EFFICACY OF INSTRUCTIONALLY CONTROLLABLE FORMATIVE ASSESSMENT ON IMPROVING PUPILS' ACADEMIC PERFORMANCE IN RADIOACTIVITY AT SELECTED SECONDARY SCHOOLS OF CHONGWE DISTRICT IN ZAMBIA

BY

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A dissertation submitted to the University of Zambia in partial fulfilment of the requirements for the award of the degree of Master of Education in Science Education.

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DECLARATION

I, Jere Bechani Castro do hereby declare that this dissertation represents my own work and that it has not previously been submitted for a degree or other qualification at the University of Zambia or any other University.

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CERTIFICATE OF APPROVAL

This dissertation by Jere Bechani Castro is approved as fulfilling part of the requirements for the award of the Degree of Master of Education in Science Education by the University of Zambia.

Hereby signed by the examiners:

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Chairperson Board of examiners	Signature	Date
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Supervisor	Signature	Date
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ABSTRACT

The effectiveness of Instructionally Controllable Formative Assessment (ICFA) on improving learners' academic performance in Radioactivity in Science 5124 (Physics) is not known in the Zambian context. The current study sought to determine the efficacy of ICFA on improving learners' academic performance in Radioactivity at selected secondary schools of Chongwe District in Zambia. The study objectives were to: (1) Establish the pupils' perception of the relationship between ICFA and academic achievement in radioactivity; (2) Find out the extent of the relationship of ICFA with academic achievements of secondary school pupils in radioactivity; and (3) Determine the efficacy of ICFA on improving pupils' academic achievement on radioactivity. The study utilized the Quantitative approach and Quasi-experimental design to address the issues involved. Cluster sampling was used to select a sample of 120 Grade 12 Science 5124 (Physics) group with 60 pupils from one public secondary school (Experimental group) and 60 from another public secondary school (Control group). Both groups were pre-tested, taught Radioactivity for two weeks. During this period the Experimental group was assessed with ICFA while the Control group was not assessed with ICFA. At the end of the two-week period, both the experimental and control groups were post-tested using the same Science 5124 (Physics) Achievement Test (SAT). Data collected using the SAT and a Likert scale was analyzed using Means, Modes, Pearson's Product-Moment Correlation coefficient (r), line chart and t-statistic. The study revealed that: (1) participants perceived a positive relationship between ICFA and academic performance in radioactivity, (2) there exists a strong positive correlation between ICFA and academic performance in radioactivity ($r = 0.85$, sig. (2 –tailed), $p = .008$) and (3) ICFA statistically significantly enhanced learner performance by 12. 42 [$t(114) = 7.534$, sig. (2-tailed) $p = .000$]. It was concluded that ICFA significantly improved learners' academic achievement. The study recommended that Science 5124 (Physics) teachers should (1) increase the use of ICFA during classroom instruction and (2) conduct school-based seminars and workshops on how to apply ICFA effectively to improve learners' academic performance.

Key Words: Efficacy, ICFA, Academic performance, Follow – up formative assessment, pupils' perception.

DEDICATION

This work is dedicated to my beloved wife Edah. N. Jere for her consistent support she rendered to enable me to complete this dissertation. My gratitude also to my children, Khumalo, Themba, S'fiso and Siphiwe for their encouragement in difficult times. May the Almighty God continue to look upon you with favour.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

ECZ	Examinations Council of Zambia.
ICFA	Instructionally Controllable Formative Assessment
MoGE	Ministry of General Education.
CTI	College of Telecomm and Information
ESP	English for Specific Purposes
MCQs	Multiple Choice Questions
QPS	Quantitative Physical Science
SMAT	Student Mathematics Achievement Test
FAS	Formative Assessment Strategies
MTAS	Mathematics Test Anxiety Scale
CAS	Continuous Assessment Strategies
SAT	Science 5124 Achievement Test
SPSS	Statistical Package for Social Sciences
IBM	International Business Machines Corporation
MKO	More Knowledgeable Others

CHAPTER 1

INTRODUCTION

1.1 Overview

The main purpose of the study was to determine the efficacy of Instructionally Controllable Formative Assessment (ICFA) on improving pupils' academic performance in radioactivity in Science 5124 (physics) at selected secondary schools of Chongwe District in Zambia. This chapter presents the background of the study, the statement of the problem, purpose of the study, study objectives and research questions. It also includes the significance of the study, scope of the study, limitation of the study, theoretical and conceptual frameworks, as well as the operational definitions of terms.

1.2 Background

One of the greatest undertakings that teachers participate in with pupils is helping to ensure that learners master the concepts in the content being covered in a given subject. Mention it part of the job, responsibility, obligation or duty, but teachers play a major part in ensuring that learners leave the classroom with a knowledge of what has been covered so that they can continue an education to eventually contribute to society in the occupation of their calling. Teachers over the generations have used different methods, styles, and processes in the education of pupils to get the most out of those with the different abilities that each one possesses. In support of this, Black and William (2001) explain that teachers have to manage complicated and demanding situations, channeling the personal, emotional and social pressures amongst a group of thirty or so youngsters in order to help them to master concepts on Science now, and to become better learners in the future. Standards can only be raised if teachers can tackle this task more effectively.

Formative assessment is a powerful way to measure what learners know against what is unknown. Conventionally, the typical way that educators and pupils have been informed of the learning that has taken place has been through summative assessment, a test that is given at the end of a chapter, a unit or a year to measure what they understand and know from the instruction that has taken place. Grades are generally given out to them, depending on how well

each one did on these tests, and then teachers and pupils alike move on to the next phase of the curriculum. Formative assessment is altogether different in that it gives teachers information that they can use to inform their teaching and improve student learning while it is in progress and while the outcome of the race can still be influenced (Greenstein, 2010).

A brief look at assessment in general can help to understand the concept of formative assessment. Assessment is defined as 'the process of gathering, interpreting, recording, and using information about the pupils' response to educational tasks' (Lambert & Lines, 2000). It becomes a helpful and constructive tool when the information derived from it is used to adapt and modify the applied teaching and learning techniques (Black & William, 1998). Ainsworth (2006) alludes to the variation between tests and assessments by arguing that the latter can: a) motivate learners to be more engaged in learning, b) help them develop positive attitudes toward a subject, and c) give novices feedback about what they know and can do.

In view of the ideas proposed by Ainsworth and others above, it is crucial for teachers to use formative assessment as a tool to enhance learners' academic performance in Science 5124, Physics. Moreover, the essence of the learning process is to provide learners with an opportunity to acquire skills and construct their own knowledge and meaning by way of social interaction with the More Knowledgeable Other (MKO). In order to achieve this goal, it is essential for the teacher to facilitate in the learning process. One way in which this would be achieved is through formative assessment. The motivation behind this formative assessment should for teachers to identify learners' needs and what they should do in order to enhance learners' academic performance in the future, and if need be, to modify the instructional practice. The National Research Council (NRC, 1996) refers to assessment and learning as being two sides of the same coin, as such when students engage in assessments they should learn from these assessments since high quality assessment in the classroom can have a positive effect on students' achievement (NRC, 2001). Therefore, the teachers of science 5124 (Physics) should not consider assessment as simply verdict, but as support to inspire and engage learners meaningfully in the learning process. This

inspiration may occur when pupils become familiar with their previous mistakes and are guided to avoid such mistakes in their future learning.

Kellough and Kellough (1999) have characterized six purposes of assessment as to: 1) assist student learning, 2) identify students' strengths and weaknesses, 3) assess the effectiveness of a particular instructional strategy, 4) assess and improve the effectiveness of curriculum programs, 5) assess and improve teaching effectiveness, 6) provide data that assist in decision making. Suffice to state that without correct implementation of these assessments, the aforesaid purposes cannot be attained. It is, therefore, fundamental to establish clear principles that may successfully guide the implementation of assessments.

The assessment of student learning begins with educational values. Educational values are real life practices that the education system of a nation intends to attain in an individual after experiencing the formal education being offered. For instance, after learning about wiring a three - pin plug in a Physics class, the educational value is that this learner should be able to correctly do the wiring at home or anywhere outside the classroom when need arises. It is incumbent upon the teacher to enlighten the learners on the purpose of every assessment being conducted, its influence on the learning experiences and the final outcome on the education process. Assessment should be part of normal classroom instruction program as a tool to identify learner needs so as to promote effective teaching and meaningful learning by adjusting instructional practices. Over time, the outcome of learning about electricity should also be seen in the learner's academic achievement in class, as well as in the individual's daily practice in the community where s/he lives.

The distinction between summative assessment and formative assessment is that in the former, grades and marks are overemphasized, while the latter promotes frequent, interactive assessments of student progress and understanding to identify learning needs and adjust teaching appropriately (OECD, 2005).

The common practice in public secondary schools in Zambian is that at the end of each school year, pupils in grade 9 and 12 take state-issued standardized examinations. In addition, the pupils in grade 8, 10 and 11 also take school-based end-of-year assessments, which provide covering data that shows overall

levels of achievement. Unfortunately, neither of these will help much when it comes to diagnosing areas for individual growth and planning personalized interventions. That is where formative assessment comes in (Learning Science International, 2016).

On the basis of the foregoing definitions, it becomes imperative for classroom instructors to possess both content and pedagogical knowledge for them to be equal to the task. This would enable teachers to ensure that they make best use of social interactions among learners and the MKO so as to enhance meaningful learning and mastery of the concepts being taught. Teachers should organize learning activities and tasks that offer opportunities for individual pupils to be fully engaged in the learning process. These learning activities and tasks should provide information to be used as feedback for pupils about their learning, including tasks to help learners to practice so that they can master the concepts that have been taught, correctly. Consequently, properly administered formative assessment can provide this useful data for educators so that they can understand in which areas their pupils are obtaining solid understanding and in which areas their pupils may need remediation. According to Black and William (1998) formative assessment is all those activities undertaken by teachers and/or by their students which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged.

Through formative assessments, teachers monitor student progress, provide students feedback, and adjust instructional approaches toward improved teaching and learning, (Earl, 2012). While both forms of assessment serve specific and separate functions, summative and formative assessments are not mutually exclusive in practice. This implies that it is the purpose of the assessment, rather than the task, that delineates the form of the assessment, (Earl& Katz, 2006). The major difference is that unlike summative assessment, formative assessment helps the students identify their strengths and weaknesses and the target areas that need to be worked on. Moreover, it helps the teacher to recognize where students are struggling and address problems immediately.

Formative assessments can function in different ways depending on what type of evidence is elicited. For instance, knowing that a pupil has scored only 25%

on a test in Physics says nothing about that pupil's learning needs, other than that he or she has apparently failed to learn most of what was expected. Three types of formative assessment are proposed by William (2010) as follows: 1) Monitoring assessment; 2) Diagnostic assessment; and 3) Instructionally Controllable Formative Assessments (ICFA) which provide easy to deal with instructional understandings. Monitoring assessment elicits the slightest amount of information of the three types. It serves only to indicate whether or not there has been a lack of understanding between the instructor and learner throughout the lesson. For example, a pupil scores 32 % on a Physics test. While the score information indicates the pupil's achievement, indicating whether or not instruction was successful, it does not provide insight into the specific problem area(s). On the other hand, Diagnostic assessment serves not only to indicate that a problem has occurred in the instructional process, it also helps to locate the specific area in which the learner or pupils are experiencing trouble. An example of this would be an assessment whereby the instructor has access to information regarding the test items, thus allowing for identification of the particular constructs, for instance goals or objectives which were not fully understood by the pupil(s). A good example would be a case of a pupil who scores 32% on a Physics test and the teacher has access to the test scripts from which s/he is able to see which particular questions a pupil was not able to answer correctly. The deficiency of the diagnostic assessment is its inability to provide insight on how to go about overcoming the pupil's lack of understanding.

The ICFA helps in identifying challenges the learners are facing and the location of the problem. It offers the educator and learners an opportunity to correct the misconception while the learning is in process (Nyquist, 2003; William, 2010). This type of formative assessments include two class exercises to be undertaken successively by pupils in order to assist in-depth understanding and mastery of concepts presented in a lesson.

For instance, in our previous example, rather than grading the Physics class exercise results, the teacher decides to use the information gathered from the exercise to decide which aspects of the unit needs to be re-taught or if pupils

have all done well, provide some extension material for more practice on the concepts.

Raising standards of learning that are achieved through school education, particularly in Science 5124 (Physics) on radioactivity, is an important national priority if the government of this Republic of Zambia is to attain its dream of Economic development. Radioisotopes are important in the economic development of a nation, including Zambia, in sectors such as medicine, Industry and agriculture. In medicine radioisotopes such as *Iodine-131* is useful for diagnosis and treatment of thyroid disorders and cancer; Cobalt- 60 is used for sterilization of medical products. In industry, for example *Sodium-24* finds its application in the Industrial pipeline leak detection and oil well studies. In agriculture *Cobalt-60* is used to kill bacteria, molds and other microorganisms in strawberries, onions, potatoes, meats, and spices, preventing the food from spoiling, and making it safer to eat (Pople, 1987; Wilkinson, 1997).

It is important to note here that learning is driven by what teachers and learners do in the classrooms during the instruction process. In the 2015 and 2016 examinations, candidates' performance in the physics component in Science 5124 was very poor compared to the chemistry component. Candidates' performance was low in radioactivity. The analysis of performance at grade 12 in the 2015 and 2016 examinations in Science 5124 showed that most candidates had poor in-depth understanding and mastery of the concepts in the subjects (ECZ, 2015 & 2016). Table1 shows pupils' mean academic performance on the National Final Examinations at grade 12 level in Science 5124 for four consecutive years, beginning 2015.

Table 1.1: Examination Council of Zambia Grade 12 examinations mean performance in Science-5124

Year	2015	2016	2017	2018
Mean performance (%)	17.65	32.83	43.58	34.32

Source: ECZ (2015,2016, 2017and 2018).

