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Exploring Science Teachers' Beliefs and Practices of ICT Integration in Secondary School Teaching: A Mixed Method Approach

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Abstract

This study investigated science teachers' beliefs and practice of ICT integration in teaching and learning in Zanzibar. Its objectives were: to assess science teachers' beliefs about the role of ICT integration in teaching and learning and to explore how science teachers integrate ICT in classroom teaching. The study involved 60 science teachers purposively selected from 5 public secondary schools in the Town District of Zanzibar. The schools were selected by using convenience sampling procedures. The study employed a mixed-methods approach and a concurrent nested design. Data were collected by using survey questionnaires, interviews and classroom observation. The quantitative data were analysed using the descriptive analysis technique while the qualitative data were analysed thematically. The findings indicated that the science teachers had varied beliefs about ICT integration in teaching and learning. While some had positive beliefs about ICT integration in teaching and learning, others held negative beliefs. The findings also revealed that the teachers' actual practice of ICT integration in teaching was inefficient. Insufficient skills and knowledge as well as a lack of confidence in ICT integration were identified as significant obstacles to ICT integration, which caused science teachers to inefficiently integrate ICT in teaching. Based on the findings, the study recommends that the Zanzibar Government through the Ministry of Education and Vocational Training, the Zanzibar Institute of Education, and other educational stakeholders, take comprehensive professional development initiatives to raise teachers' confidence, skills, and knowledge on integration of ICT in teaching and learning. Studies are needed to address the self-efficacy in ICT integration and the challenges faced by science teachers to integrate ICT in teaching and learning context.

Keywords: ICT integration, teacher beliefs, science teaching, science teachers, secondary school, Zanzibar
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Introduction

ICT has advanced tremendously in recent years, bringing about significant changes in different sectors, including business, education, health, and agriculture. In education, technological advancement has a significant impact, particularly on teaching and learning. It has brought about the use of technology in teaching, which is referred to as ICT integration. The term ICT integration in education generally refers to a technology-based approach to teaching and learning in which teachers use technology to facilitate learning in the classroom (Tshewang, 2019). It is an approach that has proved successful in enhancing learning among learners with diverse learning abilities, needs, and styles (Henderson, 2020). It plays a great role in improving teaching and learning in the classroom (Thaheem *et al.*, 2021). For instance, it increases students' cognitive understanding and learning achievement (Liu et al., 2022). Research evidence shows that nearly every subject, including science, mathematics, languages, the arts, humanities, and other important subjects, can be learned more successfully with the use of technology-based tools and equipment (Demkanin *et al.*, 2005). In teaching science subjects, ICT integration is incredibly helpful. With the integration of ICT in education, expensive laboratory supplies and samples can be replaced by ICT tools, video demonstrations, and experimental simulations. ICT is effective in developing science skills as it enhances teaching and learning of science subjects (Sekhri, 2021). Moreover, the use of ICT in teaching science improves comprehension of practical tasks and inspires students to learn the subject by keeping them interested in the learning process through visual stimulations and making them actively engage in practical situations in the classroom (Maharaj-Sharma & Sharma, 2017).

Teachers' beliefs have a crucial influence on their use of ICT to facilitate learning in schools (Ama *et al.*, 2020; Daudi & Nzilano, 2019). According to Ottenbreit-Leftwich et al. (2010), teachers' beliefs about technology predict their technology use in the classroom. In the context of this study, a belief is defined as the mental acceptance or conviction in the truth or actuality of some idea. It is a propositional view that can be articulated in the form of an attitude (Schwitzgebel, 2010). When teachers believe technology adds value to the teaching and learning process, they are more likely to use it (Taimalu & Luik, 2019). Thus, if teachers have positive beliefs about the use of technology, it is an important step toward effective integration of ICT in teaching and learning (Tondeur *et al.*, 2017). Positive beliefs about technology use in teaching and learning are reported to significantly influence teachers' participation during the Lesson Study process. Hence, it helps to deepen their knowledge about Lesson Study and its application in integrating ICT into instructional practices (Juggernath, 2020). ICT strengthens teaching and learning, saves time, and encourages effective interactions between the teacher and students in the classroom (Na-Allah, 2019). Also, the beliefs held by teachers on a certain practice have a crucial role in shaping their objectives related to the integration of technology (Silviyanti & Yusuf, 2015).

