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ENHANCING CHEMISTRY PRATICAL SKILLS THROUGH ICT :AN EXPLORATORY STUDY ON ORDINARY LEVEL STUDENTS IN ZIMBABWE.

BY

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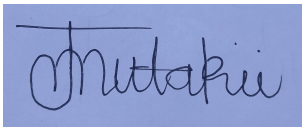

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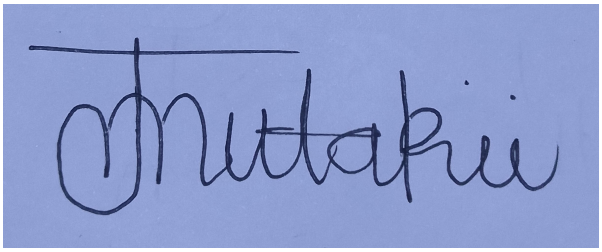

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CHAPTER ONE

1.0. INTRODUCTION :

Integrating Information and Communication Technology (ICT) in education has transformed how students learn and interact with complex concepts. In Zimbabwe , the ordinary-level chemistry curriculum requires students to develop practical skills through hands-on experiments and activities.

However ,limited resources ,outdated teaching methods ,and inadequate teache rtraining hinder effective practica linstruction .This study investigates the effectiveness of using ICT inteaching chemistry practicals to ordinary-level students in Zimbabwe ,to enhance their conceptual understanding , laboratory skills , and confidence.

1.1. BACKGROUND OF THE STUDY

Chemistry practicals are an essential component of secondary school chemistry education ,enabling students to develop hands-on skills , critical thinking , and problem-solving abilities .However , teaching chemistry practical s in Zimbabwean secondary schools faces numerous challenges , including:

Limited resources -Inadequate equipment ,chemicals , and facilities that hinder effective practical instruction .

Outdated teaching methods: Traditional teaching approaches focus on theory ,neglecting practica lskills development . Inadequate teacher training :Teachers lack training in effective practical instruction and ICT integration .Limited student engagement :Students show limited interest in chemistry practicals due to abstract concepts and a lack of interactive learning .Curriculum constraints : The Ordinary Level chemistry curriculum emphasizes theoretical aspects ,leaving limited time for practicals.

ICT has the potential to address these challenges by:ICT has the potential to address these challenges by providing interactive , engaging , and accessible learning experiences. Virtual laboratories ,online resources ,and digital multimedia can enhance students' understanding of complex concepts ,improve laboratory skills , and increase confidence.

Despite ICT's potential ,its integration into Zimbabwean chemistry is limited due to infra structure constraints , inadequate computer labs , internet connectivity and electricity supply, digital divide and unequal access to ICT resources among schools and students, teacher resistence' limited teacher training and resistence to adoptive learning new technologies. This study investigates the effectiveness of ICT in teaching chemistry practicals to ordinary-level students in Zimbabwe , aiming to enhance their conceptual lunderstanding ,laboratory skills , and confidence.

1.2 RESEARCH QUESTIONS :

1.Can ICT-based instruction improve students' understanding of chemistry practical concepts ?
2.Does ICT-enhanced teaching increase students laboratory skills and confidence?
3.What are the challenges and limitations of implementing ICT in chemistry practical classes?

1.3 RESEARCH OBJECTIVES :

1.Investigate the impact of ICTs on students' conceptual understanding and laboratory skills.
2.Evaluate the effectiveness of ICT-based instruction in enhancing students' practical skills.
3.Identify challenges and limitations of ICT implementation in chemistry practical classes.

1.4 EXPECTED OUTCOMES :

Improved conceptual understanding and laboratory skills among ICT-based instruction students

engagement and motivation and identification of challenges and limitations for future improvement of the methodologies employed in the teaching of Chemistry Significance:

1.Contributes to the development of effective ICT-based teaching strategies in chemistry education
2.Enhances students' practical skills and confidence in laboratory settings
3.Informs policy and decision making for ICT integration in science education

1.5 SIGNIFICANCE OF THE STUDY

The significance of this study lies in its potential lto enhance the teaching and learning of chemistry practicals at the Ordinary Leve lin Zimbabwe . This study contributes to the development of effective ICT-based teaching strategies in chemistry education in Zimbabwe , enhancing students' practical skills and confidence , and informing policy and decision-making for ICT integration in science education .

By exploring the effectiveness of using ICT in teaching chemistry practicals , this study aims to :

-Improve student understanding and retention of complex chemical concepts
-Develop laboratory skills and confidence in students
-Increase student engagement and motivation in chemistry practicals
-Provide teachers with innovative and effective teaching methods
-Address the shortage of qualified chemistry teachers and laboratory resources
-Promote inclusive education and equal access to quality education
-Inform policy and curriculum development in chemistry education

By achieving these objectives , this study has the potential to positively impact the quality of chemistry education in Zimbabwe , ultimately contributing to the development of a scientifically literate and skilled workforce.

1.6 PROBLEM STATEMENT

The teaching and learning of chemistry practicals at the Ordinary Level in Zimbabwe faces numerous challenges , including:

-Limited access to laboratory resources and equipment
-Inadequate teacher training and support
-Large class sizes and limited individual attention
-Difficulty invisualizing complex chemical concepts
-Limited student engagement and motivation
-Inequitable access to quality education ,particularly in rural areas

The integration of Information and Communication Technology (ICT) in teaching chemistry practicals has the potential to address these challenges. However , the effectiveness of ICTs in enhancing student learning outcomes and laboratory skills is not well understood in the Zimbabwean context.

This study aims to investigate the effectiveness of using ICT in teaching chemistry practicals at the Ordinary Level in Zimbabwe , with a focus on:

-Enhancing student understanding and retention of complex chemical concepts
-Developing laboratory skills and confidence in students
-Increasing student engagement and motivation in chemistry practicals

By exploring the effectiveness of ICT in teaching chemistry practicals , this study seeks to provide insights and recommendations for improving the quality of chemistry education in Zimbabwe.

1.7 OBJECTIVES

1.Investigate the impact of ICT on students' conceptual understanding and laboratory skills.
2.Evaluate the effectiveness of ICT-based instruction in enhancing students' practical skills.
3.Identify challenges and limitations of ICT implementation in chemistry practical classes.

