THE EFFECTIVENESS OF COMPUTER APPLICATIONS TECHNOLOGY AS A VEHICLE TO PROMOTE 21ST-CENTURY SKILLS TO THE LEARNERS OF THE LEJWELEPUTSWA DISTRICT.

BY

MAKHASANE W.M

Submitted in fulfilment of the requirements for the Degree

MASTER OF EDUCATION

in the

Faculty of Humanities at the
Central University of Technology, Free State

Supervisor: Dr. C Mphojane (D Ed, Leadership and Management)

Co-supervisor: Prof. L Schlebusch (PhD, IT and Curriculum Studies)

WELKOM

SEPTEMBER 30, 2025

© Central University of Technology, Free State

DECLARATION OF ORIGINALITY

I, Winnie Madikgetho Makhasane, _____, hereby declare that my thesis titled "THE EFFECTIVENESS OF COMPUTER APPLICATIONS TECHNOLOGY AS A VEHICLE TO PROMOTE 21ST-CENTURY SKILLS FOR LEARNERS IN THE LEJWELEPUTSWA DISTRICT" is my original work. It has not been submitted or presented for academic credit at any other university. Furthermore, I certify that all sources referenced and cited in this dissertation have been thoroughly acknowledged.

_____ _____

Signature of student **Date**

© Central University of Technology, Free State

ABSTRACT

The Computer Applications Technology (CAT) subject has become essential for promoting learners' success in the contemporary technology-driven environment. Nevertheless, several challenges arise in implementing this subject, despite its significant advantages. Thus, the aim of this paper is to examine the effectiveness of using CAT to promote 21st-century skills (21CS) in learners within the Lejweleputswa District in the Free State Province of South Africa. The study used Technological Pedagogical Content Knowledge (TPACK) as the theoretical framework to achieve this objective. A mixed-methods research design was employed. The sample consisted of the 3 principals supervising schools offering CAT, 16 CAT teachers and 131 CAT learners from secondary schools providing CAT. The data were collected through semi-structured interviews and structured questionnaire. Moreover, the data were analysed using descriptive statistics, inferential statistics, and a chi-square analysis.

The study's major findings revealed that both CAT learners and CAT teachers believe that 21CS are taught through CAT and that CAT learners' 21CS surpass those of their non-CAT peers. Additionally, CAT teachers observed that CAT learners' communication skills do not exceed those of their non-CAT peers. Moreover, CAT learners frequently struggle with English.

The study also identified several factors that contribute to the successful offering of CAT. Firstly, having adequate resources, such as sufficient computers, printers, and Internet access, is essential for facilitating a smooth teaching and learning process. Additionally, qualified teachers who receive ongoing support from a CAT subject adviser who provides necessary teaching materials to enhance the effectiveness of the subject.

However, several challenges that hinder the effective teaching of CAT exist. A major issue is learners' difficulty in understanding the Language of Learning and Teaching (LoLT). Teachers have noted that many learners struggle with English, which results in incorrect answers during examinations. Additionally, many learners enrolled in CAT have previously failed a grade or have advanced to the next grade despite being inadequately prepared, which negatively impacts their academic performance. Furthermore, the study's findings revealed that one of the primary challenges

© Central University of Technology, Free State

associated with effective learning of 21CS through CAT is the financial burden associated with replacing necessary stolen resources.

To address the gap between LoLT and understanding, the study recommends that CAT teachers adopt presentation-based learning methods. Specifically, learners should undertake informal, mini-research activities that have CAT-related content, and they should present their findings. This approach may enhance learners' confidence, improve their English proficiency, and enhance their communication skills. In addition, the study recommends that teachers develop targeted support for advanced learners. The support may include personalised assessments to identify each learner's preferred learning style, whether visual, auditory, or kinaesthetic. By understanding how advanced learners learn best, teachers can customise their teaching methods using multimedia resources, hands-on activities, or cooperative group work. This tailored approach will not only improve comprehension and retention but will also foster an inclusive environment that addresses the diverse needs of all learners. Furthermore, the study recommends that schools offering CAT enhance their security measures and consider insuring their computer laboratories and equipment. This would help mitigate the frequent need to replace stolen devices, ensuring that learners do not fall behind due to financial limitations.

© Central University of Technology, Free State

ACKNOWLEDGEMENTS

I would like to express my heartfelt gratitude and admiration to the following individuals and organisations:

- First and foremost, I would like to thank my heavenly Father for my life, his wisdom, his devotion, and the opportunity to begin and complete this study.
- I would also like to extend my gratitude to the Central University of Technology (CUT), Free State, for their financial assistance in completing this project.
- To my promoter, Dr. C. Mphojane, thank you for your invaluable support, development guidance, and thorough feedback throughout my study. I appreciate your patience during challenging times and your insightful contributions to my academic journey, which helped keep me motivated.
- I am grateful for the encouragement and input from my co-promoter, Dr. L. Schlebusch. This academic work would not have been possible without your efforts. I am thrilled to have had the opportunity to study alongside you and feel honoured to have been guided by someone of your calibre.
- Finally, I would like to thank the Free State Department of Basic Education, as well as the principals, Computer Applications and Technology teachers, and learners in the Free State Province and Lejweleputswa District, for their willingness to contribute to my study.

© Central University of Technology, Free State

DEDICATION

This dissertation is dedicated to my parents, Seshupo Phillimon and Mmalefu Bettie Moalosi, my brother Tshepo Oratile Makhasane, my younger sister Martha Mpolai Makhasane, and my beloved daughter Omphemetse Onthatile Senatla. They have been my source of inspiration and motivation throughout this research project, and I could not have completed it without their support. Thank you so much for everything.

© Central University of Technology, Free State

TABLE OF CONTENTS

© Central University of Technology, Free State

© Central University of Technology, Free State

© Central University of Technology, Free State

© Central University of Technology, Free State

© Central University of Technology, Free State

© Central University of Technology, Free State

© Central University of Technology, Free State

© Central University of Technology, Free State

LIST OF FIGURES

© Central University of Technology, Free State

LIST OF TABLES

© Central University of Technology, Free State

© Central University of Technology, Free State

LIST OF APPENDICES

© Central University of Technology, Free State

LIST OF ABBREVIATIONS AND ACRONYMS

21CS	21st-Century Skills
4IR	Fourth Industrial Revolution
APPS	Applications
B Ed	Bachelor of Education
CAPS	Curriculum and Assessment Policy Statement
CAT	Computer Applications Technology
CK	Content Knowledge
CUT	Central University of Technology
CV	Curriculum Vitae
DBE	Department of Basic Education
DoE	Department of Education
EMAIL	Electronic Mail
FET	Further Education and Training
FRIC	Faculty of Research and Innovation Committee
GPS	Global Positioning Systems
HTML	HyperText Markup Language
ICT	Information and Communication Technology
IT	Information Technology
LAN	Local Area Network
LoLT	Language of Learning and Teaching

© Central University of Technology, Free State

LP_x	Learner Participant
MAX	Maximum
OBE	Outcomes-Based Education
PP_x	Principal Participant
PAN	Personal Area Network
PAT	Practical Assessment Task
PCK	Pedagogical Content Knowledge
PGCE	Postgraduate Certificate in Education
PK	Pedagogical Knowledge
STEM	Science, Technology, Engineering, and Mathematics
TCK	Technological Content Knowledge
TK	Technology Knowledge
TP_x	Teacher Participant
TPACK	Technological Pedagogical Content Knowledge
TPK	Technological Pedagogical Knowledge
VLOOKUP	Vertical Lookup
VoIP	Voice over Internet Protocol
WAN	Wide Area Network
WIFI	Wireless Fidelity
WLAN	Wireless Local Area Network
WP	Word Processor

© Central University of Technology, Free State

WWW	World Wide Web

© Central University of Technology, Free State

CHAPTER ONE: RESEARCH INTRODUCTION

1.1 INTRODUCTION

This research focuses on the subject of Computer Applications Technology (CAT), which is available to learners in the Further Education and Training (FET) phase. CAT is considered vital for learners to succeed in a technology-driven world. According to Nordhaus (2015:9), CAT represents one of the most effective means for a country's economy to prosper by contributing educated members of the public. This is largely due to its ability to integrate auditory and visual learning, enhancing comprehension of the material (Lawrence 2018:n.p.). This integration is why organisations, including educational institutions, utilise computer applications software for communication both at the provincial and international levels. Furthermore, Thalheimer (2015:n.p.) highlights that individuals generally remember 10% of what they hear, 30% of what they see, and 50% of what they both see and hear. Consequently, given that CAT effectively combines both auditory and visual elements, its significance in today's environment cannot be overstated.

CAT has significantly contributed to the development of multimedia and effective communication methods (Roger 2019:n.p.). Moreover, CAT has emerged as a vital area for gathering meaningful data. However, it necessitates a certain level of computer proficiency, requiring learners to be able to read and write using a computer. As a result, learners in CAT classrooms should also possess information literacy skills, enabling them to find, analyse, and apply information within a specific context (Alaab, Zaidan, Talal and Kiah, 2017:49)

Furthermore, Siriwardhana, Porambage, Liyanage and Ylianttila (2021:1160) distinguish between two types of computer users, namely technical and application. Technical users primarily support and develop applications for others, requiring a solid understanding of computer hardware and software. In contrast, application users, who make up the majority of computer users, may not be comfortable with programming but are generally familiar with software applications. According to Bourgeois and Bourgeois (2014:457), this familiarity stems from subjects such as CAT being taught in schools.

© Central University of Technology, Free State

CAT is a subject that aims to provide learners with vital technological skills for the future (Hains 2019:n.p.). These skills encompass both technical literacy and end-user literacy. Technical literacy allows learners to engage critically with technology, comprehend its implications, and harness its potential to address real-world challenges. Conversely, end-user literacy equips learners to utilise software and tools, thereby maximising their productivity effectively (Barricelli, Cassano, Fogli & Piccinno, 2019:1).

However, Makena and Yengwayo (2023:2) offer a differing perspective, noting that in the past, many schools utilised computers primarily for administrative purposes, a trend that persists in some schools today. Consequently, one of the aims of this study is to investigate whether schools in the Lejweleputswa District in the Free State Province of South Africa are effectively fulfilling the objectives of the CAT curriculum as outlined in the Curriculum and Assessment Policy Statement (CAPS) document. Alternatively, the study will determine whether the schools align more with Makena and Yengwayo's (2023) observations.

In 2006, the Department of Education (DoE) introduced CAT as a new subject within the FET phase. A key objective of integrating CAT into the FET curriculum was to equip learners with the essential knowledge, skills, values, and attitudes required to create, design, and effectively communicate information in various formats (Zhang and Vieira 2021:101).

Moreover, CAT was designed to enable learners to collect, manipulate, interpret, and process information, thereby enhancing their problem-solving skills through critical and creative thinking (Birgili 2015:2). Additionally, Venter (2016:5) emphasises that CAT was implemented to better prepare FET learners for advanced studies in diverse fields such as Computer Science, Technology, Economics, Education, and Engineering at various universities.

There is no doubt that the introduction of this subject in schools was guided by a clear mandate. However, 18 years have passed since its establishment in South African schools. As with any initiative, it has faced a variety of challenges, transformations, benefits, and drawbacks in enhancing the educational experience for South African learners and the overall school curriculum. Consequently, this research aims to

© Central University of Technology, Free State

examine how CAT has effectively served as a platform for fostering 21st-century skills (21CS) among learners.

1.2 BACKGROUND OF THE STUDY

CAT is a subject that integrates both theoretical knowledge and practical application, providing learners with the chance to engage in hands-on activities that reinforce their classroom learning. In a related context, Hummel (2024:n.p.) defines 21CS as the essential competencies that learners need to excel in their careers during the information age. These skills encompass creativity and innovation, critical thinking, problem-solving, technology proficiency, and effective communication and collaboration (Geisinger 2016:246). Thus, as stated, this study aims to explore the effectiveness of CAT as a means of fostering 21CS among learners in the Lejweleputswa District.

This study has been developed through a comprehensive review of existing literature, focusing on the effectiveness of CAT instruction in meeting the subject's primary objectives. It also examines critical issues such as the lack of adequate resources necessary for presenting the subject and the shortage of qualified teachers to teach it (Venter 2016:22). Relevant research by Schlebusch (2015:361-362) reveals that in 2014, 41 schools were offering CAT in the Lejweleputswa District. Nonetheless, Nkosi (2022:n.p.) claims that while many schools initially provided CAT upon its implementation, there has been a noticeable decline in the number of schools offering the subject in recent years.

There is a pressing need to investigate the factors contributing to the decreasing number of schools offering CAT. This includes evaluating both the successful and unsuccessful implementations of the subject, exploring how CAT is utilised to teach learners vital 21CS, and assessing the financial implications associated with its offering.

1.3 SIGNIFICANCE OF THE STUDY

The data generated from this study supports schools offering CAT subject in effectively addressing the challenges associated with teaching the subject. These challenges include maintaining resources, recruiting qualified teachers, and managing financial implications of offering CAT. By tackling these issues, schools can enhance the

© Central University of Technology, Free State

effectiveness of their instruction in essential 21CS through CAT. Additionally, the findings from this study highlight the significance of providing CAT to learners in today's world, where proficiency in computer applications is vital.

1.4 STATEMENT OF THE PROBLEM

There have been concerning findings regarding the number of schools that offer CAT since the introduction and implementation of the subject in 2006. Venter (2016:56) suggests that this trend is weakening. Several factors which may contribute to this situation are indicated in the next paragraph.

Yao (2017:114) speculates that when CAT was first introduced in schools, one significant challenge was the difficulty in finding suitably qualified teachers to instruct the subject. Additionally, Venter (2016:55) believes that the teaching methods used for CAT may also play a role in the decline of schools offering this subject.

This study extends existing research on factors contributing to the decline in the number of schools offering CAT, including the availability of qualified teachers and the use of effective instructional methods. The researcher is motivated to investigate the factors influencing both the successful and unsuccessful implementation of CAT from its inception to the present. In addition, how various CAT curricula and teaching approaches are employed to equip learners with 21CS in the 21st-century world.

1.5 RESEARCH QUESTION AND OBJECTIVES

A main research question, alongside 4 secondary questions, has emanated from the research problem mentioned above. These are described below. The main and secondary research aims are discussed thereafter.

1.5.1 Main and secondary research questions

The main research question is: *How is CAT being effectively used as a vehicle to promote 21CS in the learners of the Lejweleputswa District?* To answer this question, the following secondary questions apply:

- SRQ1: How can the offering of CAT in schools modernise learners' abilities to creatively solve both educational and life problems?
- SRQ2: Which factors are contributing to the successful and unsuccessful offering of CAT in schools?;

© Central University of Technology, Free State

- SRQ3: Are the schools offering CAT in the Lejweleputswa District sufficiently equipped to offer it?; and
- SRQ4: Which educational improvements can be introduced to enhance the offering of CAT?

1.5.2 Main and secondary research aims

The aim of this study is to examine the effectiveness of using CAT as a vehicle to promote 21CS in the learners of the Lejweleputswa District. The objectives that have emanated from the aim of this study include:

- RA1: To discuss how the offering of CAT in schools can modernise learners' abilities to creatively solve both educational and life problems;
- RA2: To identify which factors contribute to the successful and unsuccessful offering of CAT in schools;
- RA3: To find out if the schools offering CAT in the Lejweleputswa District are sufficiently equipped to offer it; and
- RA4: To discover educational improvements that can be implemented to enhance the educational practice of CAT in schools.

1.6 PRELIMINARY LITERATURE REVIEW

The preliminary literature review identifies essential materials that support and validate the study. This review emphasises areas that reinforce new research and allow the researcher to evaluate and synthesise prior research concerning the current context.

1.6.1 Theoretical framework

This study uses the Technological Pedagogical Content Knowledge (TPACK) framework. The TPACK framework has been introduced to gain a deeper understanding of the knowledge that teachers require for effective technology integration (Kurt 2019:n.p.). This framework encourages a shared understanding of the interplay between content, pedagogy, and technology among teachers, thereby enhancing both teaching practices and professional development. Since its introduction in 2006, the TPACK framework has made a notable impact on both the theoretical and practical dimensions of educational technology (Taopan, Drajati, and Sumardi 2020:4). It holds particular relevance for this study, as the subject of CAT

© Central University of Technology, Free State

facilitates the teaching of both the theoretical and practical components of technology education.

1.6.2 21st-century skills (21CS)

21CS are essential for learners to succeed in today's information-driven world. According to Stauffer (2022:n.p.), the education system should redesign the curriculum based on 4 key dimensions, namely skills, knowledge, character, and metacognition. Additionally, Roslaniec (2018:n.p.) emphasises that knowledge alone is not enough to prepare learners for the real world. Therefore, learners need an education that fosters creativity, critical thinking, communication, and collaboration.

Critical skills such as information literacy, creativity and innovation, collaboration, problem-solving techniques and communication can prepare a learner for real-world challenges post-FET phase (Greenhill, Miller, Papadavid, Scottand, Scott, Stuart, Watson and Whitley 2015:2). Paniagua and Istance (2018:20) assert that teachers play a major role in creating an enriching learning environment for learners to successfully acquire the above-mentioned skills in schools. Teachers achieve this by merging their knowledge of pedagogy, subject matters and technology.

Furthermore, teachers can significantly enhance the learning experience by employing innovative uses of technology, rather than simply utilising it for information delivery (McKnight, O'Malley, Ruzic, Horsley, Franey, and Bassett 2016:204). Such innovative applications may include learner-created projects, such as digital storytelling, which demand skills such as creativity, communication, technological proficiency, and problem-solving - essential competencies for the 21st-century. However, McKnight et al. (2016:207) recommend that it is crucial to address the generational divide between teachers and evolving computer technologies to ensure effective technology application.

1.6.3 Reality of the digital world

The reality of the digital world encompasses several key concepts, such as the digital age, digital natives, digital immigrants, and digital nomads (Stegehuis 2021:3). The digital age refers to the new media age and the information age. Digital natives are individuals born into the Internet era who engage with technology daily (Ahlberg

© Central University of Technology, Free State

2021:9). In contrast, digital immigrants are those who were raised before the digital age.

Importantly, digital nomads are people who leverage technology to perform their jobs remotely, using telecommunication methods rather than being physically present in a company's office. They rely on innovations such as affordable Internet access, smartphones, and the Voice over Internet Protocol (VoIP) to stay connected with clients and employers (Richter and Richter 2020:78). Digital nomads are predominantly young individuals working in fields such as marketing, design, information technology (IT), tutoring, writing, and media.

As mentioned, digital natives engage with technology daily. There are individuals who have a natural proficiency with digital technologies and actively seek opportunities for innovation (Barak 2018:116). In contrast, digital immigrants are those who were not exposed to technology from an early age (Kivunja 2014:106). Currently, learners are considered digital natives, whereas teachers are seen as digital immigrants. This disparity has significant implications for computer technology education (Orlando and Attard 2016:109). Therefore, teachers teaching subjects such as CAT, Information and Communication Technology (ICT), and IT are encouraged to enhance their technology skills to stay current with advancements in computer technology (Kaware and Sain 2015:25).

Furthermore, the demonstration of technological fluency and ability to apply current digital knowledge to new situations is important to both digital natives and digital immigrants (Stegehuis 2021:4). This skillfully equips both learners and teachers on how to solve everyday life problems. Venter (2016:64) adds that "What learners need is not new and better curriculum but more and more of the real world". Ndalichako and Komba (2014:50) concur, stating that the facilitation of teaching and learning depends highly on the teacher's skills and how relevant the learners deem the information.

1.6.4 The offering of Computer Applications Technology (CAT) in schools

The offering of CAT in schools aims to cultivate computing skills across several key software packages, including Word, Excel, Access, Explorer, Outlook, PowerPoint, and basic HyperText Markup Language (HTML) for webpage creation (Yelisieieva 2018:58). Learners develop the ability to utilise the Internet effectively, understand its significance, locate pertinent information, process that information, and make informed

© Central University of Technology, Free State

decisions. Additionally, they learn to use ICTs responsibly. A strong level of competency is anticipated.

The points mentioned above indicate that CAT aims to develop and equip learners with useful skills that they can responsibly apply in problem-solving processes. Furthermore, CAT is not solely focused on preparing learners for technology-related tasks; it also emphasises how to address real-life problems legally and ethically (Caird and Lane 2015:60).

For a school to be qualified to offer CAT, it must have a computer laboratory outfitted with an adequate number of computers, routers or switches, printers, and a budget to cover annual operating costs (Bulman and Fairlie 2016:255). Thus, CAT cannot be taught without these essential technological resources, which are the product of expertise in computer technology. Additionally, Chen, Zou, Cheng, and Xie (2020:1) emphasise that learners should have access to at least one computer at school daily for the entirety of their instructional time. Such access provides learners with ample opportunities to explore, familiarise themselves with technology, innovate, and tackle problems in a CAT classroom. It also promotes greater independence, inspires enthusiasm for experimentation, and enhances learners' computer skills.

1.6.5 Factors influencing learners' choice of subjects

Factors that influence a learner's choice of subjects include specific elements that can either encourage or discourage participation in particular subjects. A teacher's pedagogy plays a significant role among these elements (Ndalichako and Komba 2014:52). This observation suggests that teachers have a major impact on developing learners' interest in certain subjects. Key factors such as the quality of teaching, the friendliness of the teacher, and the teacher's competence can greatly influence a learner's interest and subsequently affect their choice of subjects. Adam and Salome (2014:1297) note that a learner's subject choice often depends on the availability of qualified and competent teachers. Additionally, Akani (2015:212) states that the teaching methods employed by teachers, such as practical work in the laboratory and demonstrations, can significantly impact a learner's interest.

The relevancy of the subject and its applicability in one's life determine how significant it is (Ndalichako and Komba 2014:55). Venter (2016:31) mentions the factors that impact learners' choice in studying computer-related subjects, such as CAT, in their

© Central University of Technology, Free State

study. These factors include the learner's curiosity about the subject, how important taking this subject is in the learner's future, the availability of funding when going for further studies and the learner's desire to achieve something in the field they choose.

All of these factors play a crucial role in shaping a learner's subject choices and the career paths they may follow in the future. Consequently, CAT is a subject that sparks significant interest among learners. In today's world, learners are more inclined toward technological innovations than traditional teaching methods, as their lives are largely influenced by technology. Furthermore, CAT promotes an engaging environment that fosters creativity and enhances critical thinking and problem-solving skills.

1.7 RESEARCH DESIGN

Research design is referred to as a strategic plan used to direct the data collection and analysis phase of the research (Abutabenjeh and Jaradat 2018:238). It gives the study a framework that indicates the type of information to be collected and which procedure to follow (Collin and Stockton 2018:5). A researcher uses the research design to strategically solve a proposed problem and carry out an investigation. For this study, the researcher uses the research onion that was developed by Saunders, Lewis, Thornhill, and Bristow (2019:130). The research onion provides an effective progression through which a research methodology can be designed (Nizar and Janathanan 2018:5). The research onion is shown in Figure 1.1 below.

© Central University of Technology, Free State

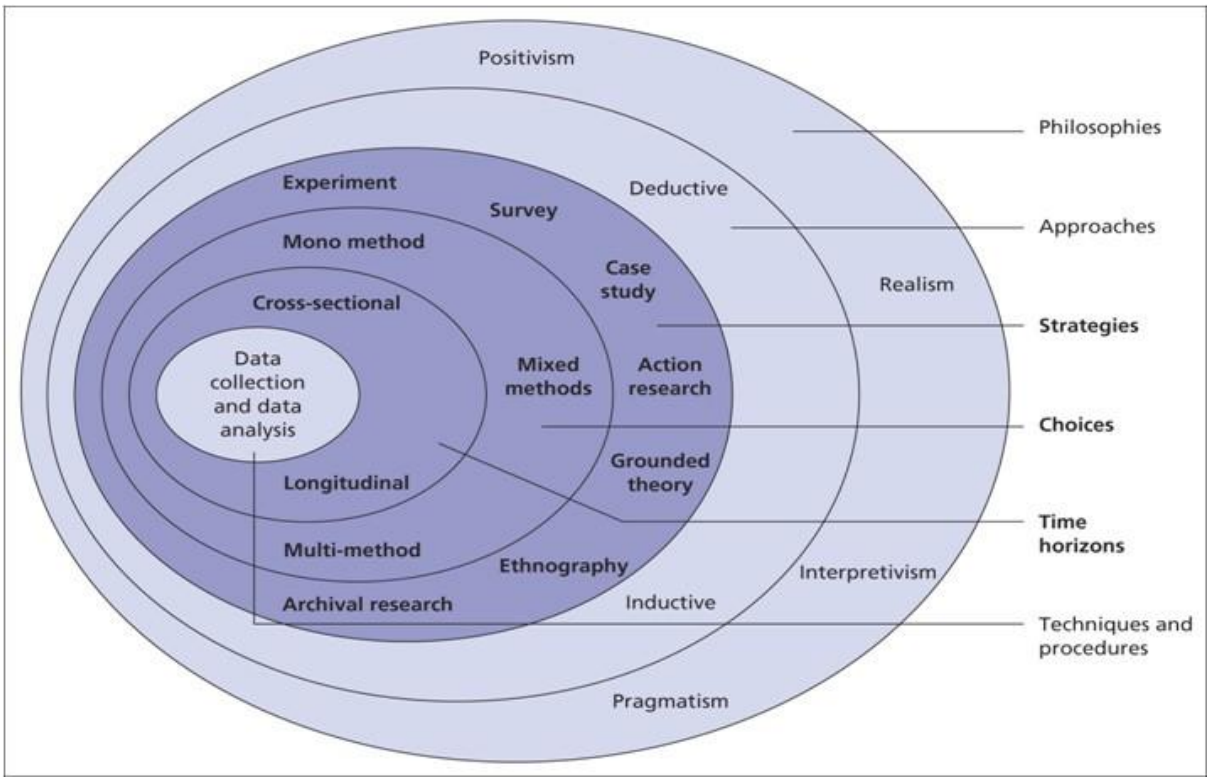


Figure 1. 1: The research onion Saunders et al. (2023)

1.7.1 Research philosophy

A research philosophy provides a framework that analysts utilise to generate reliable data for their studies. Essentially, it serves as the foundation of the research process, encompassing the selection of a research method, the definition of a topic, and the collection, preparation, and analysis of data (Dougherty, Slevc and Grand 2019:362).

This study embraces a pragmatic philosophy. Pragmatism is a philosophical approach that emphasises the interconnectedness of understanding the world and the ability to take effective action within it (Tsumake 2020:41). This overarching concept has inspired various interpretations, such as the notion that all philosophical ideas should be subject to scientific testing. In addition, it might include a claim which is deemed true if it provides practical utility (implying that philosophical theories lacking social relevance hold little value). Finally, pragmatism may lend to the belief that experience is rooted in engagement with nature rather than mere representation, and that articulate language builds upon a solid foundation of knowledge (Francis 2020:64).

In this study, pragmatism synthesises both positivist and interpretivist methodologies. This integration capitalises on the strengths of each approach while mitigating the

© Central University of Technology, Free State

limitations of the other, particularly in assessing the effectiveness of CAT in fostering 21CS among learners in the Lejweleputswa District.

1.7.2 Research approach

The research approach refers to the strategy and techniques employed in a study, encompassing everything from broad assumptions to specific methods of data collection, analysis, and interpretation (Stumpfle 2020:n.p.). This approach is shaped by the nature of the study and the research problem. There are two primary types of research approaches, namely deductive and inductive.

Deductive thinking is a logical process that moves from general concepts to specific conclusions (Indeed 2021:n.p.). It is often referred to as top-down thinking or deductive reasoning because it starts with general principles and moves toward facts, rules, definitions, and specifications towards a conclusion.

In contrast, inductive thinking begins with individual perceptions and leads to broader generalisations. It utilises observed patterns to make conclusions (Zukauskas, Vveinhardt and Andriukaitiene 2018:144). This study employs an inductive approach, in which a series of insights from all participants guide the researcher to a conclusion that may be valid. Furthermore, the inductive method is used to explore phenomena and identify themes and patterns from the participants' responses regarding the use of CAT as a means of teaching 21CS to learners in the Lejweleputswa District.

1.7.3 Research strategies

The research strategy, as outlined by Skinner, Nelson, Chin, and Land (2015:32), defines how the researcher intends to carry out the study. Several strategies are available, including experimental research, action research, case studies, concurrent embedded research, phenomenology, and explanatory sequence analysis. For this study, the researcher has opted to utilise the concurrent embedded strategy.

In mixed-methods research, a concurrent embedded strategy involves collecting data simultaneously within the same study. In this approach, one method, either qualitative or quantitative, takes precedence, while the other is integrated or "nested" within it (Aultman, Baughman, and Ludwick 2018:3578).

In this particular study, data have been gathered qualitatively and quantitatively during the first phase of the concurrent embedded strategy. The quantitative data collected

© Central University of Technology, Free State

is subsequently summarised using qualitative methods in the second phase, which focuses on data analysis. Therefore, while both qualitative and quantitative data have been collected, the interpretation of the data primarily relies on qualitative discussion.

1.7.4 Research choice

Research choice determines which data are collected from participants (Bhandari 2020:n.p.). Research choices include qualitative, quantitative, and mixed-methods (Almalki 2016:290).

A qualitative research choice focuses on participants' perceptions as the central element. Knowledge is developed through observable phenomena and the description of people's beliefs, values, intentions, and reasons (Maher, Hadfield, Hutchings, and Eyto 2018:3). This research choice emphasises detailed observations to generate rich information.

In contrast, a quantitative research choice is defined as the systematic collection of numerical data which applies statistical, mathematical, or computational methods to investigate phenomena (Mpele 2014:92). Quantitative research is grounded in the positivism paradigm, which supports statistical breakdown methods, including inferential statistics, hypothesis testing, mathematical analysis, experimental and quasi-experimental designs, and questionnaires with a limited number of predetermined responses (Hassan, 2024:n.p.).

Mixed-methods design combines quantitative and qualitative approaches within a single study (Guetterman and Fetters 2018:902). The advantage of integrating both designs is that it retains the strengths of each while addressing the shortcomings of the other (Almalki 2016:290). Furthermore, this integration allows the two data types to complement each other, offering deeper insights and generating new questions for future research. This study utilises a mixed-methods design, employing quantitative data to confirm and test conclusions drawn from qualitative data, and using qualitative data to provide meaning to the quantitative findings (Ahmad, Wasim, Irfan, Gogoi, Srivastava and Farheen 2019:2830).