Some studies have established that the use of ICT in teaching science leads to a better understanding of scientific concepts as it enables students to visualize abstract concepts quite easily. There is some evidence that science teachers find the technological tools used in teaching Biology more useful than those used in teaching Physics, Geography, and Chemistry (Kromidha, 2015). Currently, teachers are insisted to use creative teaching approaches to enable their students to get hold of the 21st-century skills so as to be able to cope with the ever-changing global labour market (Nzabalirwa & Nduwayezu, 2022). Thus, teachers are expected to be aware

of the benefits of ICT in order to conduct meaningful lessons by using ICT (Warwick & Kershner, 2008).

In many developing countries including Tanzania, Rwanda, Eritrea, Malaysia, and Kenya, studies consistently report a low level of ICT integration in teaching and learning Findings from such studies indicate that most teachers, including science teachers, do not integrate ICT into their teaching practices due to insufficiency of ICT resources, a lack of motivation, poor connectivity, poor teaching environment, insufficient training, and a lack of support from the management (Belay, 2020; Kamaruddin *et al.*, 2017; Nzabarilwa & Nduwayezu, 2022; Ngeze, 2017; Simbeye, 2020; Wanjala, 2016). A few studies have investigated the influence of science teachers' beliefs and their practice of ICT integration in teaching (Belay, 2020; Kamaruddin *et al.*, 2017; Nzabarilwa & Nduwayezu, 2022; Ngeze, 2017; Simbeye, 2020; Wanjala, 2016). These studies generally show that teachers' beliefs and actual practices constitute another factor for teachers' failure to integrate ICT into their teaching practices in the classroom. The findings of these studies underscore the significance of studying science teachers' beliefs and practices to determine the effectiveness of ICT integration in teaching science subjects. This is because ICT has rapidly grown following the advancement of science and technology in the last decade such that science teachers now have more opportunities to teach by using ICT although they have several challenges to confront (Savec, 2017). Teachers are supposed to create an environment that can enable learners to interact with the technology through collaborative learning (Asoc & Buza, 2017). Also, teachers must understand how to integrate ICT and how to use it in teaching. This would make them competent and confident enough to facilitate meaningful learning among all students in the classroom.

Purpose of the Study

The study aimed to investigate science teachers' beliefs and actual practice of ICT integration during their classroom teaching, in particular, the following research objectives:

i. To assess science teachers' beliefs on the role of ICT integration in teaching and learning science subjects.
ii. To explore how science teachers integrate ICT in classroom teaching.

Literature Review

The influence of teachers' beliefs about ICT integration on technology use in teaching has been studied by many scholars. It is argued that the beliefs held by teachers about a certain practice have a crucial role in shaping their objectives related to the integration of technology (Silviyanti & Yusuf, 2015). Thus, teachers who believe that technological tools have the potential to improve lessons, foster motivation, and introduce transformative changes to their teaching methods and techniques are more likely to adopt technology with confidence (Ama Gbemu et al., 2020). Qaddumi et al., (2023) accordingly affirm that teachers' positive beliefs about ICT have the potential to enhance technology use in teaching and learning.

The study by Bice and Tang (2022) revealed that most teachers tend to have more teacher-centred beliefs and teaching practices. These scholars established along with Ertmer (2005) and Wojney (2006) that teachers with student-centered beliefs integrate or are more likely to integrate technology in their classrooms. Yet, there is a plenty of evidence that ICT is not highly

integrated into classrooms for learner-centred teaching despite the increased availability of technology for teachers and students. Nevertheless, it is expected that teachers' beliefs about technology would change over time depending on their experience with technology use in teaching and school culture.