In its quest to improve teaching of and results in Science 5124, Ministry of General Education (MoGE) introduced Lesson Study activities for teachers. These activities included the provision of School-Based Continuing

Professional Development (SBCPD), under two educational projects known as "Strengthening Mathematics Science and Technology Education (SMASTE-SBCPD)"; and "Improvement of Pedagogical Content Knowledge (IPeCK)", a SMASTE- Phase 4 project. MoGE reported that teachers for science-5124 (Physics) were continuously improving their skills in teaching and their teaching was gradually becoming context-based as a result of these SBCPD activities (MESVTEE & JICA, 2015). Nonetheless, the national examination results in Science 5124 have remained poor as can be seen in Table 1.1. This is due to inadequate preparation of candidates by teachers for the final examinations. Radioactivity is taught under the unit 'Atomic Physics' but this is one of the sections of the syllabus which are either scantly covered or are not covered at all. These tend to give challenges to most candidates who end up performance poorly (ECZ, 2015 & 2016).

In view of the above, ECZ (2015 & 2016) recommended that teachers should give their learners a lot of classwork in order to assist in the mastery of concepts to improve academic performance in Science 5124 (Physics). ICFA (class exercises) are a form of formative assessment (Dahal, 2019; Mwebaza, 2010 &William 2010). However, the effectiveness of ICFA on improving academic achievement is not known in the Zambian context. Hence the need to determine the effectiveness of ICFA on improving pupils' academic performance in radioactivity in the Zambian context.

1.2. Statement of the problem

The Examination Council of Zambia (ECZ), in its Examination Performance Review Report of 2015 and 2016 on Grade 12 examinations, had indicated that the performance in Science 5124, Physics component, is very poor, particularly in radioactivity (ECZ, 2015 & 2016). If this poor performance continues, Science-5124 may continue to record a high failure rate and lead to low technological development in Zambia. ECZ (2015 & 2016), has recommended that teachers should give a lot of ICFA to assist in improving performance. Use of formative assessment mainly contributes to the improvement of performance levels of low performers Black (2012). However, the effectiveness of ICFA in radioactivity in Science 5124 Physics is not known in the Zambian context.

Hence this study which aimed at determining the efficacy of ICFA on improving pupils' academic performance in radioactivity at selected secondary schools of Chongwe District in Zambia.

1.3 Purpose of the study

The main purpose of the study was to determine the efficacy of ICFA on improving pupils' academic performance in radioactivity at selected secondary schools of Chongwe District in Zambia**.**

1.4 Research objectives

The objectives of this study were to:

1.4.1 Establish pupils' perception of the relationship between ICFA and academic performance in radioactivity.

1.4.2 Find out the extent of the relationship of ICFA with academic achievements of secondary school pupils in radioactivity.

1.4.3 Determine the efficacy of ICFA on improving pupils' academic performance in radioactivity.

1.5 Research questions

The study was guided by the following questions:

1.5.1 What is the perception of the pupils of the relationship between ICFA and academic performance in radioactivity?

1.5.2 What is the extent of the relationship of ICFA with academic performance of secondary school pupils in radioactivity?

1.5.3 What is the efficacy of ICFA on improving pupils' academic performance in radioactivity?

1.6 Research hypothesis

Null hypothesis:

1. **H_O:** There is no significant difference in performance between learners who received ICFA and those who did not receive ICFA.

Alternative hypothesis:

2. **H_1:** There is a significant difference in performance between learners who received ICFA and those who did not receive ICFA.

1.7 Significance of the study

It is hoped that the findings might:

- Lay a foundation of teaching of Science-5124 (Physics)
- Help School managers and teachers of Science 5124, Physics, on how to plan and teach radioactivity.
- Help curriculum reviewers in the selection of learning activities to enhance effective learning of radioactivity.
- Contribute to the existing Science 5124, Physics literature base.

1.8 Scope of the study

This study was conducted at two selected public secondary schools of Chongwe District to provide the necessary data. The two schools were selected on the basis of them offering Science-5124 curriculum under which radioactivity is taught at grade 12 level.

1.9. Limitation of study.

The results of formative assessments are never used for final pass or fail decision at grade 12 level. So the students do not take them very seriously. Also, the participants had the freedom to withdraw at any time from participating in the research. As a result, the four participants who left during the intervention negatively impacted on the results of the research.

1.10. Theoretical framework

The study is based on Vygotsky's Sociocultural Theory (SCT) of cognitive development (Vygotsky, 1978). Vygotsky's Sociocultural Theory (SCT) of cognitive development (Vygotsky, 1978), touches on Children acquiring their

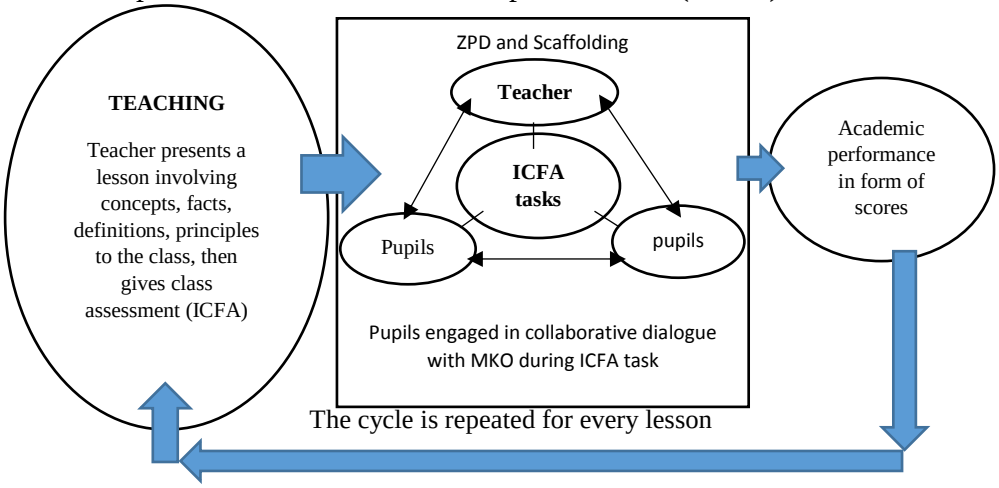
cultural values, beliefs and problem-solving strategies through collaborative dialogues with MKO of society by a socially mediated process. The fundamental ideas forming the basis of Vygotsky's SCT include: (1) an emphasis on developmental or genetic analysis as a means to understand certain aspects of mental functioning; (2) the claim that individual mental functioning has social origins; and (3) an emphasis on the mediated nature of human action (Wertsch, 1991). Primarily, this SCT indicates that the origin of knowledge construction should not be sought in the mind but in the social interaction co-constructed between a more and a less knowledgeable individual (Lantolf, 2008). It also emphasizes that: (1) Learning precedes development, (2) Mediation is central to learning, (3) Social interaction is the basis of learning and development, (4) The Zone of Proximal Development (ZPD) is the primary activity space in which learning occurs (Walqui, 2006). Therefore, Learning is a process of apprenticeship and internalization in which knowledge and skills are transformed from the social into the cognitive plane.

The ZPD refers to the difference in a child's performance when s/he attempts a problem on her own compared with when a More Knowledgeable Other (MKO) provides assistance. Vygotsky's concept of scaffolding is closely related to the concept of the ZPD. Scaffolding refers to the temporary support given to a child by a MKO that enables the child to perform a task until s/he is able to perform it independently.

As applied to the current study, this theory holds that it would be expected that the independent variable ICFA will influence the dependent variable (academic performance) because pupils will acquire skills and knowledge on radioactivity by way of collaborative and cooperative dialogue with the MKO (teacher and peers). This social influence, particularly through ICFA are expected to help improve pupils' academic performance in radioactivity.

1.11 Conceptual framework

- *Independent variable*: Instructionally Controllable formative assessments (ICFA)
- *Dependent variable*: Academic performance (scores)



Source: Researcher

Figure 1.1: Conceptual framework of the study

1.12 Operational definition of terms

1.12.1 Instructionally controllable formative assessment (ICFA): Two class exercises given to pupils after a lesson session.

1.12.2 Follow – up ICFA: Second class exercise given to address the educational needs of learners identified through first class exercise.

1.12.3 Efficacy: The statistical extent to which ICFA can enhance performance of learners in radioactivity. It was measured by the difference in the mean scores for the experimental class and control class and confirmed by the t-test statistic.

1.12.4 Academic Performance /Achievement: the learners' ability to think, reason and solve problems correctly in radioactivity, indicated by the scores obtained in a test on radioactivity.

1.13 Ethical considerations

"Researchers need to protect their research participants: develop a trust with them; promote the integrity of research; guard against misconduct and impropriety that might reflect on their organizations or institutions: and cope with new, challenging problems" (Creswell, 2009: 87). In this respect the researcher:

i. Treated the participants with respect by not causing any emotional or psychological injury on them.

ii. Obtained an informed consent from participants before they participated in the study (see Appendix E).

iii. Assured the participants that their names and information given shall be confidential.

iv. Obtained Ethical clearance from the University of Zambia Ethics committee before the commencement of the data collection process (see Appendix F).

v. Obtained permission to go into the field from Assistant Dean Postgraduate Studies- School of Education (see Appendix G)

vi. Obtained permission from the head teachers of the selected schools.

1.1.4 Chapter summary

The government of the republic of Zambia is concerned about the poor performance at grade 12 in Science 5124 especially in radioactivity of the Physics component. This is because radioisotopes are important in the economic development of a nation, including Zambia, in sectors such as medicines, Industry and agriculture. ECZ (2015 & 2016) had attributed this to poor mastery and in-depth understanding of the concepts taught in radioactivity by candidates resulting from inadequate preparation of candidates by teachers. For this reason, ECZ recommended that teachers give ICFA to assist improve results. However, efforts by MoGE through Lesson Study activities for teachers to improve the teaching of and results in Science-5124 (Physics) have not yielded much as shown in the examination reports by ECZ (see Table 1). Hence this study whose main purpose was to determine the efficacy of ICFA on improving pupils'

academic performance in radioactivity at two selected public secondary schools of Chongwe District in Zambia.

1.1.5 Structure of the study

The dissertation has six chapters. Chapter one outlines the content of the study including the background, statement of the problem, study objectives, research questions, significance of the study, limitations, theoretical framework, Conceptual framework, definition of significant terms, Ethical considerations and chapter summary.

Chapter two reviews literature with regard to the study. It considers views of those who have researched on formative assessment, including learners' perception of the relationship between ICFA and academic performance trends in secondary schools. It also covered the extent of the relationship between ICFA with academic performance in radioactivity; and the Efficacy of ICFA on improving pupils' academic performance in radioactivity. It includes the summary of related literature, with a focus on the knowledge gaps identified in line with the research objectives.

Chapter three provides the research methodology. It includes; the research design, description of site, target population, sample and sampling techniques, research instruments, validity and reliability of the instruments, data collection procedures, data analysis techniques and the rationale of choosing them.

Chapter four presents findings and analyses of the data collected, including a section title, followed by a research question, then results and ending with an interpretation of results.

Chapter five presents the discussions based on the research questions touching on all assessment variables mentioned in the study.

Chapter six gives a conclusion of the study. It also outlines recommendations for additional research in future. A reference and appendices are presented at the end of the project. The appendices include: A: Test results for Experimental group; B: Test results for Control group; C: Science 5124 Physics Achievement test; D: Likert scale; E: Consent letter for pupils; F: Ethical clearance from

Ethics Committee of the University of Zambia; G: Permission to go into the field and H: ICFA form.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

This chapter opens by discussing the historical overview of Grading and Assessments. The related literature has been reviewed according to the order of the research objectives. It ends with a summary of gaps identified in the related literature consulted by the researcher.

2.2 Historical overview of Grading and Assessments

The burden of ensuring that learners are learning effectively lies on the shoulders of school operators. As a result, objective-formative assessment, also commonly referred to as the 'test' was developed as an efficient way to measure performance and student progress. In modern society, the test is the method of determining who will receive the rewards of society (Gardner, 2004). Historically, assessments and grading have been used to measure the success of students or schools compared with other students or schools to place them in rank order. This process produces winners and losers. The mission of schools has changed from rank ordering of students to making sure that all students achieve at or above a minimum standard of achievement. This mission had been highlighted with the signing of the No Child Left Behind Act in 2002, which placed a heightened sense of accountability on helping all learners succeed in place of merely sorting, classifying, and placing them in rank order (Stiggins, 2007). Although the mission of education has changed the use of assessment has remained the same.

2.3 Learners' perception of the relationship between ICFA and academic performance in radioactivity.

A study by Al-shehri (2008) investigated Teachers' and students' attitude towards formative assessment and feedback in teaching English for Specific Purposes (ESP) in Riyadh, Saudi Arabia. The study mainly focused on how formative assessment, as the most useful type of assessment, can be seen as an effective contributor to the learning and teaching process especially when it is followed by real formative feedback. This study investigated such an influence

using mixed methods at the College of Telecomm and Information (CTI) in Riyadh, Saudi Arabia, where English is primarily taught for specific purposes (ESP). The study found that formative assessment gains the highest level of agreement among the teachers as most of them were cognizant that it was an enhancing tool to the students' language proficiency. Formative assessment, moreover, was well regarded by students: 52.6% of students supported formative assessment as a tool to enhance students‟ language proficiency.

However, the study did not look at how formative assessment alone contributes to what students learn but as a couple with formative feedback. Also, the learners' perception was limited to how they looked at the influence of formative assessment as a contributor to what students learn and how teachers teach English not of the relationship between ICFA and learners' academic performance in radioactivity in Science 5124 (Physics). Although 52.6% of students supported formative, this perception of the learners holds for English language not radioactivity. The current study will add knowledge about pupils' perception of the relationship between ICFA and academic performance in terms of: 1) the effectiveness of ICFA to enhance academic performance in radioactivity; 2) learners' willingness to use ICFA as a tool to enhance effective and meaningful learning; and 3) the effectiveness of ICFA to enhance mastery and in – depth understanding of concepts taught in radioactivity. Moreover, the study was done outside Zambia so the education systems, the teachers' and pupils' characteristics are not identical.