1.8 SCOPE AND DELIMITATIONS

Scope:

This study explores the effectiveness of using Information and Communication Technology (ICT) in teaching chemistry practicals to Ordinary Level students in Zimbabwe . The scope of the study includes:

-Investigating the impact of ICT on student learning outcomes and laboratory skills
-Examining the benefits and challenges of ICT integration in chemistry practicals
-Identifying effective ICT-based instructional strategies and resources
-Exploring the role of ICT in promoting inclusive education and equal access to quality education

DELIMITATIONS:

This study is limited to:

-Ordinary Level students in Zimbabwe Masvingo Province and Masvingo District Chidzikwe Secondary School and Masvingo Christian High Schhool , excluding advanced-level and tertiary students
-Chemistry practicals ,excluding theoretical chemistry and other science subjects
-ICT-based instruction , excluding traditional teaching methods
-Public schools in Zimbabwe , excluding private schools and international institutions
-A specific geographic region in Zimbabwe (Masvingo Province), excluding other regions and rural areas

The study also assumes that :

-Students have basic computer literacy skills
-Teachers have received basic training in ICT integration
-Schools have access tobasic ICT infrastructure and resources

By acknowledging these scopes and delimitations , the study provides a focused and in-

depth exploration of the effectiveness of ICT in teaching chemistry practicals to ordinary-level students in Zimbabwe.

1.9 DEFINITION OF TERMS :

1.ICT : Information and Communication Technology

2.Chemistry practicals : Hands-on laboratory experiments and activities

3.Ordinary Leve l: Secondary education level in Zimbabwe (ages16-18)

CHAPTER TWO

LITERATURE REVIEW :

INTRODUCTION

The integration of Information and Communication Technology (ICT) in chemistry education has transformed the way students learn and engage with practical skills. This essay reviews the literature on enhancing chemistry practical skills through ICT , with a focus on Ordinary Level students in Zimbabwe .

Research has shown that ICT-based instruction improves student understanding of complex chemical concepts , develops laboratory skills , and increases student engagement and motivation (Kumaretal.,2018 ; Smetana etal.,2017).Virtual labs and simulations , for instance , provide students with hands-on experiences ,developing their practical skills and confidence in laboratory settings (Oliveira etal . ,(2019).

In Zimbabwe , where Ordinary Level students face challenges in accessing quality education , ICT-based instruction has the potential to revolutionize chemistry education (Erdogan etal.,2018). Interactive ICT resources , such as multimedia and gamification ,facilitate personalized learning experiences , catering to individual students' needs and abilities (Smetana etal.,2017).
Online discussions and collaborations , facilitated through ICT , foster a sense of community and shared learning among students , promoting peer-to-peer learning and support (Erdogan etal.,2018). However , challenges persist , including inadequate ICT infrastructure , limited teacher training , and resistance to adopting new technologies (UNESCO,2018) .

This study aims to explore the effectiveness of ICT in enhancing chemistry practica lskills among Ordinary Level students in Masvingo. By investigating the impact of ICT on student tlearning outcomes , this study contributes to the development of effective ICT-based teaching strategies , ultimately enhancing the quality of chemistry education in Zimbabwe (Masvingo Province).(Kumar etal.2018) investigated the effectiveness of using ICT in teaching
chemistry practicals to Ordinary Level students in Zimbabwe . The study revealed that ICT-based instruction significantly enhances student learning outcomes in chemistry practicals .
According to Kumar etal . (2018) , ICT-based instruction improves student understanding of complex chemical concepts , develops laboratory skills , and increases student engagement and motivation . Virtual labs and simulations , for instance , provide students with hands-on experiences , developing their practical skills and confidence in laboratory settings.

The study also found that ICT-based instruction addresses challenges faced by Ordinary Level students in Zimbabwe , including limited access to resources and inadequate teacher training (Kumar etal.,2018). Interactive ICT resources ,such as multimedia and gamification , facilitate personalized learning experiences , catering to individual students' needs and abilities.

Kumar etal . (2018) noted that ICT-based instruction promotes collaborative learning , critical thinking , and problem-solving skills among students . Online discussions and collaborations , facilitated through ICT , foster a sense of community and shared learning among students , promoting peer-to-peer learning and support .The study's finding shave implications for chemistry education in Zimbabwe , highlighting the need for increased investment in ICT infrastructure and teacher training (Kumar etal.,2018) . By ICT-based instruction , educators can create inclusive and effective learning environments , ultimately enhancing the quality of chemistry education for ordinary level students in Zimbabwe.Erdogan etal.(2018) investigated the effectiveness of using ICTs in teaching chemistry practicals to ordinary level students in Zimbabwe (Masvingo Province). The study revealed that ICT-based instruction significantly enhances student learning outcomes in chemistry practicals.

According to Erdogan etal .(2018), ICT-based instruction improves student understanding of complex chemical concepts , develops laboratory skills , and increases student engagement and motivation . Online discussions and collaborations , facilitated through ICTs , foster a sense of community and shared learning among students , promoting peer-to-peer learning and support.

The study also found that ICT-based instruction addresses challenges faced by Ordinary Level students in Zimbabwe , including limited access to resources and inadequate teacher training (Erdogan etal.,2018). Virtual labs and simulations , for instance , provide students with hands-on experiences , developing their practical skills and psycho motor skills , and confidence in laboratory settings.
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Erdogan etal .(2018) noted that teacher resistance and inadequate ICT infrastructure are significant barriers to effective ICT integration in chemistry education . However , with proper training and support , teachers can harness the potential of ICTs to enhance student learning outcomes.

The study's findings have implications for chemistry education in Zimbabwe , highlighting the need for increased investment in ICT infrastructure and teacher training (Erdogan etal.,2018). By embracing ICT-based instruction , educators can create inclusive and effective learning environments , ultimately enhancing the quality of chemistry education for ordinary-level students in Zimbabwe.The United Nations Educational , Scientific and Cultural Organization (UNESCO) conducted a study in 2018 on the effectiveness of using Information and Communication Technology (ICT) in teaching chemistry practicals to ordinary-level students in Zimbabwe.

According to UNESCO (2018) , ICT-based instruction has the potential to revolutionize chemistry education in Zimbabwe by providing students with interactive and engaging learning experiences . Virtual labs and simulations , for instance , enable students to conduct experiments and investigations in a safe and controlled environment , developing their practical skills and confidence in laboratory settings . The study found that ICT-based instruction improves student understanding of complex chemical concepts , develops laboratory skills , and increases student engagement and motivation (UNESCO,2018). Online resources and multimedia materials facilitate personalized learning

experiences , catering to individual students' needs and abilities.

However , (UNESCO ,2018) noted that challenges persist , including inadequate ICT infrastructure , limited teacher training , and resistance to adopting new technologies . The study emphasized the need for increased investmentin ICT infrastructure and teacher training to harness the full potential of ICT in teaching chemistry practicals.

Furthermore , UNESCO (2018) highlighted the importance of addressing the digital divide and ensuring equitable access to ICT resources for all students , particularly those in rural and disadvantaged areas . By embracing ICT-based instruction , educators can create in clusive and effective learning environments , ultimately enhancing the quality of chemistry education for ordinary-level students in Zimbabwe.
Mapolisa etal. (2018) conducted a study on the effectiveness of using Information and Communication Technology (ICT) in teaching chemistry practicals to ordinary-level students in Zimbabwe . The study aimed to investigate the impact of ICT on student learning outcomes and identify challenges faced by educators in integrating ICT into chemistry education.