According to Kim *et al.,* (2013), there is a correlation between teachers' beliefs about the nature of learning and their integration of technology into teaching practices. As Almarri et al.(2020) put it, teachers with positive beliefs about ICT integration in education tend to be more disposed to use technology in teaching. Besides, the successful integration of ICT in teaching depends upon teachers' decisions on the use of ICT tools (Almarri *et al.*, 2020). Positive beliefs about ICT integration reflect teachers' comprehension of the potential benefits and advantages that ICT can bring to the teaching and learning process. Such beliefs are the basis for the effective implementation of ICT integration in teaching and learning. Teachers who believe in the usefulness of ICT are more likely to invest time and energy in learning how to effectively use these tools for teaching purposes, and innovate ways to integrate them into their pedagogical strategies. However, as per the findings by Hew (2006), teachers' beliefs can be a hindrance to successful integration of technology into instructional practices.

Following the rapid growth of ICT steered by the great advancements in science and technology made in the last decade, science teachers now have plenty of educational technologies at their disposal despite the fact that there are several challenges they have to overcome (Savec, 2017). For effective use of technology in teaching and learning, teachers have to create an environment that enables learners to interact with the technology while engaging in collaborative learning (Asoc & Buza, 2017). Teachers must understand how to integrate and use ICT during teaching sessions. This implies that they need to be competent and confident enough to facilitate meaningful learning among all students in the classroom. Unfortunately, many studies attest that teachers lack the competence to use technology effectively in teaching. For instance, Aldhafeeri *et al.,* (2016) found that the teachers were not competent enough to integrate technology into their teaching strategies effectively. Accordingly, Zungu (2022) found that teachers had basic ICT competencies, such as using a laptop connected to a digital projector for instructional purposes, but they were unable to effectively incorporate ICT into their teaching practices.

Mulhim (2020) identifies five significant teacher-related barriers to technology integration in teaching, namely: a lack of confidence, teachers' attitudes and beliefs, a lack of skills and knowledge, and time constraints. All these barriers have something to do with the factors expected to encourage teachers to integrate technology into their lessons. According to Nyakito et al. (2021), time is an additional barrier to technology integration in teaching. It can be a significant barrier to teachers in integrating ICT into their teaching practices. Smadi and Raman (2022) found insufficient time to be the main reason behind teachers' failure to integrate technology into their lessons. Meanwhile, Alharbi (2013) found a discrepancy between teachers' level of competence in integrating technology and the actual integration of technology in the classroom. Alharbi (2013) explained this to be mainly a consequence of the time constraint, which limits teacher's ability to adequately plan and organize activities that would facilitate the integration of technology into the teaching process. Many teachers reported that the time constraint hindered them from acquiring the competence to effectively integrate technology into their teaching strategies.

Zungu (2022) did a study in which he employed purposive sampling to select 3 three schools and three teachers in each school as the study sample. Zungu (2022) collected data through document analysis, questionnaire, lesson observation, and semi-structured interviews and came up with findings indicating that teachers had basic ICT competencies, such as using a laptop connected to a digital projector for instructional purposes, but they were unable to effectively incorporate ICT into their teaching practices. Zungu's (2022) findings corroborated an earlier study by Aldhafeeri *et al.*, (2016) who found that teachers were facing difficulty in integrating technology effectively into their teaching strategies due to incompetence. Unlike Zungu (2022), the current study collected data through questionnaires, semi-structured interviews, and classroom observation.

Smadi and Raman (2022) did a study using semi-structured interviews and observation. They collected information from 5 teachers from 5 Jordan schools. The study used a small number of participants who were selected purposively. The study's sample size influenced the current study in the selection of data collection methods. This is the reason why the researcher in the current study selected a small number of teachers to be interviewed and observed during the data collection process. Smadi and Raman's (2022) findings indicated that the main reason why teachers failed to integrate technology into their lessons was insufficiency of time Correspondingly, Covington (2012) found that teachers find fail to use ICT in teaching due to limited computer access, poor internet connectivity, and a shortage ICT textbooks. In addition, Kibirige (2023) found that teachers fail to integrate technology into their teaching sessions due to a lack the necessary ICT skills and support.