1.7.5 Time horizon

The time horizon defines the research timeframe, distinguishing between cross-sectional or short-term studies and longitudinal studies. Cross-sectional studies

© Central University of Technology, Free State

involve data collection at a specific moment in time, while longitudinal studies gather data over an extended period to facilitate comparisons (Melnikovas 2018:34). This study employed a cross-sectional timeframe, indicating that data are collected over a short duration.

1.7.6 Research technique and procedures

Research techniques and procedures encompass the strategies employed by researchers to gather data, uncover new insights, and achieve a deeper understanding of the subject matter (Ahmed and Ishtiaq 2019:2831). While there are numerous techniques available for data collection, researchers select the most suitable methods based on the type of information they intend to uncover. This study employs both semi-structured interviews and structured questionnaires to collect comprehensive data.

A closed-ended questionnaire features a list of questions with predefined response options from which participants can choose (Bruijtne and Wijnant 2014:955). Conversely, an open-ended questionnaire invites participants to articulate their thoughts and opinions in greater detail regarding the questions posed (Zhou, Wang, Zhang and Guo 2017:1275). This study used mixed questionnaires, which consist of both closed-ended and open-ended questions in a single form, allowing respondents to provide more elaborate answers without constraints on their responses (Marcucci, Sanchis, Ciarapica and Bevilacqua 2022:1858). The researcher has distributed these mixed questionnaires to learners enrolled in CAT as part of their FET phase subjects, as well as to the teacher responsible for teaching CAT. Table 1.1 below represents the number of structured questionnaires distributed and received from the teachers and the learners.

Table 1. 1: Total Number of questionnaires distributed and received

Participants	Number of questionnaires distributed	Number of questionnaires received
Learners	180	131
Teachers	30	16

Furthermore, the researcher has utilised semi-structured interviews to facilitate in-depth discussions, enabling the interviewer to explore and expand on the participants' responses or comments (Ruslin, Mashuri, Rasak, Alhabsyi and Syam 2022:24). An

© Central University of Technology, Free State

interview is a dialogue aimed at gathering information, where the interviewer steers the conversation and asks questions, while the interviewee provides their answers (Mann 2016:30). In this study, the researcher has interviewed 3 school principals responsible for ensuring the smooth operation of the subject.

1.7.6.1 Population and sample

Population refers to a group of individuals, objects or events that meet specific criteria (Skarupski, Gross, Schrack, Deal, and Eber 2018:157). For this study, the population consists of all public schools in the Lejweleputswa District that offer CAT. To be specific, the teachers are from 10 different schools across the Lejweleputswa District. As stated in Table 1.2 below, the population entails 3 different schools.

Table 1. 2: Population

Population name	Location
School 1	Virginia
School 2	Welkom
School 3	Odendaalsrus

Sampling involves selecting several participants to represent a larger group from which they were drawn (Ralph 2021:2). This study has employed purposeful sampling, which involves identifying and selecting individuals or groups who possess knowledge or experience related to the phenomenon of interest (Kalu 2019:2527). Therefore, the sample for this study includes CAT teachers, learners in the FET phase who receive CAT, and the principals of schools offering CAT in the Lejweleputswa District, as indicated in Table 1.3.

Table 1. 3: Sample

Participants	Total number of participants
Teachers	16
Learners	131
Principals	3
Total	150

1.7.7 Data analysis

Research data analysis is a method employed by researchers for distilling data into a narrative and analysing it to extract insights (Yan, Powell, Curtis, and Wong 2020:2). As a result of data analysis, a large amount of data can be broken down into smaller

© Central University of Technology, Free State

pieces to ensure it makes sense. Both quantitative and qualitative analysis is used in this study, as described in the subsections below.

1.7.7.1 Quantitative data analysis

Quantitative data analysis involves examining data that is numerical or can be easily converted into numerical form without losing its significance (Rahman and Muktadir 2021:300). A systematic review is an objective and repeatable method for addressing a specific research question by collecting all relevant studies and evaluating their findings (Comert, Zill, Christelle, Dirmaier, Härter and Scholl 2016:3).

Statistics can be divided into two main categories, namely descriptive and inferential. Descriptive statistics summarise the characteristics of a sample, while inferential statistics make predictions about a larger population based on the sample data (Jansen and Warren 2020:n.p.). Common procedures in descriptive statistics include calculating the mean (average), median, standard deviation, and skewness (Thomas and Vetter 2017:1). Examples of inferential statistical methods include t-tests, analysis of variance, correlation, chi-square tests, and regression analysis. This study has utilised descriptive statistics, inferential statistics, and a chi-square analysis to analyse its data.

1.7.7.2 Qualitative data analysis

For the analysis of qualitative data, this study employs thematic analysis, a method that involves identifying patterns or themes within qualitative information (Maguire and Delahunt 2017:3353). Peel (2020:1) also describes thematic analysis as a qualitative approach used to classify and present patterns relevant to the data. This method seeks to interpret meanings associated with specific themes or patterns. By utilising thematic analysis, researchers can investigate the relationships between concepts and compare these with existing data.

The researcher has adhered to a 6-phase framework as established by Braun and Clarke (2006:90-98) cited in Maguire and Delahunt (2017:3355), namely:

- **Step 1: Become familiar with the data.** This involves thoroughly reading and re-reading the collected data;
- **Step 2: Generate initial codes**. In this phase, the data is organised by distilling extensive information into manageable, meaningful segments;

© Central University of Technology, Free State

- **Step 3: Search for themes.** The researcher explores the data for patterns or themes, emphasising the significance of the information;
- **Step 4: Review themes**. At this stage, the researcher evaluates and refines the preliminary themes identified in Step 3 to ensure they are coherent and relevant;
- **Step 5: Define themes.** The researcher clarifies the significance of each theme concerning the aims of the study; and
- **Step 6: Writing up**. Finally, the researcher compiles a report based on the findings.

1.8 ETHICAL CONSIDERATIONS

The research has been carried out in compliance with the ethical standards and procedures established by the Central University of Technology (CUT), Free State. The researcher presented the research proposal to the Faculty of Research and Innovation Committee (FRIC) of the Faculty of Humanities, and after a thorough discussion, approval was obtained to conduct this study. Furthermore, authorisation has been secured from the Free State Department of Basic Education (DBE) to visit and collect data from different schools. In addition, permission was asked from the learners and parents, principals, and teachers involved in the research in the form of a consent letter. Moreover, participants were assured anonymity and protection.

1.9 ESTABLISHING TRUSTWORTHINESS

Dooly, Moore, and Vallejo (2017:354) emphasise that ethical considerations in research revolve around the distinction between what is right and wrong. In a similar vein, Arafat (2024:140) describes research ethics as the standard of professionalism that pertains to moral values, legality, and the social responsibilities owed to participants. Furthermore, Kelp and Simion (2023:668) suggest that the trustworthiness of a study can be evaluated using Guba's Model of Trustworthiness, which comprises 4 essential components, namely truth value (credibility), applicability (transferability), consistency (dependability), and neutrality (confirmability). These 4 essential components of trustworthiness are discussed in detail in Chapter 3.

Credibility is referred to as the truth-value of research findings based on the research design, participants and context (Vazire 2018:1). The issue around credibility

© Central University of Technology, Free State

surrounds how well and validly the research instrument is used to gather true information from the discovery of human experience.

Transferability is referred to as the degree to which findings can be applied to other contexts (Munthe-Kaas, Nokley, Lewin and Glenton 2020:11). This refers to how valid the findings of the study are and how applicable the findings can be in other studies.

Dependability is how the researcher determines the consistency of the findings. As such, the researcher should verify how constant the information gathered is (Carnot, Bernardino, Laranjeiro and Oliveira 2020:1).

Conformability is referred to as the “criterion of neutrality, which is achieved when truth-value and applicability of data are established” (Finotelloa, Romarowski, Gorla, Bianchi, Bedogni, Auricchio and Morganti 2021:47). Therefore, after information is gathered, it can be applied and verified by experiment or observation.

1.10 LIMITATION OF RESEARCH

The presence of the researcher during the questionnaire completion may have influenced the participants' ability to respond in a relaxed and natural manner. This could lead to uncertainty in the information collected. Additionally, factors such as participant availability and the postponement of appointments may have disrupted the study's process.

1.11 DELIMITATION OF RESEARCH

This study has been conducted in public secondary schools in the Lejweleputswa District that offer the CAT subject. Consequently, the findings may not apply to primary schools, secondary schools that do not offer CAT and private secondary schools.

1.12 DEFINITION OF TERMS

- **CAT**: The study of unified components of the computer system, which involves the hardware and the software systems (Ackerman 2023:n.p.);
- **Computer literacy**: The level of familiarity with basic hardware and software concepts that allows one to use a personal computer for data entry, word processing, spreadsheets and electronic communication (Tsai, Liang and Hsu 2021:580);

© Central University of Technology, Free State

- **Computer laboratory**: The cluster of computers that are usually networked and available for use by the public (Eisele, Troost and Berger 2021:813);
- **Pedagogy:** The method and practice of teaching, especially an academic subject (Lisell 2021:256); and
- **Critical thinking:** Intellectually disciplined process of actively and skilfully conceptualising, applying, analysing and evaluating information gathered from observation, experience, reflection, reasoning or communication as a guide to belief (Guo and Lee 2023:4877).

1.13 DIVISION OF CHAPTERS ENDED HERE

This study consists of 5 chapters. Chapter One offered a general overview of this study. It began with an introduction and background information, followed by a description of the research question, objectives, and significance of the study. Finally, it provided a brief insight into the research methodology that was employed.

Chapter Two provides a review of the literature linking the teaching and learning of CAT with the acquisition of 21CS. This chapter examines and discusses findings from related studies pertinent to this research. Additionally, it explores the theoretical framework of the study.

Chapter 3 outlines the research philosophy, approach, strategy, choice, and time horizons for this study. It also describes the research techniques, procedures, sampling plan, and analysis methodology that are employed in this study.

Chapter 4 presents the results gathered from Chapter 3. This is followed by a discussion of the findings. It also covers the data inspection process, including validity assessment.

Chapter 5 concludes the study with solutions to the main problem and provides recommendations. This chapter also includes a summary of the entire study.

1.14 SUMMARY

This chapter presented an introduction to the entire study. It provided the background to the study, statement of the problem, the aim of the study, the research questions guiding the study, the research design and the structure of the entire study. Chapter 2 will discuss the literature applicable to this study.

© Central University of Technology, Free State

CHAPTER TWO: LITERATURE REVIEW

2.1 INTRODUCTION

A meticulous examination of existing literature is necessary to establish a strong foundation for any study which seeks to generate substantive findings (Fernandez 2019:188). Therefore, it is essential to scrutinise the literature review comprehensively and ensure that it is reliable, relevant, and up-to-date (Chigbu, Atiku and Plessis 2023:2). The review must also be conducted in a manner that is consistent with established research standards and best practices. By doing so, the researcher can obtain accurate and actionable insights that will facilitate informed decision-making regarding the efficacy of CAT in promoting 21CS among learners in the Lejweleputswa District.

This chapter begins by discussing how 21CS are taught in a CAT classroom. Throughout this study, the researcher will delve into pivotal skills crucial for navigating the demands of the 21CS, examining areas such as i) creativity and innovation; ii) problem-solving and critical thinking; iii) communication proficiency and collaboration, and iv) and technological adeptness. This chapter further describes the computer-related subjects that are currently being taught in public schools in the Lejweleputswa District (including CAT). The chapter then explains the importance of CAT as a subject, along with the challenges that teachers face while teaching it. It also covers the learners' perceptions of the subject, as well as the successes and failures of teaching CAT.

This chapter will culminate in a comprehensive summary of the theoretical framework that elucidates the reason for the research problem being investigated, thereby providing the necessary support structure. The framework in question is known as the TPACK (which will be discussed further in this chapter).

2.2 21ST-CENTURY SKILLS (21CS) IN EDUCATION

Today's 21st-century education is about providing learners with the skills they need to succeed in a world of rapidly changing technology, as well as assisting them in developing the confidence to exercise these skills (Driscoll 2017:n.p.). Additionally, the concept of 21st-century education plays a crucial role in educational ideology and strategic planning. It places a greater emphasis on developing skills that revolve

© Central University of Technology, Free State

around comprehending information and employing it in innovative ways (Nichols 2019:n.p.).

The 21st-century is characterised by a profound era of transformation, wherein diverse organisations prioritise enhanced capabilities in knowledge, mobility, and collaboration (Chalkiadaki, 2018:1). This epoch demands a paradigm shift in how individuals and schools approach their objectives, placing significant emphasis on the above-mentioned capabilities.

Consistent with Martin, Nacu and Pinkard (2016:38) findings on the elaboration of the notion of the 21st-century by characterising it as a time defined by specific core competences. These skills cover important abilities, including problem-solving, critical thinking, computer literacy, and teamwork (iCEV 2024:n.p). Learners must develop and refine these skills not only to adapt but also to flourish in today's fast-paced and dynamic environment. The value of developing these skills cannot be emphasised as society and the body of knowledge continue to change.

21CS might sound modern, however, its core skills (see Figure 2.1) have always been essential (Benade, Garner, Teschers, and Gibbons, 2014:47). In addition, these core skills have gained increasing importance due to the emergent demand for technology knowledge (TK) (Hadinugrahaningsiha, Rahmawati and Ridwan 2017:1). It is, therefore, important that learners acquire 21CS to keep pace with the evolution of technology and the Fourth Industrial Revolution (4IR) (Chu, Reynolds, Notari, Taveres and Lee 2017:62).

21CS welcomes learners into an exciting learning environment that allows them to move from information delivery to information discovery and problem-solving (Berkowicz and Myers 2017:5). Figure 2.1 illustrates the components of 21CS, which include i) creativity and innovation; ii) critical thinking and problem-solving; iii) technological skills, and iv) communication and collaboration (Chu et al., 2017:63). Section 2.2.1 after Figure 2.1 will discuss the application of 21CS in CAT classrooms.

© Central University of Technology, Free State

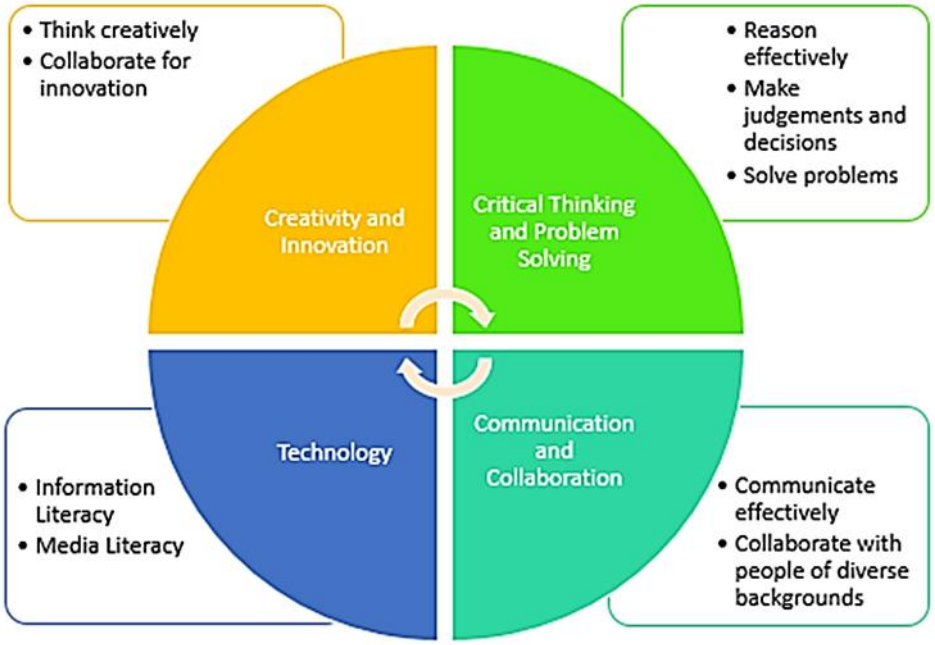


Figure 2.1: 21st-century skills

2.2.1 Creativity and innovation skills

As defined by Surabhi and Singh (2018:504), creativity pertains to the capacity to produce novel, distinct, unforeseen, and alternative ideas or solutions. This cognitive ability encompasses the capacity to think beyond conventional boundaries, leading to the generation of innovative and original concepts or approaches. Furthermore, according to Puccio (2017:331), creativity is recognising novel chances, adjusting quickly to changing circumstances, and generating original ideas. Additionally, Hadinugrahaningsiha et al. (2017:2) explain that creativity involves thinking beyond one's imagination through innovative exercises and brainstorming.

In 21st-century classrooms, subjects such as CAT enable learners to create something new out of the ordinary by receiving lessons that include software applications such as Microsoft Word, also known as a word processing application or word processor (WP). Shah (2020:20) states that a WP is a multi-purpose tool; for example, one of its functions includes serving as a logo constructor. Therefore, in CAT lessons, learners are provided with opportunities to create and design using a WP, as it allows them to combine shapes and words that can give them a good corporate design (Fan and Li 2020:5185). Moreover, a WP offers a series of pre-designed templates that cater to various needs, including simple documents, brochures, certificates, touring playing cards, and invitations. These enable CAT learners to

© Central University of Technology, Free State

personalise and craft visually appealing and easily editable documents, which can be effortlessly shared, printed and collaborated on (Yang and Chen 2015:1005).

Innovation, on the other hand, is referred to as an act of application of new ideas or implementation of something new (Surbhi and Singh 2018:504). In addition, McLean (2018:392) defines innovation as a process of applying improved solutions to meet new requirements. As technology introduces something new, CAT learners can easily adapt to changes; for example, from designing an ordinary logo using a WP to designing an extraordinary logo using Adobe Illustrator while applying knowledge and skills taught in CAT classes (Mahato, Khan and Yadav 2020:217). Adobe Illustrator is a software application for creating drawings and artwork using Windows, and it is broadly used by graphic designers and visual artists to create the finest artwork (Mazo 2021:n.p.).

Both creativity and innovation are closely tied together since creativity is related to imaginary processes, and innovation is related to the implementation of those imaginations, ideas or thoughts (McLean 2018:394). According to Henriksen, Mishra, and Fisser (2016:28), creativity is a thinking skill; therefore, it can be learned by doing or by being implemented. In an educational sense, CAT learners are given real-world tasks such as designing a logo (Henriksen, Mishra and Mehta 2015:457). As a result, learners become enthusiastic and engage in building creative skills and attain habits of applying new knowledge (Boronat and Choueiry 2022:81). Furthermore, Kantosalo, Toivanen, and Toivonen (2015:227) concur with this perspective and emphasise that the proficient utilisation of diverse digital applications within the CAT subject offers learners abundant opportunities to apply their problem-solving skills with a creative approach in handling data and formulating innovative solutions. The following subsection will discuss the abovementioned critical thinking and problem-solving skills.

2.2.2 Critical thinking and problem-solving skills

The critical thinking skill refers to the ability to analyse information and form reasoned judgments (Tomas, Evans, Doyle, and Skamp 2019:3). Additionally, Gafour and Gafour (2020:2) believe that critical thinking is the ability to think clearly, understand concepts and connect between ideas using logic to make a judgement. Furthermore, Alsaleh (2020:21) proposes the notion that critical thinking encompasses a multitude

© Central University of Technology, Free State

of skills and processes that enhance cognitive prowess in individuals. These include analytical and synthetic thinking, the ability to render sound judgments, effective decision-making, drawing well-founded conclusions, and the capacity for generalisation.

The above statement suggests that critical thinking is driven by logic - hence it is a prerequisite when technology is involved (Arevalo 2019:2). In simple terms, this means that since we live in a knowledge- and ever-changing technology era, combining critical thinking skills with technology has become essential for solving problems (Potter 2022:109).

CAT allows learners to engage with content critically; they use their critical thinking skills to solve problems using a computer or computer software accordingly (Supriyatnoa, Susilawati, and Hassan 2020:1100). Take, for example, in Microsoft Excel, when learners are being challenged to use functions to calculate. They first have to analyse the problem, understand it and make a judgement, then decide which function to use to get to the correct answer. This is pure critical thinking, which gives learners a chance to engage in the problem-solving process, as discussed in the next paragraph (Doyle 2022:n.p.).

Problem-solving is referred to as the result of critical thinking as it thoroughly analyses the problem to find the best possible solution (Alba, Keane, Chen and Kaufman 2021:2). In addition, problem-solving is the pursuit of a purpose, wherein the path to achieving that purpose is uncertain (Doyle (2022:n.p.). Furthermore, problem-solving involves the process of finding solutions to difficulties or obstacles and achieving goals that may not be immediately evident (Khalid, Saad, Hamid, Abdullah, Ibrahim, and Shahrill 2020:272). Greeno (2017: n.p.) states that problem-solving necessitates specific cognitive abilities, and a problem tends to persist if one lacks the knowledge to resolve it. Therefore, for the problem to be solved, learners must use critical thinking skills to help them identify and analyse the problem, then understand what is required, make a judgement and finally make a decision (Ifana, Hari, and Komang 2021:12).

In the context of a CAT classroom, it is common to encounter scenarios where the computer screen and case become unresponsive and fail to power on. In such situations, learners are allowed to exercise their problem-solving skills. Thus, learners can use their creativity and resourcefulness to identify and implement solutions that

© Central University of Technology, Free State

would otherwise not have been considered. Such scenarios can serve as a valuable learning experience, as they allow learners to develop essential skills crucial in the modern workplace (Ferreira, Sousa and Tereso 23:432). To solve such problems, learners may be guided by the 7 fundamental steps of the problem-solving process to devise the most effective solution (Enk and Hart 1985:249-250). The steps and their application, as followed by CAT learners, are outlined in Table 2.1 below.

Table 2. 1: 7 problem-solving steps

STEP 1	Identifying the problem	The computer screen and case are unresponsive in the CAT classroom.
STEP 2	Define the problem	When the switch buttons of both the computer case and the computer screen are pressed to switch on the whole computer system, nothing happens - no light reflects from either device, and the screen is blank.
STEP 3	List possible solutions	The learners will list proposed options to solve the problem. Examples of such may be to i) check the devices by verifying their connection to a functioning electrical socket; ii) try a different outlet if necessary, and iii) inspect for any damage or burnt areas.
STEP 4	Organising information	Learners must first collect and organise relevant information. Once the underlying cause of the problem has been identified, it will be easier to gather information about potential solutions. For instance, let us consider a scenario in which both devices are not connected to an electrical or socket outlet. In such a case, learners would need to acquire information on the safe and effective means of connecting both devices to the outlet. By diligently researching and gathering information, learners can effectively address problems and find viable solutions.
STEP 5	Allocating resources	It is recommended that learners conduct a thorough assessment of the problem at hand and prioritise the necessary actions. In the current situation, there is a lack of available space to accommodate both devices. As a result, it is imperative to acquire an electric extension socket with at least 5 outlets to facilitate the connection of all the necessary plugs.
STEP 6	Monitoring process	If progress is not being made, it may be advisable to re-evaluate the situation and explore new strategies that may better align with desired outcomes. To ensure that all electrical plugs can be accommodated, learners are encouraged to report any issues to their respective instructors, who will then provide them with an electrical extension that can support all plugs.
STEP 7	Evaluating the results	The learners may have successfully resolved the issue by identifying and implementing the most optimal solution. The electric extension socket plug was provided, and the learners proceeded to connect their respective devices to the socket. Subsequently, they may have been able to activate their devices without any issues, indicating that the chosen solution was indeed the most appropriate one.

Within the CAT classroom, this process may allow learners to work together to analyse the problem, make a judgement, and finally decide to solve the problem. These skills are some of the skills needed in the 21st-century, and they are taught in the CAT classroom.

© Central University of Technology, Free State

Critical thinking and problem-solving skills practised in the CAT classroom create a platform for the 21st-century learners to fully engage in productive and thought-provoking activities as they critically unpack the problem to come up with the best solution (Doyle 2019:n.p.). Additionally, applications such as Microsoft Excel (spreadsheet) are also facilitated in a CAT classroom, and they help with problem-solving and critical thinking skills. For instance, the use of the VLOOKUP function can be used to reconcile mismatched data between two reports, significantly reducing the time required compared to manual comparison. Spreadsheet is facilitated in CAT classes as a means to help learners store, organise, and categorise data into a logical format (Katoch 2020:48). Spreadsheets allow learners to work towards solving problems, such as mathematical problems, as it has features that allow learners to do calculation (addition, subtraction, division, multiplication, percentage, average, minimum, maximum and count formula) (Chaamwe and Shumba 2016:436). Consequently, CAT challenges learners' ways of thinking and arriving at conclusions by fusing theoretical ideas and real-world applications in a well-balanced curriculum (Ghosh, Gupta, Dua and Kumar 2020:3).

Critical thinking and problem-solving are not the only skills that learners need. As such, the next subsection will discuss how communication and collaboration skills are taught in CAT classrooms.

2.2.3 Communication and collaboration skills

Communication is a dynamic process involving the transmission and reception of messages through both verbal and non-verbal channels (Douglas and Gerde 2019:32). This comprehensive spectrum of communication encompasses speech, oral exchanges, written expressions, signals, behaviours, and graphical presentations. Communication is a crucial aspect of the CAT subject, as one of CAT's vital modules includes information management. This focuses primarily on communication technologies, such as finding and accessing information, processing information, and presenting solutions (Siddiqui and Singh 2016:71).

CAT learners are taught about exploring the effect of ICT in terms of a social computer environment. This includes social network websites and precautionary and safety measures in a legal computer environment, for example, Internet fraud (Zhou, Sun, Shafu, Wang, Juanhu and Gao 2021:43379). Communication can sometimes mean a

© Central University of Technology, Free State

few different people connecting to the Internet and working towards one goal from different spheres, and this can be taken as collaboration, which is discussed below.

Collaboration is defined as the joint effort of multiple individuals who can communicate views and contribute to the accomplishment of the task (Garner, Nicholas and Rouse 2021:764). Likewise, Brand, Allen, Altman, Hlava, and Scott (2015:152) posit that collaborative learning entails the strategic organisation of learners into groups or pairs with the shared objective of accomplishing a specific learning goal. Boveda and Weinberg (2022:9) further indicate that collaboration may sometimes be asynchronous or synchronous. Asynchronous means that those collaborating are not necessarily communicating and working together at the same time, while synchronous means parties involved work together simultaneously and in communication (McLoughlin, Patel, O'Callaghan and Reeves 2017:138).

Furthermore, Nguyen and Nguyen (2020:292) elaborate that collaborative learning environments allow learners to generate their ideas based on reflection and challenge them to express and defend their own opinions. Moreover, collaborative learning encourages learners to acquire crucial 21CS, such as the ability to work in teams to solve and apply knowledge gained through tasks in CAT classrooms (Wu, Zhou, Xie, and Cheng 2017:365). Thus, the symbiotic relationship between CAT and cloud computing becomes evident, as they jointly facilitate the learners in understanding how to effectively communicate and collaborate with others through online means to achieve shared objectives, with the Internet serving as the primary medium of communication (Sandhu 2022:32).

To use the Internet, certain skills are essential. Therefore, the following subsection will discuss how technology skills are taught in a CAT classroom.

2.2.4 Technology skills

Technology skills are vital for thriving in today's digital landscape. Proficiency in digital and technical media not only enhances personal growth but also opens doors to countless opportunities in various fields. Raja and Nagasubramani (2018:33) highlight that in the educational context, technology encompasses the use of hardware (like computers), accessible to both teachers and learners within the CAT classroom. Conversely, Mishra, Martynenko, Chemat, Paniwnyk, Barba, and Jambral (2018:1834) suggest that technology has transcended its traditional role of merely simplifying

© Central University of Technology, Free State

learning processes. Instead, it has evolved into a distinct field of study, engaging individuals in the development of educational tools and resources.

Dakhi, Jama, Irfan, Ambiyar, and Ishak (2020:50) highlight that the interpretation of technology in schools varies based on its intended use. Moreover, to foster an interactive learning atmosphere, technological advancements encourage teachers to comprehend and integrate technology into their teaching and learning practices. For this reason, Erazo, Gonzalez, and Vaca (2015:65) argue that some schools specifically utilise technology in 3 main categories, namely instructional preparation, instructional delivery, and as a learning tool.

Firstly, teachers employ technology for instructional preparation to prepare their lesson plans and presentations. In preparing lesson plans, they may use PowerPoint presentations or a WP on their computers to organise their lessons, and for presenting the lessons, a projector and projection screen may be utilised (Leon and Garcia-Martinez 2021:1044).

Secondly, technology for instructional delivery is used by a teacher in the sense that a teacher gives a lesson presentation and set of instructions displayed on a projector screen while learners are listening and interacting as they follow the instruction and do what is required of them such as answering questions (Onwuagbuizie, Singh and Fook 2015:52).

Finally, technology as a learning tool involves both parties, as learners will be required to use a specific software application to carry out the instructions and show capabilities to solve problems, create something new, communicate, and share perspectives (Shadiev and Yang 2020:2). As an illustration of the aforementioned concept, learners may be tasked with creating a comprehensive curriculum vitae (CV) for a vacant position within a specific organisation and transmitting it to the aforementioned organisation via email. To successfully execute this task, learners will proficiently utilise WP software to skilfully craft the CV, and demonstrate proficiency with email software, such as Outlook, to competently attach the CV and submit their application for the desired position. Depending on how well they are taught, some learners will find technology skills easy to grasp. However, teachers' perception of teaching 21CS through CAT may impact these skills, as discussed below.

© Central University of Technology, Free State

2.2.5 Teachers' perception of teaching 21st-century skills (21CS) through Computer Applications Technology (CAT)

Teachers' perception of teaching 21CS through CAT depends on how well the teacher is trained to teach the subject to assist learners in meeting its objectives. According to Kaware and Sain (2015:28), teachers are facing significant challenges when it comes to instructing learners in an era of instant information. This includes the widespread use of the Internet, smartphones, computers, tablets, gaming systems, and multimedia devices. The capacity of teachers to effectively impart 21CS is intricately linked to their own conceptions or mental frameworks regarding their background expertise and professional journey regarding the skills they are expected to teach (Perifanou, Economides and Tzafilkou 2021:239).