A study conducted in Kenya investigated students' perception of the effectiveness of different types of formative assessment used in online learning environments (Ogange, Agak , Okelo, & Kiprotich, 2018). Descriptive research design was used on undergraduate students who were randomly selected to participate in the study. A 31-item questionnaire was used to gather data on student perceptions. The findings suggested that students perceived the use of multiple-choice quizzes, true/false quizzes, matching quizzes, gap filling quizzes, e-portfolio, peer assessment, wikis, weekly assignments, offline assignments, essay types assignments, reflection, and database type assignments as effective tools of formative assessment in online learning settings.

Nonetheless, the students' perception of the different types of formative assessments as effective tools of formative assessment does not reflect the pupils' perception of the effectiveness of ICFA as a tool to enhance academic performance in radioactivity. The participants in this study were not pupils in secondary school but undergraduates at an institution of higher learning, therefore the subject material offered to university or college students and those offered to pupils in secondary schools are different from each other. The site of the research was outside Zambia so there are variations in the education system, teacher and pupils' characteristics, including classroom environment. The study did not look at offline learning environments but focused on online learning environments. Instead the report focused on which formative assessment tools the learners perceived as more user-friendly in online education. Furthermore, the study is silent on the learners' perception of the relationship between ICFA and academic performance in radioactivity. This is important because learners are key stakeholders in the learning process as such their participation in finding solutions to issues to do with improving performance is vital, hence the value of Research question 1. Also, teachers should take advantage of the participants' positive perception and apply assessment forms that learners are willing to use to avoid biases during classroom instruction to enhance effective and meaningful learning of the subject (Kulprasit, 2016).

Another study was conducted in Nigeria to investigate Secondary School Teachers' and Students' Attitudes Towards Formative Assessment and Corrective Feedback in English Language in Ibadan Metropolis (Fakeye, 2016). The study adopted a descriptive research design of survey type. Findings revealed that Students had positive attitudes to formative assessment and corrective feedback in English language. Based on the findings, it was recommended that formative assessment should be given more prominence in assessing students' learning outcome. In addition, English Language teachers should be exposed to seminars, conferences and workshops on how to deploy formative assessment and corrective feedback effectively in English classroom for better results.

However, the study is silent on the grade level of learners who participated in the study. In addition, the study was not conducted in Zambia, therefore, the

education system, learners' and teachers' characteristics, including classroom environment and teaching/learning materials are not the same as those in the Zambian context. Furthermore, the study focused on learners' perception of formative assessment and Corrective Feedback in English language not in radioactivity. The findings do not reflect learners' perception of the relationship between ICFA and academic achievement in the Zambian setting.

2.4 The extent of the relationship of ICFA with academic performance of secondary school pupils in radioactivity

A research was conducted in Chicago, North America to determine if the systematic use of formative assessment attributes (learning progressions, learning goals, descriptive feedback, self- and peer assessment, and collaboration) had an impact on two affective variables (Academic Efficacy and Eagerness to Learn) (Ruland, 2011). Academic Efficacy is the student's perceived ability to succeed and the student's sense of control over her or his academic well-being (Stiggins, 2008). Eagerness to Learn is defined as the student's desire to learn. Students' affect are factors which promote increases in student learning. The study utilized a quasi-experimental design along with a study of correlation. The results of the test of correlation did show a strong statistically significant correlation between the affect variables and the formative assessment attributes.

However, the study was done outside Zambia so there is dissimilarity in the education system, pupil and teacher characteristics, as well as classroom environment to those in the Zambian setting. Also the study is silent on the correlation between ICFA and pupils' academic achievement in radioactivity. Instead, the study focused on impact of formative assessment attributes on student affect variables: eagerness to learn and academic efficacy in reading and mathematics. Although the results of the test of correlation did show a strong statistically significant positive correlation between formative assessment attributes and the affect variables, it does not show a statistically significant positive correlation between ICFA and pupils' academic performance in radioactivity. The current research is looking at the correlation between ICFA and academic performance in radioactivity.

An investigation was carried out on the Correlation between Formative and Summative Assessment Results in Engineering Studies. Generally, there is limited research work available in this subject, most especially relating to engineering education (Ekolu, 2006). It was shown that a strong direct relationship exists between semester results and final marks achieved by students. The study found that students that underperform during formative assessments tend to do better in their examinations to improve their final marks.

However, the study was done outside Zambia so there are differences in terms of the education system, learner and teacher characteristics, as well as classroom environment. Though the study looked at correlation between formative assessment and Summative Assessment Results, it did not look at the strength of the relationship of ICFA with academic performance in radioactivity. Besides, the study used secondary data of modules lectured to undergraduate students and not primary data on secondary school learners. The strong direct relationship shown by the study does not show the correlation between ICFA and academic achievement on radioactivity the Zambian context.

There is paucity of literature on the correlation between ICFA and learners' academic performance on radioactivity in Science 5124 (Physics) in the Zambian situation. Therefore, there is need to systematically determine the correlation between ICFA and academic achievement in radioactivity at secondary school level in the Zambian setting.

2.5 Efficacy of ICFA on improving learners' academic performance in radioactivity

A study was carried out in Asia to examine the status of formative assessment and students' achievement in mathematics in Community Schools of Nepal using a survey research design (Dahal, 2019). The researcher assumed that classwork, homework, project work and tests, except final examinations were forms of formative assessment. The result showed that active participation of students in classwork and feedback from teacher is one of the beneficial ways to improve their learning in Mathematics. When students get more opportunities to discuss with friends, share the knowledge and experiences of particular task, these develop the level of confidence in them (Cowan, 2006).

However, the study was conducted outside Zambia so there is a possibility that the education system, the pupil and teacher characteristics, as well as the learning environment and learning materials are dissimilar. The research used survey design but not Quasi – Experimental design to examine the status of formative assessment and students' achievement in mathematics in Community Schools. Although the active participation in classwork of students positively influenced their achievement level in mathematics, this result does not indicate the influence of ICFA on pupils' academic achievement on radioactivity in the Zambian setting. Hence the need to systematically determine the efficacy of ICFA in radioactivity in the Zambian situation.

A study conducted in Turkey by Ozan and Kıncal (2018) examined the effects of formative assessment practices on students' academic achievement in the fifth-grade social studies class of a secondary school in Erzurum. Mixed method research was used to conduct the study. It was found that the experimental group in which the formative assessment practices were performed had a significantly higher academic achievement levels than the students in the control group, in which the formative assessment practices were not performed.

Although the study examined the effects of formative assessment practices on students' academic achievement, it is not known which practice was being investigated. It is silent on the effectiveness of ICFA on pupils' academic performance in radioactivity. Besides, the study was not carried out in the Zambian setting, as such there are disparities in the education system, learner and teacher characteristics, including classroom environment. In addition, the positive effect of formative assessment practices on students' academic achievement found, does not reflect the effectiveness of ICFA on learners' academic achievement on radioactivity in the Zambian setting.

To evaluate the effect of Formative Assessment of the students on their Academic performance this study was undertaken by Dandekar (2015) in Western India, Asia. This study was designed to find out the impact of formative assessment on academic performance in the Department of Kriya Sharir based on the topic of Rasa and Rakta Dhatu. The students who were assessed with formative assessment showed statistically significant

improvement in recall memory which was tested by Multiple Choice Questions (MCQs). It was concluded that students assessed with formative assessment significantly performed better than students who were not assessed. Formative assessment showed good effect on academic performance of the students and helped in enhancement of learning.

However, the study is silent on the form of formative assessment used. In addition, the study did not look at effectiveness of ICFA on pupils' academic performance on radioactivity in science 5124 (Physics). Instead, the study focused on the topic Rasa and Rakta Dhatu. Although, the study found that formative assessment enhanced students' performance, the result does not reflect the effectiveness of ICFA on learners' academic performance in radioactivity in the Zambian context.

Mehmood, Hussain Khalid and Azam (2012**)** conducted a study in Pakistan, Asia, to find out the impact of formative assessment on academic achievements of secondary school students. The study was experimental in nature and a pre-test/ post-test control group design was used. Both groups were pre-tested. The experimental group was taught and assessed with formative assessment during treatment and the control group was not assessed during treatment. It was concluded that formative assessment had positive effects on the academic achievements of students.

Nonetheless, this study is silent on the effectiveness of ICFA on academic performance in radioactivity. It also has not mentioned the subject in which students were assessed and what form of formative assessment was used as an intervention. The findings that formative assessment has positive effects on the academic achievements of students, does not reflect the effectiveness of ICFA on pupils' academic achievement in radioactivity in the Zambian milieu.

In another research, authors analyzed the extent to which participation and performance in formative assessment are associated with positive academic outcomes of pre-graduate students of health sciences in Spain (Carrillo-de-la-Pena, et al, 2009). Students from three health science degrees (Medicine, Psychology and Biology) from four Spanish universities were involved in this study. After the examinations, students had immediate feedback on their

performance. The comparison of means was carried out using Student's t-tests. The students who carried out mid-term formative assessment got better marks and had higher success rates in final summative assessment than the students who did not participate. In addition, success in formative assessment tests was associated with better summative marks. Interestingly, participation in formative assessment was a better predictor of final outcome than success in formative assessment, a result that supports the key role of feedback in formative assessment.

However, the study does not mention that it used ICFA as a form of formative assessment as an intervention. It is also silent on the type of formative assessment that was applied. Besides, the research participants were university undergraduates but not pupils in secondary school. In the study, Formative assessments were carried out at the middle of the academic term and not at the end of each lesson session. Moreover, the study looked at health science courses: medicine, psychology and biology but not radioactivity in Science 5124 (Physics). Although, participation in formative assessment was a better predictor of final outcome in summative assessment, the result does not indicate the effectiveness of ICFA on learners' academic achievement on radioactivity at secondary school level in the Zambian environment. Furthermore, the study was conducted outside Zambia, as such the education systems may not be the same.

At Rowan University in New Jersey, United States, Casey (2005) conducted a study to (a) determine if the use of formative assessment in the Science classroom improved academic achievement in a group of ninth grade honors level students. The participants of this investigation were Honors Level Quantitative Physical Science (QPS) students enrolled in three high school classes. The independent variables altered by the experimenter with the comparison group included four forms of formative assessment namely: Comment-Only Marking, Increased Wait Time, Discussion Based on Common Experiences and Self-Assessment. While the analysis of summative test scores did not show an overall increase in scores, there was a narrowing of the gap between high and low achievers which may demonstrate a relationship between achievement and formative assessment. Results of the causal attribution survey

showed a possible relationship between the use of formative assessment and the attribution of success in science to ability and effort. These attributions were associated with facilitated learning experiences.

Nevertheless, the study was done outside Zambia, therefore there is discrepancy in terms of education system, the learner and teacher characteristics, including classroom environment to those in the Zambian milieu. In addition, the study looked at chemistry in QPS but not at radioactivity in Science 5124 (Physics). Also, the study did not use Quasi – experimental design but Experimental design. Besides, the research did not look at formative assessment in form of ICFA but considered the four forms of formative assessment, namely: comment – only marking; increased wait time; discussion – based on experience; and self – assessment. The positive relationship between formative assessment and academic achievement found by this study does not reflect the effectiveness of ICFA on in the Zambian environment.

Chemeli (2019) carried out an investigation on the Impact of the five key Formative Assessment Strategies (FAS) on learner's achievement in mathematics instruction in secondary schools in Nandi County Kenya. Learning Progressions, learning Goals and Criteria for Success, descriptive Feedback, Self- and Peer-Assessment and Collaboration were identified as the key formative assessment strategies. The study utilized Pre-Post-test control Quasi experimental mixed method intervention design. The findings from the study revealed that the five key FAS had a positive impact on learners' achievement in terms of performance improvement and acquisition of problem solving skills. Reasons for positive impact were: FAS eased the teachers' workload, raised learners' attitudes and interest, improved learners' critical thinking and teachers and students enjoyed using FAS. The study recommended that Mathematics instructors should increase the use of five key FAS during instruction and use the right scaffolds. They should also emphasize on the importance of More Knowledgeable Others and understanding of learners' context in Mathematics instruction.

Nonetheless, the study was conducted outside Zambia where the education system, learner and teacher characteristics, including the classroom

environment are different from those in the Zambian context. The study did not look at radioactivity in Science 5124 Physics but mathematics. Also, the research used Quasi – experimental design with mixed methods while the current study used Quasi – experimental design with Quantitative method only. Besides, the study looked at the impact of the five key formative assessment strategies on learner's achievement in mathematics instruction in secondary schools but not on the effectiveness of ICFA on learners' academic performance on radioactivity. Furthermore, the five key formative assessment strategies identified in the study did not include ICFA, the focus of the current study. Although the research revealed that the five key FAS have a positive impact on learners' achievement in terms of performance improvement and acquisition of problem solving skills, these findings do not show the extent to which ICFA could enhance learner's academic achievement in Science 5124 (Physics) at secondary school level in the Zambian situation.

Another study was carried out to investigate the effects of formative assessment on mathematics test anxiety and mathematics performance of secondary school students in Jos, Nigeria (Ugodulunwa & Okolo, 2015). Quasi-experimental design was used in this study. The Formative Assessment Package used contained the objectives; topics and contents taught on quadratic equation, simultaneous equations, cord property, circle theorem and trigonometry; thirty-two lessons taught within eight weeks; weekly formative assessments; feedback and the remediation procedure, which focused on correction of misconceptions and process error analyses. The findings revealed that formative assessment reduced anxiety level and improved mathematics performance of the students.

However, the research was done outside Zambia so the education system, the learner and teacher characteristics, including classroom environment are different from those in the Zambian context. Besides, the study looked at the effects of formative assessment on mathematics performance of secondary school students but not ICFA on learners' academic performance on radioactivity. While the findings revealed that formative assessment improved mathematics performance of the students, the result does not show the extent to which ICFA can influence learners' academic achievement on radioactivity in the Zambian situation.