Research Gap

Most of the previous studies (e.g. Soma, 2018; Ebire, 2020; Enyi & Otu, 2021; Gbemu *et al.*, 2020; Mangare *et al*., 2022; Nandan & Sahana, 2022; Smadi *et al.*, 2021) were conducted in places other than Zanzibar. No study on the perception of ICT in teaching and learning in Zanzibar is known. This is a warrant for the present study given the fact that context has the potential to significantly influence the dynamics and outcomes of science teachers' beliefs and practice of ICT integration in teaching. Meanwhile, many of the previous studies employed mixed methods (e.g. Almarri *et al*., 2020; Gunzo, 2020; Jatileni & Jatileni, 2018; Merillo, 2021; Tshewang, 2019; Waiganjo, 2021) and a few used quantitative methods (e.g. Mangare *et al.*, 2022; Qaddumi et al., 2023). Thus, there was a limited use of the concurrent nested design in the previous studies, which calls for a study that collects qualitative and quantitative information. So, the current study employed a concurrent nested mixed design to bridge the methodological gap observed in the previous studies and to contribute insights to the broader field of ICT in education.

Theoretical Framework

This study is underpinned by the Technological Acceptance Model (TAM) put forth by Davis (1989). The main variable in this model is Actual System Use (ASU). According to Davis (1989), actual system use is an individual's observable usage of a particular system, for example, technology, which is a direct function of behavioural intention to use technology (BIUT). BIUT is the degree to which a person has formulated a conscious plan to perform some specific future behaviour, which is a function of attitude toward actual use (ATU) and perceived usefulness

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(PU). This model is suitable for this study because it shows how perceptions can influence the adoption of new technology which can enhance the intention to use technology as it supplies general information about ease of use (Shan & King, 2015). For instance, it predicts the intention of science teachers to use technology and explains how well individuals can adopt the technologies (Wu & Du, 2012). The model is very simple to use in investigating the science teachers' perceptions and practice of ICT in teaching which is influenced by perceived ease of use and perceived usefulness that can influence the behavioural intention to use the technology in teaching science subjects.

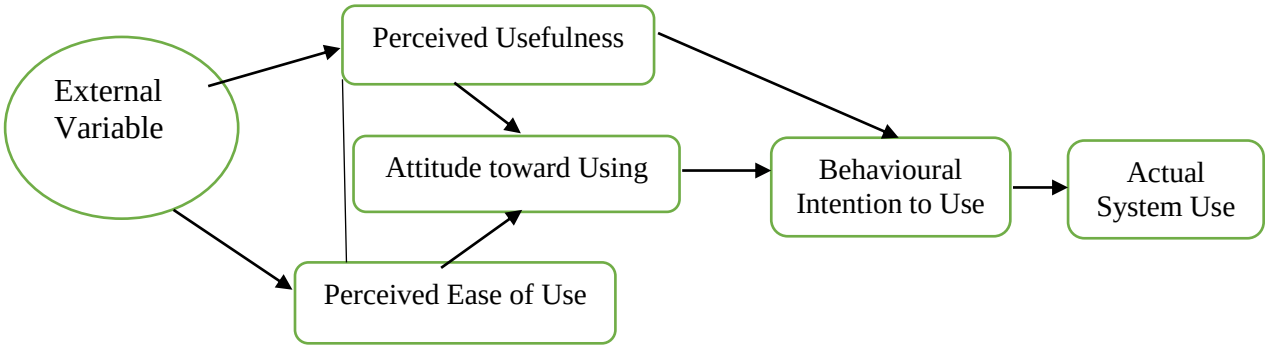

Figure 1: The Technological Acceptance Model (Davis et al., 1989, p.985)

Methodology

This study used a mixed-methods approach, which involves collecting both quantitative and qualitative data, integrating the two forms of data and then explaining them based on philosophical assumptions and the theoretical framework (Creswell & Creswell, 2018). The approach helped the researcher to gain a deeper understanding of the phenomenon under study. It gave the participants a chance to have a strong voice and share their experiences related to ICT integration throughout the research, which made it easy for the researcher to capture their perception and practice of ICT integration in teaching. It offered the researcher multiple ways to look for evidence and get detailed answers to the research questions of the study (Wisdom & Creswell, 2013). Moreover, the approach offered the researcher methodological flexibility, enabling her to understand smaller cases in detail (Maxwell, 2016) and arrive at more rigorous conclusions. By employing mixed methods, the researcher could capitalize on the strength of the qualitative method to offset the weaknesses of the quantitative method and vice versa (Plano & Ivankova, 2018).