Boonmoh, Jumpakate, and Karpklon (2021:3) explicitly underscore that to adeptly guide learners in evaluating, interpreting, and utilising technology, teachers must actively support the integration of technology in their classrooms and demonstrate proficient use of technology to accomplish tasks. Emphasising proper technology usage becomes essential in this context, empowering learners to leverage technological tools effectively. Tour (2015:126) indicates that some teachers may assume that learners are literate in technology since they have spent their lives around it. Despite the abovementioned point, Henriksen et al. (2016:32) remind teachers that 21CS, together with technology-related skills, are not automatically learned. Therefore, it is important to provide professional development for teachers so that they can explore 21CS and technology-related skills, thus allowing them to teach in different ways (Shafie, Majid, and Ismail 2019:25). Similarly, Sreeramana and Shubhrajyotsna (2016:6) also point out that there is importance in providing exemplars and guiding teachers towards appropriate methods for teaching 21CS.

All of the abovementioned skills are essential in 21st-century education. To further explore technology (and its related skills) in education, the following section discusses computing subjects in South African schools.

2.3 COMPUTING SUBJECTS IN SOUTH AFRICAN SCHOOLS

According to Sanusi, Oyelere, and Omidiora (2022:2), South Africa's computing curriculum comprises two subjects: CAT and IT. These subjects are introduced to learners from Grade 10 and continue through to Grade 12. CAT examines the

© Central University of Technology, Free State

interrelationships between the various components of computer systems, as well as useful techniques for utilising them to solve issues that arise (DBE 2020:8). While IT focuses on the design and implementation of computer programs utilising current development tools, it is a discipline that is centred on problem-solving through logical thinking, information management, and communication. Its primary objective is the instruction of computer programming, a subfield of Computer Science (Shatri 2020:421). As mentioned, South African schools have two computing subjects in schools, and this study has only focused on and discussed CAT.

2.3.1 Computer Applications Technology (CAT) in Schools

CAT in schools, as stated above, is one of the two computer-related subjects offered to FET phase learners. Outcomes-Based Education (OBE) was launched in 2006 for Grades 10 to 12 learners for CAT as a subject. The CAPS document defines CAT as the successful use of ICT in an end-user computing environment across several societal domains (DBE 2020:8). The CAPS document further states that instruction in CAT should (DBE 2020:10):

- Provide learners with the knowledge, abilities, moral principles, and attitudes necessary to design, develop, and transmit content across several platforms;
- Assist learners in gathering, interpreting, and evaluating data;
- Manipulate, process, display, and convey information to various groups; and
- Assist learners to thrive in the global information culture by ensuring they have the necessary in-demand skills.

2.3.2 Computer Applications Technology (CAT) and the learner-centred approach

The CAT subject focuses on effectively handling and working with digital information. Computer literacy is now an essential element of daily life, whether it be sending emails from home or constructing a spreadsheet to create a budget as a manager in the corporate sector. Therefore, effective teaching and learning of CAT is seen as vital (Eranzo and Esteve-Gonzalez 2015:12). CAT teachers must have computer pedagogical skills to efficiently aid CAT teaching and learning. According to Santos and Castro (2021:2), pedagogical knowledge (PK) is a collection of ideas such as

© Central University of Technology, Free State

objectives, evaluation, time, environment, activities, teacher role, community, and curricular vision that are all governed by both objective and subjective minds.

Furthermore, one of the goals of the CAT curriculum, according to Alavi, Borzabadi and Dashtestani (2016:57), is to produce learners who are computer literate and who will become competent employees. Furthermore, according to the CAT curriculum goals, learners will have a functional understanding of webpage design by the end of the course, preparing them to become skilled workers (Ackerman 2023:n.p.). Both the development of curriculum concepts and the actual implementation of specific school curricula are influenced by competency (Alsubaie 2016:107). This means that for CAT teachers, implementing a learner-centred, pragmatic teaching method is essential, and this goal is what motivates this endeavour. By moving the emphasis away from the conventional teacher-centric model, learner-centred teaching approaches put the learners at the centre of the educational process (Lawless 2019:n.p.). These teaching strategies include active learning, in which learners work together to solve issues, answer questions, and raise their concerns. They also actively participate in class discussions, debates, and brainstorming sessions (Gholam 2019:113).

Through learner-centred teaching, CAT learners experience the impact of the subject through several factors. These are discussed in the subsections below.

2.3.2.1 Participation augmentation

Participation augmentation is mostly encouraged by the availability of resources. A learner-centred approach ensures that learners have access to materials that are pertinent to their learning and are effective in the classroom (Randall and Jane 2015:382). For instance, CAT learners are more likely to use their tablet or smartphone to access CAT information. Since learners spend more time on their phones than on books, this increases their involvement in their schoolwork. This also enhances their memory of information, which is discussed in the subsection that follows.

2.3.2.2 Enhanced memory of information

Enhanced memory of information is mostly caused by repeating learning events. A learner-centred approach has a significant impact on learners' levels of interest because it places a high value on relevance and engagement (Duran and Dokme 2016:2888). The learner-centred method moves the emphasis away from conventional

© Central University of Technology, Free State

learning, which primarily focuses on the teacher's teaching, and toward learning with more engaging and realistic content, such as utilising Microsoft Excel to solve mathematical problems (Fitriani, Suryadi and Darhim 2018:125). Being assessed on real-world cases that are pertinent to their everyday issues and have specific components will force learners to use whatever prior information they may have learned from other subjects. Instead of learning with a lot of theoretical knowledge, learners may remember the information better in this manner, and this will assist them in learning how to solve problems, as discussed in the following subsection.

2.3.2.3 Learning to solve problems

Learning to solve problems is known as one of the 21CS that a learner should acquire to thrive in this digital world. According to Eranzo and Esteve-Gonzalez (2015:7), games, quizzes, and challenges are just a few of the real-world examples found in CAT's skills-based learner-centred approach. For example, the CAT subject can encompass a range of tasks and activities that replicate real-world challenges, compelling learners to devise solutions. Such training fosters the development of problem-solving abilities, which hold significant value in the context of the 21st-century (Akinmola 2014:3). Solving real-life problems also encourages learners to work together in groups, which is discussed in the next subsection.

2.3.2.4 Encouraged group learning

Encouraged group learning may result from formal tasks such as Practical Assessment Tasks (PATs), where learners are expected to conduct research based on the instructions in the CAT classroom. The learners mostly work together on such tasks. Subjects that are learner-centred, such as CAT, offer the chance to encourage collaborative learning (Randall and Jane 2015:383). In some of the group tasks included in CAT, learners work together to solve issues and exchange knowledge while teachers supervise and assist where applicable. In addition to fostering cooperation, this strategy also promotes teamwork and enhances learning enjoyment, as discussed below.

2.3.2.5 Enhanced learning enjoyment

Enhanced learning enjoyment involves having access to various learning techniques. Learners have several options thanks to a learner-centred approach (Smith 2017:n.p.).

© Central University of Technology, Free State

For instance, if a certain subject requires research, learners should be provided options for research ideas. Similar to CAT, learner-centred learning uses a variety of media, including videos, audio, practical exercises, and so forth (Glassman, Kim, Monroy-Hernández and Morris 2015:2). Learning is no longer thought of as tedious and monotonous when these components are present. Learning techniques using media such as audio and video assist learners in understanding the concepts taught in the CAT classroom better and encourage learning beyond the classroom. This learning can also be individualised, as discussed in the following subsection.

2.3.2.6 Encouraged individualised learning

Encouraged individualised learning results from the learner constantly revising content learned in the classroom at home for better understanding. As stated by Keyser (2021:n.p.), it is evident that each learner possesses unique learning needs and preferences. Some individuals may seek to comprehend the fundamental aspects of a concept, while others aspire to gain a comprehensive understanding of a subject. Moreover, learners vary in their prior knowledge, with some being familiar with the content while others remain entirely unaware (Sanger and Gleason 2020:7).

In response to these individual differences, CAT teachers can enhance the learning experience by incorporating supplementary content. Messages such as ‘Click here to learn more’ or ‘For more information, visit’ can be utilised to provide additional resources to learners. This approach not only enriches the learning process but also promotes individualised learning, catering to the diverse needs and interests of each learner.

Whilst CAT encourages the learner-centred approach, teachers can encounter some challenges in the classroom. These challenges are discussed hereafter.

2.3.3 Teachers’ challenges in teaching Computer Applications Technology (CAT)

The challenges teachers face in the CAT classroom may negatively affect their effective teaching of the subject. In a study carried out in high schools, Makena and Yengwayo (2023:2) share the difficulties faced by CAT teachers in the FET phase. In their study, most teachers encountered two main challenges, namely an acute lack of computers in classrooms and the ongoing problem of malfunctioning and broken

© Central University of Technology, Free State

computers. As a result, learners were frequently required to work in pairs, which greatly complicated the process of teaching and learning.

Similarly, Sultan (2014:178) has observed analogous issues in their study, highlighting a scarcity of resources to purchase, maintain, or update hardware and software. Furthermore, a lack of computers and inadequate Internet access have been identified as significant hindrances to effective CAT lessons. These challenges collectively underscore the pressing need for addressing infrastructure and resource constraints to facilitate a more conducive and comprehensive CAT education.

A separate study has been conducted by Johnson, Jacovina, Russell, and Soto (2016:4) regarding challenges in teaching CAT at the FET phase. Their study reveals that CAT teachers encountered numerous obstacles. These challenges predominantly stemmed from insufficient pedagogical training among teachers, the socioeconomic backgrounds of learners, which hindered their access to home computers for practice, and the lack of financial support from schools to pursue educational objectives. Consequently, integrating technology into existing lesson plans presented a formidable challenge for teachers, especially when faced with inconsistent computer connectivity (Johnson et al., 2016). Ensuring consistent access to crucial resources such as laptops, tablets, essential software, and reliable Internet connectivity emerged as critical prerequisites. The absence of these foundational elements significantly complicates the effective integration of technology into the teaching process.

Furthermore, Mukhari (2016:37) has discovered that CAT teachers spend a lot of time on administrative tasks at the schools and thus do not have enough time to teach CAT. Due to a shortage of funding, CAT teachers are sometimes required to do the duties of both technicians and teachers, including designing websites for the school and fixing malfunctioning computers. This makes it difficult for many CAT teachers to accomplish all the subject goals, resulting in learners having different perceptions of the CAT learning experience (Mukhari 2016:40).

Teachers' perceptions of CAT are not the only factor that must be considered when teaching the subject. The learners' perceptions of CAT are, therefore, discussed in the subsection below.

© Central University of Technology, Free State

2.3.4 Learners' perceptions of Computer Applications Technology (CAT)

Learners' perception of CAT is based on their CAT learning experience. In their research, Rogers (2003:12) underlines the significance of a nation's social norms in determining how well its citizens will accept technology. Norms, as defined by Wario (2014:59), are established patterns of behaviour that inform participants in the system of the appropriate behaviour. As a result, they might act as a barrier to change and hinder different or novel outcomes. It is, therefore, imperative to study and understand the learner's pattern of behaviour when it comes to the subject at hand and analyse how this behaviour impacts the initial expected outcome of the subject.

Ackerman (2023:n.p.) asserts that there is a common misconception among individuals, including learners, that CAT is an easy subject compared to other content-based subjects. This belief impedes deep learning and leads learners to approach CAT as a subject based on general knowledge rather than practical skills. For instance, consider a scenario where a company needs to analyse sales data from different regions. They have a large dataset containing sales figures for various products in different countries. To gain insights, they want to use a spreadsheet application to calculate the total sales for each region and find the highest-selling product in each region. Using the spreadsheet's SUMIFS function, they can sum the sales of specific products based on criteria such as region. By utilising the MAX function in combination with INDEX and MATCH, they can identify the highest-selling product in each region. This example illustrates how spreadsheet application functions can efficiently handle complex data analysis tasks, highlighting the practical skills-based aspect of CAT in real-world scenarios. This would not be possible if the users attempted this task based solely on general knowledge; thus, practical skills should be developed in a CAT classroom, for example.

Computer-related tasks such as those of CAT have traditionally been thought to be skewed toward learners from private schools (Charleston, George, Jackson, Berhanu, and Amechi 2014:168). This perception extends to other Science, Technology, Engineering, and Mathematics (STEM) professions as well. However, the representation of learners from public schools is being increased through several current initiatives (Debusschere 2018:80). These initiatives do not, however, change how learners from public schools view those who succeed in the computing and technology fields. Learners disregard the subject because they believe they have no

© Central University of Technology, Free State

prospect of success in the technology sector, among other reasons (Dempsey, Snodgrass, Kishi, and Titcomb 2015:110). Moreover, according to Sax, Newhouse, Goode, Skorodinsky, Nakajima, and Sendowski (2020:544), feeling like they do not belong in the field of computers is one of the reasons learners from public schools do not participate greatly because learners fail to put in the necessary effort to produce the desired learning outcomes. The learners' perception of CAT also contributes to the success or failure of the expected outcomes for the subject. Other elements can affect the successful teaching of CAT, as discussed in the subsection below.

2.3.5 The successful teaching of Computer Applications Technology (CAT)

The successful teaching of the subject means the ability of the school to i) meet the lesson aims and objectives set for the subject; ii) build the relationship between the learners, teachers, and the subject; iii) create deep learners' engagement, and iv) constantly receive content-based feedback from learners (Mupa and Chinooneka 2015:127). In addition, Decuypere and Belgium (2019:3) state that in a CAT classroom, computers, tablets, and smartphones are already regularly used by both learners and teachers. It is, therefore, only reasonable to look into CAT utilisation in the classroom to give FET learners successful and relevant educational experiences using those computers, tablets, and smartphones (Tagoe and Abakah 2014:91).

Furthermore, according to Donahoe, Rickard, Holden, Blackwell and Caukin (2019:58), utilising technology in whole-class instruction can boost learner participation for auditory and visual learners. Moreover, Cherner, Dix, and Lee (2014:161) add that including educational software and apps, Internet homework assignments, classroom tablets, and CAT resources and equipment can help learners improve in the classroom, as explained further in the subsections below.

2.3.5.1 Educational software and applications

Educational software applications are used to help learners learn more efficiently. According to Hirsh-Pasek, Zosh, Golinkoff, Gray, Robb and Kaufman (2015:5), when a lesson presentation is introduced through software such as PowerPoint, it offers the chance for involvement. This is because learners can view, read, and take notes from the projection screen. Furthermore, Rajadell and Garriga-Garzon (2017:904) highlight the possibility of incorporating links to videos within PowerPoint presentations to

© Central University of Technology, Free State

reinforce the concepts being taught. By including such visual aids, learners can better visualise and comprehend the subject matter. The combination of visual and auditory elements in videos caters to a diverse audience, enabling each user to assimilate information in a manner that resonates with their learning style. In essence, videos serve as excellent educational tools, enhancing the teaching process (Papadakis and Kalogiannakis 2017:258).

Moreover, Plump and LaRosa (2017:152) support that after a unit, teachers may review material using educational apps like Kahoot!. According to Wang and Tahir (2020:2), Kahoot! is a learner-response system that enhances classroom engagement by gamifying the learning experience. During a Kahoot! session, the teacher assumes the role of a game show host, while the learners participate as contenders (Chaiyo and Nokham 2017:179). This platform fosters an interactive and collaborative environment that promotes active learning. Additionally, Dellos (2015:49) asserts that Kahoot!, as a widely used eLearning tool, holds the potential to infuse higher education classrooms with liveliness, foster learners' engagement, and provide valuable metacognitive support, all without requiring extensive instructor or learner training. With over 9 billion users globally, this free online learning platform is underpinned by contemporary user-centred and behavioural design approaches (Newswire 2023:n.p.).

Moreover, according to Foen, Hassan, Mohammad, and Malek (2017:60), when employing Kahoot!, learners have the option to generate anonymous usernames for game participation, facilitating inclusive engagement. Furthermore, teachers can generate and distribute Kahoot! quizzes for learners. This functionality encourages participation from learners who may typically shy away from classroom involvement. Kahoot! games are accessible on both computers and smartphones, providing flexibility for learners to choose their preferred device. Additionally, teachers can opt for individual or group participation, fostering both independence and collaborative skills among learners (Bicen and Kocakoyun 2018:73). These skills may be fostered by the use of social media homework and assignments, which are discussed in detail in the subsection that follows.

© Central University of Technology, Free State

2.3.5.2 Social media homework and assignments

Social media homework and assignments involve both the teachers' and learners' participation. Nagy and Bernschütz (2016:1839) state that posting homework assignments on social media platforms such as WhatsApp is one way teachers can increase the successful teaching of CAT in and outside the classroom. Assignments are easily accessible, which can increase learner engagement and help learners become more organised. At the same time, this advancement not only initiates flexible access to information methods but also supports them by introducing a new type of information sharing between the learners and the teachers (Al-Hariri and Al-Hattami 2017:82). However, the learners will be expected to have smartphones to participate in social media homework and assignments. The use of smartphones in a CAT classroom is discussed in detail in the subsection that follows.

2.3.5.3 Smartphones in a Computer Applications Technology (CAT) classroom

A smartphone is a mobile phone with computer capabilities. This gadget gives users more advanced communication and processing capabilities than a standard mobile phone, including Internet connectivity, high-quality cameras, and management tools (Foen et al., 2017:58). Modern smartphones are no longer merely perceived as conventional phones but rather as mobile computers, owing to their exceptional computing prowess and vast memory capacity. The ability of smartphones to support feature-rich applications (apps) endows them with significant power, rendering them capable of replacing a multitude of standalone devices, including alarm clocks, calculators, computers, global positioning systems (GPS), and digital cameras (Vazquez-Cano 2014:1517).

In their research, Clayton and Murphy (2016:99) demonstrate a significant increase in learners' academic achievement when they utilise mobile learning devices such as smartphones during instructional periods. This heightened achievement is attributed to the increased time spent on task completion facilitated by device usage. Likewise, Alsayed, Bano and Alnajjar (2020:239) observe learners utilising their smartphone cameras to capture abstract concepts presented in class, aiding in the consolidation of abstract ideas into concrete understanding. Similarly, Forehand, Miller, and Carter (2017:51) report that participants in their study acknowledged the positive impact of smartphones on their productivity and overall learning outcomes.

© Central University of Technology, Free State

As per Rambitan's (2015:244) study, learners were increasingly utilising online teaching presentations and e-books to enhance their learning experiences. Similarly, Singh and Samah's (2018:83) research reveals that participants in their study leverage various mobile learning applications beyond traditional communication tools, including GPS, camera functionalities, voice calls, emails, and Google Drive, to create, access, and exchange educational resources with peers.

The collective findings underscore the pivotal role of smartphones in expanding learning avenues for learners, with a notable trend towards increased utilisation of mobile applications. This trend is particularly pronounced among higher education learners, who exhibit higher rates of smartphone ownership, facilitating the attainment of the subject's objectives (Bartholomew, Reeve, Veon, and Goodridge 2017:4).

2.3.6 Meeting the subject's initial outcomes

Meeting the subject's initial outcomes according to the amendment DBE (2024:9-11) for CAT involves offering several topic areas and subtopics with specific weightings. These are discussed in the subsections that follow.

2.3.6.1 Solution development

Solution development has a weighting of 60% with 4 subtopics, namely Word processing, Spreadsheets, Database, and Fourth Application. These subtopics are mainly known to teach learners how to solve problems. To make sure that learners meet the initial outcome of these subtopics, the school should be aware that the advancement of modern civilisation places increased demands on talent, requiring learners to grasp not only textbook theory knowledge but also actual operating ability (Xia and Lin 2021:695).

To meet the social need for talents, schools that offer CAT must pay more attention to the promotion of learners' practical ability and give more practice chances for learners (Hartikainen, Rintala, Pylvas and Nokelainen 2019:2). Transforming the typical classroom teaching mode to rich and colourful forms of classroom teaching will increase the overall quality of learners. In addition, learners should be encouraged to try to go beyond the basic techniques and skills and incorporate collaboration, creativity, productivity, and integration with CAT subtopics and real-life problems (Engelbrecht, Llianares and Borba 2020:828).

© Central University of Technology, Free State

2.3.6.2 Systems technologies

System technologies has a weighting of 13%, with 4 subtopics, namely Concept of computing, Hardware, Software, and Computer Management. These subtopics are mainly known for any goal-orientation activity requiring, benefiting from, or creating computer machinery. These subtopics are connected as a unit to perform the basic functions of a computing system, which include input, processing, output, storage, communication, and transfer of data in an electronic format (Widiaty, Riza, Abdullah and Mubaroq 2020:49). Using this set of subtopics introduces the ability to approach and solve problems effectively, based on the principles and methods of Computer Science.

In the fast-changing 21st-century, these subtopics take precedence. As such, CAT education promises to dramatically improve learners' preparedness for the future of work and active citizenship (Bell 2016:50).

2.3.6.3 Network technologies

Network technologies have a weighting of 5% with 4 subtopics, namely Personal Area Network (PAN), Local Area Network (LAN), Wireless Local Area Network (WLAN), and Wide Area Network (WAN). Computer networks are used in the CAT classroom for collaborative usage of software resources, interactive communication, quick information delivery, and ongoing assessment of the calibre of the knowledge acquired (Golubev and Testov 2015:130).

Teaching learners to utilise computer networks encourages the implementation of collaborative technologies that enable coordinating education while working together to solve study difficulties (Rodriguez, Riaza and Gomez 2017:664). It also encourages the employment of novel teaching methods in schools. According to Wang (2016:506) schools should make sure that there is always a network connection to achieve the outcome of Network technologies subtopics. Furthermore, Ratheeswari (2018:45) claims that CAT teachers make use of social network education, which allows all learners, whether neurodivergent or neurotypical, to study at their own pace and speed.

© Central University of Technology, Free State

2.3.6.4 Internet technologies

Internet technologies has a weighting of 5% with the two subtopics, namely Internet and World Wide Web, and E-communications. Today, technology and people are becoming more integrated, meaning that technologies have an impact on everyone (Ramani 2015:2). CAT teachers make use of some available electrical devices, Internet technologies, mobile technologies and so forth in their classrooms to make learning more interesting and relevant to the learners (Kassab, DeFranco and Laplante 2018:2).

In reality, most people own a smartphone or a laptop. Naturally, smartphones have WhatsApp, Facebook, or YouTube, which CAT teachers also use to share information with learners (Agustin and Ayu 2021:2). These tools have benefits and drawbacks. The initial benefit of Internet technologies tools is that they are quick and allow you to find whatever information you require (Bulman and Fairlie 2016:241). As a result, each aspect of modern life is developing further, such as distance education (Ratheswarie 2018:46). While the drawbacks include overloading learners' working memory capacity, which disrupts deep learning processes and significantly hinders their ability to synthesise information and develop critical thinking skills (Cizevska, 2025:2).

2.3.6.5 Information management

Information management has a weighting of 12% with the 3 subtopics, namely Find and Access Data and Information, Process Data and Information, and Present Solutions. These subtopics involve the collection, storage, and processing of data into information that leads to knowledge and decision-making. It entails using proper communication and presentation tools to convey new information and recommendations (Turnbull, Chugh and Luck 2021:165). Information management encourages learners to access online resources and promotes learners' interaction and collaboration skills (Spiteri and Rundgren 2018:123).

2.3.6.6 Social implications

Social implications have a weighting of 5% with 4 subtopics, namely Impact on Society, Legal and Ethical and Society Issues, Health and Ergonomic Issues, and Environmental Issues. As previously mentioned, learners are already using

© Central University of Technology, Free State

smartphones, tablets, and computers daily, employing various educational apps or engaging in educational activities.

In the context of the CAT classroom, these learners are presented with diverse social scenarios that require problem-solving, such as addressing issues like cyberbullying, computer theft, and enhancing computer/Wi-Fi security (Akrim and Sulasmi 2020:324). These challenges represent real-life situations that everyone using digital devices and social apps should be mindful of to safeguard themselves.

2.3.7 The unsuccessful teaching of Computer Applications Technology (CAT)

The unsuccessful teaching of CAT refers to challenges that hinder the expected outcome of the subject. Besides the teachers' challenges and the learners' perception of the subject, which have already been discussed, the researcher could only find an issue with resources which may hinder the subject, as discussed below.

2.3.7.1 Lack of adequate resources to support Computer Applications Technology (CAT) learning

Lack of adequate resources to support CAT learning includes a shortage of computers, insufficient Internet access, and outdated software applications. According to Mukeredzi (2016:2), the challenge of under-resourcing, characterised by inadequate teaching and learning materials in the classroom, significantly impedes the teaching and learning process of CAT. This issue contradicts the CAPS stipulation of one computer per learner in schools to offer CAT as a transformative subject (DBE 2020:11). Such under-resourced schools fail to adhere to the expectations outlined in the CAT BDE CAPS document, making it arduous to conduct practical lessons in CAT classrooms. Consequently, effective curriculum implementation becomes nearly unattainable (Mavellas, Wellington and Samuel 2016:283).

Spiteri and Rundgren (2018:119) highlight that teachers are mandated to implement the resource-driven curriculum effectively, notwithstanding the resource constraints in their classrooms. However, Daniel, Leopold, and Le (2016:1167) assert that effective teaching necessitates the availability of essential resources or teaching materials to enhance the teaching and learning process.

According to Berkowitz, Moore, Astor and Benbenishty (2017:427), the school environment significantly influences poor academic performance, particularly in cases

© Central University of Technology, Free State

where there is a lack of adequate teaching and learning resources. The absence of well-equipped computer laboratories and Internet connectivity within the school setting leads to learners encountering substantial gaps in practical learning for CAT (Konak, Clark and Nasereddin 2014:13). Consequently, these learners may graduate from Grade 12 without sufficient exposure to Internet usage, as required by the curriculum. Additionally, CAT learners in under-resourced schools tend to exhibit subpar performance and fall behind in keeping up with the curriculum (Seobi and Wood 2016:1).

2.4 THEORETICAL FRAMEWORK

The theoretical framework acts as the foundation for a research study. It includes not only the theory itself but also a narrative that explains how the researcher applies that theory and its underlying assumptions to explore the research problem (Lederman and Lederman 2017:594). For a better understanding of the kinds of knowledge needed by teachers for effective technology integration, the TPACK framework was introduced (Mishra & Koehler, 2006). The TPACK framework brings about a common understanding of content, pedagogy, and technology interaction among teachers for both effective teaching and teachers' educational development. The TPACK framework was introduced in 2006 to significantly impact the theory and practical education surrounding technology (Saubern, Henderson, Heinrich and Redmond 2020:3). The TPACK framework is relevant for this study as CAT supports the teaching of both theory and practical technology education.

2.4.1 Technological Pedagogical Content Knowledge (TPACK) framework

The TPACK framework is a theoretical model that encompasses the interaction of 3 essential bodies of knowledge, namely content, pedagogy, and technology (Alemán-Saravia and Deroncele-Acosta 2021:104). The framework has gained widespread recognition and has been extensively studied by researchers worldwide, making it a suitable guide for understanding and analysing the teaching of CAT.

The TPACK framework was first introduced in 2006 in the *Teachers College Record* as a framework for Teacher Knowledge. Since then, empirical studies have found TPACK to be a type of knowledge that emerges as teachers engage in the design of technological content lessons (Deng, Chai, So, Qian and Chen 2017:2). Additionally,

© Central University of Technology, Free State

Drajati and Sumardi (2019:5) indicate that the TPACK framework is now used worldwide by researchers studying both theoretical issues and practical issues. Since CAT incorporates both theory and practical teaching, TPACK was deemed the best framework to guide this study.

As stated, TPACK can accommodate both the theoretical and practical dimensions of CAT. Moreover, it enriches teachers' Technological Pedagogical Knowledge (TPK) by integrating subject-specific Content Knowledge (CK) and facilitating the seamless incorporation of technology, thereby fostering effective teaching and learning practices (Taopan et al., 2020:3). Since its inception, TPACK has garnered widespread acceptance as a means of elucidating the knowledge essential for teachers to proficiently implement technology-driven education (Liu, Liu, Yu, Li and Wen 2014:682).

Additionally, Taopan et al. (2020:4) state that TPACK challenges teachers to go beyond merely teaching learners how to use technology and to instead develop teachers' capacity to integrate technology into the teaching of CAT subjects. This integration works towards achieving CAT objectives (Lehiste 2015:16). Figure 2.2 below illustrates the TPACK framework with its different knowledge types, which are discussed thereafter.

© Central University of Technology, Free State

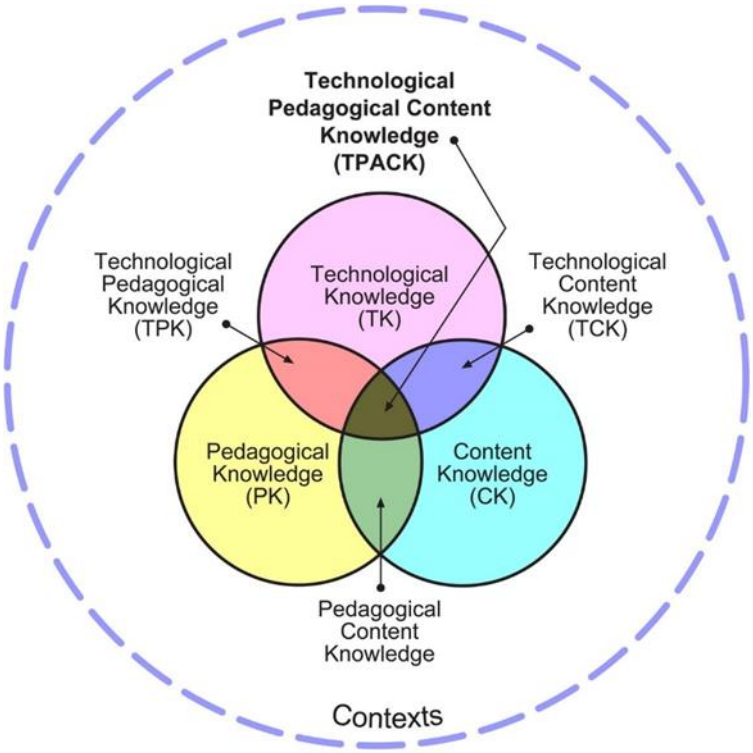


Figure 2. 2: Technological Pedagogical Content Knowledge (TPACK)

2.4.1.1 Content Knowledge (CK)

CK refers to a teacher's deep understanding of the subject matter to be taught using technology (Ward and Ayvazo 2016:195). For CAT teachers, possessing a thorough grasp of the curriculum is crucial to delivering accurate information to learners. This includes working knowledge of both computer hardware and software, as well as technological tools to prepare, present, demonstrate and facilitate lessons. Ensuring learners receive quality CK leads to a more engaging and relevant learning process. Conversely, inadequate CK may result in learners receiving incorrect information and forming misconceptions about the subject matter (Açikgül 2020:158).