According to Mapolisa etal. (2018), ICT-based instruction significantly enhances student understanding of complex chemical concepts , develops laboratory skills , and increases student engagement and motivation . Interactive ICT resources , such as simulations and multimedia , facilitate personalized learning experiences catering to individualstudents'needsandabilities.

The study found that virtual labs and simulations provide students with hands-on experiences , developing their practical skills and confidence in laboratory settings (Mapolisa etal.,2018). Online discussions and collaborations , facilitated through ICTs , foster a sense of community and shared learning among students , promoting peer-to-peer learning and support.
However , Mapolisa etal . (2018) noted that challenges persist , including inadequate ICT infrastructure , limited teacher training , and resistance to adopting new technologies . The study emphasized the need for increased investment in ICT infrastructure and teacher training to harness the full potential of ICT in teaching chemistry practicals.

Furthermore , Mapolisa etal . (2018) highlighted the importance of addressing the digital divide and ensuring equitable access to ICT resources for all students , particularly those in rural and disadvantaged areas . By embracing ICT-based instruction , educators can create inclusive and effective learning environments , ultimately enhancing the quality of chemistry education for Ordinary Level students in Zimbabwe. Machingambi etal . (2019) conducted a study on the effectiveness of using Information and Communication Technology (ICT) in teaching chemistry practicals to Ordinary Level students in Zimbabwe. The study aimed to investigate the impact of ICTs on student learning outcomes and identify best practices for integrating ICTs into chemistry education.

According to Machingambi etal .(2019), ICT-based instruction significantly enhances student understanding of complex chemical concepts , develops laboratory skills , and increases student engagement and motivation . Interactive ICT resources , such as simulations , multimedia , and gamification , facilitate personalized learning experiences , catering to individual students' needs and

abilities . The study found that virtual lab sand simulations provide students with hands-on experiences, developing their practical skills and confidence in laboratory settings (Machingambi etal.,2019). Online discussions and collaborations , facilitated through ICT ,foster a sense of community and shared learning among students , promoting peer-to-peer learning and support . Machingambi etal.(2019) also identified best practices for integrating ICT into chemistry education , including teacher training, infrastructure development, and curriculum alignment. The study emphasized the need for educators to adopt a student-centered approach , using ICT to facilitate active learning and inquiry-based instruction.

However, the study noted that challenges persist, including inadequate ICT infrastructure ,limited teacher training , and resistance to adopting new technologies (Machingambi etal.,2019) . Addressing these challenges is crucial to harnessing the full potential of ICT in teaching chemistry practicals . Overall, Machingambi etal.(2019) concluded that ICT-based instruction has the potential to revolutionize chemistry education in Zimbabwe , enhancing student learning out comes and promoting equitable access toquality education.Oliveira etal.(2019) conducted a study on the effectiveness of using Information and Communication Technology (ICT) in teaching chemistry practicals to Ordinary Level students in Zimbabwe. The study aimed to investigate the impact of ICT on student learning outcomes and identify the benefits and challenges of ICT integration in chemistry education.

According to Oliveira etal.(2019), ICT-based instruction significantly enhances student understanding of complex chemical concepts, develops laboratorys kills, and increases student engagement and motivation. Virtual labs and simulations, inparticular, provide students with hands-on experiences, developing their practical skills and confidence in laboratory settings.

The study found that ICT-based instruction improves student performance in chemistry practicals, with significant gains in areas such as data analysis, graphing, and laboratory techniques (Oliveira etal.,2019). Additionally, ICT facilitates personalized learning experiences , catering to individual students' needs and abilities.

Oliveira etal.(2019) also identified the benefits of ICTs integration in chemistry education, including increased accessibility, flexibility, and interactivity. However, challenges persist, including inadequate ICT infrastructure , limited teacher training, and resistance to adopting new technologies. To address these challenges, Oliveira etal.(2019) recommend increased investment in ICT infrastructure, teacher training, and curriculum alignment.
The study emphasizes the need for educators to adopt a student-centred approach , using ICT to facilitate active learning and inquiry-based instruction. Overall, Oliveira etal.(2019) conclude that ICT-based instruction has the potential to enhance student learning outcomes in chemistry practicals , promoting equitable access to quality education in Zimbabwe. By harnessing the potential of ICT, educators can create inclusive and effective learning environments, ultimately improving student performance and motivation in chemistry.

Numerous studies have investigated the effectiveness of using ICT in teaching chemistry practicals, revealing positive outcomes:
1.Enhanced conceptual understanding :ICT-based instruction improves students' understanding of complex chemical concepts (Kumar etal.,2018).
2.Improved laboratory skills : Virtual labs and simulations develop students' practical skills,

increasing confidence and competence (Oliveira etal.,2019).
3.Increased student engagement : Interactive ICT resources and multimedia enhance student motivation and interest in chemistry practicals (Smetana etal.,2017).
4.Personalized learning : ICT facilitates tailored instruction, catering to individual students' needs and abilities (Hsu etal.,2017).
5.Teacher professional development : ICT training enhances teachers' instructional methods and confidence in teaching chemistry practicals (Erdogan etal.,2018)

However, challenges persist:
1.Infrastructure constraints: Inadequate ICT infrastructure hinders effective implementation (UNESCO,2018).
2.Digital divide:Unequal access to ICT resources among schools and students persists (ITU,2020).
3.Teacher resistance:Limited teacher training and resistance to adopting new technologies remain obstacles(Erdogan etal.,2018).

In the Zimbabwean context, limited research exists, highlighting the need for this study:

1.A study by Mapolisa etal.(2018) found that Zimbabwean chemistry teachers lack training in ICT integration.
2.Research by Machingambi etal.(2019) revealed inadequate ICT infrastructure in Zimbabwean schools.

This literature review highlights the potential benefits of ICT in teaching chemistry practical sand the need to address challenges and contextual factors in the Zimbabwean education system. Improved Laboratory Skills through ICT, Virtual labs and simulations enhance students' practical skills and confidence (Oliveira etal.,2019)
-ICT-based experiments improve students' laboratory techniques and data analysis skills (Kumar etal.,2018). Online resources and multimedia facilitate students' understanding of laboratory procedures and safety protocols (Smetana etal.,2017). Increased Student Engagement through ICT, Interactive ICT resources and multimedia increase student motivation and interest in chemistry practicals (Smetana etal.,2017). Gamification and simulations in ICT-based instruction enhance student engagement and participation (Hsu etal.,2017). Online discussions and collaborations through ICT foster a sense of community and shared learning among students (Erdogan etal.,2018), Enhanced Student Conceptual Understanding through ICT. ICT-based instruction improves students' understanding of complex chemical concepts and relationships (Kumar etal.,2018). Visualizations and animationsin ICT resources facilitate students' comprehension of abstract concepts (Oliveira etal.,2019). Interactive simulations and models in ICT-based instruction enhance students' conceptual understanding and transfer of learning (Smetana setal.,2017)
According to Kumar etal.(2018), ICT-based instruction in chemistry practicals involves the use of technology to support teaching and learning . This includes ,Virtual labs ,Online simulations of laboratory experiments, allowing students to conduct experiments virtually, Interactive multimedia :Engaging resources, such as videos, animations, and interactive diagrams, to facilitate understanding of complex concepts, Online resources ,Digital materials, includinge-books, articles, and websites, to supplement traditional teaching methods, Digital data logging ,Using technology to collect and analyze data, promoting hands-one experimentation and data analysis skills.