The study employed a concurrent nested design, combining qualitative and quantitative data collection and analysis methods concurrently. The study mainly concentrated on quantitative objectives, such as examining science teachers' beliefs of ICT integration in teaching science subjects. Qualitative data on the teachers' actual classroom practices of ICT integration was embedded within the quantitative data. The study was conducted in the town district of Zanzibar, which was selected because it has ICT-equipped public secondary schools with sufficient ICT infrastructure for educational purposes, particularly teaching and learning. The study site was chosen to prevent external issues like resource limitations from affecting the study's investigation of science teachers' beliefs and practice of ICT integration.

Through the use of purposive sampling, 5 ICT-equipped secondary schools with sufficient ICT resources were selected. Then, 60 science teachers were selected from these schools by using the convenience sampling technique. The population of this study was 1372 science teachers from public secondary schools of Zanzibar. This target population was comprised of science teachers who specialized in teaching students in science subjects in ICT-equipped public secondary schools. This population reflects the view that if the population being studied is homogeneous, a small sample size is enough for the study (Koul *et al.*, 2016). Usually, a greater number of samples is required when there is a higher degree of variation in the population units. The more homogenous the population, the smaller the sample size can be (Johnson & Christensen, 2014). Thus, the sample size of the present study was 60 science teachers drawn from 5 ICT-equipped public secondary schools in the Town District of Zanzibar.
Some data were obtained by using a survey questionnaire that was constructed by the researcher, which contained closed-ended questions. The questionnaire used a Likert scale with 5 levels including 1=strongly disagree, 2=Disagree, 3=Neutral, 4=Agree and 5=strongly agree to measure teachers' beliefs on the role of ICT integration in teaching and learning. It was administered through face-to-face semi-structured interviews. The semi-structured interview was also used to obtain information from 20 science teachers. At each school 4 science teachers were interviewed including teachers of Biology, Chemistry, Physics and Geography. Convenience sampling was used to select 4 teachers who were available during the data collection for interview. From the 4 teachers selected for interviews, one teacher who was willing for classroom observation was used to obtain data that was obtained using a checklist. Another method was classroom observation, which was used to gather information on the actual practice of science during their classroom teaching. The quantitative data were analysed using the descriptive analysis technique with the help of IBM SPSS version 22 while the qualitative data were analysed thematically by using MAXQDA software 2020 version to identify teachers' ICT integration practices, beliefs and perceptions of using ICT tools in teaching and learning.

Findings and Discussions

Science Teachers' Beliefs on the Role of ICT Integration in Teaching and Learning Science Subjects

The findings showed that science teachers had a belief that ICT integration fosters students' academic performance. They believed that ICT integration had improved students' outcomes in science subjects. Correspondingly, they had a belief that students' understanding is greater if ICT is integrated into teaching as compared to when traditional methods of teaching are used. This means that when CT is integrated into teaching activities, it influences and boosts the understanding of the students as it makes the teaching/learning process more interesting. These findings align with the findings of Mbugua et al. (2015) which indicated a positive impact of ICT integration on students' academic performance. This means that ICT integration has a crucial role in enhancing students' academic performance.

In addition, the findings also revealed that science teachers had a belief that ICT integration enhances collaboration and interaction among science students. According to the findings, when ICT is integrated in lessons effectively, it activates students' engagement in interactive learning, collaboration, and discussion. In line with this, the findings of Kulshreshtha et al. (2023) indicated that ICT integration increases students' engagement through interactive learning

experiences, immediate feedback, and individualized content distribution. The findings also align with the findings of Kadwa and Alshenqeeti (2023) which reported that teachers believe that the incorporation of ICT plays a crucial role in enabling collaborative learning during classroom teaching.

Further, the findings indicated that science teachers had a belief that ICT integration helps to address the diversity of students' learning styles. This means that integrating ICT in teaching and learning helps to meet the needs of students who have diverse learning styles. Videos, audio, simulations, animations, and other technological instructional materials/applications enable teachers to meet the learning needs of many learners in the classroom. Thus, with ICT, teachers can meet the diverse needs of students who are distinguished by a variety of sociocultural circumstances, such as the presence of multiple intelligences (Ottestad *et al.*, 2008). The use of a variety of technologies in the classrooms, such as a virtual classroom, promotes active student engagement with the stated learning objectives. Additionally, technology use opens the way for differentiated learning, which accommodates the specific requirements of each student as an individual learner within the context of the classroom as a whole. Findings in general revealed positive beliefs among science teachers on the role of ICT integration in teaching and learning. However, the semi-structured interviews showed mixed beliefs about the matter as Table 1 shows.

