

Why Information, Communication and Technology (ICT) Integration in Biology Teaching is Challenging and achievement of learning outcomes in Nairobi City County, Kenya

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Abstract: Biology has been identified as an important scientific discipline contributing to vital innovations in health such as genetic engineering and medicine. The national examination reports in Kenya from 2013 to 2023 have however consistently revealed dismal achievement of learners' learning outcomes in Biology. Even though educators are aware of the positive impact Information and Communication Technology (ICT) integration may have on achievement of learning outcomes, researchers have reported minimal ICT integration in Biology teaching. This study investigated the challenges of ICT intergration in Biology teaching and its influence on students' attainment of intended learning. The study utilised a mixed-methods approach following the explanatory sequential design. Phase one of the study began with a quantitative survey whose results informed the qualitative inquiry which was done in selected secondary schools. The study targeted 114 public secondary schools in Nairobi City County, Kenya. Quantitative data was collected using questionnaires while qualitative data was collected using in-depth interview schedules, Focused Group Discussions (FGDs) and classroom observation schedules. Respondents of the study included: Biology teachers, students and subject experts from the Kenya Institute of Curriculum Development (KICD), the Centre for Mathematics, Science and Technology Education in Africa (CEMASTE) and Biology education lecturers from Kenyatta University. The findings revealed Teachers rarely used ICT integration due to lack of knowhow; phobia; ignorance; and principals' lack of understanding. This study concluded that ICT integration was unsatisfactory and thus enhanced achievement of low order cognitive outcomes, inadequate skills outcomes and low interests in Biology

Keywords: ICT Integration, challenges, achievement of learning outcomes, teaching and learning.

1. INTRODUCTION

Biology education is important not only in health productivity but also in medicine and biotechnology (Fernandes, Rodrigues, & Ferreira, 2019). Evidence from research has however shown that education systems are not up to the challenge in science teaching, leading to a decline in achievement of learning outcomes in science disciplines of which Biology is one of them (Xue & Li, 2021)). Further, research studies note that concerns raised regarding science teaching, including the methodology of teaching science and the introduction of technologies, among other concerns, have not been addressed.

Integration of ICT in teaching Biology according to MOEST (2015) is what can promote learning in today's world. Major challenges facing the integration of computer technology into the instruction process has been reported by many teachers. How teaching is carried out is what defines the learners' outcomes or results of the objectives or aims of a curriculum (Gatica, 2024). Learning outcomes in terms of expected knowledge, skills, attitudes and behaviors are fundamental benchmarks designated to hold education systems, schools and teachers accountable for the learners' achievements (Toh & Zaidatun, 2024). Learning outcomes are multidimensional, meaning that learning may be apparent from changes in cognitive, affective or skill capacities.

This study therefore assessed the challenges of ICT integration in Biology teaching and how it influences achievement of learning outcomes in Biology.

2. REVIEW OF LITERATURE

Research has shown that, utilization of Information, Communication Technology (ICT) in the delivery of instruction has a huge positive impact on learning outcomes. However, studies carried out in Kenya showed that ICT integration was minimal in most schools in Rachuonyo South Sub County in Kenya (Otianga, 2020). This finding is discouraging given that ICT integration is likely to lead to improvement in achievement of learning outcomes.

Research carried out in Zimbabwe identified the factors that were hindering the ICT utilization as lack of power supply, insufficient resources, fear of technology, lack of interest, ICT skills deficiency, higher ICT cost and poor physical infrastructure (Admire & Patience, 2024). Similarly, a study by Ergado, Desta, & Mehta, (2022) conducted in Ethiopia on ICT integration in teaching and learning noted that some of the critical factors preventing ICT integration were: lack of proper access to ICT resources, insufficient technical and pedagogical support. These findings show that the challenges preventing ICT integration are yet to be addressed.

Another study by Otianga (2020) in Kenya similarly showed that there is minimal ICT integration in teaching. The lack of use of ICT was attributed to inadequate number of computers and lack of sufficient training of teachers. Studies reviewed have shown that ICT integration may lead to high achievement of learning outcomes but little investigations have been done on the extent to which ICT integration influences the achievement of learning outcomes.

Admire & Patience, (2024) document about a study done in Zimbabwe whose aim was to assess the availability and utilization of ICT resources in secondary schools. The findings revealed that most of the ICT resources required for teaching and learning were missing in the sampled schools, and those that were available were inadequate. The findings further revealed that the available ICT resources were utilized to a very low extent. These findings show that ICT integration which is hoped to increase achievement of learning outcomes is yet to be achieved

3. METHODOLOGY

The researcher deployed a mixed-methods approach using the explanatory sequential design. The mixed-methods approach was selected because it can effectively draw from both qualitative and quantitative data in response to research questions (Cameron & Golenko, 2023). This way, the approach provides a wholesome view of the research problem.