A study was carried out in Akoka, Nigeria to investigate the effect of formative Assessment on students' achievement in secondary school Mathematics (Moyosore, 2015). Three hypotheses guided the study. The experimental research design was employed for the study. Findings from analysis revealed that formative assessment had a strong significant difference in the mean achievement score of Mathematics students that were exposed to it while there was no significant difference in the mean achievement scores of student who were not exposed to formative assessment. The study recommended that all School Administrators should emphasize the use of formative assessment by all teachers and they should allow, encourage and provide incentives for them to attend seminars, workshops, conference and in-services training to enhance their performance and to acquire necessary skills to constructing formative tests.

Nevertheless, the study was conducted outside Zambia, so there are variations in the education system, learner and teacher characteristics, including the classroom environment. Additionally, the study examined the effect of formative assessment under mathematics and not ICFA in radioactivity. The study did not use Quasi – experimental design but experimental research design was employed for the study. Although findings showed that formative assessment had a strong significant difference in the mean achievement score, the result is not a true reflection of the effect of ICFA on learners' academic achievement on radioactivity in science 5124 (Physics) at secondary school level in the Zambian milieu.

A study was conducted in Ebonyi North Educational Zone of Ebonyi State in Nigeria to identify factors affecting performance in secondary school Physics. The factors studied in relation to their relative effects on performance in school physics included: teacher qualification, gender, laboratory facilities and resources, school location and interest of students (Onah & Ugwu, 2010). It was found that performance in physics depended on sex (gender), teacher qualification and laboratory facilities.

However, the study was done outside Zambia where the education system, learner and teacher characteristics, including classroom atmosphere are not similar to those in the Zambian setting. Although the study focused on Physics

it did not specify the topic examined. The factors studied in relation to their relative effects on performance in school physics: sex (gender), teacher qualification and laboratory facilities did not include ICFA as one of the factors. Furthermore, the study did not find ICFA as one of the factors which influenced academic performance in Physics at that level but gender, teacher qualifications and laboratory facilities. Hence the need to systematically determine the effectiveness of ICFA on pupils' academic performance in radioactivity in the Zambian context.

There was a study in Masaka district, west of Lake Victoria in Uganda by Mwebaza (2010) to explore the assessment practice in 'A' level secondary schools with the major focus on Continuous Assessment Strategies (CAS). The study specifically sought to find out the different assessment strategies and their contribution to students' performance. This study used a descriptive survey research design utilizing both qualitative research methods and quantitative approaches. The findings of the study revealed that numerous Continuous Assessment Strategies (CAS) which included: the written tests, recap exercises, take-home assignments, check lists, observation, presentations and projects were being used in 'A' level secondary schools. Teachers strongly agreed that CAS improved the teaching and the learning processes. Most of the teachers indicated that these strategies strongly helped them to identify weak students. Drawing on teachers' and students' perceptions, there were a lot of CAS used and these were found to have a positive relationship to students' performance in the final examinations. This is because through CAS, teachers tend to realize their own weaknesses in teaching and those of their students and strive to perfect them.

Nonetheless, the study was conducted outside Zambia where the education system, the classroom environment, pupils' and teachers' characteristics are different from the situation in Zambia. Also, the study did not use Quasi – experimental design but used descriptive survey design to examine different continuous assessment strategies and their contribution to learners' academic achievements. The study is also silent on the subject taken by the students while the current study is looking at radioactivity in secondary schools. The result of the study does not show the effect of class exercises alone but a combined effect

of CAS. Although the findings of the study revealed that many CAS used had a positive relationship to students' performance in the final examinations, this result does not reflect the effectiveness of ICFA on pupils' academic performance on radioactivity at secondary school level in the Zambian scenery.

2.6 **Chapter summary**

The literature has revealed that learners perceived that a positive association existed between formative assessment and academic performance. Besides, literature also agrees that there is a positive correlation between formative assessment and academic performance. Furthermore, a number of researchers have found a positive effect of formative assessment on learners' academic achievement. However, literature is silent on the following: 1) learners' perception of the relationship between ICFA and academic performance in radioactivity; 2) the extent of the relationship of ICFA with academic achievement of secondary school pupils in radioactivity; and 3) the efficacy of ICFA on improving learners' academic performance in radioactivity at secondary school level.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Overview

This section presents the research methodology of the study. The section highlights the research design, research site, target population, sample size and sampling techniques, research instruments, data collection techniques, data analysis, ethical considerations.

3.2 Research design

A Quantitative research approach was used for the empirical numeric data collection (Creswell, 2009). This is a method of research which emphasize objective measurements and numerical analysis of data collected through a questionnaire. A Quasi-experimental design was used in this study. This is because the study involved pupils in schools, and this design allows the researcher to use groups already organized into classes in a typical school situation (Ary, Jacobs, Razavier & Ary, 2010). The main advantage of the pre-post-test study design is that it can measure change in a situation, phenomenon, issue, problem or attitude. It is an appropriate design for measuring the impact or effectiveness of a program (Kumar, 2011).

3.3 Description of the Study site

This research was conducted at two selected public secondary schools of Chongwe district in Zambia which offered Science-5124 (Physics) syllabus, under which radioactivity is taught at grade 12 level. One of the two schools was used as Experimental group while the other school was a Control for the study. The schools were located considerably distant from each other and of similar status in terms of ranking, organization and environment. The area also offered proximity advantage to the researcher, consequently providing easy accessibility to both schools.

3.4 Study population

All the pupils in Grade 12 classes at the selected public secondary schools constituted the population of this study because "radioactivity", the topic of interest in Science 5124 (Physics) is taught at Grade 12 level.

3.5 Study sample

A group of 120 pupils in Grade 12, consisting of 60 in one intact class from one selected public secondary school made up the experimental group while the other 60 in another intact class from another public secondary school made up the control group.

3.6 Sampling techniques

First, two public secondary schools were selected by purposive sampling because they both offered Science 5124 under which radioactivity is taught. Then a sample consisting of two intact classes (clusters) was selected from the population of all Grade 12 classes in the selected public secondary schools by Cluster sampling. This technique offered each of the clusters an equal chance of being chosen, and the unit chosen was not an individual but, rather, a group of individuals who were already organized into classes (clusters). These individuals constituted a cluster insofar as they were similar with respect to characteristics relevant to the variables of the study. The clusters which were actually included in the study were chosen at random from a population of clusters and all the members of the cluster were included in the sample. In this study cluster sampling took the form of a chance procedure of picking a folded piece of paper containing the name of a class from a box. Names of all grade 12 classes in each of the selected secondary schools were written on small pieces of paper, folded and placed in a small box. A selected teacher shook the box and randomly selected one piece of paper and gave the researcher. The class contained in the paper was selected to participate in the study. The same procedure was repeated at another selected school to select another class.

Random assignment technique was then used to allocate one class as experimental group, and the other class as control group. Random assignment is a procedure used after random selection of a sample of participants to decide

which group should be experimental or control before we expose them to a treatment (Ary, Jacobs, Razavier & Ary, 2010). In this study random assignment took the form of a chance procedure of tossing a coin to decide which of the selected classes had to get the treatment (Experimental group) and which one would not receive the treatment (Control group).

3.7 Data collection instruments

Primary numeric data was collected using a Science 5124 Physics Achievement test (SAT) (see Appendix C) and Likert scale (see Appendix D) since this study was informed by Quantitative approach. The SAT comprised twenty (20) Multiple Choice Questions (MCQs) only. It was used because the study was aimed at measuring skills and knowledge learned in grade 12 on radioactivity through classroom instruction. The Likert scale contained twenty (20) statements. Each statement was followed by four opinion items namely: "Strongly agree (SA), Agree (A), Disagree (D) and strongly disagree (SD)". The Likert scale was used because it is a suitable way to measure perception (Denscombe, 2003). Also, it is more reliable because it is anonymous, it encourages greater honesty, it is economical in terms of time and money (Cohen, Manion & Morrison, 2000).

3.8 Validity and Reliability of research instruments

Validity of an instrument is its capacity to measure that for which it was designed. On the other hand, if findings from research are replicable consistently they are reliable. In order to ascertain the validity and reliability of instruments, expert opinion was sought from the supervisor, other lecturers, and peers on face, content and format of both the Likert scale and the SAT. These consultations helped to identify some weaknesses and offered the opportunity to modify and improve the instruments. On the Likert scale, some statements were ambiguous as they could not elicit the needed data from the respondent. Also, the number of statements was reduced from 30 to 20. Some statements were a repeat of others so they were dropped from the instrument.

In the SAT, some questions were dropped because they were above the level of learners at grade 12. Other questions were a repeat of a concept already addressed in another question so they were removed. Yet, some radioactivity

equations were incorrectly set so corrections were made. The SAT was further subjected to a pilot study on five pupils at a school in Lusaka that did not participate in the actual study. The same test was repeated by the same pupils. The internal consistency of the SAT was measured using Cronbach's Alpha reliability test in IBM-SPSS, version 21 because it was appropriate for dichotomous and continuously scored variables used in this study. The Cronbach's (Coefficient) alpha ($\propto$) = 0**.** 85, indicating that the set of SAT pilot test scores in attempt 1 and 2 as a group were closely related. This means that the participants' performance was essentially the same in both attempts. This result implies that there was good internal consistency and the SAT was reliable.

Drawing on the expert opinions from the supervisor, other lecturers, and peers, appropriate corrections were made on the instruments. Thereafter, both instruments were administered by the researcher and collected immediately.

3.9 Data collection procedure

Firstly, the researcher obtained written Approval of study from the Directorate of Research and Graduate Studies Research department and permission to collect data from the field from the Dean, School of Education, through the assistant Dean Postgraduate studies of the University of Zambia.

The researcher then met the participants and explained the study after meeting the school administration. Thereafter, individual participants signed consent forms. Both the Experimental and the Control groups were then pre-tested using SAT in order to find out their knowledge level of the subject material before treatment with ICFA. The participants' test results were then recorded. Each correct answer was awarded one [1] mark while an incorrect answer scored zero [0].

The two groups were then taught radioactivity for a period of two weeks. The experimental group was taught and received ICFA during treatment while the control group did not receive ICFA. Class exercises are a form of formative assessment (Dahal, 2019; Mwebaza, 2010).

On each of the days during the treatment, the teacher presented a lesson and assessed both experimental and control classes. For the control class, the class

exercise was marked and then books given back to the pupils without further guidance to the learners. On the other hand, the experimental class was assessed with ICFA, that is to mean two class exercises. The first class exercise was given as a Monitoring and Diagnostic assessment based on the lesson taught. On the basis of the outcome of the first exercise, the teacher gave a follow-up assessment to address the educational needs of the identified learners.

In order to collect data required for measuring correlation between ICFA and academic performance, one more exercise was given per day during the first four days. On the fifth day four exercises were given. Then on each of the subsequent three days, the number of exercises was decreased by one until the eighth day. Pupils worked out solutions in consultation with each other, and the teacher. The Average Class Mean score per day was recorded. The teacher was a university graduate with a Bachelor of education degree and a teaching experience of 16 years at both junior and senior secondary levels.

At the end of the two weeks learning session, the two groups were together exposed to a post-test using the same SAT. A cross (X) was used by participants on the SAT to give their preferred answer. The test lasted for forty- five (45) minutes, after which the scripts were collected and scored using a marking scheme. The test was written strictly under standard examination conditions to avoid any form of communication among the participants during the test.

The Likert scale was then administered to all the participants to establish their awareness about the relationship between ICFA and academic performance in radioactivity. Ticks (√) were used by participants to indicate their preferences. At the end of the session all the scripts were collected for further processing.

3.10 Data analysis

The study generated quantitative data which was analyzed using Modes, Means, Pearson's product-moment Correlation coefficient (r) and Line chart in Excel (descriptive statistics) and the Independent samples t-test (inferential statistics) generated by IBM-SPSS, version 21. Pearson's product-moment correlation coefficient (r) was used because it is a suitable common index of relationships between two variables used in this study. A Line chart was used because it is appropriate for displaying trends over time (days) since the order was important,

as in the current study. The Independent samples t-test was used because this study involved two independent small samples of size ($n \geq 30$) and provided a way for testing of hypothesis (Cohen, Manion & Morrison, 2000). The interpretation of the descriptive and inferential statistics made it possible to draw appropriate conclusions based on the findings of the study.

3.11 Chapter summary

The study used Quantitative approach and Quasi – experimental design. Cluster sampling was used to select a study sample of 120 grade 12 learners from a population of all grade 12 classes at the selected public secondary schools. A Likert scale and a Science Achievement Test (SAT) were the instruments used to collect the necessary numeric data. The research instruments were valid and reliable at Cronbach's alpha of 0.85. Ethical clearance was obtained from the University of Zambia Ethics Committee and all other relevant authorities before commencing the study. Data collected was analyzed using Modes, Means, Pearson's Product-moment Correlation coefficient (r), a Line chart and t- test statistic.

CHAPTER 4

FINDINGS AND ANALYSIS

4.1 Overview

This chapter presents findings in sections based on, and in the order of the research questions. Section 4.1 contains a comparison of pre-test scores for both Control and Experimental groups. It is followed by Learners' perception of the relationship between ICFA and academic performance on radioactivity. It continues with the extent of relationship of ICFA with academic performance of secondary school pupils in radioactivity. Thereafter, it presents the efficacy of ICFA on improving pupils' academic performance in radioactivity and ends with the summary of findings.

4.2 Comparison of Pre-test scores for both Control and Experimental groups

The pre-test was given to both the experimental and control groups in order to find out if the participants were at the same knowledge level of the subject material before commencing the treatment

Table 4.1: **Summary of Pre-test Independent Samples t - test showing difference between Mean scores of Experimental and Control groups**

Group	**N**	**Mean**	**t-cal**	**Df**	**Sig. (2-tailed)**	**95% C. I**		**Remark**
						lower	**upper**	
Experimental group	60	12.92	- . 460	118	. 647	-2.65	1.65	Not Significant
Control group	60	13.42						

Source: Researcher's own based on data in Appendix A using IBM-SPSS 21.