Table 1: Science Teachers' beliefs on the role of ICT integration in teaching

ITEM N=60	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**	**Mean**	**S. D**
ICT integration has improved student outcomes in science subjects.	0	0	3(5%)	25(41.7%)	31(51.7%)	4.47	.598
ICT integration influences students' active engagement.	0	0	1(1.7%)	26(43.3%)	32(53.3%)	4.54	.539
ICT integration encourages cooperative learning.	0	1(1.7%)	2(3.3%)	27(45%)	30(50%)	4.43	.647
ICT integration fostering students' academic performance	2(3.3%)	0	2(3.3%)	26(43.3%)	30(50%)	4.37	.843
ICT integration enhances collaboration and interaction among science students	0	0	1(1.7%)	23(38.8%)	35(58.3%)	4.58	.532
ICT integration helps to address diverse learning styles in science teaching.	0	0	3(5%)	26(43.3%)	31(51.7%)	4.47	.596
Overall	0.3(0.5%)	0.1(0.2%)	2(3.3%)	26(43.3%)	32(53.3%)	4.47	.626

Table 1 shows that 96.6% of the participants agreed that ICT integration is effective in improving students' learning, active engagement, and cooperative learning. Also, they agreed that it helps to enhance interaction and meet the needs of learners who have diverse learning styles. However, the qualitative findings obtained through semi-structured interviews with the science teachers showed that the teachers had mixed beliefs concerning the role of ICT in

teaching. A total of 16 science teachers said that ICT helps to visualize abstract ideas and make them understand and retain the information. Others were opposed to this belief, arguing that ICT integration hinders students' understanding, makes students passive during lessons, and consumes much time. This mixture of science teachers' beliefs on the role of ICT integration was reflected in their comments on their experiences and methods of instruction that they employ in teaching. For example, one participant said:

> ICT integration can show things that even with normal eyes are not visible but by using these ICT devices can see them easily, and when students see, they understand more than when they study in theory, (Physics Teacher; School C; 15 February, 2024).

This indicated that science teachers had a belief that integrating ICT in teaching helps students understand complex concepts through visual representations of invisible situations, using technology tools like microscopes and computer simulations. Another participant said:

> ICT integration enables students to understand because we teach subjects in the classroom theoretically but what we teach is in real life. So, when you show them videos or pictures, they bring the thinking back to reality and they understand more than a concept and even if you ask them later what they understand they can remember easily, (Biology Teacher; School A; 14 February 2024).

The participants had a belief that integrating ICT in teaching connects theoretical knowledge with practical applications by offering visual and interactive presentations of abstract concepts. According to this belief, ICT helps students understand and retain information as it makes lessons more concrete and accessible. This is in alignment with previous studies which revealed that ICT integration in teaching has a positive influence on students' academic performance(Makueni, 2018; Mbugua *et al.,* 2015). This implies that many teachers around the World understand and believe that ICT integration helps students to understand concepts easily in the classroom when the teacher is teaching. In turn, students' enhanced understanding in the classroom leads to improvement of academic performance. A total of 20 science teachers had a belief that ICT integration has benefits in teaching and learning, but 4 expressed concerns about its potential negative effects, such as causing passive engagement and hindering the learning of science concepts. For example, one participant said;

> ICT integration hinders the students' understanding and they become very passive watching videos or animations rather than actively engaging in the teaching/learning process and generating knowledge. For example, I teach chemistry which requires the student to practice more by themselves, (Chemistry Teacher; School E; 14 February 2024).

