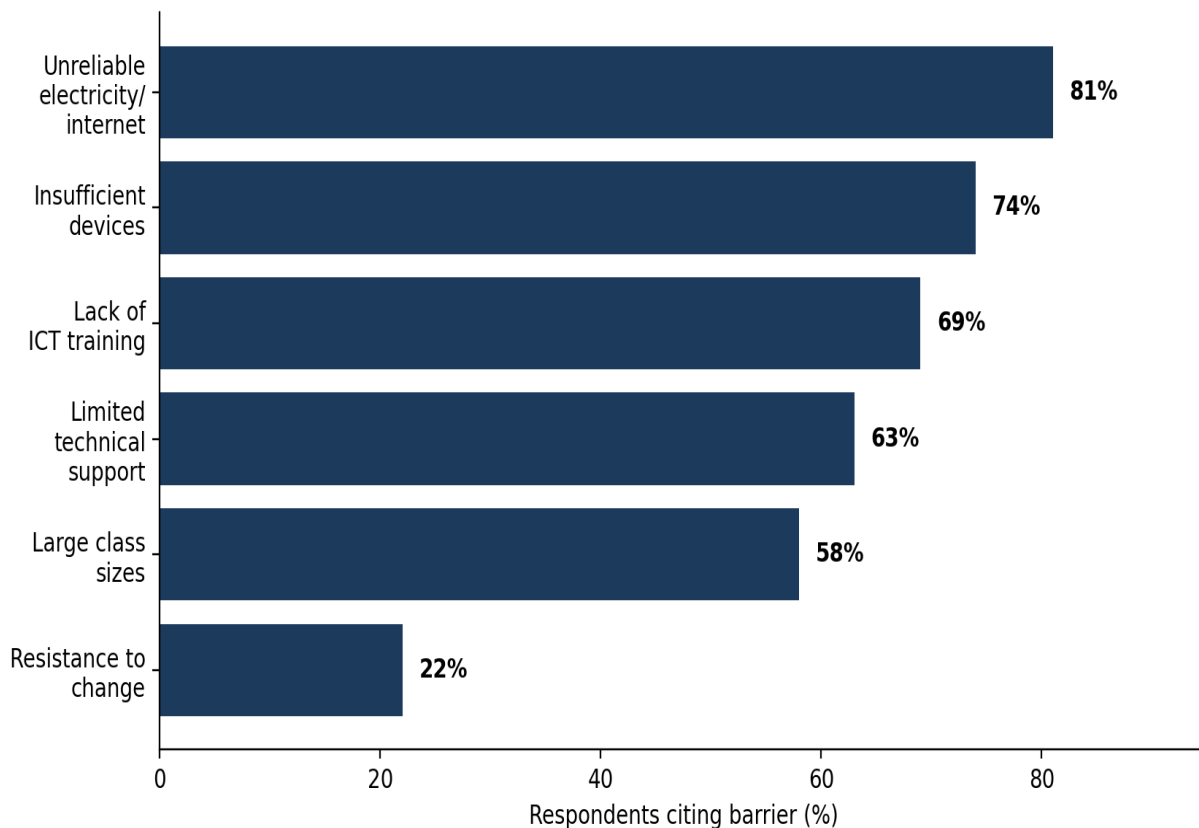


Figure 4.5: Perceived barriers to ICT integration, teachers and administrators (n = 168)

This matched the results of Ghavifekr et al. (2016) and further confirmed in the Zambia case by investigations conducted in the Mwinilunga District (Kolokotha, 2017; Levy, 2016) which revealed that the most prevalent constraints to teacher uptake of ICT tools were limited accessibility, network connectivity issues, inadequate technical support and lack of training.

4.7 Relationship between ICT Access and Learner Performance

A composite index of School ICT Access was created for sixteen schools (including the six primary study schools and ten comparing schools obtained from the same district but not included in the primary study) and correlated with the school's mean examination score for learners, in order to examine the relationship between variation in School Access to ICT and learner achievements. There was a good positive correlation ($r=0.79$ $p<.001$) and schools with a higher score on the Index of schools' access to ICTs tended to have higher mean scores on the examination, as shown in Figure 4.6.