From Table 4.1, the 60 participants who were in the Experimental class (M= 12.92) compared to the 60 participants who were in the Control class (M= 13.42) did not perform significantly better [t (118) = - .460, sig. (2-tailed) p = .647 > 0.05, 95% Confidence Interval [-2.65, 1.65]. This implied that at the

beginning of the study all the participants, regardless of group (Experimental or Control) were essentially the same in terms of knowledge level of the subject material on radioactivity.

4.3 Learners' perception of the relationship between ICFA and academic achievement in radioactivity

Data obtained from the Likert scale were analyzed using descriptive statistics of frequency count (Mode) to answer the research questions 1.

(i). Research question 1*:* What is the pupils' perception of the relationship between ICFA and academic achievement in radioactivity.

To measure pupils' perception, the items on the Likert scale were presented into three sections as follows: 1) effectiveness of ICFA to enhance academic achievement in radioactivity; 2) pupils' willingness to use ICFA as a tool to enhance effective and meaningful learning; 3) the effectiveness of ICFA to enhance mastery and in-depth understanding of concepts taught in radioactivity. The pupils' perception was depicted by the level of agreement with the highest number of responses (Mode) for each item on the Likert scale.

4.3.1 Effectiveness of ICFA to enhance academic achievement in radioactivity

Pupils' perception of the effectiveness of ICFA to enhance academic achievement in radioactivity was measured on the basis of their responses to items 1, 6, 12, 16 and 20 on the Likert scale. The results are shown in Table 4.2.

Table 4.2: **Pupils' perception of the effectiveness of ICFA to enhance academic achievement in radioactivity.**

S/N	Item	Level of agreement			
		SA	**A**	**D**	**SD**
1	The class exercises given to us by our teacher helped me to improve my grades in the test on radioactivity.	62	38	12	7
6	Questions given to us in class exercises were taken from what we learned during a lesson on radioactivity.	42	72	16	4
12	The class exercises helped me to score high grades in the test on radioactivity.	37	55	22	6
16	Class exercises did make a great positive contribution to my performance in the test on radioactivity.	35	63	14	8
20	Pupils who did not take class exercise seriously scored low grades in the test on radioactivity.	55	33	14	17

Source: Researcher, based on data from Likert scale (see Appendix D)

From Table 4.2, for item 1and 20, the mode was 62 and 55, indicating that participants strongly agreed with the statement. For items 2, 12 and 16 the modes were 72, 55 and 63, respectively showing that participants agreed with the statements. This indicated that the participants perceived that ICFA had a positive effect on academic achievement in radioactivity.

4.3.2 Use of ICFA as a tool to enhance effective and meaningful learning on radioactivity

The willingness of the pupils to take ICFA as a tool to enhance effective and meaningful learning was measured on the basis of their responses to items 7, 10, 11, 13, 14, and 19 on the Likert scale.

Table 4.3: **Learners' willingness to use ICFA as a tool to enhance effective and meaningful learning on radioactivity**

S/N	Item	Level of agreement			
		SA	A	D	SD
7	We were free to ask questions to help us understand what we learned during a lesson on radioactivity.	70	43	4	3
10	I enjoyed working out solutions to questions given as class exercise after taking a lesson on radioactivity.	39	72	5	4
11	I made sure I tried to answer all the questions given as class exercise on radioactivity.	49	58	8	4
13	When I failed to give all correct solutions to questions given as class exercise on radioactivity, I always put in more effort in the following task.	54	52	7	6
14	I made sure that I did correction on any question that I did not score correctly after my teacher had marked my class exercise.	41	60	11	4
19	It is important for teachers to assist pupils to make corrections on class exercises given on radioactivity to help them to learn from their mistakes.	72	42	4	2

Source: Researcher, based on data from Likert scale (see Appendix D)

From Table 4.3, for item 7, 13 and 19 the modes were 70, 54 and 72 respectively, indicating that participants strongly agreed with the statements. For items 10, 11 and 14, the modes were 72, 58 and 60 respectively showing that participants agreed with the statements. This indicated that participants perceived the importance of ICFA hence their willingness to use it as a tool to enhance effective and meaningful learning in radioacrivity.

4.3.4 Effectiveness of ICFA to enhance mastery and in-depth understanding of concepts taught in radioactivity

Pupils' perception of the effectiveness of ICFA to enhance mastery and in-depth understanding of concepts taught in radioactivity was measured based on their responses to items 2, 3, 4, 5, 8, 15, 17 and 18.

Table 4.4: **Participants' perception of the effectiveness of ICFA to enhance mastery and in-depth understanding of concepts taught in radioactivity.**

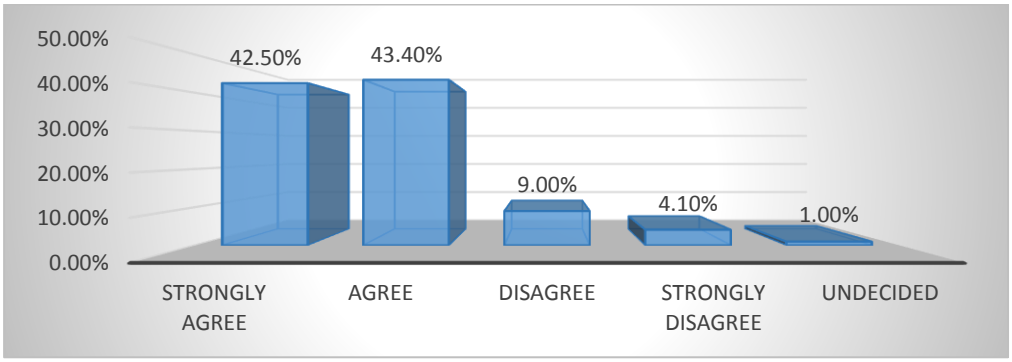
S/N	Item	Level of agreement			
		SA	A	D	SD
2	Class exercises were useful because they helped me to master the key points taught on radioactivity.	57	49	8	5
3	Teachers should give pupils a lot of class exercises in order to assist mastery of concepts to improve performance in radioactivity.	51	48	17	2
4	The more class exercises a learner did in radioactivity the better was one's performance and vice versa.	39	44	24	6
5	Class exercises were an important part of every lesson on radioactivity, they were not a waste of time for pupils.	61	47	8	3
8	The questions our teacher asked when he was teaching us helped me gain deeper understanding of concepts that were taught on radioactivity.	43	64	7	6
9	Pupils should generate questions for class exercise because they know where they find difficulties to understand concepts taught on radioactivity.	45	50	18	5
15	I believe that class exercises were important because they helped correct my misunderstanding of concepts taught on radioactivity.	57	58	4	1
17	There was need for a class exercise after every lesson on radioactivity to help me master what was learned.	57	45	11	7
18	Class exercises were necessary because they helped me to focus on key points of a lesson learned on radioactivity.	60	54	2	3

Source: Researcher, based on data from Likert scale (see Appendix D)

From Table 4.4, for item 2, 3, 5, 17 and 18 the modes were 57, 51, 61, 57 and 60 respectively showing that participants strongly agreed with the statements. For items 4, 8, 9 and 15, the modes were 44, 64, 50 and 58 indicating that participants agreed with the statements. This shows that participants perceived a positive effect of ICFA on enhancement of mastery and in-depth understanding of concepts taught in radioactivity.

4.3.5 Participants' overall perception of the relationship between ICFA and academic achievement in radioactivity

The overall perception of the participants was measured based on all their responses to the statements on the Likert scale (see Table 3, 4 & 5). The result is shown in Figure 4.1.



Source: Researcher, based on data from the Likert scale (see Appendix D)

Figure 4.1: **Participants' overall perception of the relationship between ICFA and academic achievement on radioactivity**

From Figure 4.1, the result shows that 42.5 percent representing 51 participants strongly agreed and 43.4 percent representing 52 participants agreed with the statements. This implies that participants' perception was that there is a positive relationship between ICFA and academic achievement in radioactivity.

4.4 The extent of the relationship of ICFA with academic performance of secondary school pupils in radioactivity

Research question 2: What is the extent of the relationship of ICFA with academic achievements of secondary school pupils in radioactivity?

In order to determine the extent of the relationship of ICFA with academic achievements of secondary school pupils in radioactivity, the number of ICFA

tasks given to the Experimental group and the Average Class Mean scores per day were analyzed using a Line chart in Excel and Pearson's product-moment correlation coefficient, (r) in IBM-SPSS version 21. Excel is a Microsoft computer software while IBM-SPSS stands for International Business Machines Corporation- Statistical Package for Social Sciences. Results were as shown in Table 4.5, Figure 4.2 and Table 4.6.

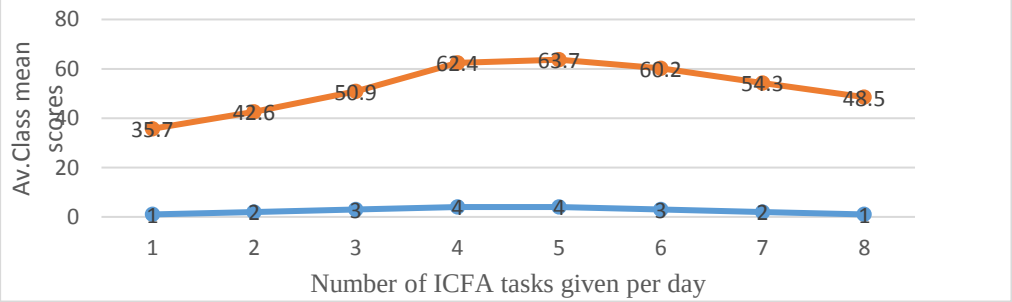
Table 4.5: **Summary of the extent of the relationship of ICFA with academic achievements of secondary school pupils in radioactivity**

Day	Number of ICFA tasks given per day (x)	Average class mean score (y)
1	1	35.7
2	2	42.6
3	3	50.9
4	4	62.4
5	4	63.7
6	3	60.2
7	2	54.3
8	1	48.5

Source: Researcher, based on data collected during assessment sessions

From Table 4.5, the Average Class Mean scores are increasing with increasing number of ICFA tasks given; and decreasing with decreasing number of ICFA tasks. This indicates that there is a linear relationship between ICFA and academic performance in radioactivity.

The data from Table 4.5 was analyzed using a Line chart to gain further insight into the effect of increasing and decreasing the number of ICFA tasks on the Average Class Mean score. The results are shown in Figure 4.2



Source: Researcher, based on data from Table 4.5

Figure 4.2**: Showing relationship between ICFA and academic achievement on radioactivity**

From Figure 4.2, the Average Class Mean scores are increasing and decreasing as the number of ICFA tasks given to the participants, indicating that there is a linear relationship between the number of ICFA tasks given and academic achievement. This implies that there exists a positive correlation between ICFA and academic achievement on radioactivity.

The data in Table 4.5 were further analyzed using the Pearson's Product-Moment correlation coefficient (r) to determine the extent of the relationship of ICFA with academic performance in radioactivity. The result is shown in Table 4.6.

Table 4.6: **Showing the extent of the relationship of ICFA with academic achievements of secondary school pupils in radioactivity**

Correlations

		1	0
1	Pearson Correlation	1	.846**
	Sig. (2-tailed)		.008
	N	8	8
0	Pearson Correlation	.846**	1
	Sig. (2-tailed)	.008	
	N	8	8

**. Correlation is significant at the 0.01 level (2-tailed).

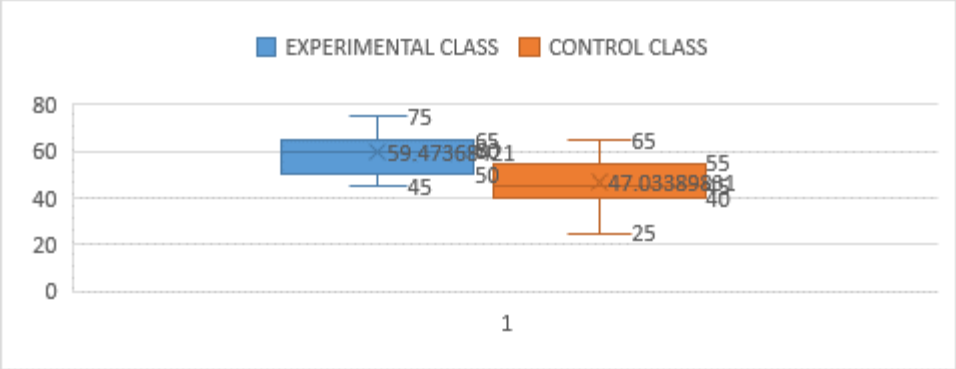
Source: Researcher, based on analysis of data from Table 4.5 using IBM-SPSS – 21

From Table 4.6, the Pearson's Product-Moment Correlation coefficient (r) = 0.85, sig (2- tailed), p = 0.008 indicating that a statistically significantly strong linear relationship exists between ICFA and academic achievement on radioactivity. This implies that there is a strong positive correlation between ICFA and academic achievement on radioactivity.

4.5 **Efficacy of ICFA on improving pupils' academic performance in Radioactivity**

Research question 3*:* What is the efficacy of ICFA on improving pupils' academic performance in radioactivity?

In order to determine the effectiveness of the ICFA on improving pupils' academic performance on radioactivity, the researcher first calculated the Mean score values of Post-test scores for pupils who received ICFA (Experimental class) and those who did not receive ICFA (Control class). This was necessary to find out if there is a difference in the Mean score values. Microsoft excel, a computer software was used to calculate and display the two Means by a statistic chart called the Box and Whisker. This type of chart was used because it is easy to display variation within a set of data or a multiple of data sets which relate to each other in some way as can be seen in Figure 3.



Source: Researcher based on analysis of data from Appendix A & B.

Figure 4.3: Mean scores for Experimental and Control classes based on the SAT Post-test scores.

The result in Figure 4.3 shows that there is a difference in the Mean performance between the group that recived ICFA and the group which did not receive ICFA. However, it is not yet clear whether the difference in the Mean scores is significant or not. Hence the need to compare the result by statistical methods.