Explanatory Sequential mixed method design involved a two-phase collection of data. The researcher collected quantitative data in the first phase using questionnaires as data collection instruments, analyzed the results, and then used the results to plan (or build on to) the second, qualitative phase. The quantitative results typically informed the types of participants to be purposefully selected for the qualitative phase and the types of questions that were asked of the participants so as to gather explanations to the quantitative data.

The qualitative data was collected using focus group discussions (FGDs), Key informant interviews and class observations. The qualitative results helped to understand the process of teaching Biology and the product (the learning outcomes) of the process (Cameron & Golenko, 2023). To counter the challenges posed by Mixed methods such as the time-intensive nature of analyzing both qualitative and quantitative data, the researcher designed a clear flow of research activities. The researcher also assigned enough time for data collection and data analysis to give credibility to the research approach and consequently the findings.

The study targeted all the 114 public secondary schools in Nairobi City County, Biology specialists from CEMASTE, KU and KICD, Biology teachers and students. For the quantitative phase, the researcher used single-stage sampling procedure using random sampling to identify 114 out of the 228 teachers of Biology. Quantitative data was analyzed and findings represented in tables and graphs. For the qualitative phase the researcher used purposive sampling to select six schools for further study. Data was analyzed thematically according to the objectives of the study and findings recorded. The findings were used to draw conclusions and suggest recommendations.

4. FINDINGS AND DISCUSSION

Quantitative Study on challenges of ICT Integration in Biology Teaching

In the quantitative phase, the researcher sought to find out the reasons why teachers do not integrate ICT despite its usefulness. The teachers were presented with four statements depicting statements why teachers do not use ICT and asked to rate them in a scale of 1-5 (1 being the lowest rate and 5 the highest).

ICTIBT6 Teachers do not use ICT due to lack of facilities

ICTIBT7 Teachers do not use ICT due to lack of training/know how

ICTIBT8 Teachers do not use ICT due to time constraints

ICTIBT9 Teachers even though there is availability of time and ICT facilities ignore to use of ICT

The table below shows the reasons why Biology teachers do not integrate ICT in their teaching according to the quantitative study.

Table 1: Reasons for Non-Integration of ICT by Biology Teachers

Gender		ICTIBT6	ICTIBT7	ICTIBT8	ICTIBT9
Age	Male	75%	71%	63%	67%
	Female	91%	77%	73%	55%
	25-34 years	95%	73%	68%	64%
	35-44 years	73%	73%	64%	64%
Experience	45-54 years	70%	80%	70%	50%
	55 years+	67%	67%	67%	67%
	4 years or less	100%	100%	88%	75%
	5-10 years	83%	57%	52%	48%
	11-15 years	80%	80%	80%	80%
	16-20 years	100%	100%	100%	0%
	21-25 years	75%	100%	100%	100%
	30 years and above	60%	80%	60%	60%
	Average	83%	74%	67%	61%

Most teachers, 83%, agreed that teachers do not use ICT due to scarcity or lack of ICT facilities, 74% of the teachers agreed that they do not use ICT due to lack of knowhow, 67% noted that they do not use ICT due to time constraints while 61% of the teachers who participated in the study agreed that teachers just ignore using ICT. These findings agree with other researchers (Belay, Khatete & Mugo, 2020) who identified the factors that were hindering the ICT Utilization as lack of power supply, insufficient resources, fear of technology, lack of interest, ICT skills deficiency, higher ICT cost and poor physical infrastructure. These findings show that lack of facilities and infrastructures were the main reason why teachers failed to use ICT. This means that teachers could be willing to integrate ICT if provided with facilities.

From the qualitative study, the researcher established from the key informants how ICT integration influences achievement of learning outcomes. The key informant Y said the following:

KI Q: How does ICT Integration influence achievement of learning outcomes? KIY:

ICT integration can help learners visualize things so they will never forget. When learners see processes through simulations, they understand better. ICT integration makes teaching easier by allowing teachers to play more than one video allowing learners to compare and analyze knowledge.

Key informant Y reported that ICT integration may help learners achieve cognitive learning outcomes like remembering, understanding and analysis. These findings are in line with Ali et al, (2021) who indicate that ICT integration may help learners remember and understand concepts better. From these findings, ICT use may promote fairly higher learning outcomes.

On the same concern of how ICT integration influences achievement of learning outcomes, key informant W said the following:

KI Q: How does ICT Integration influence achievement of learning outcomes? KIW

When there is ICT integration it amalgamates both low level and higher cognitive learning outcomes. For example, Simulation promotes cognitive outcomes such as understanding. When you use non digital technology, students may touch and observe and even experiment. This promotes skills learning outcomes such as observation and experimentation. ICT integration definitely promotes positive attitudes to learning Biology. The truth is that learners actually enjoy and we have seen cases where in a school only one teacher is using technology and the students wishing that they could be taught by that teacher who is using technology.