2.4.1.2 Pedagogical Knowledge (PK)

PK refers to a teacher's understanding of various technologies that influence the teaching and learning processes, digital tools, and practices that align with academic objectives (Santos and Castro 2021:2). In the CAT classroom, this knowledge is essential for creating a conducive digital learning environment, employing suitable software, and applying appropriate technological methods of instruction. Teachers need to consider different learners' learning styles, such as visual, aural, and kinaesthetic, to accommodate learners' needs and enhance understanding. CAT

© Central University of Technology, Free State

teachers often employ various teaching methods, such as videos, audios, digital storytelling, collaboration, and discussions, to facilitate meaningful learning experiences.

2.4.1.3 Technology Knowledge (TK)

TK encompasses a teacher's understanding of both traditional and new technologies that can be integrated into the curriculum (Açikgül 2020:160). Mastery of technology facilitates its effective use in teaching and learning processes. This knowledge is essential for developing information processing, communication, and problem-solving skills, which are crucial in the CAT classroom. Acquiring TK enables teachers to accomplish a variety of tasks using technology and enhances their ability to impart knowledge to learners.

2.4.1.4 Pedagogical Content Knowledge (PCK)

Pedagogical Content Knowledge (PCK) refers to the integration of pedagogical expertise with a specific subject matter (Ward and Ayvazo 2016:195). In the context of CAT, PCK involves understanding how technology influences and interacts with the subject matter. Teachers need to be adept at interpreting and representing the content in various ways, accommodating learners' prior knowledge, and using different instructional materials. Emphasising the relationship between technology and content allows for innovative and effective teaching methods.

2.4.1.5 Technological Content Knowledge (TCK)

Technological Content Knowledge (TCK) involves understanding the interplay between technology and subject matter (Mian, Lamine and Fayolle 2016:2). CAT teachers must be well-versed in specific technologies that can be employed to teach the subject effectively. This knowledge allows them to comprehend how technology changes the content, and thus, they design instructional approaches that align with the subject matter. In CAT classrooms, teachers utilise computer applications and technology tools to enhance the learning experience.

2.4.1.6 Technological Pedagogical Knowledge (TPK)

TPK refers to a teacher's understanding of how specific technologies influence teaching and learning in different ways (Rosenberg and Koehler 2015:187). TPK

© Central University of Technology, Free State

requires teachers to be adaptable and creative in their approach. Teachers must be aware of the benefits and limitations of various technology tools and align them with educational designs and tactics. In the CAT classroom, TPK enables teachers to look beyond conventional uses of technology and customise them for pedagogical purposes, fostering innovative and effective teaching methods.

In conclusion, the TPACK framework offers a holistic approach that acknowledges the interdependence of content, pedagogy, and technology within CAT instruction. Prioritising these elements empowers teachers with the essential skills to craft stimulating and efficient learning environments for their learners.

2.5 SUMMARY

This chapter investigated the landscape of computing education in South African schools, focusing on CAT and the integration of 21CS within this context. It explored the challenges faced by teachers in effectively imparting CAT education, including resource shortages and perceptions of the subject. Additionally, the chapter examined the significance of 21CS in CAT classrooms and the hurdles teachers encounter in teaching these skills. Furthermore, it delved into the TPACK framework's role in guiding CAT teachers to seamlessly integrate content, pedagogy, and technology, enhancing learner engagement and readiness for the digital age. The following chapter will discuss the research methodology used in this study to achieve the research aims.

© Central University of Technology, Free State

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

Chapter 3 describes the research methodology used to conduct and guide the process of data collection for this research. The chapter begins by restating the study's purpose and research questions. It then describes the research design, research locale, and participants of the study, as well as a description of the data collection and data analysis processes. It concludes with a discussion of ethical issues, measurements to ensure validity, and finally, a summary of the chapter.

The primary goal of this study was to understand how successful the offering of CAT is in developing and enhancing 21CS in Lejweleputswa District learners so that they can compete in the 4IR. The study investigated the elements that contribute to the successful and unsuccessful offering of CAT, as well as educational enhancements that may be made to improve CAT offerings.

3.2 RESEARCH QUESTIONS

This study had one main research question and 4 secondary questions. These are described below.

3.2.1 Main and secondary research questions

The main research question was *How is CAT being effectively used as a vehicle to promote 21CS in the learners of the Lejweleputswa District?* To answer this question, the following secondary questions were applied:

- SRQ1: How can the offering of CAT in schools modernise learners' abilities to creatively solve both educational and life problems?;
- SRQ2: Which factors are contributing to the successful and unsuccessful offering of CAT in schools?;
- SRQ3: Are the schools offering CAT in the Lejweleputswa District sufficiently equipped to offer it?; and
- SRQ4: Which educational improvements can be introduced to enhance the offering of CAT?

© Central University of Technology, Free State

3.3 RESEARCH DESIGN AND METHODOLOGY

A research design is a strategy for addressing the research problem. A research methodology is the method for carrying out that strategy. The researcher first explains what research is, followed by the research design then the research methodology.

3.3.1 Research

Various scholars and researchers from diverse fields have put forth different definitions of research. According to Jain (2023:n.p.) research refers to the systematic and thorough examination of a given topic using a scientific approach. This involves framing the problem as a question to find a solution through a study. Aspers and Corte (2019:140) define research as the process of generating fresh ideas, methods, and insights by acquiring new information and creatively utilising existing knowledge. This may entail synthesising and analysing prior research to develop innovative concepts.

3.3.2 Research design

In the context of a dissertation, a research design, as described by Akhtar (2016:68), encompasses a comprehensive approach to shaping the inquiry's focus and serves as a benchmark for bolstering the credibility of the study. Furthermore, Vosloo (2014:299) asserts that the research design serves as the structure, methodology, and strategy employed to determine the pertinent data to be gathered from research participants, aimed at addressing specific research inquiries, resolving research dilemmas or testing hypotheses. The primary objective of a particular research design is to outline a strategy for amassing empirical evidence to address the research inquiries (Dahlin 2021:2). This strategy delineates the steps that the researcher must undertake to address the study's inquiries.

3.3.3 Research methodology

Research methodology is a way of thinking about how an inquiry should proceed (Jugenheimer, Kelley, Hudson, and Bradley 2015 cited in Ababneh 2020:77). It comprises investigating the assumptions, principles, and procedures that underpin a certain approach to a study. Moreover, Eisenhardt (2021:148) suggests that methodologies serve to delineate and elucidate the nature of issues to be explored, define the scope of study topics, formulate testable hypotheses, determine the optimal approach and techniques for investigating a problem, and select and refine

© Central University of Technology, Free State

appropriate data collection methods. This research adopted Saunders et al. (2019) research onion model as a guiding framework for data collection, analysis, and interpretation, as depicted in Figure 3.1 below.

The concept of the research onion delineates the systematic execution of research using a predetermined methodology, as advocated for by Saunders et al. (2019:130). It provides a structured framework for selecting the most appropriate research strategies and methodologies.

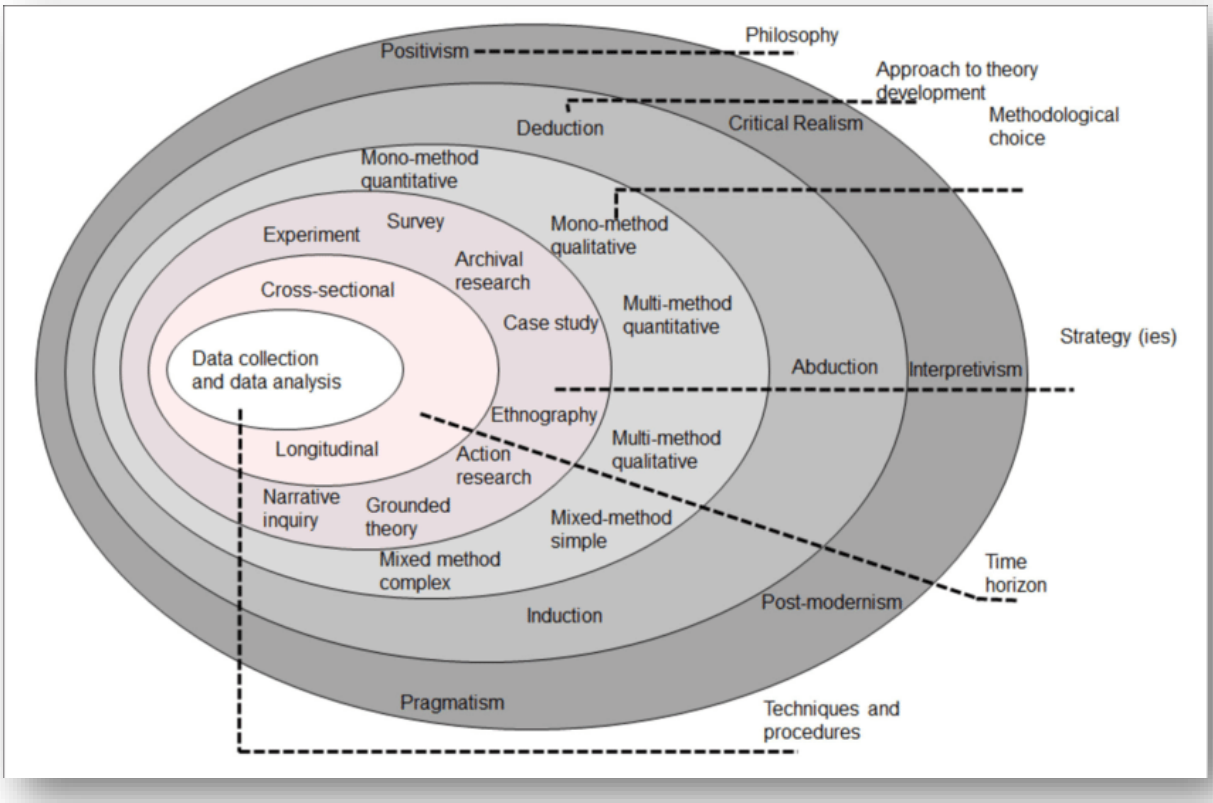


Figure 3. 1: Saunders et al. (2019) research onion

3.4 RESEARCH PHILOSOPHY

Research philosophy is a foundational framework for analysts that enables them to generate fresh and reliable data pertinent to their study (Gannon, Taheri and Azer 2022:2). It serves as the starting point for reflection, encompassing the development of a research plan, the identification of a central theme, and the processes of data collection, preparation, and analysis (Saunders et al., 2019:131).

© Central University of Technology, Free State

Throughout the research process, researchers inevitably make a range of assumptions (Kivunja and Kuyini 2017:27). These assumptions encompass beliefs regarding human understanding (epistemological presumptions); beliefs about the nature of the evidence encountered during the study (ontological assumptions), and beliefs about how personal perspectives affect research practices (axiological assumptions). Melnikovas (2018:30) asserts that a sound research philosophy is grounded in a thoughtfully constructed and coherent set of assumptions that shape methodological choices, research design, data collection strategies, and analytical techniques. This cohesive framework enables researchers to develop a unified research endeavour that integrates all dimensions of the study (Chege and Otieno 2020:36). The subsections that follow examine the 3 fundamental assumptions, namely epistemology, ontology, and axiology.

3.4.1 Epistemology

Epistemology influences individuals' perceptions of the world, shaping their interpretations and the tools they use for understanding (Pritchard 2016:1). As a theory of knowledge, epistemology critically analyses the legitimacy of intended knowledge and the interaction between the knower and that knowledge (Cassam 2016:160).

Epistemology addresses essential aspects of knowledge, such as its nature, variations, acquisition, and methods of communication. Its primary focus is on comprehending the nature and extent of human knowledge, which allows researchers and individuals to develop and enrich their expertise in their respective fields of study (Brenner and Schmid 2015:161).

3.4.2 Ontology

Ontology is a branch of logic that explores the assumptions individuals make to recognise the validity and distinctive characteristics of the social phenomena under examination (Couldry and Kallinikos 2017:146). It involves a theoretical investigation into the fundamental categories of existing objects, their interrelations, and the nature of existence, reality, and being (Nasution 2018:1).

Ontology centres on the beliefs that individuals hold regarding the nature or essence of the social phenomena they study, as well as the reasoning that leads to certain ideas being viewed as rational or authentic (Hammar, Wallin, Karlberg and Hälleberg

© Central University of Technology, Free State

2019:5). This branch of study aids in conceptualising the structure and essence of reality while shaping our perceptions of what can be understood about it (Jackson 2016:1). To delve into these assumptions surrounding social phenomena, the researcher employed a qualitative data collection approach.

3.4.3 Axiology

Axiology encompasses the examination of the philosophical principles guiding the formulation of morally sound decisions, particularly addressing the ethical considerations essential in crafting a research proposal (Shahin 2016:981). In the context of research, axiology involves the identification, analysis, and comprehension of concepts about appropriate and inappropriate conduct. It evaluates the relative significance of various elements within a study, including participants, data, and the audience to whom researchers disseminate their findings (Biesta 2015:18).

Aliyu, Singhry, Adamu, and Abubakar (2015:13) suggest questions to consider before conducting research. These include i) What values will guide your research?; ii) How will you uphold participants' rights?; iii) Which moral issues and characteristics must be addressed?; iv) What cultural and intercultural challenges may arise, and how will you handle them?, and v) How can you conduct the research socially, courteously, and peacefully while ensuring participants' goodwill?

In line with the axiology assumptions, the researcher requested ethical clearance from the FRIC for this study, given the CUT Research Ethics and Integration Framework. This was done to ensure all ethical aspects are covered before data collection, during data collection and in the analysis of data. Moreover, the researcher also requested permission to conduct the research in Free State schools from the DoE.

Since the different assumptions that are related to research philosophy are being discussed, this study adopted the pragmatism philosophy, given that researchers such as Kelly and Cordeiro (2020:2) believe that the views of human behaviour offered by pragmatism are fuller and more realistic than those offered by only rationalist or structuralist interpretations. The pragmatic philosophy is a technique or a combination of approaches that functions best in a real-world setting and is regarded as meaningful when it results in tangible results (Saunders et al., 2019:143). The pragmatist philosophy is discussed in detail in the next subsection.

© Central University of Technology, Free State

3.4.4 Pragmatism

The ability of an individual to engage with the world is fundamentally tied to their understanding of it (Tsumake 2020:41). This overarching idea has spurred diverse interpretations, including the belief that all philosophical concepts should undergo scrutiny via scientific experimentation and the assertion that a statement holds truth only if it proves beneficial. Simultaneously, a philosophical doctrine holds little value if it fails to actively contribute to societal advancement. It suggests that genuine experience involves direct interaction with nature rather than mere representation, and that coherent language relies on a substantial base of knowledge (Saunders et al., 2019:151).

Investigating how CAT is employed to cultivate 21CS among FET learners in the Lejweleputswa District could greatly enhance social progress. A balanced integration of positivist and interpretivist concepts would be beneficial in this endeavour. By harnessing the strengths of each approach while mitigating their respective weaknesses, the researcher was well-positioned to achieve the research's objectives.

3.5 RESEARCH APPROACH

The research approach entails formulating hypotheses and identifying suitable methodologies for gathering, scrutinising, and comprehending data (Azungah 2018:384). It is, therefore, dependent on the nature of the study and the current issue. There are two known research approaches to data analysis, namely inductive and deductive. Inductive reasoning begins with specific observations and leads to general conclusions, while deductive reasoning starts with general premises and leads to specific conclusions (Eisenhardt, Graebner and Sonenshhein 2016:1113).

In this study, the inductive method was used to explore how CAT has been used to teach 21CS to learners in the Lejweleputswa District from different schools. Patterns were identified from participant responses to research questions.

3.6 RESEARCH STRATEGY

The research strategy, as outlined by Skinner et al., (2015:32), is the approach the researcher intends to use for conducting the study. Several strategies can be implemented, including experimental research, action research, case studies, concurrent embedded research, phenomenology, and explanatory sequence analysis.

© Central University of Technology, Free State

In this study, the researcher adopted the concurrent embedded research strategy, which is briefly elaborated upon in the subsection hereafter.

3.6.1 Concurrent embedded

The term "concurrent" refers to the simultaneous collection of both qualitative and quantitative data (Bell, Warren and Schmidt 2022:6). According to Lohstroh, Menard, Bateni, and Lee (2021:7), in concurrent embedded research, one approach takes precedence while the other is embedded, as illustrated in Figure 3.2 below.

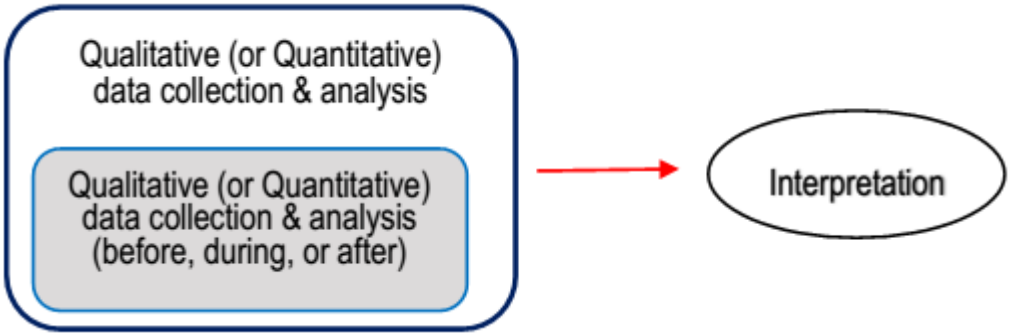


Figure 3. 2: Concurrent embedded Creswell (2009)

The embedded technique can be used to address either a secondary research question or to explore a specific subtopic that is closely related to the primary research issue (Gashe, Ferede, Weldemichael and Endries 2025:n.p.). The concurrent embedded research strategy operates on the premise that a single data collection is often insufficient, leading to the necessity of utilising various data types. Haerazi and Kazemian (2021:3) highlight the importance of primary data, which can be either qualitative or quantitative, while also acknowledging the supporting role of other data types.

One of the key advantages of the concurrent embedded research strategy is that it enables researchers to gather both qualitative and quantitative data simultaneously (Mine 2017:5). In this study, data were collected concurrently, allowing for the integration of both types of data during the data collection and analysis stages. As a result, both quantitative and qualitative data analyses were conducted at the same time.

Furthermore, in this study, the quantitative data were integrated with the qualitative data, demonstrating a deliberate emphasis on the qualitative research strategy within

© Central University of Technology, Free State

the framework of the mixed-methods approach. The rationale for employing mixed-methods in this study was grounded in the belief that the inclusion of qualitative research would facilitate a more comprehensive interpretation of the quantitative findings.

Moreover, the data collection process included semi-structured interviews as its secondary method. Participation in these interviews was limited to the principals overseeing the schools where CAT is taught. The researcher aimed to uncover correlations between participants' feedback and the factors influencing the successful or unsuccessful implementation of CAT in schools. Both mixed questionnaires and interviews were administered during a single school visit at each location, scheduled after regular school hours to be considerate of the school's time.

3.7 RESEARCH CHOICE

According to Njie and Asimiran (2014:36), there are two major research choices for collecting data, namely qualitative and quantitative. This may also result in two data analyses, namely inductive and deductive, as shown in Figure 3.3 below.

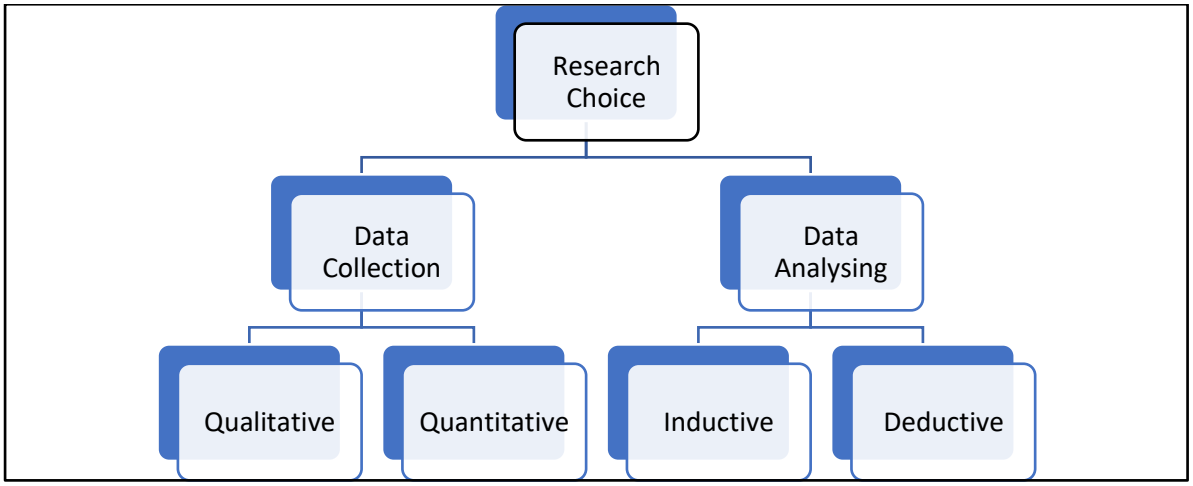


Figure 3. 3: Research choice, data collection and data analysis

3.7.1 Qualitative

Qualitative research, also known as field research, critical research, or interpretative research, is a type of non-numerical research that conveys facts verbally (Bengtsson 2016:8). Qualitative research is used in investigations where the subject matter under inquiry is new or underdeveloped. Thus, qualitative approaches can assist in the definition of vocabulary, concepts, or investigational subjects (Corona 2026:26).

© Central University of Technology, Free State

Njie and Asimiran (2014:35) explain that qualitative research is a subjective and interactive method used to give meaning to life events. A qualitative design involves collecting primary data directly from the natural environment where the phenomenon under investigation occurs (Nigar 2020:14). This study employed both mixed questionnaires and semi-structured interviews to gain rich primary qualitative data from the study's participants.

3.7.2 Quantitative

According to Mpele (2014:92), quantitative research involves the systematic gathering of numerical data through statistical, mathematical or computational means to explore various phenomena. It is based on the positivist paradigm, which supports the use of statistical methods such as questionnaires, quasi-experimental design, randomisation, experiments, mathematical exposition, hypothesis testing, and inferential statistics with predetermined responses (Bambale 2014:866). To procure quantitative data for the study, closed-ended questions were utilised in a structured questionnaire administered to CAT learners and teachers.

3.7.3 Mixed-method research

The mixed-methods approach is an imperative research technique that amalgamates both quantitative and qualitative data into a single investigation or programme (Onwuegbuizie and Frels 2013:17). The goal of integrating quantitative and qualitative research approaches is to keep the strengths of each while improving the flaws of the other (Stern, Lizarondo, Carrier, Godfrey, Reiger, Salmond, Apostolo, Kirkpatrick and Loveday 2020:8). Therefore, integrating these two methodologies can help them complement one another, provide deeper insights, and generate new questions for future research.

It is believed that combining quantitative and qualitative methodologies provides a better understanding of the study problem and question than employing one method alone (Ahmed, Pereira and Jane 2015:97). To integrate the methods effectively when mixed-methods research is employed, the researcher must have a working grasp of both quantitative and qualitative methodological designs. As a result, mixed-methods research is more advanced (Dawadi, Shrestha and Giri 2021:27).

© Central University of Technology, Free State

According to Shorten and Smith (2017:74), researchers can use a mixed methods approach to confirm and test the conclusions of quantitative data with qualitative data, and to provide meaning to quantitative data with qualitative data. The strengths and the weaknesses of using mixed-methods research, according to McCusker and Gunaydin (2014:1), are described in Table 3.1 below.

Table 3. 1: Strengths and weaknesses of mixed-method embedded design

Strengths of Mixed Methods Design	Weaknesses of Mixed Methods Design
Words, photographs, and narratives may be utilised to give numbers meaning, while numbers can provide words, photos, and narratives precision.	They can be challenging for a single researcher, especially when the two designs are best employed simultaneously; in this situation, a research team may be required.
As the researcher is not restricted to a single study design, they can address a greater range of research problems.	When concurrency is involved, it might be more time-consuming and costly.
They can provide insight and understanding that might otherwise be lost if only one study design were used.	This method demands that the researcher(s) understand several approaches to mix them intelligently, defend their usage, and employ them professionally.
It can help gather more evidence and have more faith in conclusions.	Conflicts in the interpretation of the findings may be difficult to settle.

3.8 TIME HORIZONS

The examination of time horizons encompasses two distinct methodologies known as longitudinal and cross-sectional. Longitudinal studies are distinguished by their repetition over an extended period, whereas cross-sectional studies are confined to a specific time frame (Reilly, Souder and Ranucci 2016:3). It is worth noting that longitudinal studies enable the tracking of changes in variables over time, which renders them particularly valuable in establishing cause-and-effect relationships (Bigoni, Casari, Skrzypacz and Spagnolo 2015:588). In contrast, cross-sectional studies offer a snapshot of data at a specific moment, providing a comprehensive understanding of a particular phenomenon (Melnikovas 2018:39). This study employed a cross-sectional timeframe for its data collection and analysis.

3.9 TECHNIQUES AND PROCEDURES

The methods and procedures used by researchers to collect information, uncover new facts, and enhance their understanding of the subject are known as research techniques and procedures (Marais, Swart, Fourie, Berry, Knoetze and Malan 2017:74). There are diverse approaches for gathering data, and researchers choose the most suitable ones based on the nature of the information they seek. This study

© Central University of Technology, Free State

employed a combination of structured questionnaires, along with semi-structured interviews, to obtain a more comprehensive set of data.

3.9.1 Questionnaire

When conducting a survey, a questionnaire is an essential tool that consists of a set of questions specifically designed for a significant number of respondents. Its primary purpose is to collect demographic information or public opinion (Youngshin, Youn-Jung and Doonam 2015:324). In the words of Patel and Joseph (2016:1), a questionnaire is a written set of questions that a group of people must answer as part of a survey.

Questionnaires, according to Kuphanga (2024:5), have the advantage of being widely utilised since they give an effective means to acquire information from surveys of large populations about a wide range of research problems. There are, however, some disadvantages to using questionnaires. For example, a majority of people who receive questionnaires do not return them. Wijnveen, Rijst and Driel (2016:479) add that the sample size may be small, and the people who do respond may not be representative of the original sample.

This study employed mixed questionnaires, which are a combination of quantitative and qualitative questionnaires. The quantitative component featured closed-ended questions, which required respondents to select from predetermined answers. While these questions were straightforward to administer, evaluate, and code, they had the potential to miss important response options. In contrast, the qualitative aspect consisted of open-ended questions that offered respondents the opportunity to provide contextual insights. This method fosters a diverse range of in-depth and nuanced responses.

Mixed questionnaires were distributed to learners studying CAT to evaluate their perceptions of CAT and its content, especially regarding how it prepares them for the essential 21CS that will simplify their lives in the future. Additionally, these questionnaires were administered to CAT teachers to investigate the strategies they employ to effectively teach these skills, as well as to identify factors that may hinder successful instruction in the subject.

© Central University of Technology, Free State

3.9.2 Interview

Face-to-face interactions between researchers and participants allow the researcher to acquire insight into the participants' perspectives, views, experiences, and lives by listening to them speak (Janghorban, Roudsari, and Taghipour 2014:1). Interviews are taped and then transcribed before being analysed. Researchers must provide participants the opportunity to express themselves without imposing their personal beliefs on them (Alsaawi 2014:151). Researchers can learn more about the subjectivity of their issue by doing this.

Structured, unstructured, and semi-structured interviews are the 3 types of interviews that can be employed. A structured interview consists of a set of questions that must be asked in a specific order and with the exact wording and method for all participants (McLeod 2014:n.p.). Unstructured interviews are more open-ended, allowing participants to raise and explore issues as they see fit (Wikijob 2021:n.p.). Semi-structured interviews are a hybrid of structured and unstructured interviews, and one of the benefits of this style of interview is that it gives the researcher the freedom to move in more fruitful directions (DeJonckheere and Vaughn 2019:2). Semi-structured interviews were employed in this study.

In mixed-method research, questionnaires and interviews are frequently used simultaneously (Jansena, Leeuwena, Janssena and Kestera 2020:38). Qualitative interviews are the superior method for uncovering detailed insights into participant attitudes, ideas, and behaviours compared to questionnaires, which are limited by their ability to capture information from large populations (Alsaawi 2014:152).

As part of this study, the researcher employed semi-structured interviews as a method for gathering secondary data. The content of the interviews was guided by the literature review. A total of 3 separate interviews were conducted with 3 different principals from schools offering CAT in the Lejweleputswa District of the Free State Province. The objective of these interviews was to evaluate the support provided by the schools to both the teachers and learners of CAT, ensuring the effective delivery of the subject. All interviews were held and recorded in the schools where these principals serve, with each interview lasting 21 minutes and 41 seconds, 26 minutes and 36 seconds, and 33 minutes and 32 seconds.

© Central University of Technology, Free State

3.9.3 Research site

Thomson (2015:n.p.) defines a research site as a specific location where research activities take place. Common research settings include universities, hospitals, research centres, and outdoor environments. For this study, research was conducted in 3 secondary schools that offer CAT in the Lejweleputswa District.

3.9.4 Sample design process

A sample is a group of participants or a portion of the population from whom data is gathered (Leedy and Ormond 2015:73). A key step in the research process is sampling, since it influences the validity of the inferences the researcher draws from the underlying data (Chiechi 2022:n.p.). According to McCombes (2023:n.p.), sampling procedures are more challenging when using both qualitative and quantitative research approaches simultaneously or sequentially

Maree and Pietersen (2016:164) claim that non-probability approaches, in which subjects are specifically chosen to reflect particular qualities in samples, are used in qualitative research. According to McCombes (2019:n.p.), non-probability sampling is a sampling strategy in which samples are picked based on the researcher's subjective judgment rather than by random selection. Since the sample is already known to the researcher, it has the advantage of yielding results more rapidly and inexpensively than chance sampling. When compared to people chosen at random, the respondents are likewise very motivated to participate and respond quickly (Showkat and Parveen 2017:6).