Next, the researcher compared the Means of the Experimental group and the Control group using the Independent Samples t-test statistic to determine whether there is statistical evidence that the associated population means are significantly different. The hypothesis was tested at 0.05 level of significance. The result is presented in Table 4.7.

4.6 Testing Hypothesis

H_o: There is no significant difference in performance between learners who received ICFA and those who did not receive ICFA.

H_1: There is a significant difference in performance between learners who received ICFA and those who did not receive ICFA.

In order to test the hypothesis, the Mean scores calculated on the post-test scores for both the experimental and control groups were analysed using the Independent samples t-test by a software known as IBM-SPSS, version 21. The results are shown in Table 4.7.

Table 4.7: **Summary of Post-test Independent Samples t-test showing difference between Mean scores of Experimental and Control groups**

Group	**N**	**Mean**	**t-cal**	**Df**	**Sig. (2 - tailed)**	**95% C. I**		**Remark**
						Lower	**upper**	
Experimental group	57	59.47	7.534	114	.000	9.156	15.690	Significant
Control group	59	47.05						

Source: Researcher, based on Post-test data in Appendix A & B using IBM-SPSS 21

From table 4.7, the 57 participants who received ICFA (M= 59.47) compared to the 59 participants who did not receive ICFA (M= 47.05) performed significantly better [t (114) = 7.534, sig. (2-tailed) p = .000 < 0.05]. This implied that ICFA had a significant positive influence on the pupils' improved academic achievement on radioactivity in Science 5124 Physics. Therefore, we reject the null hypothesis and conclude that ICFA positively influenced learners' achievement with respect to performance, mastery and in – depth understanding of concepts taught in radioactivity.

The study revealed that ICFA statistically significantly enhanced learner achievement by 12.42 [t(114) = 7.534, sig. (2-tailed) p = .000 < 0.05]. Hence, ICFA had a positive influence on learners' improved achievement on radioactivity in Science 5124 (Physics).

4.7 Summary of chapter

The study revealed that participants perceived that a positive association existed between ICFA and academic performance in radioactivity. In addition, their perception was that ICFA enhanced academic achievement in radioactivity since it assisted mastery and in-depth understanding of concepts taught (see

Table 4.4 & Fig. 4.1). In relation to research question 2, the study revealed that there is a strong positive correlation between ICFA and academic performance on radioactivity (see Fig. 4.2 & Table 4.6). In terms of research question 3, findings showed that there is a statistically significant difference in the mean performance of 12.42 units between the group that received ICFA and that which did not receive ICFA(see Table 4.7). It was then concluded that ICFA has a positive influence on learners' achievement in terms of performance, mastery and in – depth understanding of concepts taught on Radioactivity.

CHAPTER 5

DISCUSSION OF FINDINGS

5.1. **Overview**

This chapter is presented in sections. Section 5.2 is a comparison of pretest mean scores for both Control and Experimental groups. Next is pupils' perception of the relationship between ICFA and academic achievement in radioactivity. Thereafter, is the discussion on the extent of the relationship of ICFA with academic performance of secondary school pupils in radioactivity.The chapter ends with the discussion on the Efficacy of ICFA on improving pupils' academic achievement in radioactivity.

5.2 Comparison of Pre-test Mean scores for both Control and Experimental groups

All the participants regardless of group (experimental or control) were essentially similar in terms of knowledge level of the subject matter in radioactivity at the beginning of the study. In this study, it was important for all the participants to be at the same knowledge level of th subjecr matter in order to determine efficiently the effectiveness of ICFA on academic performance. The meaning is that it confirms to the assumption of a quantitative study that the two groups were the same at the beginning of the study.

5.3 Learners' perception of the relationship between ICFA and academic performance in radioactivity

In the first problem of the research, the question "What is the perception of the pupils of the relationship between ICFA and academic performance in radioactivity? was asked. Participants' perception of the relationship between ICFA and academic achievement was measured in terms of: 1) effectiveness of ICFA to enhance academic achievement in radioactivity, 2) parcipants' willingness to use ICFA as a tool to enhance effective and meaningful learning in radioactivity and 3) the effectiveness of ICFA to enhance mastery and in-depth understanding of concepts taught in radioactivity in Science 5124 Physics.

5.3.1 Effectiveness of ICFA to enhance academic performance in radioactivity

The participants perceived that there was a positive relationship between ICFA and pupils' academic performance in radioactivity (see Figure 2). This means that participants had valued ICFA given to them by their teacher during instruction in the classroom as helpful in improving achievement scores in radioactivity. They were also mindful that what was given in ICFA was directly linked to the concepts taught in radioactivity, therefore it needed to be taken seriously. Furthermore, participants were cognizant that for them to improve their academic performance they needed to handle ICFA with due seriouness. Consequently, teachers of Science 5124 Physics should take advantage of the participants' perception of a positive relationship of ICFA with academic performance in radioactivity and give more and effective ICFA to their learners so as to improve academic achievement in radioactivity.

This result is in line with the results from the Independent samples t-test which showed that ICFA statistically significantly improved pupils' academic achievement (see table 8). In addition, this result supports the recommendation by ECZ (2015 & 2016) that teachers should give their learners ICFA to assist improve performance in radioactivity. The result also agrees with Mwebaza (2010) who found that students had positive perception of a relationship between continuous assessment strategies and students' performancein the final examinations. This could have been as a result of similaries in the education policies and practices based on similar challenges.

On the other hand, this result does not agree with the findings by Onah and Ugwu (2010) who found that formative assessment is not a predictor of improved academic performance but gender, teacher qualification and laboratory facilities. This may be because the education system there is already implementing the policy which emphasizes the use of formative assessment during classroom instruction. In addition, teachers there may not be facing a lot of challenges applying ICFA to enhance academic achievement of their learners.

5.3.2 Pupils' willingness to use ICFA as a tool to enhance effective and meaningful learning.

Findings of the study indicated that the participants had a positive perception of the use of ICFA as a tool to enhance effective and meaningful learning in radioactivity(see Table 4.3). Consequently, participants were willing to use ICFA as a tool to enhance effective and meaningful learning in radioactivity. This means that participants enjoyed working out solutions to questions given as ICFA after taking a lesson in radioactivity. In addition, they made sure they tried to answer all the questions given as ICFA in radioactivity. Furthermore, it means that participants were willing to put in their best to answer the questions given as ICFA in radioactivity. Moreover, the participants indicated that they would appreciate if teachers assisted them to make corrections on ICFA given in radioactivity to help them learn from their mistakes.This result shows that pupils also valued the integration of formative feedback in ICFAs as a way of helping them to avoid repeating the same mistakes. These findings are in line with Kulprasit (2016) who found that all of the participants had positive perception of the writing rubric since they appreciated its values. That is, it played a significant role in the writing process as an effective assessment tool and a useful source of feedback to improve their writing in English in terms of both their writing performance and writing products. Hence, teachers of science 5124 (Physics) should take advantage of the participants positive perception and apply assessment forms that learners are willing to use to avoid biases during classroom instruction to enhance effective and meaningful learning of the subject. The result is also in line with Ogange, Agak and Okelo (2018) whose findings suggested that students perceived the use of multiple-choice quizzes, true/false quizzes, matching quizzes, gap filling quizzes, e-portfolio, peer assessment, wikis, weekly assignments, offline assignments, essay types assignments, reflection, and database type assignments as effective tools of formative assessment in online learning settings. These findings are very useful as they can help teachers to use formative assessment strategies which are favourable to learners.

5.3.3 Effectiveness of ICFA to enhance mastery and in-depth understanding of concepts taught in radioactivity.

Findings from the study revealed that participants‘ perception of ICFA enhancing academic performance in radioactivity was positive (see table 5). The participants indicated that ICFA tasks were useful because they helped them to master the key points taught in radioactivity lessons. They also believed that ICFAs were important because they helped in correction of misunderstanding of concepts taught in radioactivity lessons.This result shows that ICFA assisted learners to master and attain in-depth understanding of concepts taught in radioactivity. The result supports the recommendation by ECZ (2015) that teachers should give ICFA to assist learners master the concepts taught in radioactivity. Therefore, teachers of Science 5124 (Physics) should integrate the ICFA to assist mastery and in-depth understanding of concepts taught in radioactivity. Moreover, understanding pupils' perception of different value aspects about ICFA used in radioactivity is critical in helping teachers to utilise tools that pupils are aware about in a positive way. By giving pupils more ICFA teachers can lessen biases that pupils might have towards a particular aspect of formative assessment and assist them to master and develop an in – depth understanding of concepts taught in radioactivity. Consequently, teachers should resourcefully use ICFA in their classroom teaching practice for better results.

This result coincides with Fakeye (2016) who found that students had positive perception of formative assessment and corrective feedback in English language. The study concluded that formative assessment was indispensable to students' learning outcome in English Language classroom. The researcher recommended that Formative assessment should be given more prominence in assessing students' learning outcomes. These findings are also in line with Kulprasit (2016) who found that all of the participants had positive perception of the writing rubric since they appreciated its values. With the writing rubric as a guide to assess their own work as well as their peers', their writing was greatly improved in various aspects apart from grammatical aspects.

5.4 The extent of the relationship of ICFA with academic performance of secondary school pupils in radioactivity

Findings of this study revealed that there exists a strong positive correlation between ICFA and pupils' academic performance in radioactivity, (see Table 4.5 & 4.6; Figure 4.2). This result coincides with the findings by Ekolu (2006) who found that a strong direct relationship existed between semester results (formative assessment) and final marks achieved by students (summative assessment). Further, the findings also agree with Ruland (2011) who found that there existed a strong statistically significant correlation between the affect variables and the formative assessment attributes. The formative assessment attribute were: learning progression, learning goals, and descriptive feedback. The affective variables included academic efficacy and eagerness to learn, the factors that promote increase in learning. This result also supports the recommendation by ECZ (2015 & 2016) that teachers should give a lot of classwork in form of ICFA to assist mastery and in – depth understanding of concepts to improve academic performance in radioactivity. Therefore, teachers of Science 5124 (Physics) should take advantage of the strong positive correlation and give more ICFAs to assist mastery and in-depth understanding of concepts taught and improve academic achievement scores in radioactivity.

5.5 Efficacy of ICFA on improving pupils' academic achievement on radioactivity

In the third problem of the study, the question 'What is the efficacy of ICFA on improving pupils' academic performance in radioactivity?' was asked. The difference in learner performance was statistically significant since t- statistic of 7.534, sig. (2-tailed) had a $p = .000 < 0.05$. This implies that ICFA enhanced learner performance in radioactivity by 12. 42 units. This led to the rejection of the null hypothesis which stated that there is no significant difference in performance between learners who received ICFA and those who did not receive ICFA. Therefore, ICFA has a statistically significant positive influence on learners' achievement in terms of performance, mastery and in – depth understanding of concepts taught in radioactivity.

(see Table 4.7 and Figure 4.3). This means that the increase in the academic performance (dependent variable) was influenced by ICFA (independent variable) by way of collaborative and cooperative dialogue of learners with the More Knowledgeable Other (MKO) and mediated by the teacher. The MKO in this study were the teacher and peers while the less knowledgeable individuals were the pupils who received assistance from the MKO. It can be conclude that the efficacy of ICFA on academic performance in radioactivity is 12.42 units. This result is in line with the recommendation by ECZ (2015 & 2016) that teachers of Science 5124 (Physics) should give their learners a lot of classwork in form of ICFA in order to assist mastery and in – depth understanding of concepts to improve academic performance on radioactivity. The findings also coincided with Vygotsky's SCT assertion that individual mental functioning has social origins; and an emphasis on the mediated nature of human action (Wertsch, 1991). Besides, it supports Vygotsky's SCT that the origin of knowledge construction should not be sought in the mind but in the social interaction co-constructed between a more and a less knowledgeable individual (Lantolf, 2008). It is also in agreement with the SCT emphases on: 1) Mediation as being central to learning; 2) Social interaction as the basis of learning and development; 3) Learning as a process of apprenticeship and internalization in which skills and knowledge are transformed from the social into the cognitive plane; 4) and the zone of proximal development (ZPD) as the primary activity space (Figure 1.1) in which learning occurs (Walqui, 2006). In this study, mediation was equated to Scaffolding which took the form of instant remedial work in the follow – up ICFA, the information about the correct results and explanations given to pupils on areas of the subject material which were identified as challenging difficult during the first class exercise session. Furthemore, this result agrees with the findings on research question 1 of this study where the participants had a positive perception of a relationship between ICFA and academic achievement in radioactivity. The participants agreed that ICFA helped to improve their performance in the post test on radioactivity. This result further agrees with findings on research question 2 of the current study that there is a strong positive correlation between ICFA and academic performance in radioactivity. This result confirms Vygotsky's Sociocultural Theory (SCT) of cognitive development (Vygotsky, 1978), that Children

acquire their cultural values, beliefs and problem-solving strategies through collaborative dialogues with MKO of society by a socially mediated process. This is because the participants who received ICFA attained an improvement in academic performance of 12.42 units in radioactivity based on collaborative dialogue with the MKO during ICFA activites.

The outcome of this study supports previous findings by many researchers on the influence of formative assessment on academic achievement in literature. It coincides with Moyosore, (2015) who reported that when formative assessments were used for diagnostic purposes, it improved the academic performance of the students on the subject and also enabled them to understand the contents of the subject better than the use of summative test only. Also formative tasks served as a basis for finding out the sources of difficulties on the contents of the subject (William, 2010). In this way, the teacher would be able to give necessary remediation and corrective measure to improve the students understanding of the contents of the subject material in order to improve their academic achievements in the subject concerned. Besides, Dahal(2019) agrees with the findings of this study that class tasks of students influenced their achievement level. He added that regularity of teachers' responses (check) and effective feedback on the students' subject classwork had a creditable role in improving their students' learning performance. Therefore, by integrating ICFA in their classroom instruction teachers can help improve pupils' academic performance on radioactivity in Science 5124 (Physics). Mehmood, Hussain & Khalid (2012), Chemeli, (2019) and William (2010) all agreed that formative assessment is useful to the pupils as it helped to diagnose their learning difficulties and the prescription of alternative remedial measure all towards improvement in the academic achievement in the subject. To the teacher, formative assessment serves as means of locating the specific difficulties that pupils are experiencing within the contents of the subject and forecast the appropriate teaching strategies to help the pupils overcome the difficulties in contents in order to improve their academic achievements in the subject. Findings further agree with the report by Chemeli (2019), which revealed that Formative Assessment Strategies (FAS) had a positive impact on learners' achievement. It was also reported that the reasons for positive impact

included: easeness of the teachers' workload as a result of FAS; raised learners' attitudes and interest; improved learners' critical thinking; and teachers and students enjoyment derived from using FAS. Also, it was repoted that the five FAS improved learners' acquisition of problem solving skills before and after the intervention respectively.