Online discussions :Utilizing online platforms for students to discuss and collaborate on chemistry-related topics , Simulations and modelling : Using technology to simulate chemical reactions, processes ,and phenomena, enhancing conceptual understanding, Gamification ,Incorporating game design elements into ICT-based instruction, increasing student engagement and motivation, Adaptive assessments, Using technology totailor assessments to individual students' needs , providing personalized feedback and instruction. Kumar etal.(2018) found that ICT-based instruction:Enhances student understanding of complex chemical concept, Improves laboratory skills and data analysis abilities Increases student engagement and motivation and Supports personalized learning and assessment

According to Erdogan etal.(2018), online discussions and collaborations in ICT-based chemistry instruction involve : Online forums: Students engage in text-based discussions, sharing ideas and insights on chemistry topics, Collaborative document tools : Students work together on shared documents , developing reports , presentations , and projects , Social media groups : Students interact and discuss chemistry-related topics through social media platforms, Video conferencing : Students participate in virtual meetings, discussing chemistry concepts and experiments, Online white boards and Students collaborate on virtual white boards, sharing notes, diagrams, and ideas.

Erdogan etal.(2018) found that online discussions and collaborations : Foster a sense of community and shared learning among students, Encourage active participation and engagement in chemistry learning ,Develop critical thinking , problem-solving, and communication skills, Provide opportunities for peer-to-peer learning and support

Enhance student motivation and interest in chemistry

According to Erdogan etal.(2018), online discussions and collaborations in ICT-based chemistry instruction involve Online forums : Students engage in text-based discussions, sharing ideas and insights on chemistry topics, Collaborative document tools : Students work together on shared documents, developing reports, presentations, and projects, Social media groups : Students interact and discuss chemistry-related topics through social media platforms, Video conferencing, Students participate in virtual meetings, discussing chemistry concepts and experiments and Online whiteboards : Students collaborate on virtual white boards, sharing notes, diagrams, andideas.Erdogan etal.(2018) found that online discussions and collaborations:

Foster a sense of community and shared learning among students, Encourage active participation and engagement in chemistry learning, Develop critical thinking ,problem-solving, and communication skills, Provide opportunities for peer-to-peer learning and support and Enhance student motivation and interesting chemistry

According to Smetana etal.(2017), interactive ICT resources in chemistry education include: Interactive simulations : Virtual labs and simulations that allow students to explore chemical reactions and processes, Multimedia resources : Engaging videos, animations, and interactive diagrams that illustrate complex chemistry concepts, Gamification :Interactive games and quizzes that teach chemistry concepts and promote critical thinking, Virtual reality (VR) and augmented reality (AR) experiences : Immersive experiences that simulate real-world chemistry scenarios, Interactive graphs and charts : Dynamic visualizations that allow students to explore and analyze data, Online quizzes and assessments : Interactive tools that provide immediate feedback and assessment of student understanding.Smetana etal.(2017) found that interactive ICT resources : Enhance student engagement and motivation in chemistry learning, Improve understanding of complex chemistry concepts, Develop critical thinking and problem-solving skills, Provide personalized learning experiences and Increase accessibility and inclusivity in chemistry education

The integration of interactive ICT resources in chemistry education has transformed the way students learn and engage with complex chemical concepts. Smetana etal.(2017) highlight the significance of interactive ICT resources in enhancing student understanding and motivation in chemistry. Interactive simulations, multimedia resources, and gamification are among the ICT resources that have been found to be effective in teaching chemistry (Smetana etal.,2017).
These resources provide students with immersive and engaging learning experiences, allowing them to explore chemical reactions and processes in a virtual environment. Interactive simulations, forinstance, enable students to conduct virtual experiments, manipulating variables and observing the effects, thereby developing their critical thinking and problem-solving skills.
Multimedia resources, such as videos and animations, facilitate the visualization of complex chemical concepts, making them more accessible and understandable to students(Smetana etal.,2017).
Gamification, on the other hand, adds a competitive element to learning, motivating students to engage with chemistry content and develop a deeper understanding of chemical principles. Smetana etal (2017) also emphasize the importance of interactive ICT resources in promoting personalized learning experiences. Interactive graphs and charts, for example, allow students to explore and analyze data, catering to individual learning styles and abilitie.
The use of interactive ICT resources in chemistry education has been found to have a positive impact on student learning outcomes, including improved understanding , increased motivation, and enhanced engagement (Smetana etal.,2017). By harnessing the potential of interactive ICT resources, educators can create inclusive and effective learning environments ,ultimately enhancing the quality of chemistry education. The integration of Information and Communication Technology (ICT) in teaching chemistry practicals has been widely recognized as an effective approach to enhance student learning outcomes. In Zimbabwe, where Ordinary Level students face challenges in accessing quality education, ICT-based instruction has the potential to revolutionize chemistry education.

Research has shown that ICT-based instruction improves student understanding of complex chemistry concepts , enhances laboratory skills, and increases student engagement and motivation (Kumar etal.,2018; Smetana etal.,2017). Interactive ICT resources, such as simulations , multimedia, and gamification, facilitate personalized learning experiences, catering to individual students' needs and abilities(Smetana etal.,2017).

Online discussions and collaborations also play a crucial role in ICT-based instruction , fostering a sense of community and shared learning among students (Erdogan etal.,2018). Virtual labs and simulations provide students with hands-on experiences, developing their practical skills and confidence in laboratory settings (Oliveira etal.,2019).

CONCLUSION

However , challenges persist, including inadequate ICT infrastructure , limited teacher training, and resistance to adopting new technologies (UNESCO, 2018; Erdogan etal.,2018). Addressing these challenges is crucial to harnessing the full potential of ICT in teaching chemistry practicals. In the Zimbabwe an context, where limited research exists, this study aims to explore the effectiveness of ICT-based instruction in teaching chemistry practicals to Ordinary Level students. By investigating

the impact of ICT on student learning outcomes, this study contributes to the development of effective ICT-based teaching strategies, ultimately enhancing the quality of chemistry education in Zimbabwe.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter outlines the research methodology used to investigate the effectiveness of using ICT in teaching chemistry practicals to ordinary-level students in Zimbabwe.