The key informant W informed that ICT integration promoted both low and high order cognitive learning outcomes. For instance, simulations may promote understanding of concepts. ICT integration by use of non-digital devices may promote skills outcome such as observation and experimentation. The key informant W mentioned that ICT integration definitely promotes affective outcomes like helping students develop a positive attitude towards Biology. These findings about how ICT influences learning outcomes is in agreement with (Toh & Zaidatun (2024), who note that ICT integration is what can promote learning in today's world in not only enhancing achievement of both low and high order learning outcomes but also promoting interests of learners. These findings show that ICT integration can help learners achieve a range of learning outcomes and therefore ICT use should highly be supported by schools and the government.

From the qualitative study, the researcher established from the key informants why ICT integration was minimal in schools. The following is the responses from the key informants Y.

KIQ: why do teachers fail to integrate ICT in Biology teaching? KI Y

Some teachers just have phobia for ICT. Some schools are lacking connectivity. There is lack of power, internet and also the attitude of some teachers they just refuse to use ICT because they think it is a lot of work. Also lack of gadgets they can be expensive to afford.

Key informant Y listed challenges such as phobia for ICT, lack of electricity in some schools, lack of internet, poor attitude towards ICT integration and lack of gadgets due to high cost as the main challenges why teachers fail to integrate ICT in Biology teaching.

On the same note on why ICT integration was minimal in schools, key informant X said the following:

KIQ: why do teachers fail to integrate ICT in Biology teaching? KI X

We have 2 types of principals. Science based and art based. Anything to do with laboratory and such the science based understands. But now when it comes to ICT both these principals are the same; they think if teachers use computers and projectors they steal. If they are given a chance to use they will spoil. I was talking to one principal who has locked all the ICT gadgets in a certain school. I asked him 'don't you think they will get a virus?' so he asked me you mean computers can also get a virus? I said 'yes' he asked if a computer gets a virus and I go to the chemist which drug will I buy to kill those viruses? So that fear of unknown of stealing, getting spoilt etc is real. Some teachers can be funny though like in some schools where they were given the gadgets, ipads and locked up. Teachers were organizing with outsiders in breaking into the school and stealing them away because the head teacher was refusing to allow them. But it is sad some school principals cannot encourage you to have your own computer and prepare your schemes of work with it. They want hand written and yet there is technology.

The key informant X said that the main challenge hindering ICT integration is the principals' lack of understanding on the need to avail the gadgets to the teachers. Many principals thought that the teachers may steal or spoil the gadgets and so they keep them under lock and key. Some principals were even unaware that locking the gadgets may expose them to more harm for example the computer may get viruses. Due to this behavior of principals in some schools, the teachers were organizing with outsiders to steal the gadgets from school. These findings from the key informants on lack of use of ICT integration by teachers rhyme with the findings of Belay, Khatete & Mugo (2020) who revealed that most of the ICT resources required for teaching and learning were not available in schools, and those that were available were utilized to a very low extent. These findings call for awareness creation in schools to both the teachers and administrators on the usefulness of ICT integration in teaching and learning of Biology.

Convergent /Divergent Findings from the Quantitative/Qualitative Study on Use of ICT Integration in Biology Teaching

From both the quantitative and qualitative studies above, a lack of ICT use is largely due to the scarcity of ICT facilities and when available, the facilities are not being utilized especially by older teachers. Both studies point to an improvement in learning outcomes with integration of ICT in biology teaching. This concurs with Rind et al, (2022) who state that integration of ICT positively impacts academic achievement.

A divergence, however, is portrayed whereby many teachers are not aware that ICT use can be integrated in Biology teaching without the use of computers. While the quantitative study implied that lack of use was due to unavailability of ICT equipment, the qualitative study revealed that in some areas where ICT equipment had been provided, they were locked away by school administrators and thus remained unused. This largely diverged from Masu & Abe (2025)'s study which directly linked inclusion of broadcast television and current affairs news channels in teaching to improved learning outcomes.

5. CONCLUSION

Teachers rarely used ICT integration due to lack of knowhow; phobia; ignorance; and principals' lack of understanding on the need to avail the gadgets. This study therefore concludes that ICT integration was unsatisfactory and thus enhanced achievement of low order cognitive outcomes, inadequate skills outcomes and low interests in Biology.

6. RECOMMENDATIONS

The Ministry of Education (MOE) working with partners should provide ICT gadgets and internet connectivity to all schools. Kenya Institute of Curriculum Development (KICD) and the Centre for Mathematics, Science and Technology Education in Africa CEMASTEIA should organize awareness seminars for principals on the usefulness of ICT integration and organize In-service Training (INSETs) for teachers on how to use digital resources and ICT integration.

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