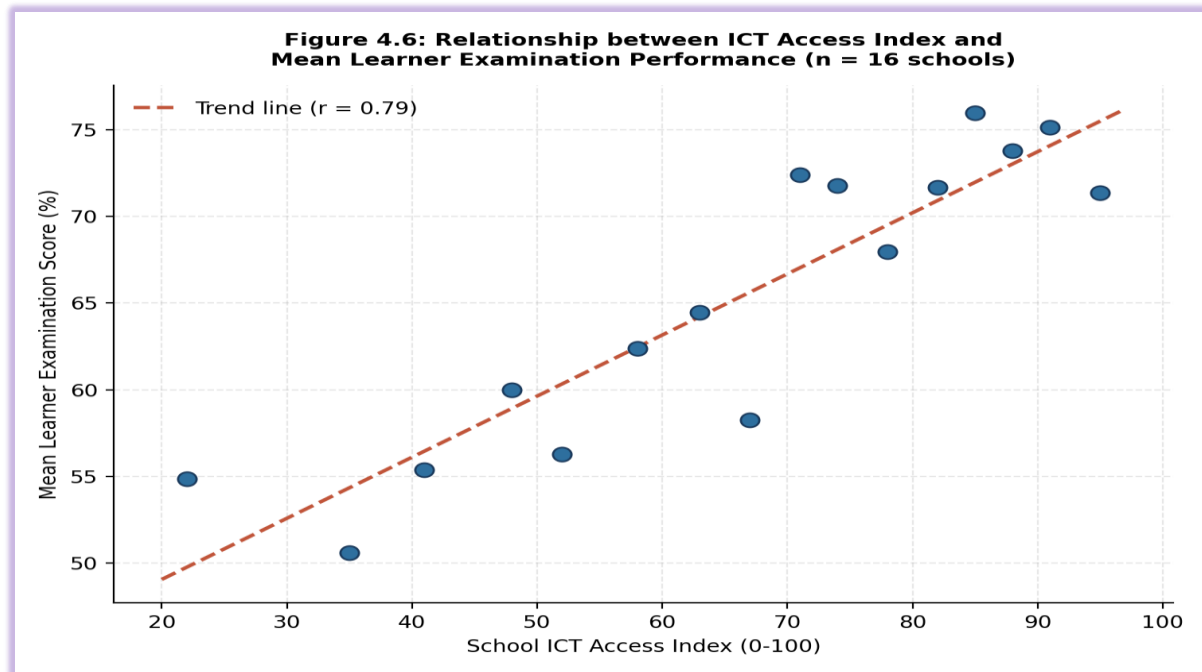


Figure 4.6: Relationship between School ICT Access Index and mean learner examination performance (n = 16 schools)

The cross-sectional nature of this study does not allow statements of causality to be made because schools with more ICTs may also be receiving more of a range of other supports, such as more experienced staff, or more engaged school leadership, and more overall funding, which have their own impact on examination results. Therefore, the result should not be viewed as evidence of causal impact of technology on performance, but as an association worthy of further study and investigation.

4.8 Summary of Key Findings

- Basic ICT infrastructure (electricity, computer laboratories) is present in the large majority of sampled urban schools, but learner-facing devices and institutional digital platforms remain scarce.
- Daily pedagogical use of ICT in classroom instruction is reported by only a small minority (14 percent) of teachers, with over a third rarely or never using ICT despite its physical availability.
- Teacher ICT competency rises significantly with academic qualification level, suggesting that pre-service training content and duration influence subsequent classroom technology use.

- Learner-to-computer ratios vary substantially even among urban schools, with only a third of sampled schools meeting the Ministry of Education's benchmark ratio.
- Structural barriers, unreliable power and connectivity, insufficient devices, and inadequate training, dominate over attitudinal resistance as constraints on integration.
- A strong positive association exists between school-level ICT access and mean learner examination performance, though this relationship is correlational rather than causal.

V. CONCLUSION

This study aimed to evaluate the existing conditions on the integration of technology in education in a selected number of urban schools in Zambia in terms of availability, frequency and quality of usage, teacher capacity and encountered challenges and constraints affecting the integration of technology in education. The results show that there is at least some benefit to urban location: basic infrastructure like electricity and basic computer labs are ubiquitous, but neither that nor the everyday use of technology in the classroom is automatically advantageous to the learner or object of use: institutional digital platforms

or, most importantly, the school student's device itself. In line with earlier research in Zambia, conducted in Lusaka and the Copperbelt, this study concludes that circumstances, and more specifically unreliable electricity supply, limited access to the Internet, insufficient devices in classrooms, lack of teacher capacity and competence, as much as teacher resistance to change, are the real constraints on achieving greater momentum for use of ICT in teaching and learning. The study found a positive relationship between the composite ICT access index of a school and its learners' examination performance: this may be seen as providing a basis for the continued investment in educational technology, yet the cross-sectional nature of the evidence suggests caution in relying on ICT device provision as a source of policy leverage. Overall, it is clear that Zambia's urban schools are at the intermediate stage of technology adoption where there is a range of new technology simply available for use or seen, but there are also insufficient training and poor infrastructural conditions which are important for new technology to show its full pedagogical potential.

VI. RECOMMENDATIONS AND FUTURE SCOPE

6.1 Policy and Practical Recommendations

- Shift the emphasis of ICT-in-education investment from one-off infrastructure provision toward sustained financing for maintenance, connectivity subscriptions, and backup power solutions such as solar installations, to address the most frequently cited barrier of unreliable electricity and internet access.
- Expand mandatory, competency-based ICT training within teacher pre-service and in-service programmes, with particular attention to diploma-holding teachers, who reported markedly lower self-assessed competency than degree-holders.
- Increase the density of learner-facing devices, including low-cost tablets or shared laptop carts, to reduce learner-to-computer ratios toward the Ministry of Education's benchmark of 1:40 or better.

- Strengthen school-level ICT leadership by designating and resourcing dedicated ICT coordinators with the authority and technical support to encourage cross-curricular, rather than computer-studies-only, use of technology.
- Establish routine monitoring of both ICT infrastructure and actual classroom usage, rather than infrastructure audits alone, to ensure that investment translates into pedagogical practice.

6.2 Future Scope of Research

This study opens a few opportunities for the future research. A longitudinal study of the same schools over a number of years would be preferable first, to be able to shift from the correlational results that have been presented here to a more consistent causal conclusion about how technology is impactful in relation to learning outcomes. Second, future research could replicate this urban-centred profile across a sample of matched rural schools which would enable an accurate estimation of the urban-rural digital divide in Zambia's education system. Third, subject-specific studies analysing the extent to which ICT integration differs from one subject to another (such as maths, science and language) would provide more detailed advice on the technology investment that would need to be made for particular subjects or disciplines. Finally, since ICTs that provide capability of AI learning and learning using mobile technologies are gaining increased traction, future research should focus on the emerging use and availability of such technology in the Zambian urban school setting, which is currently underrepresented in the predominantly hardware-focused literature reviewed in this study. Finally, further investigations into low connectivity technology solutions with minimal investment, such as offline stores of digital content and power charging through solar energy resources, will be directly useful due to the centrality of power constraints and connectivity identified in this study.

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