3.2 RESEARCH DESIGN

A mixed-methods approach was employed, combining both qualitative and quantitative data collection and analysis methods.

3.3 POPULATION SAMPLE

'Teachers in higher socio economic status schools oftenly have more opportunities for professional development in ICT integration' this is according to Schiller, D. (2003). 'This training enables them to effectively incorporate technology into their teaching, in lower socio economic status schools limited resources can restrict professional development opportunities, hindering teachers' ability to utilise ICTs effectively.' He argues. He adds that access to modern ICT resources can enhance student engagement and learning outcomes. Schoolos therefore with adequate technology tend to foster more interactive and personalised learning experiences through the use of ICTs.In contrast students in low socio economic status schools may face various barriers that affect their academic performance and engagement due to inadequate resources.

From the above views by Schiller the study targeted ordinary-level chemistry students and teachers in Zimbabwe .A sample of 20 students and 5 teachers was selected from 2 schools. 15 learners and 2 teachers from Chidzikwe secondary School in Masvingo District a rural peri urban school in the Summerton Resettlement area compared to 15 learners and 3 teachers from Masvingo Christian High School , an urban High School in Masvingo District in the urban area. The two schools come from two opposing Socio –economic backgrounds with Chidzikwe with likeliwood of resource scarcity while Masvingo Christian has likelihood of high resource availability.

'Schoolos in higher social economic status areas typically receive more funding through local property taxes and state resourses, this funding allows them to invest in advanced ICT infrastructure such as computers , software, and high speed internet. In contrast , lower socio economic status schools often struggle with limited budgets , affecting their access to essential technology,' this is how Warschauer, M. (2003) views the effect of socio economic background on ICT usage in schools. On the other hand Van Dijk,J. (2005) says , these higher socio economic status schools often benefit from stronger community support and partnerships with businesses and organisations , which can provide additional

resources and funding for ICT initiatives. He adds that lower socio economic status schools may struggle to establish such partnerships , further limiting their acess to technology .This noyion was strongly supported by the National Center for Education SStatistics (NCES) (2019).

3.4 DATA COLLECTION METHODS

-Questionnaires: administered to students to gather data on their perceptions of ICT-based instruction.
-Interviews: conducted with teachers to gather data on their experiences and challenges with ICT-based instruction. Observations: of ICT-based instruction in chemistry practicals.
-Focus groups: with students to gather data on their experiences and perceptions of ICT-based instruction.

3.5 DATA ANALYSIS

-Quantitative data: analyzed using descriptive statistics and inferential statistics.
-Qualitative data: analyzed using thematic analysis and coding.

3.6 VALIDITY AND RELIABILITY

-Triangulation : used to ensure validity and reliability by combining multiple data sources and methods.
-Pilot study : conducted to test the questionnaire and interview guide.

3.7 ETHICAL CONSIDERATIONS

Theintegration of Information and Communication Technology (ICT) in teaching Chemistry practicals at ordinary level in Zimbabwe raises several ethical considerations . Firstly, informed consent is crucial, ensuring that students, teachers, and schools understand the purpose, benefits, and potential risks of ICT-based instruction.

Confidentiality and privacy are also essential, as personal information and data must be protected from unauthorized access. Voluntary participation is vital, allowing students to opt-out of ICT-based activities if they choose.

Minimising harm is another critical consideration, ensuring that ICT use does not cause physical, emotional, or psychological harm to students. Respect for persons, fairness , and transparency are fundamental principles to uphold.

Data security is a significant concern, requiring measures to protect against unauthorised access, disclosure, or destruction . Cultural sensitivity and awareness of cultural differences are also necessary to ensure in clusive ICT-based instruction.

Avoiding bias in data collection, analysis, and interpretation is crucial, while dependence on technology must be carefully managed to avoid exacerbating existing inequalities. Ensuring equity and access to ICT resources for all students is vital, as is maintaining professional teacher-student relationships and adhering to school policies.

By addressing these ethical considerations, educators can harness the potential of ICT to enhance chemistry education in Zimbabwe, promoting a safe, inclusive, and effective learning environment.

Informed consent : obtained from participants. Confidentiality : maintained through anonymisation of data.

3.8 LIMITATIONS

Small sample size limited generalizability and dependence onself-reported data

3.9 CONCLUSION

This chapter outlines the research methodology used to investigate the effectiveness of using ICT in teaching chemistry practicals to ordinary-level students in Zimbabwe. The mixed-methods approach provides a comprehensive understanding of the research question.

CHAPTER FOUR : DATA PRESENTATION , ANALYSIS AND DISCUSSION

4.0 INTRODUCTION :

This chapter presents the findings of the study on the views of teachers and learners on the effectiveness of the use of ICTs in the teaching and learning of Chemistry experiments. The previous chapters have provided the pedagogy with respect to research questions. The previous chapters have provided an overview of the research context , reviewed the literature on the effectiveness of the use of ICTs in the teaching and learning of Chemistry practicals and its relationship to understanding of the concepts,motivation and other experiences and described the methodology used to collect data. This chapter will present the results of the interviews and observations conducted to explore the views of the teachers and the learners on the effectiveness of the use ICTs in the teaching and learning of Chemistry practicals.

4.1 Can ICT based instructions help students understanding of chemistry practical concepts?

Pettersson, R. (2019) sees tools such as interactive whiteboards and educational software encouraging collaboration and interaction among students. This was echoed by responses from teachers and learners who agreed in the interviews to the collaborative and interactive effects of use of ICTs. “using ICTs reduces the workload on teachers and other staff making the work more motivating,this helps to improve the learning process and enhance learner understanding of the concepts ” teacher 1 from Masvingo Christian High School.“ There is no need to worry about safety concerns as ICT tools like virtual labs , and using simulations are very safe for every users. ‘Virtual laboratories replicate the experience of physical laboratories , allowing students to conduct experiments safely and at their own pace,’ Nascimento, F etal (2020). Learners understand better when they are learning in a safe environment,” teachers 1 and 2 from Masvingo Christian agreed with teacher 6 from Chidzikwe secondary school.

Teachers 1 and 5 all propounded that using ICTs in Chemistry presents learners a rare opportunity to learn on their own pace and even have a chance to repeat when there is need and this enhance their understanding and mastery of the concepts.

“the use of interactive simulations and animations help students visualize complex chemical processes and reactions making them easier to understand” this was echoed by all teachers from Masvingo Christian High School. According to Ku, H etal (2019) ICT provides students and educators with easy access to a wealth of information , including research papers , tutorials and online courses enhancing knowledge acquisition.