The researcher made use of purposive sampling, also referred to as judgmental sampling, which involves selecting samples based solely on the researcher's knowledge and judgment (Kalu 2019:2527). In other words, the researcher has selected individuals deemed suitable for participation in the study (Showkat and Parveen 2017:7).

In the qualitative section, participants for the interviews were selected through purposive sampling, which included school principals from the Lejweleputswa District schools that offered the CAT subject. For the quantitative section, participants for the questionnaires were also recruited using purposive sampling, including FET learners

© Central University of Technology, Free State

enrolled in CAT, as well as CAT teachers. Approval to engage with these participants and collect data through questionnaires was obtained from the Free State DBE.

3.9.5 Target population

McLeod (2019:n.p.) states that a population is a collection of items or situations that meet specific criteria, such as humans, objects or events. The population of this study were principals, teachers and learners from the public schools in the Lejweleputswa District of the Free State Province that offer CAT as one of their school subjects.

3.9.6 Sample frame

An actual collection of units from which a sample has been drawn is known as a sampling frame (Watson, Porteous, Bolt, and Ryan 2019:828). In an ideal world, the sampling frame would be the same as the population being examined. A population differs from a sample frame in that the former is more general and the latter is more specialised.

For purposive sampling, the population was drawn from the Lejweleputswa District's schools. The sample frame was the principals who supervise the schools that offer CAT, the FET learners who receive CAT in Grades 10, 11, and 12, and the teachers who teach CAT.

3.9.7 Sampling technique and size

The sample should be built according to recognised mixed-method sampling principles. The procedure should be well-organised, conceptually sound, and well-documented (Etikan and Bala 2017:215). Negative or contradictory examples or opinions should be included in the sample, and the sample should include enough people to ensure adequate representation of critical characteristics.

Therefore, for purpose sampling, the questionnaires were administered to CAT learners and teachers from each school that offers CAT in the Lejweleputswa District. Furthermore, for purposive sampling, the interviews were conducted with principals from the schools that offer CAT in the Lejweleputswa District.

The study gathered information on CAT education by administering questionnaires and interviews to a range of participants, including learners, teachers, and principals. Regrettably, out of the 180 questionnaires given to learners, only 131 were completed

© Central University of Technology, Free State

and returned. Similarly, while 30 CAT teachers were approached to complete the questionnaire, only 16 provided feedback. Moreover, although the researcher had planned to interview 5 principals of schools that offer CAT, only 3 were willing to participate. As a result, the intended sample size of 215 was reduced to 150 complete responses.

3.10 DATA COLLECTION

The process of data collection entails identifying and selecting individuals for the study, obtaining their consent to participate, and gathering information through various means (Alshenqeeti 2014:41). This includes administering questionnaires or observing their behaviours

3.10.1 Description of the qualitative data collection instrument

The main techniques for gathering qualitative data are interviews, focus groups, observation, and document analysis. Semi-structured interviews were used in this study to examine individual experiences and perceptions. A typical semi-structured interview is a one-on-one conversation between a study participant and a researcher (McLeod 2014:n.p.). Interviews, according to Alshenqeeti (2014:42), enable an in-depth study of individual experiences and perceptions.

Semi-structured interviews are open-ended, allowing the respondents to be as honest as possible with their responses (O'Keeffe, Buytaert, Mijic, Brozovic´ and Sinha 2016:1913). According to Mojtahed, Nunes, Martins, and Peng (2014:88), the format allows the respondent to identify and describe issues or ideas that the researchers may not have anticipated or considered. The interview process is participatory. The interviewer must also strive to be sensitive to the interviewee's terminology and ideas.

Ruslin, Mashuri, Sarib, Alhabsyi, Syam, and Ruslin (2022:24) contend that interviewers must be adept at passive listening and the use of neutral, non-judgmental language to encourage respondents to speak in-depth. Interviewers must simultaneously maintain control over the data collection by paying close attention to the interview's objective, selecting the appropriate questions to elicit pertinent information, and providing suitable verbal and nonverbal feedback (Bearman 2019:4).

During the semi-structured interview, the researcher engaged with 3 participants. While the initial plan was to interview 5 participants, only 3 were able to participate.

© Central University of Technology, Free State

These individuals are the principals of 3 separate schools that include CAT as part of their curriculum. The interviews were conducted separately on different days at the participants' respective schools.

Another qualitative data collection method that the researcher used was the mixed questionnaire. In the mixed questionnaire, the participants responded to questions that were both closed- and open-ended. The questionnaire was issued to the purposefully selected participants, consisting of CAT learners and CAT teachers. All learners from each grade (Grades 10, 11, and 12) were requested to participate.

In the teacher's questionnaire, qualitative responses were collected for Questions 5 to 8. Similarly, the learners' questionnaire gathered qualitative responses for Questions 3, 4, 9, and 10. All learners met in a single classroom with the teacher and the researcher to complete the questionnaire together, which minimised the possibility of duplicate answers.

3.10.2 Description of the quantitative data collection instrument

Data collection approaches in which each respondent is asked to answer the same set of questions in a predetermined order are referred to as questionnaires (Ndukwu 2020:n.p.). Learners and teachers filled in questionnaires to gather information for the systematic phase of this study.

The researcher used a structured questionnaire to gather data from both CAT teachers and learners. This questionnaire contained a combination of closed- and open-ended questions. Teachers provided quantitative responses to Questions 1 to 4, while learners answered Questions 1, 2, 5, 6, 7, and 8 quantitatively. The researcher personally distributed the questionnaires to the schools, supervised their completion, and subsequently collected them.

3.11 DATA ANALYSIS

According to Wang, Kung and Byrd (2018:6), research data analysis is a method employed by researchers to distil data into a narrative and analyse it to extract insights. As a result of data analysis, a large amount of data can be broken down into smaller pieces to make sense.

© Central University of Technology, Free State

3.11.1 Analysis of qualitative data

In contrast to quantitative studies, where data collection is often completed before data analysis begins, qualitative data collection and analysis are iterative (Rock, Schumacker, Gregg, Howard, Gable and Zigmond 2014:161). The research team switches back and forth between the data gathering and data analysis processes to allow for the development of new lines of inquiry when fresh data is obtained (Ivanov, Tang, Dolgui, Battini and Das 2021:2063).

Thematic analysis examines data to gain an understanding of participants' viewpoints. Analysis of data by theme allows for a deeper comprehension of study data (Kiger and Varpio 2020:2). It is a valuable tool for qualitative data, as participants' communication is not bound by any response constraints, allowing for patterns to be discovered (Richards and Hemphill 2018:5). An examination of replies to open-ended survey questions, focus group talks or interviews can be done using thematic analysis.

Mixed questionnaires and interviews were utilised to gain insights into the participants' views. This included asking specific questions related to their attitudes, beliefs, behaviours, and feelings (Adams 2015:497). By incorporating both semi-structured interviews and structured questionnaire, the researcher was able to develop a deeper understanding of how principals, learners, and teachers perceive CAT and the 21CS they acquire through it. Thus, conducting a thematic analysis of the responses from principals, learners, and teachers proved to be valuable. The information gathered through mixed questionnaires and interviews was transcribed verbatim and analysed thematically using content analysis, allowing for the emergence of themes and categories. To investigate any connections between learners' perceptions of CAT and the findings from teachers, the responses of learner participants and teacher participants (referred to as LPs and TPs in Chapter 4) were examined.

3.11.2 Analysis of quantitative data

Quantitative data analysis is the process of analysing data that is numerical or that can be easily converted to numbers without losing its significance (Abulela and Harwell 2020:69). A systematic review is an objective, repeatable approach to determining the answers to a specific research issue by gathering all relevant studies and assessing and analysing their findings (Nuzzo 2016:268).

© Central University of Technology, Free State

As a general rule, closed-ended questionnaire questions feature one main question and a set of answer options to give participants a defined number of responses from which they need to select their answers (Vishnu, Joao and Camara 2021:2124). The study employed a structured questionnaire, which consisted of both open- and closed-ended questions in a questionnaire survey; however, closed-ended questions were analysed quantitatively.

The researcher employed descriptive statistics to present essential information about the number of participants in a quantitative study, their characteristics, and their perceptions of CAT content as a vehicle for fostering 21CS. In addition, inferential statistics were utilised to compare learners' responses with those of teachers concerning the acquisition of 21CS through CAT. Furthermore, a statistical test called a chi-square test was used to compare actual outcomes with predictions. Moreover, the researcher implemented a concurrent-embedded research strategy to interpret and discuss mixed-method findings, providing qualitative insights into the quantitative data.

3.12 ETHICAL CONSIDERATIONS

The ethical considerations surrounding research are as crucial as determining an appropriate research methodology and procedures. Arifin (2018:31) highlights several ethical challenges that researchers may encounter, including power differentials, behavioural norms, and ongoing interactions with participants. However, delving deeper into the fundamentals of ethical research involving human participants is imperative.

Newson and Lipworth (2015:172) state that if there are human participants in the study, it is vital to have ethical approval for human research. Since human research ethics committees cannot approve research after data collection has commenced, that approval must be secured before the start of data collection from humans.

The mixed-method is a blend of the two methodologies; thus, the ethical considerations that apply to quantitative and qualitative methods also apply to mixed-method research. According to Arifin (2018:30), authorisation must be obtained, anonymity must be protected, site disruption must be avoided, and the study's aim must be communicated. The researcher applied for and received an authorisation from the BDE to collect data from different schools in the Lejweleputswa District (cf.

© Central University of Technology, Free State

Appendix G). The consent letters were given to all the participants, including parents, for the learners' participation in this study. Moreover, the participants were assured of anonymity and protection (cf. Appendix B & C).

Qualitative investigations demand that the study's purpose be communicated, that deceptive techniques be avoided, that the study population be respected, that any power concerns be addressed, and that confidentiality be maintained. The researcher was granted permission from the Free State Department of Basic Education (DBE) (cf. Appendix H), as well as from the learners' parents, principals, and teachers involved in the research.

3.13 MEASURES TO ENSURE VALIDITY AND RELIABILITY

The study's methods for obtaining the participants' validity and reliability are covered in this section. These subsections outline the methodology for obtaining accurate and trustworthy participant responses.

3.13.1 Credibility

According to Schmidt (2017:33), credibility is defined as a truthful picture of phenomena. To achieve credibility in this study, participants' perceptions and experiences were interpreted utilising mixed questionnaires and semi-structured interviews. Using an appropriate sampling strategy ensured reliable participant responses (Christensen and Miguel 2016:27). The researcher ensured that the data gathered from all participants were recorded and analysed accurately.

3.13.2 Reliability

According to Mohamad, Sulaiman, Sern, and Mohd (2015:169), the term "reliability" refers to a measurement that produces consistent results with equal values. Furthermore, Helen and Joanna (2015:34) suggest that it is used to assess a study's consistency, precision, and reproducibility. This assessment reveals the degree of bias and ensures consistent measurement across time and various elements in the instruments (Ahmed and Ishtiaq 2019:2402).

Rather than using the term "reliability," some quantitative researchers prefer the term "dependability" (Ahmed 2024:2). This term refers to how well an evaluation instrument delivers reliable and consistent outcomes. In essence, it means that a measure's

© Central University of Technology, Free State

observed score corresponds to its true value (Haradhan 2017:10). Throughout the process, the researcher remains objective, guarding against subjectivity and bias, which could influence the interpretation and description of data.

Understanding the importance of measurement reliability in both academic and professional settings is crucial. This concept guarantees that research conclusions are drawn from accurate and consistent data. Therefore, the researcher was careful in their methodology and aimed to achieve maximum dependability in their instruments by employing a statistical test called a chi-square test which is used to compare actual outcomes with predictions (Shan and Gerstenberger 2017:1). This test aims to determine whether a discrepancy between observed and expected data is the result of random variation or a relationship between the variables being examined.

3.13.3 Transferability

The degree to which topics or research techniques can be translated or generalised to different settings, contexts, or populations is known as transferability (Schloemer and Schroder-Back 2018:n.p.). The researcher provided enough detail for the reader to assess whether the findings are applicable or can be transferred to a different context. Stahl and King (2020:27) suggest that purposive sampling (one of the sampling methods used in this study) provides helpful information for answering questions and thus makes findings transferable and applicable. To ensure transferability, sufficient descriptive information was presented in this study and may be of use in future research.

3.13.4 Validity

How accurately a research tool measures the variables it was designed to capture is determined by its validity (Ahmed 2024:2). It refers to how accurately the results are in measuring the concepts under examination. To do so, a research instrument is needed, such as the questionnaire and interview that were utilised in this study (Kyngas, Kaariainen and Elo 2020:44). Validity covers the entire experimental idea and assesses if the outcomes satisfy the requirements of the scientific research procedure (Stahl and King 2020:28). The researcher ensured that the data collection methods used were accurate and reliable and that the results obtained were not tampered with in any way.

© Central University of Technology, Free State

3.14 SUMMARY

The research methodology was discussed in this chapter. The mixed-methods strategy used in the research was explored by the researcher. It explained how data were collected, analysed, and interpreted. Additionally, the study's ethical implications were discussed, and the chapter concluded with the procedures used to guarantee reliability.

© Central University of Technology, Free State

CHAPTER 4: DATA ANALYSIS, PRESENTATION AND DESCRIPTION OF THE RESEARCH FINDINGS, AND DISCUSSION

4.1 INTRODUCTION

In Chapter 2, the current state of computer education in South African schools was examined, with particular emphasis on CAT and the integration of 21CS within this context. The analysis highlighted the challenges teachers encounter in delivering effective CAT instruction, such as limited access to resources and existing perceptions surrounding the subject. Furthermore, the chapter investigated the significance of 21CS in CAT classrooms, along with the obstacles teachers face in imparting these skills. The discussion also addressed the TPACK framework's role in supporting CAT teachers to effectively blend content, pedagogy, and technology, ultimately improving learner engagement and equipping them for the digital age.

In Chapter 3, the research design and methodology for this study were discussed. This included a discussion of the research questions, an explanation of the research design, and details regarding the sampling and instruments used. The chapter concluded by describing the steps taken to ensure the trustworthiness and ethical consideration of the research procedure and its results. The main aim of this study was to assess the effectiveness of offering CAT in developing and enhancing 21CS in learners from the Lejweleputswa District so that they can thrive in the 4IR.

This chapter aims to thoroughly present the research findings concerning the research questions, drawing on data collected through questionnaires and interviews, which served as the primary data collection tools for the study. To obtain comprehensive insights and understand participant perspectives on the effectiveness of CAT in promoting 21CS among learners in the Lejweleputswa District, a mixed-methods approach, combining both qualitative and quantitative research designs, was utilised. Following the analysis and interpretation, the significance of the quantitative and qualitative data will be explored and discussed.

4.2 RESEARCH QUESTIONS

The study intended to answer 4 secondary research questions, based on the main research question (*How is CAT being effectively used as a vehicle to promote 21CS*

© Central University of Technology, Free State

in the learners of the Lejweleputswa District?) These secondary questions are listed in Table 4.1 below.

Table 4. 1: Secondary research questions

SRQ1:	How can the offering of CAT in schools modernise learners' abilities to creatively solve both educational and life problems?
SRQ2:	Which factors are contributing to the successful and unsuccessful offering of CAT in schools?
SRQ3:	Are schools in the Lejweleputswa District sufficiently equipped to offer CAT?
SRQ4:	Which educational improvements can be introduced to enhance the offering of CAT?

4.3 QUESTIONNAIRE: LEARNERS' RESEARCH SITES

The next section provides information about the research sites where the learners' questionnaires were distributed. Information about the sites of the 3 schools that participated in the research, as well as the number of learners' questionnaires distributed and received from each school, is discussed below.

Table 4. 2: Research sites for learners' questionnaires

	Research sites	**Number of questionnaires distributed**	**Number of questionnaires received**
School 1	Virginia	50	33
School 2	Welkom	80	72
School 3	Odendaalsrus	50	26
Total	**3**	**180**	**131**

A total of 180 questionnaires were distributed to learners across selected schools in the Lejweleputswa District. Of these, 131 were returned, resulting in a response rate of 72.7%. The participation rate was attributed to the distribution of the questionnaires after school hours, which reduced learners' willingness to engage. Additionally, some learners arrived late due to classroom cleaning duties, as a result, others left early out of frustration. It is worth noting that School 2 was issued with more questionnaires compared to other schools because it has a large number of learners studying CAT, resulting in a higher number of returned questionnaires compared to other schools.

4.4 QUANTITATIVE ANALYSIS

The following section presents the study's quantitative findings. This includes the presentation and interpretation of the learners' and teachers' questionnaires and the inferential statistics of CAT learners' creativity, critical thinking, communication,

© Central University of Technology, Free State

collaboration and technological skills. It is important to note that all these skills were analysed individually, and inferential statistics were not performed for innovation and problem-solving skills.

4.4.1 Presentation of quantitative findings from the learners' questionnaires

Using descriptive statistics, the learners' questionnaire is first discussed. As such, the learner participants' (hereafter LPs) responses to the quantitative questions will be assessed, with statistics used to substantiate findings.

4.4.1.1 Learners' descriptive statistics

Descriptive statistics involves summarising data in an organised manner by highlighting the relationships between various elements in a sample or population. The researcher needs to calculate these statistics before delving into any comparisons using inferential statistics. In total, there were 131 LPs, and their characteristics are discussed below.

- ***Age***

The LPs were in Grades 10 through 12, with a mean age of 17 years. The youngest participant was 15 years old, while the oldest was 21. The standard deviation of 1 shows that the sample was homogeneous in terms of age (Pannel 2023:n.p.). This may suggest that most learners are in the expected age range for the FET phase. It is also worth noting that there was one missing value in the data. In addition, it should be noted that the researcher issued consent forms to parents before engaging with the learners.

Table 4. 3: Learners' ages

N	Valid	131
	Missing	1
Mean		17.10
Median		17.00
Std. Deviation		1.281
Range		6
Minimum		15
Maximum		21

© Central University of Technology, Free State

- ***Schools' participation frequency***

From Figure 4.1, 72 (55%) of the LPs were from School 2. Additionally, 26 (19.8%) of the LPs were from School 3, and 33 (25.5%) were from School 1. This indicates that most LPs were from School 2 since the school had more CAT learners than other schools. The findings supported the suggestion that if a school has more than enough resources to teach CAT, most learners are more likely to choose the subject, as they will be accommodated (cf. 2.3.7.1).

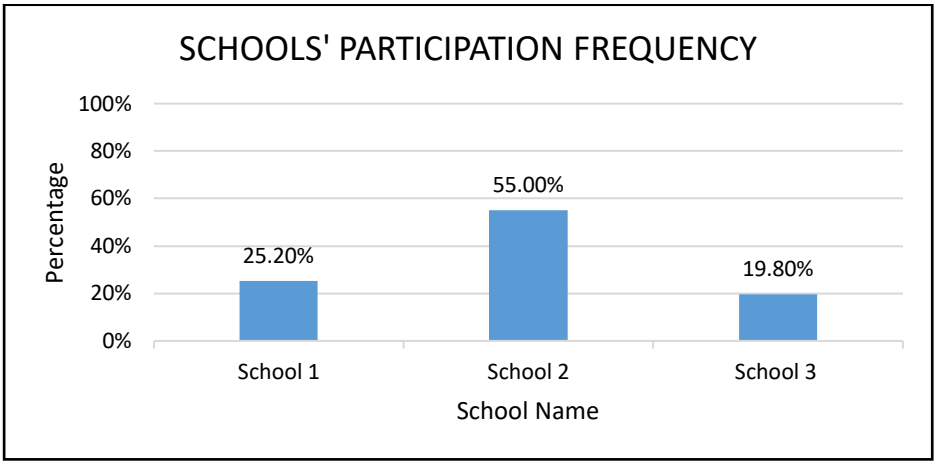


Figure 4. 1: Schools' participation frequency (n=131)

4.4.1.2 Learners' perception of Computer Applications Technology (CAT)

The learners' open-ended questionnaire responses have revealed factors related to learners' perception of CAT. These perceptions are quantitatively presented below, followed by their interpretation.

- ***Reasons why learners chose Computer Applications Technology (CAT) as one of their Further Education and Training (FET) subjects***

Based on the information in Table 4.4, LPs had different reasons for choosing CAT as one of their FET phase subjects. The reasons for choosing CAT were as follows:

- To pursue a career in IT/Computer Sciences (*n*=100, 47%);
- Interest in the subject (*n*=90, 42%);
- Liking the teacher (*n*=18, 8%);
- Friends taking the subject (*n*=4, 2%); and
- Parents forcing them (*n*=1, 1%).

© Central University of Technology, Free State

This implies that most LPs chose CAT as one of their FET subjects to pursue a career in IT or Computer Science. These findings are in line with the research conducted by Ghavifekr and Wan Rosdy (2015:3), who have found that many LPs perceive CAT as a valuable foundation for their future careers. Additionally, 42% of LPs indicated that their interest in the subject influenced their decision to study CAT. This finding aligns with existing literature, emphasising relevance and engagement's significant impact on learners' interest levels (cf. 2.3.2.2).

Table 4. 4: Reasons why LPs chose CAT as one of their FET subjects (n=131)

Multiple Response						
Case Summary **Cases**						
	Valid		Missing		Total	
	N	Percentage	N	Percentage	N	Percentage
Reasons for choosing CAT:	131	100.0%	0	0%	131	100.0%
Responses						
				N	Percentage	Percentage per case
Reasons for choosing CAT:	I want to pursue a career in IT/ Computer Sciences			100	47%	76.3%
	I am interested in CAT			90	42%	68.7%
	I like the teacher			18	8%	13.7%
	My friends took the subject			4	2%	3.1%
	My parents forced me			1	1%	0.8%
Total				213	100%	162.6%

- ***Subject enjoyment***

From Figure 4.2 below, 97% (*n*=127) of the LPs responded "yes" to enjoying CAT as one of their FET subjects, while only 3% (*n*=4) responded "no". This suggests that the majority of learners enjoy CAT as a subject in the FET phase. This finding aligns with existing literature, affirming that CAT encompasses instructional videos, audio components, and hands-on activities, thereby augmenting the overall learning experience for learners (cf. 2.3.2.5).

© Central University of Technology, Free State

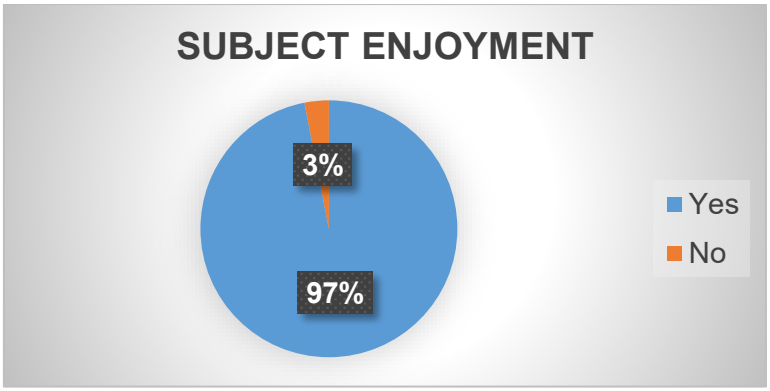


Figure 4. 2: Subject enjoyment (n=131)

- ***Computer Applications Technology (CAT) improves learners' chances of going to universities***

From Figure 4.3, 118 (91%) of the LPs believed that having CAT as one of their FET subjects improves their chances of going to university. Meanwhile, 12 (9%) of LPs did not think so. This may suggest that learners studying CAT believed that it would enhance their likelihood of being accepted into university after Grade 12. This perception may motivate learners to diligently grasp the concepts taught in the classroom, believing that having CAT can improve their chances of gaining university admission. Additionally, this belief may incentivise learners to strive for higher marks in the subject, thereby aiding in the attainment of the subject's expected outcomes as stated in the literature (cf. 2.3.6).

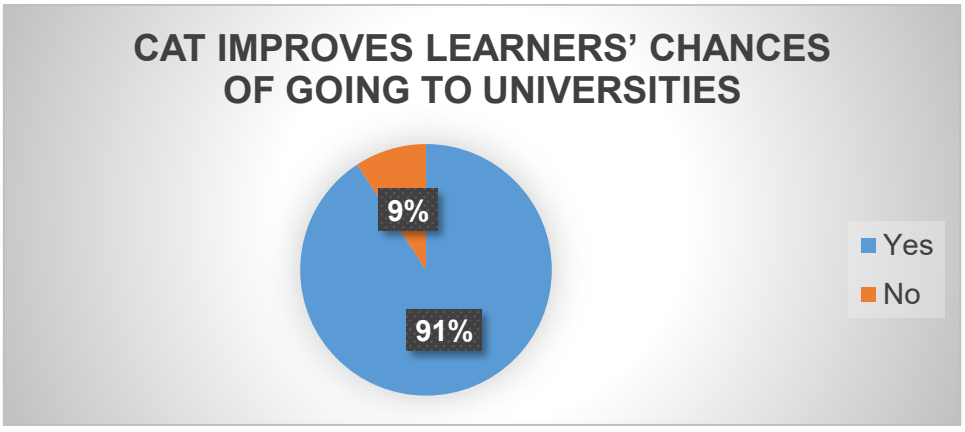


Figure 4. 3: CAT improves learners' chances of going to universities (n=131)

- ***Computer Applications Technology (CAT) recommendation to peers***

From Figure 4.4, 115 (88%) of the LPs would recommend CAT to their peers, as opposed to 16 (12%) who would not. This indicates that a high percentage of learners

© Central University of Technology, Free State

would recommend CAT to their peers, which may be associated with the belief that CAT prepares learners for several possible future careers (Yengwayo and Makena 2022:64).

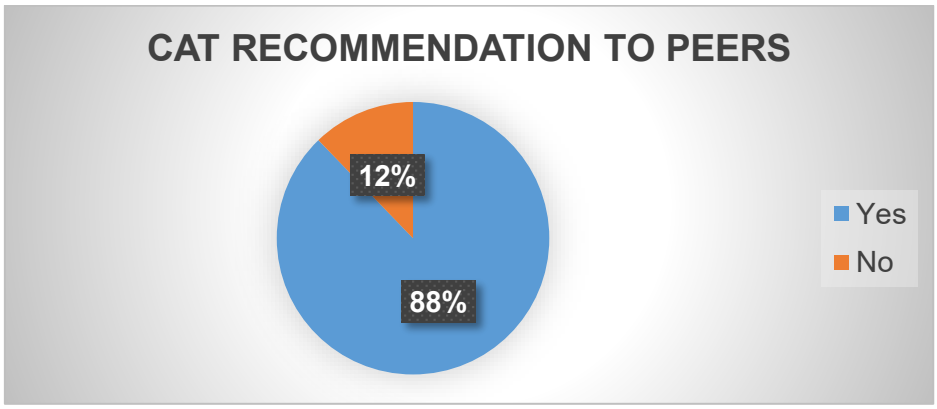


Figure 4. 4: CAT recommendations to peers (n=131)

- ***Additional access to the computer laboratory to do assignments***

From Table 4.5, 105 (80.2%) LPs had additional access to the computer laboratory to do their assignments and revisions, while 22 (16.8%) LPs did not. There were also 4 (3.%) LPs who did not answer the question. This suggests that most learners can access the computer laboratory for their school assignments as well as revisions, which could lead to a better understanding of the subject. This improved understanding can result in better academic performance and enable learners to grasp the principles of computing and its real-life applications (Engelbrecht et al., 2020:828). These findings align with literature suggesting that learners should be encouraged to move beyond basic techniques and skills, and instead focus on collaboration, creativity, productivity, and integration with CAT subtopics and real-life problems (cf. 2.3.6.1).

Table 4. 5: Additional access to the computer laboratory (n-131)

		Frequency	**Percentage**	**Valid Percentage**
Valid	Yes	105	80.2	82.7
	No	22	16.8	17.3
	Total	127	97	100.0
Missing	System	4	3	
Total		131	100.0	

© Central University of Technology, Free State

- ***Computer Applications Technology (CAT) compared to other subjects***

From Table 4.6, 77 (58.8%) LPs indicated that the CAT learning experience was better than other subjects, while 35 (26.7%) said it was the same as other subjects, and 15 (11.5%) mentioned that it was more difficult than other subjects. There were also 4 (3%) LPs who did not give their opinion. It is evident from the data that the majority of the LPs (59%) considered the CAT learning experience to be better than that of other subjects. This preference may be because CAT learning involves the use of a computer and Internet access, which makes it more relevant to real-life situations, since learners use the Internet daily. This observation aligns with existing literature (cf. 2.3.6.4).

Table 4. 6: CAT compared to other subjects (n=131)

		Frequency	Percentage	Valid percentage
Valid	Better	77	58.8	60.6
	Same	35	26.7	27.6
	Difficult	15	11.5	11.8
	Total	127	97	100.0
Missing	System	4	3	
Total		131	100.0	

4.4.2 Interpretation of the quantitative data analysis of learners' questionnaire

This subsection discusses the findings of the quantitative analysis of the learner questions regarding the 3 schools in the Lejweleputswa District. The LPs were between 15 and 21 years old and from Grades 10 to 12. The majority of LPs who participated were from School 2, which is located in Welkom. This was because School 2 was issued with more questionnaires compared to other schools, as it has more resources to accommodate more learners. The findings suggest that some schools are unable to offer the CAT subject to a large number of interested learners due to insufficient resources (Apuke and Iyendo 2016:3). Consequently, the findings are in line with Nwana, Ofoegbu and Egbe (2017:112), who state that the subject is only available to a limited number of learners in each grade during the FET phase due to the lack of teaching resources.

Most LPs indicated that they chose CAT as one of their FET phase subjects because they would like to pursue careers in IT or Computer Sciences. This supports the discussion in Chapter 2 (cf. 2.3.2) surrounding CAT and its importance in learners'

© Central University of Technology, Free State

lives. This also aligns with Alavi et al. (2016:57), who highlight that one of the goals of the CAT curriculum is to produce computer-literate learners who will be competent employees. Consequently, if learners believe that CAT will be beneficial to them in the future, it encourages them to excel in the subject and achieve the expected goals. Achieving CAT curriculum goals may, therefore, mean that the learning and the offering of the subject were successful.