These findings also agree with findings of the study by Mwebaza (2010) who established that teachers strongly agreed that Continuous Assessment (CA) strategies, including class recap exercises improved the teaching and the learning processes. The report added that most of the teachers indicated that CA strategies strongly helped them to identify weak students. Drawing on teachers' and students' perceptions, there were very many continuous assessment strategies used and these were found to have had a positive relationship to students' improved performance in the final examinations. This was because through CA, teachers had a tendency to realize their own weaknesses in teaching and those of their students and endeavored to perfect them.

However, this result does not agree with Onah and Ugwu (2010), who found that performance in physics depended on sex (gender), teacher qualification and laboratory facilities. This shows that ICFA or indeed formative assessment is not among the factors of improved academic performance in Physics. A possible reason for this could be that the education policy and clasroom instruction practices laid emphasis on the deployment of formative assessment. It may also imply that even the learners were interested in their learning and so they put in their best except they were let down by issues to do with gender, teacher qualification and laboratory facilities in the schools, as revealed by the study.

5.6 Chapter summary

All the participants regardless of group (experimental or control) were essentially similar in terms of knowledge level of the subject matter in radioactivity at the beginning of the study. It was important for all the participants to be at the same knowledge level of th subjecr matter in order to determine efficiently the effectiveness of ICFA on improving academic performance. The participants perceived that a positive association existed between ICFA and academic achievement in radioactivity. Additionally, there

was a strong positive correlation (r = 0.85, (2-tailed), p = 0.008) between ICFA and academic performance in radioactivity. Furthermore, ICFA statistically significantly improved academic achievement by 12.42 units with p = .000 < 0.05. Therefore, it was concluded that ICFA has a statistically significant positive infuence on learners' improved academic achievement in radioactivity. This implies that when ICFA is appropriately integrated into the classroom instruction it would assist learners to gain mastery and deeper understanding of concepts taught in radioactivity and improve performance.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusion

The main purpose of the study was to determine the efficacy of ICFA on improving pupils' academic performance in radioactivity at selected secondary schools of Chongwe District in Zambia**.** The study revealed that participants' perception was that there was a positive relationship between ICFA and academic achievement in radioactivity. This means that the participants valued the use of ICFA as a tool to improve their academic performance in radioactivity. Findings further showed that there exists a strong positive correlation between ICFA and academic achievement ($r = 0.85$, (2-tailed) $p = 0.008$). This shows that the extent of the relationship of ICFA with pupils improved academic performance in radioactivity is valuable. The result implies that when the number of ICFA tasks is increased the performance of the pupils in radioactivity is expected to improve significantly.

The results also showed that ICFA has a statistically significant positive influence on learner performance in radioactivity and enhanced learner performance by 12.42 units with $p = .000 < 0.05$. This implies that when ICFA is appropriately applied in the classroom instruction, it can assist mastery and in-depth understanding of the concepts taught on radioactivity and improve learners' academic performance in radioactivity. The integration of ICFA in the classroom instruction process can help both teachers and learners. Teachers would be able to identify pupils with learning challenges; the specific area where the challenge lies; and have an opportunity to address these challenges promptly. Learners would be able to identify their own weaknesses, difficult areas of the subject matter and a chance of doing remedial work in order to improve their academic achievement scores.

6.2. Recommendations

The study recommends that teachers of Science 5124 (Physics):

6.2.1. should increase the use of ICFA during classroom instruction to assist mastery and in-depth understanding of the concepts taught on radioactivity and improve learners' academic performance.

6.2.2. should be exposed to school-based seminars, conferences and workshops on how to deploy ICFA effectively in radioactivity for better results.

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APPENDICES

Appendix A: Pre-test and Post-test scores for Experimental group

Table 8.1: Science 5124(Physics) Achievement Test results for Experimental class

PARTICIPANT CODE	PRETEST	POSTTEST
E001	20	50
E002	15	50
E003	10	75
E004	20	65
E005	20	60
E006	10	70
E007	20	75
E008	5	55
E009	10	50
E010	15	60
E011	0	55
E012	15	50
E013	15	50
E014	20	60
E015	15	75
E016	5	50
E017	20	70
E018	5	60
E019	20	70
E020	15	65
E021	15	55
E022	10	45
E023	20	60
E024	10	A
E025	15	70
E026	0	55

E027	15	60
E028	20	50
E029	15	65
E030	5	70
E031	10	60
E032	15	65
E033	10	75
E034	20	A
E035	10	50
E036	5	45
E037	5	55
E038	10	65
E039	20	45
E040	15	60
E041	10	45
E042	15	60
E043	10	50
E044	10	55
E045	20	50
E046	5	70
E047	0	65
E048	15	50
E049	5	65
E050	10	60
E051	20	65
E052	15	75
E053	10	45
E054	25	A
E055	15	70
E056	10	50
E057	10	60

E058	5	55
E059	15	70
E060	10	65

Appendix B: Pre-test and Post-test results for Control group

Table 8.2: Science 5124 (Physics)Achievement Test results for Control class

PARTICIPANT'S CODE	PRE-TEST	POST-TEST
C001	10	25
C002	25	40
C003	15	40
C004	20	55
C005	10	50
C006	15	45
C007	5	35
C008	10	60
C009	20	40
C010	15	45
C011	10	40
C012	15	50
C013	15	25
C014	20	55
C015	15	40
C016	10	65
C017	15	55
C018	5	60
C019	20	40
C020	15	45
C021	5	A
C022	10	40
C023	20	30
C024	15	60
C025	15	45
C026	20	55
C027	10	35
C028	20	45

C029	10	45
C030	5	55
C031	10	40
C032	15	55
C033	10	60
C034	20	45
C035	10	40
C036	5	45
C037	15	50
C038	10	45
C039	20	55
C040	15	45
C041	10	40
C042	25	45
C043	10	60
C044	15	40
C045	5	50
C046	25	45
C047	10	45
C048	15	50
C049	5	45
C050	10	50
C051	20	50
C052	15	45
C053	0	50
C054	25	40
C055	10	50
C056	20	55
C057	10	45
C058	5	55
C059	15	45
C060	10	60

Appendix C: Science 5124 (Physics) Achievement Test for pupils

CODE OF PARTICIPANT: ……..... Subject: SCIENCE 5124 (PHYSICS)

INSTRUCTIONS **Time: 45 minutes**

Mark with a cross (X) on the letter of the answer of your choice on this paper

---

1.Which statement best describes the structure of an atom?

a) A positive core surrounded by electrons packed tightly around it

b) A particle comprised of a mixture of protons, electrons and neutrons

c) A tiny nucleus of protons and neutrons with electrons orbiting around it.

d) Large core of protons and electrons surrounded by neutrons.

2.Of the following, when an atom emits an alpha particle its mass number is ..

a) Decreased by 4 and its atomic number is increased by 2

b) Decreased by 4 and its atomic number decreased by 2

c) Increased by 4 and its atomic number is increased by 2

d) Decreased by 4 and its atomic number is decreased by 2.

3.Of the following the one which can penetrate through 20 cm thick steel plate is..

a) Positive rays b) α-rays c) β-rays d) γ-rays

4.The half-life period of a radioactive nuclide is 3 hours, its activity will be reduced by a factor of

$a)\ \frac{1}{8}$ b) $\frac{1}{6}$ $c)\ \frac{1}{27}$ $d)\ \frac{1}{9}$

5.Which of the following radioactive decay emits α –particle?

a) ${}^{214}_{82}Pb \longrightarrow {}^{214}_{93}Bi + \ldots$ $b)$ ${}^{234}_{91}Th \longrightarrow {}^{234}_{91}Pa +$ ..

c) ${}^{238}_{92}U \longrightarrow {}^{234}_{90}Th + \ldots$ d) ${}^{234}_{91}Pa \longrightarrow {}^{234}_{92}U + \ldots$

6. A sample contains 16 g of radioactive material, the half-life of which is 2 days. After 32 days the amount of radioactive material left in the sample is

a) 1 g b) 0.5g c) 0.25g d) <1g

7. Which of the following is true about a neutral atom?

a) the number of protons equals the number of neutrons

b) the number of protons equals the number of electrons

c) the number of neutrons equals number of electrons

d) the number of protons greater than number of electrons

8. As a result of radioactive decay a ${}^{238}_{92}U$ nucleus is changed to ${}^{234}_{91}Pa$ nucleus.

During this decay the particles emitted are

a) two β -particles and one proton b) two β-particles and one neutron

c) one α-particles and one β-particles d) one proton and two neutrons

9. If the half-life of a radioactive metal is 2 years

a) the metal will completely disintegrate in 2 years

b) $1/4^{th}$ of it will remain after 8 years

c) the metal will completely disintegrate in 4 years

d) it will never disintegrate completely

10. When Aluminum is bombarded with α-particles, radioactive phosphorus is

formed, that is ${}_{13}Al^{27} + {}_{2}He^{4} \rightarrow {}_{15}P^{30}$. One more particle formed in the reaction is

a) an electron b) a neutron

c) negatively charged helium atom d) a negatively charged hydrogen atom.

11. If α, β, γ-rays have ionizing powers I_α, I_β, I_γ respectively, then

a) $I_\alpha, > I_\beta, > I_\gamma$ b) $I_\alpha, < I_\beta, < I_\gamma$ c) $I_\alpha, = I_\beta, = I_\gamma$ d) $I_\alpha, < I_\beta, > I_\gamma$

12. Which of the following is correct statement

a) β -radioactivity is the process in which an electron is emitted from an

unstable atom whose atomic number Z remains unchanged

b) γ -radioactivity is the process in which the daughter nucleus has atomic

number 1 unit more than that of the parent nucleus

c) α -radioactivity is the process in which an unstable atom emits the nucleus

of a helium atom

d) $\alpha\ \gamma$ -radioactivity is the process in which a heavy atom emits

electromagnetic radiations of very high frequency

13. An α-particle is a helium nucleus, having ……..

a) two protons and two neutrons b) two protons and one neutron

c) three protons and two neutrons d) three protons and one neutron

14. Isotopes are atoms having

a) Same number of protons but different number of neutrons

b) Same number of protons but different number of protons

c) Same number of protons and neutrons

d) Same number of electrons and neutrons

15. Which of the following statements are true regarding radioactivity?

a) All radioactive elements decay exponentially with time

b) Half life time of a radioactive element is time required for one half of the radioactive atoms to disintegrate

c) Age of earth can be determined with the help of radioactive dating

d) Half life time of a radioactive element is fifty percent of its average life period

16. Consider a radioactive material of half-life 1.0 minute. If one of the nuclei decays now, the next one will decay

a) after 1 minutes b) after $^1/_2$ minutes c) after 2 minutes d) after any time

17. Moderators are used in the nuclear reactors to

a) accelerate the neutrons b) slow down the neutrons

c) slow down protons d) accelerate the electrons

18. The 210*Po* decays by the emission of an alpha particle. The reaction can be written $^{210}\text{Po} \longrightarrow {}^{206}\text{Pb} + {}^{4}\text{He}$

This Polonium, *Po* nucleus has 84 protons and 126 neutrons. The ratio of protons to neutrons is Z/N =?

a) 84/126 b) 82/124 c) 48/ 216 d) 84/162

19. What isotope decays into Lead, Pb - 210 when it undergoes beta decay?

$$^{A}_{Z}X \longrightarrow {}^{210}_{82}Pb + {}^{0}_{-1}e$$

a) $^{210}_{82}Tl$ b) $^{220}_{83}Tl$ c) $^{210}_{81}Tl$ d) $^{220}_{81}Tl$

20. The nuclide radium- 226 undergoes alpha decay by emitting an alpha particle according to the equation below. Determine the nuclide symbol of the new atom $^{226}_{88}Ra \longrightarrow \square + {}^{4}_{2}He$

a) $^{222}_{86}Rn$ b) $^{228}_{86}Rn$ c) $^{222}_{90}Rn$ d) $^{228}_{84}Rn$

END

THANK YOU FOR YOUR PARTICIPATION

Appendix D: Likert scale for pupils

LIKERT SCALE

INSTRUCTIONS TO PARTICIPANTS CODE OF PARTICIPANT'S CODE …….

1. Put a tick (√) in the box with the statement that best matches the way you understand the main sentence.
2. Do not write your name on this paper
3. Please try to answer all the statements in this paper.

1. The class exercises given to us by our teacher helped me to improve my grades in the test on radioactivity in Science 5124 (Physics).

Strongly agree	Agree	Disagree	Strongly disagree

2. Class exercises were useful because they helped me to master the key points taught on radioactivity in Science 5124 (Physics) lessons.

Strongly agree	Agree	Disagree	Strongly disagree

3. Teachers should give pupils a lot of class exercises in order to assist mastery of concepts to improve performance on radioactivity in Science 5124 (Physics).

Strongly agree	Agree	Disagree	Strongly disagree

4. The more class exercises a learner did on radioactivity, the better was one's performance and vice versa.

Strongly agree	Agree	Disagree	Strongly disagree

5. Class exercises were an important part of every lesson on radioactivity, they were not a waste of time for pupils.

Strongly agree	Agree	Disagree	Strongly disagree

6. Questions given to us in class exercises were taken from what we learned during a lesson on radioactivity in science 5124 (Physics).