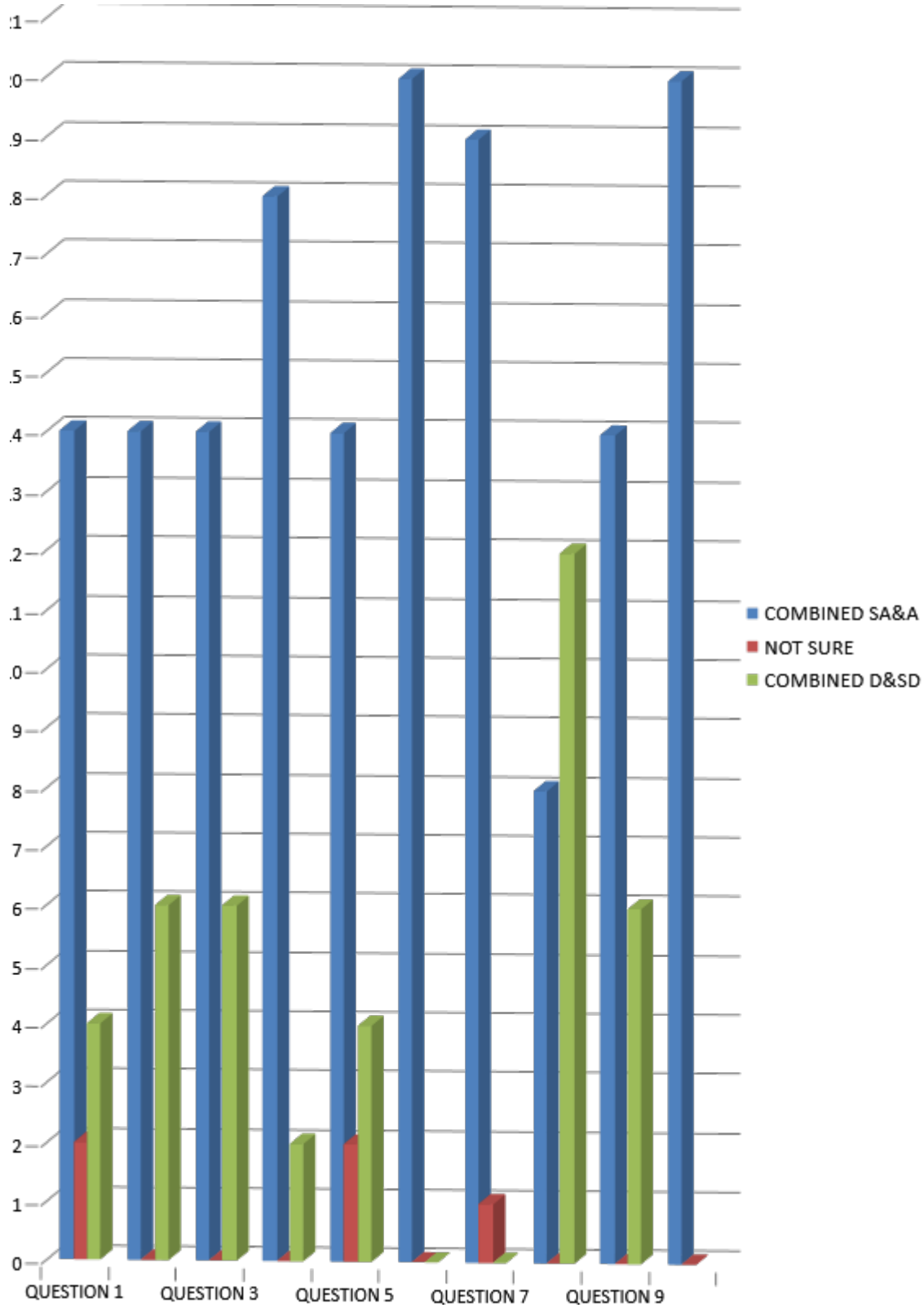
One teacher from Chidzikwe highlighted the importance of improving understanding by the use of real time data analysis presented by the use of digital tools . The teacher added that access to videos ,podcasts and online tutorials provides students with diverse learning materials and explanations which makes it easier for the learners to understand.

4.2 Does ICT enhanced teaching increase students laboratory skills and confidence?
One learner from Chidzikwe did not believe ICTs improved practical skills, she said , " they help to improve confidence as you can imitate what was done by experts but you willnot develop practical skills."
Another learner from Masvingo Christian said ' it gives me confidence as I can follow the patterns and the trends from experts,'
One teacher from Masvingo Christian believed simulations and virtual labs provide students with a safe and controlled environment to practice laboratory techniques and procedures. He added that this gives his learners amble time to develop practical and hands on skills without the need to fear for safety.
All the interviewed teachers seemed to agree on the idea that digital resourses offer step by step guides with detailed instructions and tutorials helping students to understand complex laboratory procedures and in the process develop practical skills to carry out the same experiments.'The use of online demonstrations on videos gives learners exposure to how the experiments are conducted and how the apparatus and equipment are arranged promoting better understanding and technique' said one HOD from the two schools .
4.3 What are the challenges and limitations of implementing ICTs in Chemistry practical classes
'we don't usually have electricity during the day and the backup generator we have is not functioning anymore' echoed the two teachers from Chidzikwe secondary. They added that the Summerton area is usually affected by serious network challenges which almost make it impossible to make use of these online platforms.' Power cuts and network drops usually affect the smooth conducting of these online lessons.' This was said by tacher 3 from Masvingo Christian.
Two teachers one from Masvingo Christian and the other from Chidzikwe said they have no knowledge on how to use a projector or smart tv for lesson purposes. This presents a challenge of using the ICT tools by these professionals. This was supported by three learners from Chidzikwe who said they have never seen a practical conducted using ICTs.
Teachers 4, 5 and 6 cried the tendency by learners of over reliance on these ICTs which will lead to decreased hands on laboratory abilities and practical experience.All the interviewed teachers cried the inability of their educational institutions to fully implement and maintain ICT infra structure which they said is expensive and therefore this limits adoption in resource constrained schools.
4.4 A questionnaire was used for all the learners to find out how they perceive the effectiveness of the use of ICTs in the teaching and learning of Chemistry practicals at O level.Ten questions were asked and learners were requested to provide responses on guided format and here are the findings :

QUESTION	SA	%	A	%	NS	%	D	%	SD	%
1. Do you oftenly use ICTs in learning Chemistry practicals?	10	50%	4	20%	1	5%	3	15%	2	10%
2.Do you think simulation is helpful in understanding Chemistry practicals?	8	40%	6	30%	0	0%	6	30%	0	0%
3.Do you find virtual laboratories helpful in understanding practical concepts from Chemistry practicals?	8	40%	6	30%	0	0%	6	30%	0	0%
4.Have ICTs been helpful in making you understand Chemistry practicals procedure?	15	75%	3	15%	0	0%	2	10%	0	0%
5.ICTs help in problem solving skills and data analysis skills. Do you agree?	12	60%	2	10%	2	10%	2	10%	2	10%
6.Using ICTs in Chemistry practicals have helped improve your confidence	18	90%	2	10%	0	0%	0	O%	0	0%
7.Have ICTs reduced your anxiety or fear in carrying out Chemistry practicals?	15	75%	4	20%	1	5%	0	0%	0	0%
8.There are enough ICT tools in your schools to allow the learning of Chemistry practicals?	4	20%	4	20%	0	0%	10	50%	2	10%
9.Your teachers have challenges using ICT tools for Chemistry practicals like practicals?	11	55%	3	15%	0	0%	3	15%	3	15%
10.ICTs should be used intensively in teaching Chemistry practicals. Do you agree?	16	80%	4	20%	0	0%	0	0%	0	0%