Additionally, findings have indicated that the LPs enjoy the subject, which supports the discussion in Chapter 2 (cf. 2.3.2.5) regarding CAT being one of the subjects that enhances learning enjoyment. As a result of enjoying the subject, learners engage with enthusiasm, which also motivates them to effectively complete their schoolwork. Furthermore, Chapter 2 (cf. 2.3.2.5) highlights that teaching and learning in CAT utilise a variety of techniques to accommodate diverse learning styles. These include audio resources for aural learners, videos for visual learners, and practical exercises for kinaesthetic learners. Consequently, the application of these varied teaching methods ensures that all learners are engaged, contributing to the subject's overall success.

Moreover, findings state that most LPs believed that CAT improves their chances of going to different universities for further studies. As a result, most learners would recommend CAT to their peers. Furthermore, while many have reported having additional access to the computer laboratory for completing school assignments and studying, some have noted that they do not enjoy such access. This inconsistency is one of the factors that contribute to the unsuccessful teaching of CAT. Therefore, it is essential to address this gap through an educational improvement strategy, ensuring that all learners have additional access to the necessary resources for success in CAT.

4.4.3 Presentation of quantitative findings from the teachers' questionnaires

When analysing the teachers' questionnaire results, the researcher begins with descriptive statistics and follows the questionnaire structure for discussion. As such, the teacher participants' (hereafter TPs) responses to the quantitative questions will be assessed, with statistics used to substantiate findings.

© Central University of Technology, Free State

4.4.3.1 Teachers' descriptive statistics

In this section, the researcher will provide descriptive statistics for the TPs. These include TPs' years of experience, their qualifications and the training they received to teach CAT, alongside a brief interpretation.

- ***Years of experience as a Computer Application Technology (CAT) teacher***

From Table 4.7, TPs' average experience was 6.5 half years working as a CAT teacher. Most of the TPs had been CAT teachers for 2 to 3 years. Since the sample's standard deviation was more than 4, it can be concluded that the sample was heterogeneous in terms of years of CAT teaching experience. This suggests that teachers' experience in teaching CAT may vary in years, indicating that some may have developed new skills and been exposed to effective teaching methods for the subject as indicated in the literature (cf. 2.4.1.5). This thorough development promotes their ability to properly impart CAT knowledge to learners (Santos and Castro 2021:2).

Table 4. 7: Years of experience as a CAT teacher (n=16)

N	Valid	16
	Missing	0
Mean		6.50
Median		5.00
Mode		2.00 and 3.00
Std. Deviation		4.872
Range		15
Minimum		1
Maximum		16

- ***Teachers' qualifications***

From Figure 4.5, there was a total of 16 TPs, representing 10 different schools. 3 teachers were from 1 school, another 3 from a second school, 2 from a third school, and the remaining 8 teachers were each from different schools. It is worth noting that there were no missing values. Of the TPs, 56.25% (*n*=9) held a Postgraduate Certificate in Education (PGCE), 25% (*n*=4) held a Bachelor of Education (B.Ed), 12.5% (*n*=2) held a project management certificate and 6.25% (*n*=1) held an international certification in digital literacy. This finding indicates that most teachers

© Central University of Technology, Free State

teaching CAT hold a PGCE, which is an appropriate qualification to teach in the FET phase, since CAT is an FET phase subject.

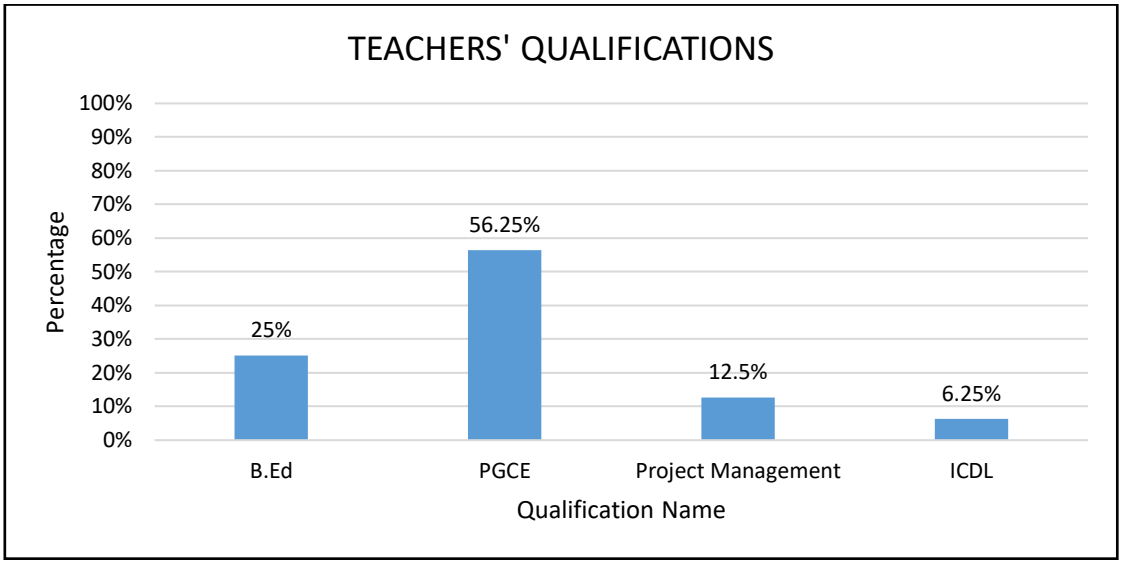


Figure 4. 5: Teachers' qualifications (n=16)

- ***Training to teach Computer Applications Technology (CAT)***

In Table 4.8, the responses from teachers regarding receiving training or mentorship in teaching CAT are shown. The majority (*n*=14, 87.5%) of TPs stated that they have received training, while a minority (*n*=2, 12.5%) of teachers stated that they did not receive any training in how to teach CAT in schools. This suggests that the majority of teachers have received training in teaching the subject, which may have improved their CK, PCK, TCK, as well as TPK, which is in line with the existing literature (cf. 2.4.1).

Table 4. 8: Training to teach CAT (N=16)

		Frequency	Percentage	Valid percentage
Valid	Yes	105	87.5	87.5
	No	2	12.5	12.5
	Total	16	100.0	100.0

4.4.3.2 Factors contributing towards the successful teaching of Computer Applications Technology (CAT)

This section represents the findings from the teachers' questionnaire regarding the factors that contribute to the successful teaching of CAT. This is followed by a brief interpretation of the findings.

© Central University of Technology, Free State

- ***Availability of computer laboratories in schools that offer Computer Applications Technology (CAT)***

From Table 4.9, all 16 (100%) TPs stated that their schools have a computer laboratory. Thus, no school is offering CAT without having a computer laboratory. This promotes the successful offering of CAT, as the literature states (cf. 2.3.5).

Table 4. 9: Availability of computer laboratories in schools that offer CAT (n=16)

		Frequency	Percentage	Valid percentage
Valid	Yes	16	100.0	100.0

From Table 4.10, 13 (81.3%) TPs mentioned that their learners have additional access to the computer laboratory for doing school assignments. However, 3 (18.7%) teachers indicated that their learners do not have extra access to the computer laboratory for their assignments and revision. Therefore, most teachers noted that their learners have additional access to the computer laboratory to do their revisions, which improves their TCK, making it easier for the teachers to track their efforts in learning the subject. This helps in achieving the subject's initial outcomes as indicated in the literature review (cf. 2.3.6).

Table 4. 10: Learners' additional access to the computer laboratory (n=16)

		Frequency	Percentage	Valid percentage
Valid	Yes	13	81.3	81.3
	No	3	18.7	18.7
	Total	16	100.0	100.0

- Recommendation of Computer Application**s** Technology (CAT) to learners

Table 4.11 indicates the number of TPs who would advise their learners to take CAT as a subject. All (*n*=16, 100%) of the teachers indicated that they would recommend CAT as one of the learners' subjects in the FET phase. This could be attributed to their recognition of the influence that CAT has on learners within the digital realm in which they are immersed, as emphasised in the literature (cf. 2.3.2).

Table 4. 11: Recommendation of CAT to learners (n=16)

		Frequency	Percentage	Valid percentage
Valid	Yes	16	100.0	100.0

© Central University of Technology, Free State

4.4.4 Interpretation of the quantitative data analysis of teachers' questionnaire

The findings of the quantitative responses from the teacher's questionnaire have been presented on the previous page. They show that the teachers who took part in this study had experience in the subject, ranging from 1 to 16 years. The teachers' qualifications differed, and most teachers' highest qualification was PGCE, followed by the B.Ed. This indicates that all the teachers teaching CAT have TPK of the subject and are qualified to teach CAT. This is in line with the TPACK framework in Chapter 2 (cf. 2.4.1.2), which indicates that in the CAT classroom, TPK is essential for creating an immediate and interactive technological learning environment where digital tools and various technologies are used appropriately with understanding by teachers to present lessons and collect feedback from learners.

It is evident from the findings that having received training for the CAT subject strengthens teachers' TCK. This is in line with Chapter 2 (cf. 2.4.1.1), which indicates that having sufficient TCK may ensure that teachers know how to use different software, like a spreadsheet tool to model data or a database to represent the information, resulting in making the learning process effective and free of misconceptions (Açikgül 2020:158). Additionally, Chapter 2's (cf. 2.4.1) TPACK framework indicates that CAT teachers' skills must be developed to understand and master integrating technology items and CAT content in the classroom to achieve CAT objectives. Thus, well-trained CAT teachers play a crucial role in ensuring that the integration of technology enhances learners' 21CS. The technological tools used in this context include computers, printers, and smartphones, which provide practical opportunities for learners to develop essential 21CS such as creativity, problem-solving, and technological proficiency.

Findings also show that the schools all have computer laboratories which they use to teach CAT; this supports the successful offering of the subject as discussed in detail in Chapter 2 (cf. 2.3.5). Additionally, many teachers noted that their learners have further access to the computer laboratory, where they can utilise computer networks. This access fosters the use of collaborative technologies that facilitate coordinated learning efforts, allowing learners to work together to overcome challenges (Rodriguez et al., 2017:664). This aligns with the information presented in Chapter 2 (cf. 2.3.6.3), which emphasises that the availability of resources enhances a conducive teaching

© Central University of Technology, Free State

and learning environment and significantly contributes to the successful teaching of subject content.

All the teachers have expressed their willingness to recommend the CAT subject to other learners. This endorsement may stem from their recognition that the 21CS acquired through CAT will equip learners for success in the digital world, even outside the classroom. Within the CAT classroom, learners are taught about social implications, in which they are given diverse social scenarios that necessitate problem-solving, addressing issues such as cyberbullying, computer theft, and the enhancement of computer and Wi-Fi security (Akrim and Sulasmi 2020:324). These challenges reflect real-life situations that everyone using digital devices and social applications should be aware of to safeguard themselves.

4.4.5 Inferential statistics

Inferential statistics is defined as using the sample descriptive statistics to infer the population (Amrhein, Trafimow and Greenland 2019:263). Furthermore, according to Sutanapong and Louangrath (2015:31), inferential statistics is the process of using sampled data to infer or forecast characteristics of a larger sample data set or population. To better understand how teachers and learners in the Lejweleputswa District perceive the use of CAT as a tool for fostering 21CS, the researcher attempts to infer features from the LPs and TPs in this study.

4.4.5.1 Chi-squared results

A statistical test called a chi-square test is used to compare actual outcomes with predictions (Shan and Gerstenberger 2017:1). This test aims to determine whether a discrepancy between observed and expected data is the result of random variation or a relationship between the variables being examined (Turhan 2019:576). A chi-square analysis was run to determine any differences between the perception of CAT teachers and learners on how CAT promotes 21CS in learners. The tables and interpretations in the subsections below represent the inferential statistics of learners' and teachers' questionnaires concerning the determination of CAT learners' 21CS.

© Central University of Technology, Free State

- ***Comparison of Computer Applications Technology (CAT) learners' creativity skills with other learners***

In Table 4.12, the differences in responses between LPs and TPs regarding the creative skills of CAT learners are presented. According to the chi-square results, there is no significant variance in the perceptions of CAT's impact on improving learners' creativity skills. Specifically, 100% of teachers and 90% of learners believed that CAT enhances learners' creativity skills ($t=0.68$, $p>0.05$). Furthermore, all the teachers (100%) and a significant proportion of learners (79%) felt that CAT learners' creativity skills surpass those of their peers ($t=3.19$, $p>0.05$). It appears that both CAT learners and their teachers perceive CAT learners to possess superior creativity skills compared to their peers. This belief may stem from the CAT curriculum's emphasis on engaging learners' creativity during practical lessons. This finding aligns with existing literature that indicates CAT nurtures learners' creativity and enhances their capacity to devise innovative solutions to address new challenges (cf. 2.2.1).

Table 4. 12: Comparison of CAT learners' creativity skills with other learners

Variables	**Teachers (% who said yes)**	**Learners (% who said yes)**	**Chi-squared results**	
			X^2-value	*P*-value
Creativity				
CAT improves creativity skills	100%	90%	0.68	0.41
The creativity skills of CAT learners are better than peers without CAT	100%	79%	3.19	0.07

- ***Comparison of Computer Applications Technology (CAT) learners' critical thinking skills with other learners***

Table 4.13 compares the responses from LPs and TPs regarding the impact of CAT's Critical Appraisal of a Topic programme on learners' critical thinking skills. The results of the chi-square test suggest that there is no significant difference between the perceptions of learners and teachers regarding the effectiveness of CAT in improving critical thinking skills. Specifically, 94% of teachers and 87% of learners believed that CAT improves critical thinking skills ($t=0.60$, $p>0.05$). Additionally, 69% of teachers and 71% of learners believed that CAT learners' critical thinking skills are superior to those of their peers ($t=0.35$, $p>0.05$).

© Central University of Technology, Free State

It appears that both CAT learners and teachers were aligned in their belief that CAT enhances learners' critical thinking skills, and that CAT learners' critical thinking abilities exceed those of their peers. This belief may be attributed to the CAT content, which includes Microsoft Excel. In this software application, learners are expected to perform calculations using various formulas. These exercises not only enhance learners' mathematical knowledge but also prepare them to employ calculation formulas to demonstrate their approach to specific answers, improving problem-solving skills. This is in line with existing literature (cf. 2.2.2).

Table 4. 13: Comparison of CAT learners' critical thinking skills with other learners

Variables	**Teachers (% who said yes)**	**Learners (% who said yes)**	**Chi-squared results**	
			X^{2}-value	*P*-value
Critical thinking				
CAT improves critical thinking skills	94%	87%	0.06	0.80
The critical thinking skills of CAT learners are better than peers without CAT	69%	71%	0.35	0.52

- ***Comparison of Computer Applications Technology (CAT) learners' communication skills with other learners***

In Table 4.14, the replies from LPs and TPs regarding the CAT learners' communication skills are compared. The chi-square results suggest that there is no significant difference between the perceptions of learners and teachers on whether CAT improves learners' communication skills. Specifically, 69% of teachers and 85% of learners believed that CAT improves learners' communication skills, with a t-value of 3.55 and a p-value greater than 0.05. However, there is a noteworthy difference in the responses of teachers and learners regarding whether CAT learners' communication skills are superior to those of their peers. Only 25% of teachers, compared to 63% of learners, felt that CAT learners' communication skills were not better than those of their peers ($t=9.27$, $p<0.05$), showing a statistical difference between teachers' and learners' perceptions on this matter.

The research findings suggest that CAT contributes to enhancing learners' communication skills by providing instruction across various online platforms. This aligns with existing literature, which indicates that learners can improve their

© Central University of Technology, Free State

participation using online platforms (cf. 2.2.3). However, the findings also indicate that despite CAT's role in teaching communication skills, learners' communication skills do not surpass those of their peers. This may be due to the opinion that some learners excel in communication only when using social media platforms, as discussed in the literature (cf. 2.3.5.3), rather than in face-to-face interactions. According to Oyundoyin, Jacob, Oyundoyin, and Onasanya (2023:142), these social media platforms encourage learners to communicate with distant individuals while reducing their communication with those nearby.

Table 4. 14: Comparison of CAT learners' communication skills with other learners

Variables	**Teachers (% who said yes)**	**Learners (% who said yes)**	**Chi-squared results**	
			X^2-value	*P*-value
Communication				
CAT improves communication skills	69%	85%	3.55	0.06
The communication skills of CAT learners are better than peers without CAT	25%	63%	9.27	0.002

- ***Comparison of Computer Applications Technology (CAT) learners' collaboration skills with other learners***

In Table 4.15, the data illustrate the variance in responses between LPs and TPs concerning the collaboration skills of CAT learners. The chi-square results suggest that there is no significant difference in the perceptions of CAT improving learners' collaboration skills, with 94% of teachers and 82% of learners believing in its efficacy ($t=0.70$, $p>0.05$). Additionally, 88% of teachers and 71% of learners perceived that CAT learners' collaboration skills surpass those of their peers ($t=0.84$, $p>0.05$), indicating no significant difference in the responses between teachers and learners.

The findings indicate that both CAT learners and teachers believed that CAT enhances the learners' collaboration skills, surpassing those of their peers. This may be attributed to CAT being a subject taught exclusively in the FET phase, where learners work together to comprehend the subject's content. Furthermore, their collaboration skills may be enhanced through the use of online teaching and learning platforms, as emphasised in the literature (cf. 2.3.5.1). This enables them to work with others from

© Central University of Technology, Free State

the comfort of their homes to achieve a common goal, which is also supported by existing literature (cf. 2.3.5.2).

Table 4. 15: Comparison of CAT learners' collaboration skills with other learners

Variables	Teachers (% who said yes)	Learners (% who said yes)	Chi-squared results	
			X^2-value	*P*-value
Collaboration				
CAT improves collaboration and thinking skills	94%	82%	0.70	0.40
The collaboration skills of CAT learners are better than peers without CAT	88%	71%	0.84	0.36

- ***Comparison of Computer Applications Technology (CAT) learners' technological skills with other learners***

Table 4.16 compares the responses of LPs and TPs regarding CAT learners' technological skills. The chi-square results indicate that there is no significant difference between the perceptions of teachers and learners regarding the impact of CAT on learners' technological skills. Specifically, 100% of teachers and 89% of learners believed that CAT improves learners' technological skills ($t=1.23$, $p>0.05$). Additionally, 100% of teachers and 85% of learners felt that CAT learners' technological skills surpass their peers ($t=2.27$, $p>0.05$). This suggests that there is no significant difference in the way teachers and learners perceive the technological skills of CAT learners in comparison to their non-CAT peers.

The findings suggest that both CAT learners and teachers believed that CAT enhances learners' technological skills, surpassing those of their peers. This is supported by existing literature indicating that CAT classrooms are equipped with technological resources that learners use to engage with the subject's content. This prepares them to effectively apply technology in solving real-life problems, in line with the existing literature (cf. 2.2.5).

Table 4. 16: Comparison of CAT learners' technological skills with other learners

Variables	Teachers (% who said yes)	Learners (% who said yes)	Chi-squared results	
			X^2-value	*P*-value
Technological				
CAT improves technological thinking skills	100%	89%	1.23	0.27

© Central University of Technology, Free State

The technological skills of CAT learners are better than peers without CAT	100%	85%	2.27	0.13

4.4.5.2 Discussion of inferential statistics

The inferential statistics mentioned above pertain to the concept of 21CS taught through CAT. The objective was to ascertain whether teachers and learners believe that CAT, as a subject, teaches and enhances these skills, and whether their 21CS surpasses that of their non-CAT peers.

The findings indicate that both learners and teachers believe that CAT enhances the creativity, critical thinking, collaboration, and technological skills of CAT learners. This is consistent with existing literature suggesting that CAT content teaches 21CS to learners (cf. 2.2). Participants also noted that these skills surpass those of non-CAT peers. These beliefs may stem from the fact that CAT content repeatedly tests learners' skills by assigning real-life tasks, such as using various software applications to creatively solve challenges, technologically employing critical thinking skills, and occasionally collaborating to complete tasks (Henriksen et al., 2015:457).

The findings suggest that both learners and teachers believe that CAT enhances the communication skills of learners. This aligns with existing literature (cf. 2.2.3), which emphasises that CAT learners are educated on exploring the impact of ICT in social computer environments, including social network websites, as well as precautionary and safety measures in legal computer environments, encompassing Internet fraud (Zhou et al., 2021:43379).

However, teachers have noted that the communication skills of the learners do not surpass those of their peers. This may indicate that teachers perceive all learners as performing well in terms of communication skills, as they interact with them when answering questions in the classroom to demonstrate their understanding of the concepts taught, which is considered an effective teaching method, as supported by the literature (cf. 2.3.1.5).

4.5 QUALITATIVE DATA ANALYSIS

The following section presents the study's qualitative findings. This includes the presentation and interpretation of the themes and subthemes from the learners' and teachers' questionnaires.

© Central University of Technology, Free State

4.5.1 Presentation of qualitative findings from learners' questionnaire

The presentation of qualitative findings, discussion and interpretation of the learners' questionnaire are discussed in this section. This section presents and analyses the qualitative findings that were obtained from the open-ended questionnaires conducted with 131 CAT LPs. These LPs were from 3 different schools. The subsections are divided according to the major themes and subthemes that emerged from the collected data. These themes were derived through a thematic analysis of the participants' responses. Initially, the researcher became familiar with the data and performed line-by-line coding to label the insights. Subsequently, these initial codes were refined into more focused categories by recognising patterns among them, paving the way for the development of themes. Finally, the researcher reviewed and assigned names to these themes as part of the analysis process. It is important to note that the LPs' direct words are quoted in the discussions, and their codes are indicated as LP1 to LP131. It is also worth noting that not all LPs were quoted.

Table 4. 17: Themes and subthemes from CAT learners' open-ended questionnaires

Themes	Subthemes
Theme 1	**CAT curriculum learning experience**
Subtheme 1.1	What learners enjoy the most about CAT
Subtheme 1.2	CAT challenges
Theme 2	**Resources for CAT subject learning**
Subtheme 2.1	No additional access to the computer laboratory
Subtheme 2.2	Personal resources used to help with the learning of CAT
Theme 3	**The CAT learning experience compared to other subjects**
Subtheme 3.1	The learning experience is better than other subjects.
Subtheme 3.2	The learning experience is the same as other subjects.
Subtheme 3.3	The learning experience is more difficult than other subjects.

Table 4.16 illustrates the main themes and subthemes identified qualitatively from the open-ended learners' questionnaires. These themes and subthemes will be discussed in more detail in the subsections that will follow.

4.5.1.1 Theme 1: Computer Applications Technology (CAT) curriculum learning experience

The CAT curriculum and classroom include both practical and theoretical components for learners, as supported by the TPACK framework in the literature (cf. 2.4.1). Each

© Central University of Technology, Free State

learner's CAT learning experience is unique. This learning experience has been divided into 2 subthemes, which are discussed below.

- ***Subtheme 1.1: What learners enjoy most about Computer Applications Technology (CAT)***

Numerous LPs conveyed their strong preference for applying the practical skills they have acquired in the CAT classroom. These practical applications encompass Microsoft Word, Microsoft Excel, HTML, research, and Microsoft PowerPoint presentations. As a result, the LPs believed that these hands-on activities offer them valuable insights into computers and technology, making the learning process more enjoyable, as supported by the literature (cf. 2.3.4). Furthermore, some LPs highlighted their affinity for mathematics, noting that working with calculations in Microsoft Excel generally enhances their engagement with the subject, which is also in line with the literature (cf. 2.3.2.2):

LP22 "I enjoy CAT when we're doing practicals of what we have been taught about".

LP25 "I enjoy learning Microsoft Word, Spreadsheet".

LP93 "Editing documents from Microsoft Word".

LP28 "HTML, it's like you learn a computer language".

LP76 "When we research the computer assignment.

LP102 "Creating posters or covers on PowerPoint".

LP106 "Enjoy practical because I am good when it comes to spreadsheet because I enjoy doing calculations".

Furthermore, LPs expressed their appreciation for the CAT subject, finding it both interesting and beneficial for improving their computer skills. They also emphasised the significant role their teachers play in making the CAT learning experience more enjoyable and manageable. This is in line with the literature which states that, to cater for learners' differences, teachers in CAT can enhance the learning experience by incorporating supplementary content - thereby accommodating all learners (cf. 2.3.2.6). Additionally, LPs believed that CAT is essential for preparing them for various work industries, given that most careers require computer knowledge. They also highlighted that learning CAT helps them effectively troubleshoot phone problems, which they find particularly intriguing:

© Central University of Technology, Free State

LP106 "Because I find it interesting".

LP12 "It helps me improve my computer skills and gain more knowledge about CAT life".

LP21 "It gives you an insight of computers and technology so really enjoying studying technology and computers".

LP104 "Because it provides many opportunities in future".

LP126 "Because my teacher makes it easier for me to understand".

LP128 "Because it is a subject that is easy to work with and it applies to most careers".

LP1 "Because since I was getting older I started playing with phones and I like the way technology works and how to solve phones problem and I got interested".

- ***Subtheme 1.2: Computer Applications Technology (CAT) challenges***

LPs identified several challenges faced in the CAT classroom, with these challenges supported in the literature (cf. 2.3.7.1). For example, one of the challenges is grasping CAT theory and applying it practically, which they find to be quite demanding. Additionally, LPs mentioned that CAT involves numerous difficult terminologies and necessitates extensive reading:

LP53 "Comprehending some of the theory of it and applying it to real-life situations".

LP9 "It wants time to practice and know better about it".

LP13 "Bombastic words".

LP42 "The definition, some of them are hard but others I can operate apparently".

Moreover, LPs expressed that CAT practical work can pose significant challenges, particularly when dealing with HTML and performing calculations that involve spreadsheet formulas. Additionally, they highlighted the inability to conduct practical assessments on computers during power outages:

LP23 "There are certain things that are challenging for me especially when we deal with HTML".

LP94 "Excel activities, which deals with calculations".

LP54 "When electricity is gone we can't use computers".

LP65 "Being unable to do practical because of load shedding".

© Central University of Technology, Free State

4.5.1.2 Theme 1 interpretation and discussion

The proficient use of various computer applications in the CAT subject offers learners ample opportunities to creatively apply their problem-solving skills in handling data and developing innovative solutions (Kortesi, Simonka, Szabo, Guncaga and Neag 2022:3). This is supported by the data collected from the LPs, who expressed their enjoyment in working with different computer applications to manipulate data. The LPs indicated a strong preference for practical work in the CAT classroom, finding it enjoyable and beneficial for their learning journey. The literature further supports the open-ended questionnaire findings by emphasising that 21CS taught through CAT enable learners to create something new from the ordinary, with lessons incorporating software applications such as Microsoft Word (cf. 2.2.1).

It is crucial to emphasise that teachers must actively support the integration of technology in their classrooms and demonstrate proficient use of technology to guide learners in evaluating, interpreting, and utilising technology effectively (Boonmoh et al., 2021:3). Furthermore, LPs expressed that the way their teachers incorporate CAT teaching significantly impacts their ability to comprehend concepts and enjoy learning. These findings align with literature emphasising the importance of providing examples and guiding teachers toward effective methods for teaching 21CS through CAT (cf. 2.2.5).

The CAT curriculum aims to cultivate computer-literate learners who will thrive as competent employees (Alavi et al., 2016:57). LPs expressed their enthusiasm for CAT, emphasising its potential to open doors in the future. They also highlighted the practical relevance of CAT in numerous contemporary job roles, given the widespread requirement for computer literacy in the workplace. These findings corroborate the existing literature, underscoring the significance of CAT as a crucial subject in secondary education (cf. 2.3.2).

Despite CAT being a subject that learners enjoy, it also presents its own set of challenges. LPs indicated that one of these challenges is grasping CAT theory, as they find the terminology difficult to comprehend. This finding is supported by the literature, suggesting that assessing real-world cases relevant to everyday issues will compel learners to draw on prior knowledge from other subjects. This approach may lead to

© Central University of Technology, Free State

better retention of information compared to relying solely on theoretical knowledge (cf. 2.3.2.2).

Furthermore, LPs expressed difficulty performing Microsoft Excel calculations due to the need to use different formulas. This finding aligns with existing literature, suggesting that learners using Microsoft Excel are required to apply critical thinking and problem-solving skills when using functions to calculate (cf. 2.2.2). LPs also highlighted the challenge of working on computers in the CAT classroom due to load shedding. This finding is consistent with the literature, which emphasises that under-resourcing, including insufficient teaching and learning materials, significantly hinders the teaching and learning process in CAT classrooms (cf. 2.3.7).

4.5.1.3 Theme 2: Resources for Computer Applications Technology (CAT) subject learning

It is crucial to ensure that there are ample resources available to learners for an optimal learning experience in the CAT classroom. These resources encompass materials provided by the school for daily classroom use, as well as resources that learners can utilise at home. These resources can be classified into 2 subthemes, as elaborated upon in the following subsections.

- ***Subtheme 2.1: No additional access to the computer laboratory***

Learners taking CAT require additional access to the computer laboratory for revisions, assignments, and PATs. From Table 4.5, 105 LPs confirmed that they have the necessary access to the computer lab, while 22 LPs indicated that they do not. This lack of access forces some learners to attend extra classes to complete their CAT practical work and assignments. Additionally, some LPs found themselves doing assignments during CAT periods instead of focusing on the lesson presentation:

LP10 “When I attend the after-school classes”.

LP16 “Only when it is CAT period”.

- ***Subtheme 2.2: Personal resources used to help with the learning of Computer Applications Technology (CAT)***

LPs reported using personal resources such as smartphones, home computers, and personal laptops to facilitate their learning of CAT. The majority of LPs indicated a

© Central University of Technology, Free State

preference for using their smartphones. This finding aligns with existing literature, which recognises modern smartphones not only as conventional phones but also as mobile computers, given their remarkable computing capabilities and extensive memory capacity (Foen et al., 2017:58):

LP1 "By using our textbook or cell phones".

LP21 "By using my computer at home".

LP12 "At home with my sister's laptop".

LP7 "It wants time to practice and some's don't have computers in their homes".

LP9 "You have to buy your own data with your cell phone at home to do your assignments".

4.5.1.4 Theme 2 interpretation and discussion

From Table 4.5, 22 LPs indicated that they lack additional access to the computer laboratory for their revisions and assignments. As a result, they attend extra classes while others complete their assignments during CAT lessons. These findings align with existing literature, highlighting the critical need for consistent access to essential resources such as laptops, tablets, necessary software, and reliable Internet connectivity. The absence of these foundational elements significantly complicates the effective integration of technology into the CAT learning process (cf. 2.3.3).