This quote reflects teachers' belief that ICT integration makes students passive by diverting their focus on visual aids such as videos or animations, thus hindering their ability to engage with the topic and apply theoretical knowledge, especially in a subject like Chemistry. Science teachers believe this way because Chemistry and other subjects like Physics, and Biology need students to do practical activities, for example, chemical reactions, electrolysis, titration, and other practical experiments which make them discover knowledge through reasoning and problem-solving. This situation differs from the findings that 16 science teachers had the belief that ICT integration influences students' understanding. This also contradicts the findings by Mbugua *et al.,* (2015) which indicated that ICT integration influences students' academic performance.

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Two science teachers had negative beliefs about ICT integration in teaching students with learning difficulties. They argued that technology does not adequately meet the needs of such students. For example, the participant said:

> ICT integration wastes time because it requires you to have enough time to teach. After all, the teaching time is very limited and if you look at the nature of our students. Many students enter the school with an average of F, so you find their understanding is poor; even if you use the ICT tools they still can't understand. But for those students who have high understanding, ICT integration helps a lot. (Biology Teacher; School B; 14 February, 2024).

These science teachers meant that ICT integration is unsuitable or ineffective for students with learning difficulties though it has plenty of benefits for bright students. This finding is incongruent with the finding that ICT integration is helpful for learners with learning difficulties in different unique ways (Wettasinghe & Hasan, 2007). For example, Wettasinghe and Hasan (2007) indicated that ICT integration allows for the syllabus to be linked with real-life issues. Students can participate in the virtual worlds of real life, which promotes guided and reflective inquiry.

Science Teachers' Actual Practice of ICT Integration During Classroom Teaching

The researcher observed the actual implementation of ICT integration during classroom teaching of science teachers. Different aspects were observed, including how the science teachers integrated ICT during their classroom teaching, the skills and knowledge of how to integrate ICT in teaching and learning, and their self-confidence in implementing ICT integration in their teaching sessions.

Science Teachers' Skills and Knowledge of ICT Integration in Teaching and Learning

The science teachers who were observed while teaching in the classroom were found to have insufficient skills and knowledge on how to connect projectors and laptops ready for use. Some of them sought help from other teachers. One of them admitted this during an interview by saying,

> When I want to use it, I have to seek assistance from another teacher to help me with the projector and put everything in order so that I can use it. (Chemistry Teacher; School D; 15 December 2023).

This is an indication that they lacked the knowledge and skills to integrate ICT into their classroom teaching. It implies science teachers are ready to integrate ICT in teaching but they fail to do so daily because of their lack of skills and knowledge. This was affirmed by one participant who said:

> Now I see that if I had experience, ICT would be easy for me too, then I'm also afraid and I don't trust myself to use it. I'm afraid I might damage these devices for nothing. (Biology Teacher; School E; 11 December, 2023).

Teachers' lack of skills and knowledge to operate or use ICT tools points to the possibility that the training that was offered to these teachers was not effective and helpful. It is also possible that the training did not involve practice and excessive tasks for teachers to improve their abilities and skills or maybe it was offered in a very short time that was not enough for every teacher to acquire what they were supposed to acquire. This means that their training was not effective in offering them useful skills and knowledge. Similar findings have been reported by

Zungu (2022) who revealed a weakness in teachers' ability to effectively integrate ICT into their instructional methods. Also, the findings corroborate with Aldhafeeri *et al.*, (2016) whose findings showed that teachers were facing difficulty in attaining competence in technological integration, and developing the ability to effectively integrate technology into their teaching sessions. The findings also support Mulhim (2020) who found a gap between the competence of teachers in integrating ICT and their actual integration into their teaching practices in the classroom. The findings imply that teachers may have a positive perception of ICT integration and the intention to use it but may fail to integrate it due to the lack of effective training to improve their ability and skills of ICT integration in teaching. Thus the effectiveness of integrating ICT in the teaching process may be low, something which may reduce their self-confidence in their ability to integrate ICT in teaching sessions.

Science Teachers' Self-Confidence

The science teachers who were studied exhibited low self-confidence, especially in applying ICT tools like computers and projectors during their teaching sessions. They were not comfortable to use ICT tools in teaching. This was also admitted by one participant who commented

> I only use it once in a while because I still don't have much experience with it and I'm still not good at using it. (Biology Teacher; School D; 15 December 2023).