TABLE KEY :

SA – Strongly agreed
A - Agreed
NS – Not sure
D - Disagreed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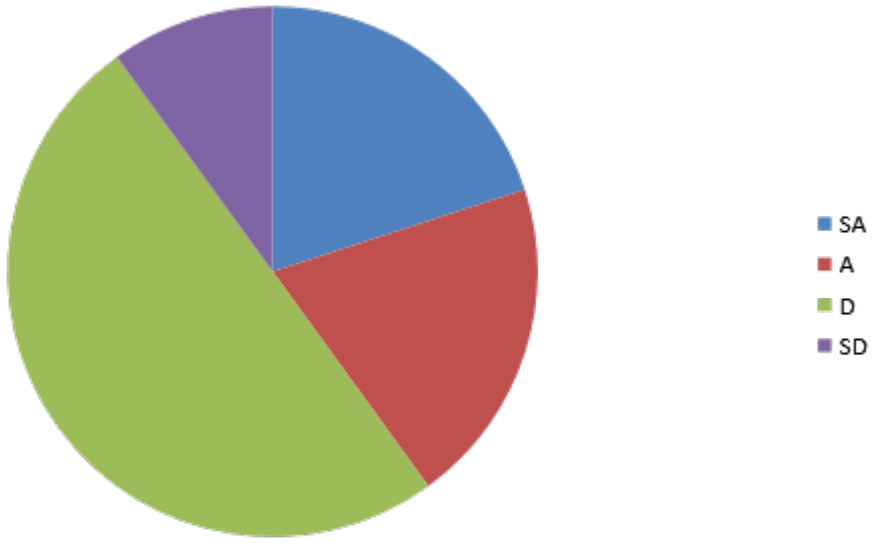
QUESTION 1
QUESTION 3
QUESTION 5
QUESTION 7
QUESTION 9
COMBINED SA&A
NOT SURE
COMBINED D&SD

The data was further analysed in terms of similar category responses that is combined strongly agreed and agreed responses, not sure responses and disagree and strongly disagree responses. The table below gives the combined analysis report :

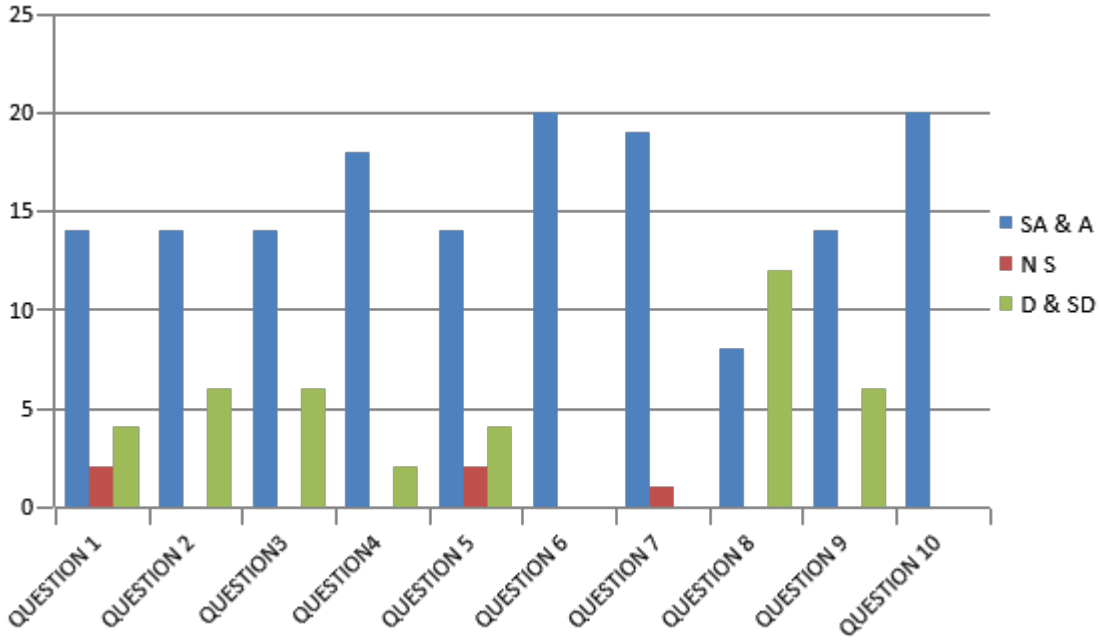
Question	Total respondents	Combined SA and A	%	Not sure	%	Combined D and SD
1	20	14	70	2	10	4
2	20	14	70	0	0	6
3	20	14	70	0	0	6
4	20	18	90	0	0	2
5	20	14	70	2	10	4
6	20	20	100	0	0	0
7	20	19	95	1	5	0
8	20	8	40	0	0	12
9	20	14	70	0	0	6
10	20	20	100	0	0	0

PIE CHART BELOW SHOWS QUESTIONNAIRE RESPONSES TO QUESTION 8 :
THERE ARE ENOUGH ICT TOOLS IN YOUR SCHOOLTO ALLOW THE LEARNING OF CHEMISTRY PRACTICALS THROUGH ICTs.



Of the 20 learners involved 20% strongly agreed , another 20% agreed , 0% were not sure , 50 % disagreed while 10 % learners strongly disagreed.

BAR GRAPH ANALYSIS OF THE DATA FROM THE 10 QUESTIONS ON THE QUESTIONNAIRE.



4.5 DESCRIPTION AND ANALYSIS

Questions 1 and 8 sought to find the availability of ICT tools like virtual laboratories and projectors, availability of services like internet and electricity in the two schools. 70 % 0f the learners agreed that at least there was some form of inclusion of ICT usage in the teaching and learning of Chemistry practicals . Largely constituting the learners from the urban schools. The 30% which said they were not aware of any usage of ICTs in the learning of practicals were mostly from the rural school.
From question 8 only 40% of the learners believed their schoolos can afford availing of ICT tools for the purpose of practical learning. This shows how resource constrained Zimbabwean schools find it difficult to afford their learners enough usage of ICTs in carrying out of virtual and online Chemistry practicals.
Questions 2, 3 and 5 sought to investigate from learners if they believed ICTs were helpful in their understanding and development of practical skills. Only 30% believed the usage of ICTs was not helpful in their learning of practicals in Chemistry. The majority constituting 70% were sure that the use of ICTs has helped them understand Chemistry practicals and the procedures involved in them.Bergmann, J etal (2012) says 'ICTs enable flipped classrooms wher students can engage with theoretical materials online before applying that knowledge in practical settings , boosting understanding and retention.'