Moreover, the majority of LPs indicated that they rely on their smartphones for studying and completing assignments when they do not have access to computers or laptops. These findings are consistent with existing literature, which demonstrates the widespread use of smartphones by both learners and teachers. Therefore, the utilisation of technology-assisted learning in the classroom to provide successful and relevant educational experiences for FET learners is a reasonable approach (cf. 2.3.5). The use of learners' smartphones for learning is further supported by the idea that learners can access a diverse range of resources, offering flexibility and the ability to continue learning even in the absence of computer access (cf. 2.3.5.3).

© Central University of Technology, Free State

4.5.1.5 Theme 3: Computer Applications Technology (CAT) learning experience compared to other subjects

The learning experience in CAT diverges from that of other subjects, as indicated by data obtained from learners' questionnaires. These disparities can be classified into 3 subthemes, as expounded upon in the subsequent subsections.

- ***Subtheme 3.1: The learning experience is better than other subjects***

The LPs indicated that the CAT learning experience surpasses that of other subjects. They believed that they acquired more skills when being taught CAT and have come to realise the importance of utilising computers for their benefit beyond entertainment. Moreover, they felt that CAT prepares them for their future endeavours as technology continues to advance. Additionally, LPs appreciated that CAT allows them to apply the theory they have learned through practical activities, making the learning experience more enjoyable. They also found that learning CAT through visual aids, such as videos, helps them understand concepts better and leads to improved academic performance (Glassman et al., 2015:2):

LP2 "Because you can experience many things".

LP12 "CAT enabled me to learn about the usefulness of the computer rather than playing videos and games".

LP13 "CAT's experience is different compared to other subjects because everything is being prepared for the future. It gives you a lesson or a guide on how things are going to be in the future because technology will take over".

LP15 "CAT is better than other subjects because after being taught about something, we do practical".

LP23 "It is better and different because its learning skills are amazing and fun to learn".
LP44 "Because we can learn by watching Videos".

LP14 "My marks for CAT are higher than other subject marks; in that case, my experience for CAT is way better".

- ***Subtheme 3.2: The learning experience is the same as other subjects***

Some LPs indicated that the learning experience in CAT is similar to their experience in other subjects, as emphasised in the literature (cf. 2.3.4). They believed this because they give equal attention to all of their subjects, which helps them understand

© Central University of Technology, Free State

each one. Additionally, LPs noted that their academic performance is consistent across all subjects; however, they found CAT more interesting due to its focus on technology. They also mentioned that, as with any other subject, CAT has both theoretical and practical components, which require a balanced approach to understand and perform well in both areas:

LP79 "Because I make all my subjects to be equal".

LP94 "I pass CAT the same as others but it's more interesting because you learn about technology".

LP89 "Is same but it is more enjoyable subject".

LP112 "You practice it and read theoretically as much as other subjects in other words you balance your subjects".

- ***Subtheme 3.3: The learning experience is more difficult than other subjects***

It was mentioned by some LPs that CAT is more difficult to learn compared to other subjects. CAT is one of those subjects whose content is different from other subjects, thus making it more challenging. This is because learners only encounter its concepts in the CAT curriculum and not in other subjects, making it difficult for learners to do well. Additionally, LPs indicated that CAT is difficult to learn because they have to learn constantly or work with technology, which they regard as being more beneficial than other subjects. The LPs also stated that CAT requires more time and discipline during class, so as not to lose their way when doing PATs:

LP123 "Because CAT have not same topic to another subject and is difficult to another learning to know CAT".

LP128 "Because we most work with Technology and we learn better things than other subject".

LP131 "Because it wants someone who is fast".

LP125 "It requires more time and to be focused during lessons".

LP120 "Because in CAT you use electricity and computers whereby, we learn from it".

© Central University of Technology, Free State

4.5.1.6 Theme 3 interpretation and discussion

LPs held varying perspectives on the complexity of CAT learning. The majority indicated that the learning experience in CAT surpassed that of other subjects. They mentioned acquiring a diverse set of skills since studying CAT and emphasised that it uniquely prepares them for a future defined by evolving technology. These findings reinforce the idea in the literature, namely that learning 21CS through CAT equips learners to thrive in a rapidly changing technological landscape and empowers them to confidently apply these skills (cf. 2.2).

According to the findings, other LPs indicated that they perceive CAT in the same way they perceive other subjects. They claimed to have given equal attention to all of their subjects. However, LPs also indicated that learning CAT is more enjoyable. These findings support the existing literature, which suggests that using a variety of media, including videos, audio, and practical exercises, makes the CAT learning experience more enjoyable for the learners (cf. 2.3.2.5).

Furthermore, many LPs expressed that learning CAT is more challenging compared to other subjects. They argued that CAT content is unique to the subject and not covered in other courses. This finding contradicts existing literature, as Ackerman (2023:n.p.) explains that there is a common misconception among individuals, including learners, that CAT is an easy subject compared to other content-based subjects (cf. 2.3.4).

Moreover, LPs noted that CAT requires a considerable amount of time and focus, particularly when working on PATs. This finding is consistent with existing literature, which suggests that in formal tasks such as PATs, learners are expected to conduct research based on the instructions provided in the CAT classroom (cf. 2.3.2.4). Research for assignments in classes typically demands between 20 to 40 hours of work for a 20-page paper (Owens 2024:n.p.)

4.5.2 Presentation of qualitative findings from the teacher's questionnaire

The presentation of qualitative findings, as well as the interpretation of teachers' questionnaires, will be discussed in this section. This section presents and analyses the qualitative findings that were obtained from the open-ended questionnaires conducted with 16 CAT TPs. These TPs were from 10 different schools in the

© Central University of Technology, Free State

Lejweleputswa District. The section is divided according to the main and subthemes that emerged from the collected data. The TPs' direct words will be quoted in the discussion, using the codes TP1 to TP16. It is worth noting that not all TPs' answers will be quoted.

Table 4. 18: Themes and subthemes from CAT teachers' open-ended questionnaires

Themes	Subthemes
Theme 1	**The importance of offering CAT**
Subtheme 1.1	4IR skills
Subtheme 1.2	CAT improves employability
Theme 2	**CAT curriculum**
Subtheme 2.1	What learners enjoy most about CAT
Subtheme 2.2	What learners mostly struggle with in CAT
Subtheme 2.3	CAT learning barriers

4.5.2.1 Theme 1: The importance of offering Computer Applications Technology (CAT)

Learners can gain intermediate to advanced end-user computer skills with CAT. This ensures that learners can pursue a variety of career paths in other industries or use these and related abilities to earn a living. Based on the open-ended questionnaire that the TPs filled out, the study's findings have identified 2 subthemes that fall under the major theme of the importance of providing CAT. These are discussed in the subsections below.

- ***Subtheme 1.1: Fourth Industrial Revolution (4IR) skills***

TPs mentioned that we are all living in the 4IR, where most things are done or achieved using technology; therefore, learners need to become familiar with technology and everything that evolves around it. In addition, TPs added that having a computer applications background comes with great opportunities, as many careers require device operation. Moreover, TPs mentioned that learning CAT improves learners' communication skills across different media platforms (Nagy and Bernschütz 2016:1839). Furthermore, TPs noted that doing CAT in the FET phase will help those learners who intend to further their studies:

TP1 "It provides them with the necessary skills for the 4IR".

TP2 "4IR requires a little background of computer knowledge in order to operate the devices used at offices, school, cars and even at home. (It forms part of the CAT syllabus). Learners

© Central University of Technology, Free State

will gain more knowledge about different media platforms such as Facebook, Twitter, e-mailing etc. on how to communicate effectively and responsibly. Good netiquette rules on how to behave over the Internet and avoid flame wars. Social implications such as scamming, phishing identity theft, etc. Should a learner want to further his/ her studies at university, the computer is a prerequisite to do things such as assignments".

- ***Subtheme 1.2: Computer Applications Technology (CAT) improves employability***

TPs mentioned that CAT learning improves learners' chances of employment, as learners get exposed to computer-related work in the CAT classrooms in which computer-related work is considered necessary in the corporate world - as indicated in the literature (cf. 2.3.2). Therefore, TPs strongly believe that through CAT lessons, learners can gain an idea of what is after secondary school and in the world of work:

TP9 "Learners who are doing CAT get exposed to the technological work environment and that helps them to get ready to do most computer-related work. Since most things are done technologically these days, it is crucial that these learners get the idea of what is expected of them in tertiary level or in a certain work environment".

4.5.2.2 Theme 1 interpretation and discussion

The TPs expressed their belief that CAT equips learners with the essential skills for the 4IR. They also emphasised that these skills are instrumental in enhancing learners' proficiency in using various devices and improving their communication across all social media platforms.

Additionally, the TPs argued that CAT education prepares learners for social challenges such as scamming and identity theft; these are prevalent issues on the Internet. These findings align with existing literature, which highlights the diverse social scenarios presented to learners, necessitating problem-solving abilities to address concerns such as cyberbullying, computer theft, and the enhancement of computer and Wi-Fi security (Akrim and Sulasmi 2020:324). The literature also emphasises that these challenges mirror real-life situations, underscoring the importance of vigilance for all users of digital devices and social applications (cf. 2.3.6.6).

In addition, TPs indicated that CAT prepares learners for success at the tertiary level by enabling them to easily apply their computer knowledge to assignments and tasks. These findings are supported by literature that highlights the importance of CAT

© Central University of Technology, Free State

education in enhancing learners' readiness for future work and active citizenship in our fast-changing 21st-century (cf. 2.3.6.2).

Furthermore, TPs expressed that the CAT learning experience, which involves the use of modern technology, enhances learners' employability prospects for the future and prepares them for the expectations of tertiary studies and the work environment. These findings align with literature that emphasises the increasing integration of technology and its impact on people in today's world (cf. 2.2.4).

4.5.2.3 Theme 2: Computer Applications Technology (CAT) curriculum

The CAT curriculum, like any other subject's curriculum, consists of modules. Based on their academic performance, these modules can provide insight into whether learners are finding them difficult or enjoyable. The teacher's open-ended responses identified 3 subthemes under the main theme of the CAT curriculum, as discussed below.

- ***Subtheme 2.1: What learners enjoy most in Computer Applications Technology (CAT)***

The TPs noted that learners particularly enjoy being in the computer laboratory as it provides them with Internet access, which helps them in completing their CAT assignments. Additionally, TPs observed that learners appreciate visual lesson presentations, as they enable them to better comprehend the material, making learning more accessible and enjoyable for them, as indicated in the literature (cf. 2.2.1). Furthermore, learners are known to derive enjoyment from working in groups:

> *TP3 "Being in the computer lab, access to the Internet and having the privilege to do their other assignments as well".*
>
> *TP9 "Working on the Internet, word processing and visual lesson presentation".*
>
> *TP12 "The learners enjoy working in teams more especially for their assignments. They also enjoy working on word processing for data manipulation, and also the Internet".*

TPs noted that learners enjoy practical applications in addition to completing their PATs. PATs employ a structured process to teach good principles that help learners stay focused, integrating the skills acquired in CAT. According to TPs, learners appreciate the PATs because they allow them to unleash their creativity without limitations based on their specific interests:

© Central University of Technology, Free State

TP4 "Learners enjoy solving problems using word processing and also working on the Internet, the most".

TP11 "Learners enjoy when we for Microsoft Excel, especially when dealing with calculations formulas".

TP6 "CAT projects often allow for creative expression through design, multimedia, and programming, which many learners find enjoyable. Many CAT courses involve project work, giving learners the freedom to explore and create based on their interests".

- ***Subtheme 2.2: What learners mostly struggle with in Computer Applications Technology (CAT)***

Acquiring new computer skills demands consistent effort and dedication. For learners who have had limited exposure to computers, the subject can pose challenges in Grade 10, as it expects a certain level of proficiency, such as typing and using a mouse (Sanger and Gleason 2020:7). TPs identified various aspects of CAT that prove challenging for learners, including poor reading skills, grasping concepts, and coping with complex Microsoft Excel functions. These challenges can cause learners to feel overwhelmed:

TP2 "Theory: Poor reading skills with understanding or no reading at all even at home. Lack of subject vocabulary for instance understanding of CAT acronyms and their meaning, use of jargon and terminologies. Comprehension (to remember what was done in the past) Practical: Excel - a serious challenge to use complicated functions such as COUNTIF, NESTEDIF, TRUNC, FIND, CONCATENATE etc. in the context of the scenario".

TP6 "Learners struggle with using various software applications and understanding technical concepts, which can be overwhelming for some learners, especially those with limited prior experience. Identifying and fixing technical issues and errors within software applications can be frustrating and time-consuming".

TPs mentioned that learners often lack self-motivation, struggle with time management, and are easily distracted. These issues lead to lower marks in formal assessments, as learners frequently fail to complete assignments on time and struggle to answer all questions in tests due to slow progress. Moreover, TPs indicated that learners struggle a lot with understanding English, making it difficult for them to comprehend the terminology used in the CAT classroom:

© Central University of Technology, Free State

TP16 "Self-motivation, time management and distractions. Excel calculations and inability to finish work/ tasks/ test on time".

TP1 "Understanding the computer language. Our learners struggle a lot with English".

- ***Subtheme 2.3: Computer Applications Technology (CAT) learning barriers***

TPs highlighted barriers that impede learners' successful acquisition of CAT skills. These barriers encompass inadequate resources, time constraints, limited access to equipment, and insufficient technical support (Chuene and Teane 2024:3). TPs contended that restricted access to computers, Internet connectivity, and suitable software may hamper learners' ability to practice and apply their knowledge, particularly for those without access to these resources beyond the classroom. Additionally, TPs noted that the number of learners in a class exceeds the number of computers available. Moreover, TPs asserted that technical issues with hardware or software within the classroom setting can disrupt lessons and cause frustration among learners:

TP2 "Large number of learners per session, which is more than the number of available workstations. Breakage and maintenance (regular service plan), Sustainability plan to upgrade or replace software and equipment every 4-5 years. Lessons interruption through load shedding".

TP5 "Learners' computers that don't have Internet access".

TP6 "Limited access to technology - some learners may not have access to computers or software outside of the classroom, hindering their ability to practice and reinforce what they learn. Technical issues - technical problems with hardware or software in the classroom can disrupt lessons and frustrate learners".

Additionally, TPs highlighted load shedding as another obstacle to learning, as it prevents learners from accessing and utilising computers in schools without electrical generators. They further indicated that their computer systems are not maintained regularly:

TP9 "Load shedding also disturbs them from accessing the computer lab when they need it".

TP15 "Load shedding. Computers that are not serviced/ maintained regularly".

© Central University of Technology, Free State

In addition, it has been observed that many learners who study CAT during their FET phase are those who have not necessarily passed their previous grade but are simply being advanced to the next grade. These learners often face academic challenges and find CAT terminology difficult to grasp. Consequently, they tend to struggle during practical lessons, leading to a lack of focus and a tendency to avoid completing their classroom tasks:

> *TP12 "Most learners who consider doing CAT are the learners who have been promoted to the next grade, so most of them struggle with English, concentration and avoid doing their schoolwork".*

4.5.2.4 Theme 2 interpretation and discussion

TPs mentioned that learners appreciate having access to the computer laboratory. They have the opportunity to complete their assignments with the aid of available resources such as computers and Internet access. These findings align with the literature, which emphasises the importance of consistent access to essential resources such as computers, tablets, necessary software, and reliable Internet connectivity for effective learning in CAT (cf. 2.3.5).

TPs further indicated that the majority of CAT learners excel in hands-on classroom environments. Learners are more focused when they have a screen in front of them. Thus, when teachers use projectors and screens, many learners struggle to see or comprehend the content. It is more effective to have the screen on a table in front of them than across the room. This allows learners to work at their own pace and spend more time engaging with the screen. However, due to a shortage of workstations teachers are expected manage the consequences of insufficient computers in a CAT classroom (Johnson et al., 2016:4). Furthermore, insufficient computers and inadequate Internet access were identified as significant hindrances to effective CAT lessons. These challenges collectively underscore the pressing need to address infrastructure and resource constraints to facilitate a more conducive and comprehensive CAT education (cf. 2.3.3).

Moreover, TPs identified various obstacles to learning in CAT, such as software updates, power outages, language barriers, and challenges related to advancing learners to the next grade without the necessary skills. They observed that outdated software in the CAT classroom makes it difficult for learners to effectively utilise

© Central University of Technology, Free State

computer software and results in wasted learning time. Additionally, TPs highlighted that power outages impede CAT learning, as both learners and teachers are unable to use computers in schools without electrical generators. In addition, TPs noted that the majority of their learners struggle with English (the LoLT), making it difficult for them to grasp CAT content, especially the theoretical aspects. Finally, TPs highlighted that many of the CAT learners have advanced to the next grade and teaching them is challenging due to their lack of motivation, understanding and their tendency to avoid schoolwork.

4.6 FINDINGS AND ANALYSIS OF INTERVIEWS

Semi-structured interviews were carried out. These interviews were limited to the principal participants (referred to as PPs) from the schools offering CAT.

4.6.1 Research site and participants' demographics

To gain a deeper understanding of how CAT has been applied to achieve its initial goals, the researcher conducted interviews with school principals (PPs) currently offering CAT. These interviews provided insight into the success of CAT in meeting its objectives. The table below displays the locations of the schools where the interviews were conducted and the duration of the audio recordings.

Table 4. 19: Schools' locations (n=3)

	Location	Gender	Audio time	Experience under supervision	Code
School 1	Welkom	Male	33:32	3 years	PP1
School 2	Virginia	Male	26:36	13 Years	PP2
School 3	Odendaalsrus	Male	21:40	6 Years	PP3

According to Table 4.19, all the PPs who voluntarily took part in the interview were male principals from different schools in the Lejweleputswa District. The CAT subject has been offered for 3 to 13 years under their supervision. This may indicate that they would be able to provide the researcher with a lot of information regarding offering CAT. The interviews were digitally recorded, with lengths ranging from 21 minutes and 40 seconds, 26 minutes and 36 seconds, and 33 minutes and 32 seconds. The data were transcribed by a statistician, then coded and interpreted, whereafter patterns were identified. The transcriptions and their analyses are detailed below.

© Central University of Technology, Free State

4.6.2 Presentation of the findings and discussion from interviews

The emerged themes and subthemes from the perspectives, opinions, and beliefs of the PPs, as gathered through the interviews, are listed in Table 4.20. Direct quotations from the PPs are utilised to support the in-depth discussion of these themes and subthemes.

Table 4. 20: Themes and subthemes for the interview

Theme 1	**Factors relating to the learning of CAT**
Subtheme 1.1	21CS
Subtheme 1.2	Subject challenges
Theme 2	**Factors relating to the teaching of CAT**
Subtheme 2.1	Adequate training
Subtheme 2.2	Curriculum support
Theme 3	**Subject management**
Subtheme 3.1	Finances allocated for CAT
Subtheme 3.2	Technical infrastructure

4.6.2.1 Theme 1: Factors relating to the learning of Computer Applications Technology (CAT)

Schools offering CAT must be well-equipped to ensure that learners successfully meet the CAT objectives outlined by the DBE (cf. 2.3.1). After conducting interviews with PPs, certain concerns emerged regarding the offering of CAT. In this section, the researcher presents the PPs' responses regarding the skills they believe learners acquire through learning CAT, as well as the challenges posed by the subject.

- ***Subtheme 1.1: 21st-century skills (21CS)***

During the individual interviews, all the PPs emphasised that they noticed a clear difference between the learners who were enrolled in the CAT programme and those who were not. According to these PPs, the disparities included learners being adept at leveraging technology to their advantage, demonstrating discipline, and effectively completing their schoolwork using their cell phones, which is in line with the literature (cf. 2.3.6.3):

> *PP2: "Learners who have been offered CAT are able to use this technology to their advantage".*

© Central University of Technology, Free State

PP3: "Immediately after matric eh, learners are now eh, getting into the world of universities and its laptop all-, everything you have to through-, you have to do through-, technical assignments, whatever, everything is now on, on, on digital".

PP1: "Yes, there is a difference. There is a difference uh- in the sense uh, that uh- what I've learned those who are doing CAT. They're a bit more disciplined. Most of the time when they have what chance eh, they'll be busy with maybe what-, cell phones eh-. Doing their work using what-, the app. One other thing, those who are not doing Grade 12, we expect them to register for Siyavula, which is an app for the government."

- ***Subtheme 1.2: Subject challenges***

The PPs highlighted some challenges they face when supervising the smooth operation of offering CAT. Among these are load shedding, which causes delays until power is restored, ink supply issues for printers, and the serious challenge of burglary, mentioned by one PP. These challenges hinder the effectiveness of offering the subject (Sultan 2014:178):

PP2: "Load shedding is worse. It has got a negative effect because after load shedding you have to wait for about 15 minutes for the, the, the network to come back, so that the computer can work, more effectively"

PP1: "We are running in short of the ink uh, and that disturbed eh, educating. From then on, burglars. Burglary. It's a serious one. Uh- If I remember, in our school, they managed to break [in] twice"

PP3: "When it loadshedding, we, we have to assist in terms of keeping the sys-, system running. So, it's another, it's another expense. We have to buy petrol uh, for, for, for those times."

4.6.2.2 Theme 1 interpretation and discussion

Fundamental abilities, including computer literacy, give young people a crucial foundation and are a prerequisite for problem-solving, numeracy, and socio-emotional abilities. It also makes financial sense to assist young people in acquiring these skills. PPs who offer CAT mentioned the skills they believe the CAT learners acquire through CAT lessons. These skills include a technological skill which forms part of the 21CS as discussed in Chapter 2 (cf. 2.2.4). Additionally, one of the PPs mentioned that learners use computers at the tertiary level to do their assignments post-Grade 12. Thus, they believe CAT prepares the learners for the world of technology post-Grade

© Central University of Technology, Free State

12. Moreover, a PP added that CAT learners are more disciplined than other learners who are not doing CAT.

Furthermore, the PPs also indicated that despite the subject having positive effects on the learners, offering CAT has its challenges. These challenges include load shedding, which is one of the most serious challenges since it disrupts or causes delays in terms of curriculum coverage, as learners will wait for about 15 minutes to resume their activities once the power is back. Furthermore, as discussed in Chapter 2 (cf. 2.3.7.1), the absence of Internet connectivity within the school setting leads to learners encountering substantial gaps in practical learning for CAT.

The PPs also indicated that, as part of the challenges regarding offering this subject, there is a serious issue of burglary, even with the measures in place to prevent theft. This may suggest that the burglaries leave the schools under-resourced, and as a result, CAT learners may not have adequate resources for learning this subject.

4.6.7.3 Theme 2: Factors relating to the teaching of Computer Applications Technology (CAT)

Based on the interview findings, it was revealed that there are factors contributing to both effective and ineffective teaching of CAT. These factors primarily relate to the teachers, who are considered crucial in ensuring that CAT is taught in a manner beneficial to the learners (Eranzo and Esteve-Gonzalez 2015:12). The PPs emphasised the importance of adequate training for CAT teachers and curriculum support in ensuring the accurate delivery of the subject. These factors were categorised into 2 subthemes, as discussed in detail below.

- ***Subtheme 2.1: Adequate training***

PPs noted that when CAT was introduced, they did not have well-trained teachers to teach the subject. This made it challenging for the school to achieve the subject's goals as discussed in detail in Chapter 2 (cf. 2.3.5). However, one of the PPs mentioned that a well-trained teacher was eventually found, who effectively teaches the subject to the learners:

> *PP2: "Uh, mainly-, you know when we started the-, there weren't a lot of teachers who were uh- Well equipped, or who knew the subject, who, who, who were well trained in the subject. So, that was the main thing."*

© Central University of Technology, Free State

PP3: "Ya, when we started we struggled to, to get the qualified teacher who could offer the subject but, fortunately after some searches we managed to get the-, a, a, very good teacher."

- ***Subtheme 2.2: Curriculum support***

As mentioned, the PPs noted that when the CAT subject was introduced, most schools received teachers who were not adequately equipped to teach the subject. However, one participant mentioned that this is now a thing of the past, and the school now has a very competent teacher for the subject. Additionally, one PP highlighted that CAT is a monitored subject, with the school receiving support from supervisor visits. Furthermore, the DBE assists the school by providing technicians to help maintain the resources used in the CAT classroom:

PP2: "I should also maybe just mention that eh-, one of the other challenges was the person who was supposed to control the teacher-.Also was not really that confident with the subject. It also pose, pose some challenges but we managed to eh, get him to be trained on how to, to, to evaluate the subject and things are, are much better now. We, we, we had this Departmental head that was not confident with-.With, with eh, the managing of CAT. So, it means-, but eh, fortunately as, as time went by we managed to rope in eh, the, the-, to the teacher-, to-, through the-, some training courses through the, the help of the subject advisor and eh-, I think it's, it's alright now."

PP1: "No from time to time uh, we have what uh, a visit eh, by the subject advisor for CAT, and he's the one who see to it that uh, we do things as expected."

PP3: "Ya, we've got the subject advisors, they are work-, we work hand-in-hand just on material that's supposed to be taught to learners. And also, the Department is offering their technicians in terms of uhm, repairing eh, the, the, the units if, if, if there's a challenge. So, there and there they are, they are, they, they are assisting by offering their technicians and also the eh, subject advisors assisting with, with the material, do that-, that needs to be learnt."

4.6.7.4 Theme 2 interpretation and discussion

PPs indicated that upon the initial introduction of CAT in schools, teachers who were teaching the subject were not fully equipped; this is no longer the case. Additionally, PPs indicated that most recently, they have received the best teachers to teach the

© Central University of Technology, Free State

subject, leading to its successful offering. The element related to the successful teaching of this subject is discussed in detail in Chapter 2 (cf. 2.3.5)

PPs stated that the teachers are receiving support from the CAT subject advisors to guide and monitor the success of the subject (namely, meeting its main objectives). They indicated that the subject advisors assist teachers with the subject's learning material. In addition, one PP indicated that the DBE also assist the school by sending technicians to repair and fix computers when necessary, which helps to maintain the computer laboratory and makes it ready for the learners to continue their lessons.

Interestingly, a PP mentioned that they had a problem with the departmental head who was supposed to evaluate a CAT teacher in their school. To solve the issue, the PP took the departmental head to the training so that they could work together.

4.6.7.5 Theme 3: Subject management

According to the PPs, CAT requires a lot of support from all the parties involved in making sure that the subject meets its objectives. The interviews revealed 2 subthemes for this theme, as discussed below.

- ***Subtheme 3.1: Finances allocated for Computer Applications Technology (CAT)***

PPs were concerned about the budget needed to teach CAT. A PP mentioned that to keep teaching the subject, money had to be set aside for a generator, which runs on petrol during load shedding. The finding differs from the literature, which states that there is usually a lack of financial support from schools to pursue CAT's educational objectives (cf. 2.3.3).

- ***Subtheme 3.2: Technical infrastructure***

According to the PPs, their schools are fully equipped to offer CAT. In addition, a PP indicated that they are going to install sound bars, and another stated that they are even trying to improve their computer laboratory by introducing an interactive board and adding another computer laboratory for their learners. The findings indicate that schools offering CAT are well equipped to offer the subject:

> *PP1: "Yes, at the moment it's fully resourced eh, the only challenge is the issue of the chairs that they need to attend to".*

© Central University of Technology, Free State

PP2: "As far as I'm concerned, it's fully resourced, because at the moment we are just going to install the sound bars".

PP3: "Yeah, ya, now, now it's fully resourced but like I'm-, like I said we are still- are to eh, eh, equip this other-, because we got two centres. So, one centre is well equipped and then this other one is yet to be uh, to be furnished with computers. And then-, but we are still looking continuously to improve on, on, on, on the laboratories because we were thinking of eh, introducing or buying eh, interactive board for, for, for, for, for the co-, the centre. Uh, so, continuously try to improve the, the centre, ya".

4.6.7.6 Theme 3 interpretation and discussion

CAT, like any other subject, comes with its own financial needs. A PP mentioned that they incur additional costs on petrol due to having to purchase a generator to use during load shedding. Additionally, the PPs have pointed out that their schools boast fully resourced computer laboratories. The impact of these well-resourced laboratories fosters individualism, as discussed in Chapter 2 (cf. 2.3.2.6).

4.7 SUMMARY

The data's results were thoroughly examined in this chapter. The data were meaningfully analysed and presented, providing a clear overview of the answers obtained from the learners' and teachers' questionnaires, as well as principals' semi-structured interviews. The results were compared with the literature discussed in Chapter 2. Deep insight and comprehension were imparted by the presentation of the data's parallels and discrepancies.

© Central University of Technology, Free State

CHAPTER FIVE: SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1 INTRODUCTION

The previous chapter offered a comprehensive analysis of the findings obtained from learners, teachers, and principals of schools that provide CAT, utilising both mixed questionnaires and interviews. This chapter will discuss the conclusions of the study before presenting recommendations based on these conclusions, as well as any new insights that emerged during the investigation. Furthermore, the themes identified from both the qualitative and quantitative data will be considered and integrated into the recommendations.

The main aim of this study was to examine the effectiveness of using CAT as a vehicle to promote 21CS in the learners of the Lejweleputswa District. According to the literature review, these 21CS include critical thinking, problem-solving, collaboration, creativity, communication and technology (cf. 2.2). The structured questionnaire responses from both learners and teachers provided insight into how these skills are developed in the CAT classroom, which involved the use of hardware, software, Internet access, and smartphones (cf. 4.6.1.3). To assess the effectiveness of CAT in promoting these skills, a chi-squared analysis was conducted to compare the responses of learners and teachers regarding the 21CS of learners receiving CAT instruction versus those who are not (cf. 4.4.5.1). The paragraphs below discuss the secondary research aims of the study.

RA1: To discuss how the offering of CAT in schools can modernise learners' abilities to creatively solve both educational and life problems. Chapter 2 indicated that one of the outcomes of CAT includes social implications. Under this outcome, CAT learners are taught several subtopics, namely the impact on society, legal and ethical issues, health and ergonomic concerns, and environmental issues (cf. 2.3.6.6). In the CAT classroom, learners are expected to engage in problem-solving related to social issues such as cyberbullying, computer theft, and enhancing computer/Wi-Fi security (Akrim and Sulasmi 2020:324). These are real-life problems that often need to be addressed outside the CAT classroom. This objective was highlighted in the principal's semi-structured interview, which revealed that some of the challenges faced by the school included data depletion and burglary (cf. 4.6.2.1).