Strongly agree	Agree	Disagree	Strongly disagree

7. We were free to ask questions to help us understand what we learned during a lesson on radioactivity in Science 5124 Physics.

Strongly agree	Agree	Disagree	Strongly disagree

8. The questions our teacher asked when he was teaching us helped me gain deeper understanding of concepts that were taught on radioactivity.

Strongly agree	Agree	Disagree	Strongly disagree

9. Pupils should generate questions for class exercise because they know where they find difficulties to understand concepts taught on radioactivity in Science 5124 Physics.

Strongly agree	Agree	Disagree	Strongly disagree

10. I enjoyed working out solutions to questions given as class exercise after taking a lesson on radioactivity Science 5124 (Physics).

Strongly agree	Agree	Disagree	Strongly disagree

11. I made sure I tried to answer all the questions given as class exercise on radioactivity in Science 5124 (Physics).

Strongly agree	Agree	Disagree	Strongly disagree

12. The class exercises helped me to score high grades in the test on radioactivity in Science 5124 Physics.

Strongly agree	Agree	Disagree	Strongly disagree

13. When I failed to give all correct solutions to questions given as class exercise on radioactivity in Science 5124 (Physics), I put in more effort the in following task.

Strongly agree	Agree	Disagree	Strongly disagree

14. I made sure that I did correction on any question that I did not score correctly after my teacher had marked my class exercise on radioactivity in Science 5124 (Physics).

Strongly agree	Agree	Disagree	Strongly disagree

15. I believe that class exercises were important because they helped correct my misunderstanding of concepts taught on radioactivity in Science 5124 (Physics) lessons.

Strongly agree	Agree	Disagree	Strongly disagree

16. Class exercises did make a great positive contribution to my performance in the test on radioactivity in Science 5124 (Physics).

Strongly agree	Agree	Disagree	Strongly disagree

17. There was need for a class exercise after every lesson on radioactivity in Science 5124 (Physics) to help me master what was learned.

Strongly agree	Agree	Disagree	Strongly disagree

18. Class exercises were necessary because they helped me to focus on key points of a lesson learned on radioactivity in Science 5124 (Physics).

Strongly agree	Agree	Disagree	Strongly disagree

19. It is important for teachers to assist pupils to make corrections on class exercises given on radioactivity to help them learn from their mistakes.

Strongly agree	Agree	Disagree	Strongly disagree

20. Pupils who did not take class exercises seriously scored low grades in the test on radioactivity in Science 5124 (Physics).

Strongly agree	Agree	Disagree	Strongly disagree

END OF TASK

THANK YOU VERY MUCH FOR YOUR PARTICIPATION

Appendix E: Consent letter for pupils

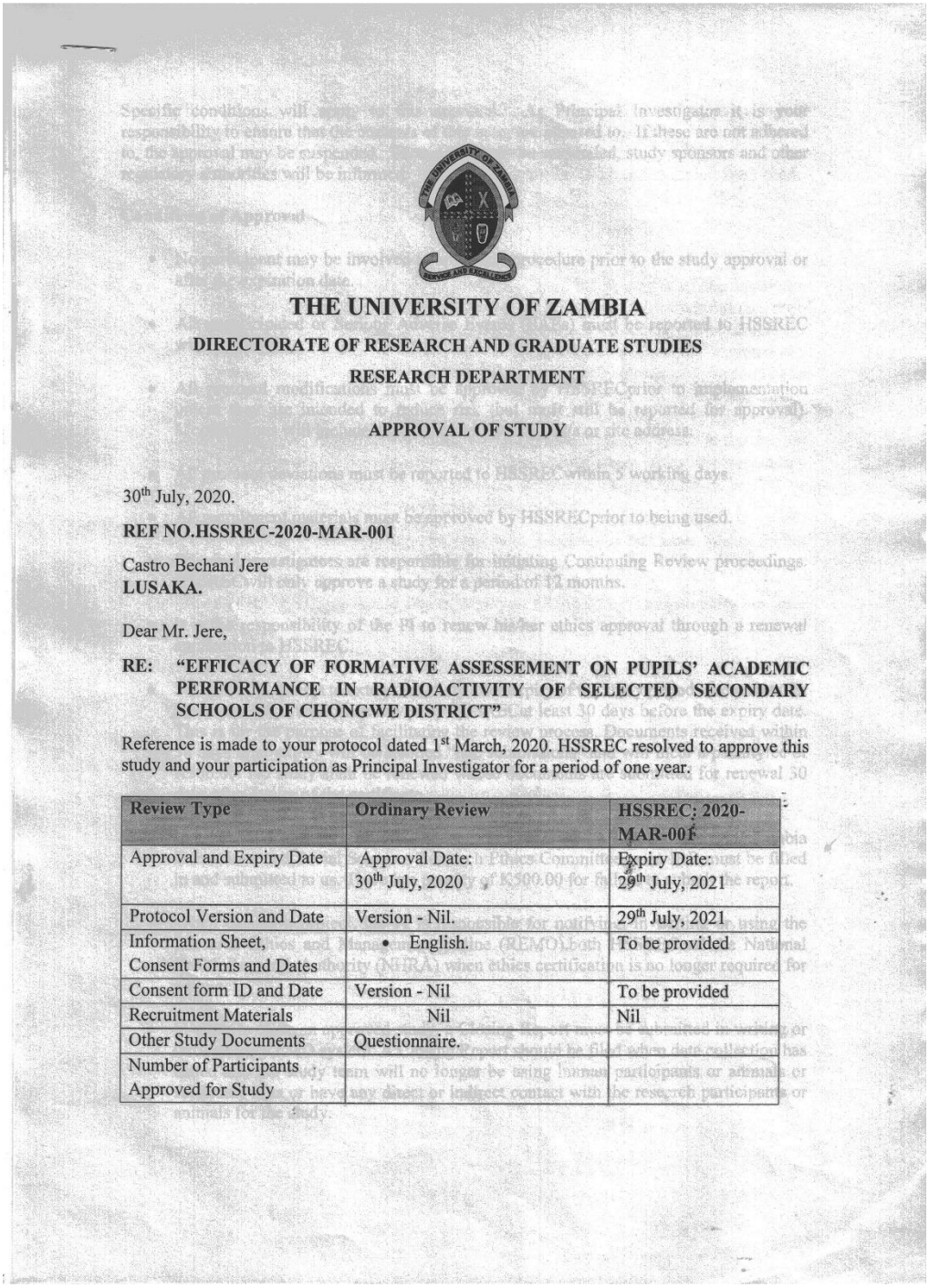
INFORMED CONSENT FORM (ICF)

I …….. (name), *freely agree* to participate in a research entitled: **Efficacy of formative assessment on pupils' academic performance in radioactivity at selected secondary schools of Chongwe district in Zambia.** I understand that I shall attend a learning session for a period of two weeks and shall be required to complete an Attitude scale and write two tests in Science 5124 Physics; based on a topic 'Radioactivity' in science 5124 Physics at grade 12 level within my school. I also understand that my results from the tests and Attitude scale shall only be used for the purpose of this research, and will not affect my performance in any other tests or examinations that I will undertake in my future learning.

Signature…… Date ……

THANK YOU VERY MUCH FOR YOUR CONSENT

Appendix F: Ethical clearance letter



THE UNIVERSITY OF ZAMBIA

DIRECTORATE OF RESEARCH AND GRADUATE STUDIES

RESEARCH DEPARTMENT

APPROVAL OF STUDY

30th July, 2020.

REF NO.HSSREC-2020-MAR-001

Castro Bechani Jere
LUSAKA.

Dear Mr. Jere,

RE: "EFFICACY OF FORMATIVE ASSESSEMENT ON PUPILS' ACADEMIC PERFORMANCE IN RADIOACTIVITY OF SELECTED SECONDARY SCHOOLS OF CHONGWE DISTRICT"

Reference is made to your protocol dated 1st March, 2020. HSSREC resolved to approve this study and your participation as Principal Investigator for a period of one year.

Review Type	Ordinary Review	HSSREC: 2020-MAR-001
Approval and Expiry Date	Approval Date: 30th July, 2020	Expiry Date: 29th July, 2021
Protocol Version and Date	Version - Nil.	29th July, 2021
Information Sheet, Consent Forms and Dates	• English.	To be provided
Consent form ID and Date	Version - Nil	To be provided
Recruitment Materials	Nil	Nil
Other Study Documents	Questionnaire.	
Number of Participants Approved for Study		

Specific conditions will apply to this approval. As Principal Investigator it is your responsibility to ensure that the contents of this letter are adhered to. If these are not adhered to, the approval may be suspended. Should the study be suspended, study sponsors and other regulatory authorities will be informed.

Conditions of Approval

- No participant may be involved in any study procedure prior to the study approval or after the expiration date.
- All unanticipated or Serious Adverse Events (SAEs) must be reported to HSSREC within 5 days.
- All protocol modifications must be approved by HSSRECprior to implementation unless they are intended to reduce risk (but must still be reported for approval). Modifications will include any change of investigator/s or site address.
- All protocol deviations must be reported to HSSRECwithin 5 working days.
- All recruitment materials must be approved by HSSRECprior to being used.
- Principal investigators are responsible for initiating Continuing Review proceedings. HSSRECwill only approve a study for a period of 12 months.
- It is the responsibility of the PI to renew his/her ethics approval through a renewal application to HSSREC.
- Where the PI desires to extend the study after expiry of the study period, documents for study extension must be received by HSSRECat least 30 days before the expiry date. This is for the purpose of facilitating the review process. Documents received within 30 days after expiry will be labelled "late submissions" and will incur a penaltyfee of K500.00. No study shall be renewed whose documents are submitted for renewal 30 days after expiry of the certificate.
- Every 6 (six) months a progress report form supplied by The University of Zambia Humanities and Social Sciences Research Ethics Committee as an IRB must be filled in and submitted to us. There is a penalty of K500.00 for failure to submit the report.
- When closing a project, the PI is responsible for notifying, in writing or using the Research Ethics and Management Online (REMO),both HSSRECand the National Health Research Authority (NHRA) when ethics certification is no longer required for a project.
- In order to close an approved study, a Closing Report must be submitted in writing or through the REMO system. A Closing Report should be filed when data collection has ended and the study team will no longer be using human participants or animals or secondary data or have any direct or indirect contact with the research participants or animals for the study.

- Filing a closing report (rather than just letting your approval lapse) is important as it assists HSSRECin efficiently tracking and reporting on projects. Note that some funding agencies and sponsors require a notice of closure from the IRB which had approved the study and can only be generated after the Closing Report has been filed.

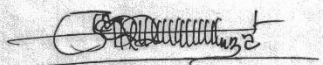
- A reprint of this letter shall be done at a fee.

- All protocol modifications must be approved by HSSREC by way of an application for an amendment prior to implementation unless they are intended to reduce risk (but must still be reported for approval). Modifications will include any change of investigator/s or site address or methodology and methods. Many modifications entail minimal risk adjustments to a protocol and/or consent form and can be made on an Expedited basis (via the IRB Chair). Some examples are: format changes, correcting spelling errors, adding key personnel, minor changes to questionnaires, recruiting and changes, and so forth. Other, more substantive changes, especially those that may alter the risk-benefit ratio, may require Full Board review. In all cases, except where noted above regarding subject safety, any changes to any protocol document or procedure must first be approved by HSSREC before they can be implemented.

Should you have any questions regarding anything indicated in this letter, please do not hesitate to get in touch with us at the above indicated address.

On behalf of HSSREC, we would like to wish you all the success as you carry out your study.

Yours faithfully,



Dr. J. Mwanza

Dip. Clin. Med. Sc., BA.M.Soc., PhD

CHAIRPERSON
THE UNIVERSITY OF ZAMBIA HUMANITIES AND
SOCIAL SCIENCES RESEARCH ETHICS COMMITTEE - IRB

cc: Director, Directorate of Research and Graduate Studies
Assistant Director (Research), Directorate of Research and Graduate Studies
Assistant Registrar (Research), Directorate of Research and Graduate Studies

Appendix G: Permission to go into the field

THE UNIVERSITY OF ZAMBIA
SCHOOL OF EDUCATION

Telephone: 291381
Telegram: UNZA, LUSAKA
Telex: UNZALU ZA 44370

PO Box 32379
Lusaka, Zambia
Fax: +260-1-292702

Date 2nd MARCH 2020

TO WHOM IT MAY CONCERN

Dear Sir/Madam

RE: FIELD WORK FOR MASTERS/ PhD STUDENTS

The bearer of this letter Mr./~~Ms~~ JERE BECHANI CASTRO Computer number 2018248481 is a duly registered student at the University of Zambia, School of Education.

He/~~She~~ is taking a Masters/~~PhD~~ programme in Education. The programme has a fieldwork component which he/~~she~~ has to complete.

We shall greatly appreciate if the necessary assistance is rendered to him/~~her~~/.

Yours faithfully

SCHOOL OF EDUCATION
P.O. BOX 32379, LUSAKA
- 2 JAN 2020
ASSISTANT DEAN (PG)
UNIVERSITY OF ZAMBIA

B. Kalinde (Dr)
ASSISTANT DEAN POSTGRADUATE STUDIES- SCHOOL OF EDUCATION

cc: Dean-Education
Director-DRGS

Appendix H: Instructionally Controllable Formative Assessment form

Section A: Application of radioisotopes

Explain five different uses of radioisotopes

1. ……
   ……
2. ……
   ……
3. ……
   ……
4. ……
   ……
5. ……
   ……

Section B: Nature of radioactivity

All radioactive nuclides have certain features in common. Briefly explain five characteristics of radioactive nuclides.

1. ……
   ……
2. ……
   ……
3. ……
   ……
4. ……
   ……
5. ……
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Section C: Detection of radioactivity

Radioactivity can be detected in a number of different ways. Briefly explain how each of the following devices is used to detect radioactivity.

1. Scintillation counter
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2. Spark counter
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3. Geiger-müller (GM) tube
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