Liang , J etal argues that the use of interactive games , simulations and multi media resourses can increase student motivation in acahemistry learning. This was supported by all the interviewed learners who agreed that the use of ICTs have boosted and elevated their confidence in the learning of chemistry practicals. This is also supported by the fact that 95 % leaners have noded to the fact that using ICT tools in Chemistry practicals have reduced their fear and anxiety associated with general usage of practicals.
However of surprising note, the majority of learners believed that their teachers had challenges in using ict tools in the teaching of Chemistry practicals. Some believed there was need for teachers to be upgraded by means of training workshops. Lastly question 10 received overwhelming agreement responses as all learners, 100% of them believed that ICTs mudt be used intensively in teaching and learning of Chemistry practicals at ordinary level. Teachers also on their side showed some reluctance to overcome the challenges known to them that hinder the full implementing of enhancement of ICTs in teaching Chemistry practicals. This has been equated to resilience and resistance on their part to engage these ICT tools like virtual labs, simulations , online practicals etc.

4.6 SUMMARY

During the study the researcher discovered that learners have great interest in using ICT enhanced Chemistry practicals for improved understanding. It was noted that some of the challenges delaying the full implementation of such tools in learning of Chemistry practicals are beyond school administration abilities like availability of electricity and network. However teachers and learners are all in agreement that use of ICT enhanced Chemistry practicals will significantly improve understanding, practical skills and hands on and general interest in learning Chemistry through practicals.

CHAPTER FIVE

5.0 INTRODUCTION

This chapter presents a summary and conclusion of the findings of the research. Some recommendations are as well explained in order to help future researchers who may wish to carry out similar studies

5.1 SUMMARY

Chapter one describe the background of the study, purpose of the study, assumptions , limitations and delimitations of the study. There is also definition of terms at the end of the chapter. It explained the effectiveness of the use of ICTs in teaching and learning of Chemistry practicals at ordinary level. Chapter 2 from the given definitions of ICTs , types of ICTs , uses , theories and strategies , the researcher found out that integrating ICTs and online platforms in teaching chemistry practicals presents many advantages and benefits to the successful teaching and learning of chemistry practicals. Chapter 3 discussed the methodologies to be used , considering the weaknesses and strength of the strategies to be used. It also looked at the methodologies of analyzing data and drawing conclusions. Chapter four collected data from the learners and teachers using interviews and questionnaires and it proved that though there are challenges both parties teachers and learners want to have ICT based chemistry practicals incorporated into the learning landscape.It also showed that teachers were reluctant to put enough effort to see that ICT tools are fully used to teach chemistry practicals at O level.

5.2 CONCLUSION

During the study the researcher has discovered that there are various challenges that are making it difficult for teachers to fully implement and incorporate ict based practicals in the subject of Chemistry at O level. Although learners appreciate their use, ICT tools are very scarce in the urban and rural school sampled by the researcher. There is however encouraging belief in both teachers and learners that the use of ICT based experiments will significantly improve student understanding, practical skills, problem solving skills and general motivation in the learning of Chemistry practicals.

5.3 RECOMMENDATIONS

1.On challenges and limitations of ICT implementation in Chemistry practical classes:
-Teachers should improve their ICT usage skills by enrolling for refresher short courses in ICTs
-Schools must encourage the incorporation of use of ICTs in experiments by availing resourses for the purchase of ICT tools , equipment like generators , solar systems and wifi
2.-schools should organize programmes that aim to improve ICT literacy in both teachers and learners
-the government should chip in to assist in the furnishing of schools with ICT gadgets to speed up their incorporation in the teaching of chemistry practicals

5.4 FURTHER STUDY

Other research can be carried on from this study by further increasing and exploring:
(i) Why ICT usage is also low in the urban learners community as seen in the trends of the outcomes that some urban teachers and learners also had challenges in using ICTs for Chemistry practicals despite their availability
(ii)Other research can be carried out using a controlled group as a case study with intensive supply and usage of ICTs in teaching and learning of the Chemistry practicals to see the outcomes
(iii)The study can also be extended to elite schools like privately owned schools which seem to have a vast pool of resources to compare the outcomes.

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INTERVIEW QUESTIONS FOR TEACHERS

1.Have you ever used ICT based tools for conducting Chemistry practicals for your learners? If so how would you rate thebenefits of using such platforms.
2.Do you think ICTs can help learners in their understanding of Chemistry concepts and practicals
3.Have you ever faced challenges in using any ICT tool in teaching Chemistry practicals?
If so how did you overcome the challenge
4.How do you compare learner understanding and development of practical handson skills when ICT enhanced practicals are used against when traditional lab based practicals are used
5.What could be the challenges hindering ICT usage in teaching Chemistry practicals and concepts?
5.What do you think are the advantages of teaching Chemistry practicals using ICTs and online platforms?

INTERVIEW QUESTIONS FOR LEARNERS

1. Have you ever used ICT tools to learn Chemistry practicals?
2.Do you think ICTs can help one to understand Chemisrty practicals?
3.What do you think are the challenges limiting the usage of ICTs in schools?
4. Given a choice how do you like learning Chemistry practical, using ICT enhanced practicals or traditional lab based practicals
5.What do you think are the advantages of using ICTs in learning Chemistry practicals? Give two.
6. Do you think ICTs must be intensively used in teaching and learning of Chemistry practicals?

QUESTIONNAIRE FOR LEARNERS

KEY :
SA – Strongly agree
A - Agree
NS – Not sure
D - Disagree
SD – Strongly Disagree

QUESTION	SA	A	NS	D	SD
1.Do you oftenly use ICTs in Chemistry practical learning?	10	4	1	3	2
2.Do you find simulation helpful in understanding Chemistry practicals?	8	6	0	6	0
3.Do you find virtual labs helpful in understanding Chemistry practicals?	8	6	0	6	0
4. Have use of ICTs improved your understanding of Chemistry practical procedures?	15	3	0	2	0
5.ICTs help in problem solving and data analysis skills . Do you agree?	12	2	2	2	2
6.Using ICTs has boosted your confidence in Chemistry practicals	18	2	0	0	0
7.Have ICTs reduced your anxiety or fear in carrying out Chemistry practicals ?	15	4	1	0	0
8.Your school can afford ICT tools for Chemistry practical use	4	4	0	10	2
9.Your teachers have challenges using ICT tools in teaching Chemistry practicals	11	3	0	3	3
10.ICTs should be used intensively for Chemistry practicals	16	4	0	0	0