This teacher explained that her limited use of ICT integration was due to insufficient experience and skills. This means that the science teachers were willing to implement ICT integration in teaching but their competence to do so was poor or insufficient. Insufficient competence makes them uncomfortable to use ICT tools in their teaching sessions.

The findings imply that even if science teachers have positive beliefs about ICT integration, their level of technology use will be low if they do not have enough of the requisite skills and knowledge, and hence not confident in integrating ICT in teaching. This aligns with Waiganjo's (2021) study, which found that most teachers had positive beliefs about the usefulness of ICT in teaching and learning but they were put back by a lack of skills and insufficiency of ICT tools in their schools. However, while Waiganjo (2021) found the lack of ICT to be another main factor behind the ineffective integration of ICT in teaching, this was not the case in the present study since it was conducted in ICT-equipped schools in Zanzibar. Thus, the findings of the present study clash with those of Waiganjo (2021) in this case. In the schools where the present study was conducted, the teaching/learning environment was supportive, and the science teachers had a positive perception of ICT use. Yet, their level of ICT integration was low, not because of insufficient resources, but because of their lack of confidence, skills, and knowledge to integrate ICT into their teaching practices.

Conclusions

This study provides useful knowledge about the way science teachers perceive and practice ICT integration in teaching and learning. The findings have indicated that science teachers have a positive perception of the implementation of ICT tools in teaching and learning. The findings imply that science teachers are aware of the significance of ICT integration in improving education but they face some challenges that prevent them from effectively using ICT in

teaching. The most impeding challenge is the lack of confidence, skills, and knowledge on how to integrate ICT into their instructional practices. This challenge has something to do with the lack of proper or comprehensive training on ICT integration. To get rid of the challenges, science teachers have to be offered comprehensive training to equip them with sufficient skills and knowledge on how to integrate ICT in teaching and learning. This will increase their confidence, lead to positive outcomes for students, and help teachers to achieve curriculum objectives easily. The curriculum states different objectives that are to be achieved by the end of every level of education where the main implementers of the curriculum are teachers while students are the beneficiaries. So, for teachers to achieve every objective that the curriculum states, they must receive support from the Government and other educational stakeholders, including training in ICT integration. Training will help them acquire skills and knowledge on how to integrate ICT in teaching and simplify the implementation of the curriculum.

Recommendations

The Government of Zanzibar through the Ministry of Education and Vocational Training of Zanzibar, Zanzibar Institution of Education (ZIE), and other Educational Stakeholders should plan and run continuous professional development (CPD) programs for science teachers to improve their competence in integrating ICT. This situation can enhance hands-on activities in science teaching and learning and improve their instructional practices. The CPD programs should go beyond the provision of fundamental instructions and emphasize practical, hands-on instruction in the integration of ICT and should develop teachers' skills in incorporating pedagogical approaches with ICT. The programs should also focus on techniques and procedures that minimize the preparation time and maximize instructional effectiveness to overcome the time constraint. These programs should also assist teachers in incorporating ICT efficiently when teaching students with learning difficulties. This would help to address the learning needs of these students to promote inclusion in education.

In addition, the Ministry of Education and Vocational Training of Zanzibar should establish genuine systems for continuous evaluation and feedback on ICT integration in the teaching among science teachers. This could involve regular evaluation, in-class monitoring, and constructive discussions to pinpoint areas of enhancement and offer necessary assistance.

Moreover, the heads of schools should develop consistent feedback systems to enable teachers to evaluate their ICT integration practices. The combination of constructive feedback and opportunities for professional development will improve teachers' abilities and make them gradually gain confidence. As well, there is a need to promote peer mentoring and collaboration among science teachers to facilitate sharing of experiences regarding effective methods and approaches to ICT integration in teaching. This would provide a conducive atmosphere for teachers to engage in mutual learning and develop their confidence in integrating ICT. Further, science teachers themselves should be ready to try and implement ICT integration in their day-to-day teaching. This will enable them to gain self-confidence and experience in using ICT integration in their classrooms.

As the present study is confined to the science teachers' beliefs and practices, studies are needed to investigate the effective strategies to address the challenges faced by science teachers to integrate ICT in teaching and learning. Likewise, studies needed to use a large sample to investigate the self-efficacy of science teachers in ICT is of great importance in the context.

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