© Central University of Technology, Free State

RA2: To identify which factors contribute to the successful and unsuccessful offering of CAT in schools. Chapter 2 indicated that the availability of necessary resources for CAT is essential for successfully delivering the subject. Conversely, a lack of these resources can lead to unsuccessful teaching outcomes (cf. 2.3.7.1). Challenges such as load shedding and burglary were identified in the principals' semi-structured interviews as contributing factors to the ineffective teaching of the subject (cf. 4.5.1.1). However, responses from learners and teachers in the structured questionnaire highlighted several factors that enhance the successful teaching of CAT. These factors included accommodating diverse learning styles by utilising various teaching aids, such as audio and video resources (cf. 4.5.1.6).

RA3: To find out if the schools offering CAT in the Lejweleputswa District are sufficiently equipped to offer it. Chapter 2 highlighted that a fully equipped computer laboratory is essential for effective teaching and learning of CAT (cf. 2.3.7.1). This concern is addressed in the principal's semi-structured interview, where it was indicated that the schools under their supervision are well-equipped to offer CAT (cf. 4.6.7.5).

RA4: To discover educational improvements that can be implemented to enhance the educational practice of CAT in schools. CAT teachers can improve the learning experience by incorporating additional content. Phrases like "Click here to learn more" or "For more information, visit" can be used to provide extra resources for learners (cf. 2.2.2). This method not only enriches the learning process but also supports individualised learning, addressing the diverse needs and interests of each learner.

To effectively address the needs of advanced learners, as highlighted by TPs, (cf. 4.5.2.3) educators can develop targeted support tailored specifically for these learners. This support may involve personalized assessments designed to identify each learner's preferred learning style be it visual, auditory, or kinaesthetic. By understanding how advanced learners grasp information most effectively, teachers can refine their instructional methods. This may include leveraging multimedia resources, implementing hands-on activities, or fostering cooperative group work to enrich the learning experience as discussed in Chapter 2 (cf. 2.2.5).

© Central University of Technology, Free State

5.2 SUMMARY OF THE LITERATURE

Chapter 2 presented a literature review that begins with an introduction emphasising the importance of engaging with existing literature. It also outlined the structural framework of this literature. The review suggested that 21CS are successfully taught through CAT (cf. 2.2). The following paragraphs discuss these skills and the methods by which they are successfully taught through CAT.

Creativity skills are developed in the CAT classroom through various computer applications, such as Microsoft Word. Here, learners complete tasks such as creating brochures, certificates, and invitation cards (cf. 2.2.1). Similarly, innovation skills are nurtured using Adobe Illustrator, a software program that enables CAT learners to create detailed and high-quality digital drawings (cf. 2.2.1). These skills are crucial in today's workplace, having fundamentally transformed advertising and marketing. Unlike traditional hand-drawn methods, images can now be quickly and easily created, manipulated, edited, and updated (Bakhshi, Djumalieva, and Easton 2019:4). The literature indicates that both creativity and innovation skills require learners to think critically and possess problem-solving abilities.

According to the literature, CAT enhances **critical thinking and problem-solving skills** in learners through the use of Microsoft Excel (c.f. 2.2.2). Through this software, learners are assigned tasks that require them to apply various functions and formulas to perform calculations. This process not only improves their problem-solving capabilities but also necessitates following specific steps to arrive at correct answers, benefiting them in real-life challenges and other subjects (Shah, Hamid, and Mariadass 2017:2).

Additionally, the literature indicates that CAT teaches **communication and collaboration skills** by focusing on information management, which includes mastering communication technologies such as finding, accessing, processing information, and presenting solutions (cf. 2.2.3). Furthermore, CAT learners explore the impact of ICT in social environments, including social networking sites, and learn about precautionary measures and safety in a legal context, including issues such as Internet fraud (Zhou et al., 2021:43379). Learners also engage with educational software and applications such as Kahoot!, which fosters an interactive and collaborative environment that promotes active and enjoyable learning (cf. 2.3.5.1).

© Central University of Technology, Free State

The use of smartphones for social media-related homework and assignments further enhances their communication and collaboration skills through online interactions (cf. 2.3.5.3).

Moreover, the literature indicates that CAT learners acquire essential **technological skills**, including word processing, data management, cybersecurity, and emailing in the CAT classroom (cf. 2.2.4). These skills are vital in the 21st-century, as companies and higher education institutions consider them economic imperatives (Sousa and Wilks 2018:400).

The literature review delved into **teachers' perceptions of delivering 21CS** through CAT (cf. 2.2.5). It revealed that a teacher's capacity to effectively teach 21CS through CAT is intricately connected to their personal beliefs and mental frameworks - shaped by their background expertise and professional experiences related to the skills they are expected to teach (Perifanou et al., 2021:239). Teachers often operate under the assumption that learners possess a high level of technological literacy simply because they have grown up in a digital environment. However, it is essential to acknowledge that learners come from varied backgrounds, and some may have limited exposure to technology despite being surrounded by it (García, Carmona, Torres, and Fernández 2022:1186).

Additionally, literature highlights the importance of CAT in fostering **learner engagement**. It suggests that the enthusiasm generated from utilising resources in the CAT laboratory, such as Internet access, contributes to enhanced academic performance (cf. 2.3.2.1). Furthermore, the skills that learners develop in the CAT classroom, such as managing large datasets in spreadsheets, significantly improve their future employability (Eranzo and Esteve-Gonzalez 2015:12). However, the literature also points out that learners frequently perceive CAT as a less challenging subject compared to others. This perception impedes deep learning, leading learners to approach CAT primarily as a matter of general knowledge rather than a focus on practical skills, which ultimately results in less-than-optimal performance in the subject (cf. 2.3.4).

The literature examines both **effective and ineffective strategies** for teaching CAT. Successful approaches include the integration of educational software and applications, the use of social media for homework and assignments, and the

© Central University of Technology, Free State

incorporation of smartphones in the classroom. These resources facilitate the attainment of initial learning outcomes, particularly in solution development, which focuses on equipping learners with problem-solving skills (cf. 2.3.6.1). System technologies play a crucial role in enabling goal-oriented activities that involve the use of computer machinery (cf. 2.3.6.2). Network technologies are employed in the CAT classroom to promote collaborative usage of software resources, foster interactive communication, provide rapid information access, and conduct ongoing assessments of the knowledge that learners acquire (cf. 2.3.6.3). Internet technologies offer quick access to a wide range of information (cf. 2.3.6.4). Information management encompasses the processes of data collection, storage, and processing, transforming raw data into information that fosters knowledge and supports sound decision-making (cf. 2.3.6.5). Furthermore, the social implications within the CAT classroom expose learners to diverse scenarios that require effective problem-solving, such as tackling issues like cyberbullying, computer theft, and enhancing the security of computers and Wi-Fi connections (cf. 2.3.6.6).

The ineffective teaching of CAT can be attributed to insufficient resources to support learners' learning. This situation includes a lack of computers, limited Internet access, and outdated software applications, all of which obstruct progress and contradict the curriculum policy's requirement of one computer per learner (DBE 2020:11) in schools offering CAT as a transformative subject. Under-resourced schools find it difficult to meet the expectations outlined in the CAT CAPS, resulting in challenges when conducting practical lessons in CAT classrooms (cf. 2.3.7.1).

The literature also outlined the study's framework, TPACK, which is a theoretical model that integrates 3 essential domains of knowledge, namely content, pedagogy, and technology. The researcher employed the TPACK framework because CAT is a subject that offers learners both theoretical and practical content while incorporating technology. TPACK reflects the type of knowledge that develops as teachers engage in designing lessons that integrate technology with content (Deng et al., 2017:104).

5.3 SUMMARY OF THE EMPIRICAL STUDY

The purpose of this study was to examine the effectiveness of CAT as a means of fostering 21CS among learners in the Lejweleputswa District. Additionally, the study aimed to understand how both learners and teachers perceive CAT content

© Central University of Technology, Free State

concerning teaching and learning these skills. To address the research questions, an appropriate research methodology was selected.

5.3.1 Research methodology

To effectively address the main research question and fulfil the research objectives, the researcher employed Saunders et al.'s (2019) research onion framework (cf. 3.2.3). Each choice made within the various layers of the framework was justified, as summarised below.

The research philosophy guiding this study was pragmatism, a blend of interpretivism and positivism (cf. 3.3.4). The researcher opted for pragmatism because it effectively bridges the gap between the scientific method and the structuralism approaches of earlier paradigms. Additionally, it recognises the possibility of single or multiple realities that can be investigated through empirical inquiry (Kaushik and Walsh 2019:3).

An inductive approach was chosen for this study due to its capability to begin with specific observations that lead to broader conclusions and a deeper understanding of human experiences (cf. 3.4). The concurrent embedded research strategy facilitated the integration of a mixed-methods approach, which combines both qualitative and quantitative methods. Both the qualitative and quantitative data were collected at the same time. This approach aimed to enhance the validity and reliability of the research findings (cf. 3.5.1).

The population for this study comprised public schools in the Lejweleputswa District of the Free State Province that offer CAT as a subject. Purposive sampling was utilised to select participants, which included principals who are the supervisors in the schools that offer CAT, FET learners enrolled in CAT classes for Grades 10, 11, and 12, as well as CAT teachers. The sample frame was the principals who supervise the schools that offer CAT, the FET CAT learners and the CAT teachers. The sampling size of this research included 16 CAT teachers and 131 CAT learners, and 3 principals of schools that offer CAT (cf. 3.8.1).

The researcher employed 2 data collection instruments, namely mixed questionnaires and semi-structured interviews (cf. 3.9). Mixed questionnaires were distributed to CAT learners to assess their perceptions of the subject and its content, particularly

© Central University of Technology, Free State

regarding how it provides them with essential 21CS that will simplify their futures. Additionally, these questionnaires were administered to CAT teachers to explore the strategies they use to effectively teach these skills, as well as to identify factors that may hinder successful instruction.

Semi-structured interviews were conducted with the principals to evaluate the support provided by the schools to both teachers and learners of CAT, ensuring the effective delivery of the subject. All interviews took place in the respective schools, 21 minutes and 41 seconds, 26 minutes and 36 seconds, and 33 minutes and 32 seconds. (cf. 3.8.2).

The data collected from the mixed questionnaires were analysed using descriptive and inferential statistics, including chi-squared data analysis, which was deemed suitable for this study (cf. 3.10.2). The semi-structured interviews were analysed using thematic data analysis to allow for the emergence of themes and categories (cf. 3.10.1). Section 3.13 discussed the measures of trustworthiness. The researcher adhered to all ethical guidelines necessary for this study. The next section will discuss the findings of the empirical research.

5.3.2 Findings based on the empirical research

Chapter 4 presented a comprehensive analysis of the findings derived from the CAT learners, CAT teachers, and principals of schools offering CAT's responses. Data collection involved utilising mixed questionnaires (quantitative and qualitative) and semi-structured interviews (qualitative) targeted at CAT teachers and learners, and principals, respectively. This data collection aimed to address both the main research question and its secondary questions. The descriptive statistics of the participants are subsequently detailed below.

5.3.2.1 Learners

Based on the data collected, all participants in this study were learners enrolled in the CAT course during the FET phase, with ages ranging from 15 to 21 years (cf. 4.4.1.1). The primary motivation for these learners in choosing CAT was their interest in pursuing careers in IT and Computer Sciences (cf. 4.4.1.2). According to Alavi et al. (2016:57), this suggests that learners believe the CAT curriculum will benefit their

© Central University of Technology, Free State

future by fostering computer literacy and preparing them to become competent employees, as supported by the literature (cf. 2.3.2).

Moreover, the findings indicate that CAT learners perceived taking this subject as enhancing their chances of gaining admission to their chosen universities. This belief may motivate them to engage more thoroughly with the concepts taught in class, increase their class participation, and develop their problem-solving skills, which ultimately contributes to improved academic performance (cf. 2.3.2.3).

Additionally, a majority of learners found CAT to be an enjoyable subject and are eager to recommend it to their peers. This aligns with existing literature, which highlights that CAT incorporates instructional videos, audio elements, and hands-on activities, thereby enriching the overall learning experience (cf. 2.3.2.5).

Furthermore, the findings show that most CAT learners have supplementary access to the school's computer laboratory, which they utilise for practice and completing assignments. Conversely, some learners indicated that they use their smartphones for these tasks when access to a computer lab is unavailable. This is consistent with previous research suggesting that CAT learners are more inclined to use tablets or smartphones to access CAT-related information (Randall and Jane 2015:382). As learners tend to spend more time on their phones than on traditional textbooks, this trend enhances their engagement with schoolwork (cf. 2.3.2.1).

5.3.2.2 Teachers

The findings indicate that the majority of the CAT teachers in this study possess a PGCE certificate, which is recognised as an appropriate qualification for teaching in the FET phase (Kahn 2021:70). Furthermore, the average experience of the participating teachers is 6 and a half years, with most having taught CAT for 2 to 3 years (cf. 4.4.3.1). This suggests that these teachers have accumulated considerable experience in teaching CAT, enhancing their PK and understanding of teaching and learning processes, methods, and practices that align with academic objectives (cf. 2.4.1.2).

Additionally, their years of experience imply that they have developed a solid understanding of how to integrate technology into CAT content. This expertise allows them to design instructional approaches that are well aligned with the subject matter.

© Central University of Technology, Free State

This observation supports the literature that emphasises the critical role of teachers' TCK in helping learners effectively grasp the content (cf. 2.4.1).

5.3.2.3 Inferential statistics

Inferential statistics were employed to compare the perceptions of learners and teachers regarding the effectiveness of CAT in assisting CAT learners (versus non-CAT learners) in acquiring 21CS (cf. 4.4.5). A chi-squared test was conducted, revealing that the p-values for creativity, critical thinking, collaboration, and technological skills were all above 0.05. This indicates a statistical similarity between the perceptions of teachers and learners (cf. 4.5.1.1). However, for the communication skill, the p-value fell below 0.05, suggesting a statistical difference in perceptions between teachers and learners.

5.3.2.4 Identified themes

Themes were identified from the learners' and teachers' mixed questionnaires as well as from the principals' semi-structured interview responses. The themes identified per participant group are discussed in the subsections below.

- ***Themes from the learners' mixed questionnaires***

There were 3 main themes from the mixed questionnaires completed by the learners. The first theme pertained to the CAT curriculum learning experience and included 2 subthemes, namely what learners most enjoy about CAT and the CAT challenges they face. Learners conveyed their enthusiasm for the CAT subject, emphasising its potential to create future opportunities (cf. 4.5.1.1). However, they also expressed concerns regarding the challenges of using computers in the CAT classroom, particularly due to load shedding (cf. 4.5.1.1).

The second theme focused on resources for CAT subject learning, encompassing 2 subthemes, namely no additional access to the computer laboratory and the personal resources used to help with the learning of CAT. Some learners reported a lack of additional access to the computer laboratory for revisions and assignments. As a result, they attend extra classes, while others choose to complete their assignments during regular CAT lessons (cf. 4.5.1.3). A majority of learners indicated that they rely

© Central University of Technology, Free State

on their smartphones for studying and completing assignments when they do not have access to computers or laptops (cf. 4.5.1.3).

The third theme compared the CAT learning experience to that of other subjects and included 3 subthemes, namely the learning experience is better than other subjects, the learning experience is the same as other subjects, and the learning experience is more difficult than other subjects. Responses varied among learners; some noted that their CAT experience is superior due to the skills they gain, while others believed it is similar to their experiences in other subjects, as they devote equal attention to all of them. Additionally, some learners pointed out that the CAT learning experience is more difficult because its content differs significantly from that of other subjects (cf. 4.5.1.5).

- ***Themes from the teachers' mixed questionnaires***

There were 2 primary themes identified from the teachers' mixed questionnaires. The first theme emphasised the importance of offering CAT. This theme included 2 subthemes, namely the 4IR and CAT improves employability. Teachers highlighted that we are currently experiencing the 4IR, where technology is integral to most processes and achievements (cf. 4.11.2). Consequently, learners must familiarise themselves with technology and its ongoing developments. Furthermore, teachers noted that studying CAT significantly improves learners' employment prospects, as it exposes them to computer-related tasks that are essential in the corporate world (cf. 2.3.2).

The second theme focused on the CAT curriculum and comprised 3 subthemes. The first subtheme explored what learners enjoy most about CAT. Teachers reported that learners particularly appreciate being in the computer laboratory, as it provides them with Internet access that helps them complete their CAT assignments (cf. 4.5.2.3). The second subtheme addressed what learners mostly struggle with in CAT. Teachers indicated that learners with limited prior exposure to computers often struggle in Grade 10, as the subject demands a certain level of proficiency in skills such as typing and mouse navigation (cf. 4.5.2.3). The third subtheme highlighted CAT learning barriers. Teachers pointed out that the large number of learners in each session, often exceeding the available workstations, presents a significant challenge (cf. 4.5.2.3).

© Central University of Technology, Free State

- ***Themes from the principal's semi-structured interviews***

The themes from the principals' semi-structured interviews can be categorised into 3 key areas. The first theme regards factors relating to the learning of CAT. It includes 2 subthemes. The first subtheme, 21CS, reveals that the principals believed learners who study CAT are better equipped to leverage technology effectively (cf. 4.6.2.1). This finding is consistent with the 21CS framework discussed in the literature review (cf. 2.2.4). In the second subtheme, subject challenges, principals highlighted the significant obstacles faced in offering the subject, specifically mentioning load shedding and burglary (cf. 4.6.2.1).

The second main theme regards factors relating to the teaching of CAT, which also encompasses 2 subthemes. The first subtheme, adequate training, indicates that the principals felt the hiring of well-trained teachers was crucial for effectively instructing learners in the subject (cf. 4.6.3.3). The second subtheme, curriculum support, notes that CAT is a monitored subject, with schools receiving valuable support through supervisor visits. Additionally, the DBE provides technicians to help maintain the resources utilised in CAT classrooms (cf. 4.6.7.3).

The third main theme is subject management, consisting of 2 subthemes. The first subtheme, finances allocated for CAT, presents concerns regarding the financial implications of sustaining the subject, particularly the necessity of budgeting for a generator to operate during load shedding (cf. 4.6.7.5). The second subtheme, technical infrastructure, conveys that principals feel their schools are well-equipped for offering CAT and are proactively planning to enhance their computer laboratories by introducing interactive boards and establishing an additional computer lab for learners (cf. 4.6.7.5).

5.4 SYNTHESIS OF THE RESEARCH FINDINGS

The previous sections summarised the literature review and data collected from the empirical study. This section discusses the similarities and contradictions that were discovered.

5.4.1 Similarities

There were similarities identified from the findings and the literature. The first similarity identified was that learners are taught 21CS through CAT. The literature indicated that

© Central University of Technology, Free State

in CAT lessons, learners have the opportunity to create and design using a WP, which allows them to effectively combine shapes and text to produce professional-looking designs (Fan and Li 2020:5185). Additionally, these applications offer a variety of pre-designed templates that cater to diverse needs, including simple documents, brochures, certificates, playing cards, and invitations (cf. 2.2.1). Supporting this, findings reveal that learners expressed a strong preference for utilising practical skills such as Microsoft Word, with many indicating that they enjoy the process of editing documents using this software (cf. 4.5.1.1). Furthermore, teachers noted that their learners find joy in working with Microsoft Word, a tool recognised for enhancing creativity and innovation skills (cf. 4.5.2.3). Importantly, inferential statistics and the chi-squared analysis show that both CAT learners and their teachers perceive CAT learners as having superior creativity skills compared to their non-CAT peers (cf. 4.4.5.1).

The second similarity highlighted was that the literature indicated that CAT effectively fosters collaboration skills among learners. Nguyen and Nguyen (2020:292) assert that collaborative learning environments empower learners to generate their ideas through reflection, challenging them to articulate and defend their opinions (cf. 2.2.3). Furthermore, collaborative learning promotes crucial 21CS, including the ability to work in teams to address problems and apply knowledge acquired through tasks in CAT classrooms (Wu et al., 2017:365). Complementing this, the chi-squared analysis in the inferential statistics indicated that both CAT learners and teachers perceive CAT as enhancing learners' collaboration skills, surpassing those of their peers.

The third similarity highlighted is that the CAT curriculum equips learners with essential technology skills. Learners are required to utilise specific software applications to follow instructions and showcase their ability to solve problems, create new projects, communicate, and share their perspectives (Shadiev and 2020:2). In support of this, many learners expressed that the experience of studying CAT is superior to that of other subjects, as it allows them to acquire more valuable skills (cf. 4.5.1.5). They recognised the significance of using computers not just for entertainment but for their personal and educational development (cf. 4.5.1.5). Moreover, they believed that CAT effectively prepares them for a future in which technology will play an increasingly important role. This view is further supported by findings from the principal’s semi-structured interview, which indicated that learners are becoming adept at leveraging

© Central University of Technology, Free State

technology for their benefit (cf. 4.6.2.1). According to the principals, they exhibit discipline and efficiently complete their assignments using smartphones, which aligns with the existing literature (cf. 2.3.6.3) and the learners' questionnaire findings indicating that they employ their smartphones to fulfil CAT-related tasks (cf. 4.5.1.3).

The fourth similarity emphasised was that the literature has indicated that teachers' perceptions of teaching 21CS through CAT are significantly influenced by their training in the subject. This training is crucial for guiding learners to achieve the intended objectives (cf. 2.2.5). Furthermore, the TPACK framework highlights that TCK involves a deep understanding of how technology interacts with and influences subject matter. By focusing on the relationship between technology and content, teachers can implement innovative and effective teaching strategies (cf. 2.4.1.4). This is reinforced by insights from the principal's semi-structured interview, which revealed that the schools employ qualified teachers specifically trained to teach CAT. As a monitored subject, CAT benefits from support provided through visits by subject advisors (cf. 4.6.7.3). Additionally, the study found that all participating teachers were qualified, with an average of 6 and a half years of teaching experience in CAT. This experience indicates exposure to effective teaching methods, thereby enhancing their ability to convey CAT knowledge to their learners (cf. 4.4.3.1).

The fifth similarity highlighted in the literature is that educational software applications are used to help learners learn more efficiently (cf. 2.3.5.2). Supporting this, the principals' interviews indicated that they expect learners to register for Siyavula, which is an educational application (cf. 4.6.2.1).

5.4.2 Contradictions

The first contradiction highlighted was that the literature claims CAT teaches learners critical thinking skills through the use of software applications like Microsoft Excel. In this software application, learners are tasked with employing functions to perform calculations, which necessitates analysing the problem, comprehending it, making informed judgments, and deciding which function to use to achieve the correct answer (cf. 2.2.2). This process exemplifies critical thinking and problem-solving skills in their purest form (Doyle 2022:n.p.). In support of the above, chi-squared analysis from the inferential statistics indicated that both CAT learners and teachers generally agree that CAT enhances learners' critical thinking skills and that CAT learners' abilities in this

© Central University of Technology, Free State

area are greater than those of their peers (cf. 4.4.5.1). However, learners expressed that one of the significant challenges they encounter in CAT is performing calculations that involve spreadsheet formulas (4.5.1.1). Additionally, teachers reported that learners frequently struggle with utilising complex functions such as COUNTIF, NESTEDIF, TRUNC, FIND, and CONCATENATE in Microsoft Excel (cf. 4.5.2.3).

The second contradiction highlighted in the literature is the pivotal role of communication in the CAT subject. A key module within CAT emphasises information management, focusing primarily on communication technologies, such as locating and accessing information, processing data, and presenting solutions (cf. 2.2.3). Additionally, learners investigate the effects of ICT within social computing environments, including social networking sites, as well as safety precautions in legal computing contexts, which address issues such as Internet fraud (cf. 2.3.6.6). Supporting this, chi-squared results from learners suggested that CAT significantly enhances their communication skills by providing instruction across various online platforms (cf. 4.4.5.1). However, despite CAT's role in teaching communication skills, teachers contend that learners' abilities in this area do not surpass those of their non-CAT peers (cf. 4.4.5.1).

The third contradiction identified was that the literature indicated that the unsuccessful teaching of CAT is primarily due to a lack of adequate resources. This includes shortages of computers, insufficient Internet access, and outdated software applications (cf. 2.3.7.1). In support of this, findings from teachers revealed various barriers to teaching CAT, including inadequate resources, time constraints, limited access to equipment, and insufficient technical support (cf. 4.5.2.3). In contrast, however, principals indicated that their schools are fully equipped to offer CAT and are taking steps to enhance their computer laboratories by introducing interactive boards and establishing additional computer labs for learners (cf. 4.6.7.5). Moreover, the principals expressed financial concerns regarding the cost associated with offering the subject. Specifically, a portion of the budget had to be allocated for the generator, which operates on petrol during load shedding (cf. 4.6.7.5).

© Central University of Technology, Free State

5.5 CONCLUSIONS TO THE RESEARCH QUESTIONS

The findings were derived from the literature, mixed questionnaires, and semi-structured interviews. These findings were interpreted concerning the research questions of the study as discussed below.

5.5.1 How is Computer Applications Technology (CAT) being effectively used as a vehicle to promote 21st-century skills (21CS) in the learners of the Lejweleputswa District?

The objective of this study was to examine the effectiveness of the CAT curriculum in fostering 21CS among learners in the Lejweleputswa District. The reviewed literature identifies the specific 21CS imparted through CAT, which encompass creativity and innovation, critical thinking and problem-solving, technology, as well as communication and collaboration (cf. 2.2).

This study employed the chi-squared statistical method to analyse the findings from questionnaires completed by both teachers and learners. This analysis allowed for a comparison between the 21CS of CAT learners and those of their peers who are not enrolled in the subject. The results revealed that, according to the participating learners and teachers, CAT learners exhibited enhanced skills in critical thinking and innovation, largely due to the use of software applications such as Microsoft Word and Adobe Illustrator in the classroom.

Furthermore, the chi-squared analysis indicated that the critical thinking and problem-solving abilities of CAT learners exceed those of their peers. The CAT curriculum effectively imparts these skills by utilising software like Microsoft Excel, which enables learners to manage significant datasets and perform calculations. This process encourages learners to engage in critical thinking as they identify problems, analyse them, and make informed decisions.

Additionally, while the chi-squared analysis demonstrated that CAT contributes to improved communication and collaboration skills among learners, communication skills did not surpass those of their peers not taking CAT. This is despite the integration of ICT, social media, and smartphones in the classroom.

Finally, the analysis affirmed that CAT learners possess superior technology skills compared to their counterparts. The CAT curriculum leverages computer hardware,

© Central University of Technology, Free State

software, and smartphones to facilitate the development of these technological competencies.

5.5.2 How can the offering of Computer Applications Technology (CAT) in schools modernise learners' abilities to creatively solve both educational and life problems?

The incorporation of various software applications in CAT classrooms equips learners with skills that extend beyond the confines of the CAT subject, proving beneficial in other academic areas and real-world situations (cf. 2.3.2.2). Furthermore, learners expressed a particular enthusiasm for mathematics, noting that engaging with calculations in Microsoft Excel enhances their interest in the subject (cf. 4.5.1.1).

The study also indicated that proficiency in Microsoft Excel prepares learners for future employment opportunities, especially in positions that require analysis of sales data from diverse regions. For example, a company may possess a substantial dataset containing sales figures for multiple products across different countries. To extract meaningful insights from this data, the company would utilise a spreadsheet application to calculate total sales for each region and identify the highest-selling product in each area. By employing the SUMIFS function, they can sum sales of specific products based on predetermined criteria, such as region. Moreover, using a combination of the MAX function along with INDEX and MATCH will allow them to pinpoint the highest-selling product in each region.

This example illustrates how the functionalities of spreadsheet applications can effectively manage complex data analysis tasks. This underscores the practical, skills-based dimension of CAT in real-world applications (cf. 2.3.4).

5.5.3 Which factors are contributing to the successful and unsuccessful offering of Computer Applications Technology (CAT) in schools?

The study identified several factors that contribute to the successful teaching of CAT. Firstly, having adequate resources, such as sufficient computers, printers, and Internet access, is essential for facilitating a smooth teaching and learning process. Furthermore, qualified teachers who receive ongoing support from a CAT subject adviser, who provides necessary teaching materials, enhance the effectiveness of the subject (4.12.4.5, PP3).

© Central University of Technology, Free State

A proper budget that includes provisions for essential resources, such as generators for use during load shedding, is crucial to keeping the computer laboratory functional. This allows learners to continue with their CAT lessons uninterrupted. Additionally, robust security measures are important to prevent burglaries, ensuring that valuable teaching and learning materials remain available.

The integration of social media and smartphones in the CAT classroom significantly aids learners in completing their tasks, as they are used to spending substantial time on their phones. This incorporation makes their learning experience more enjoyable and leads to improved academic performance.

However, there are also several challenges that hinder the effective teaching of CAT. A major issue is learners' difficulty in understanding the LoLT (cf. 4.5.2.3, TP1). Teachers have noted that many learners struggle with English, which results in incorrect answers during examinations. Additionally, many learners enrolled in CAT have previously failed a grade or have advanced to the next grade despite being inadequately prepared (cf. 4.5.2.3, TP12). This lack of motivation negatively impacts their academic performance.

Moreover, load shedding presents a significant disruption to effective CAT instruction, especially in schools without generators (cf. 4.6.2.1, PP2). When the power is out, the CAT laboratory cannot operate, causing learners to fall behind in their curriculum. Inadequate security measures in some schools can also lead to theft, which is a significant barrier to effective learning. When CAT equipment is stolen, it can take a considerable amount of time for schools to procure replacements due to budgetary constraints (cf. 4.6.2.1, PP1).

5.5.4 Are schools in the Lejweleputswa District sufficiently equipped to offer Computer Applications Technology (CAT)?

The findings indicated that schools offering CAT are well-equipped to deliver the subject. According to the principals, their schools have the necessary resources to teach CAT effectively. A principal mentioned plans to install sound bars, while another is working on enhancing their computer laboratory by introducing an interactive board and adding a second computer lab for learners (cf. 4.6.7.5, PP3). However, a teacher pointed out a significant challenge: the large number of learners in each session exceeds the available workstations (cf. 4.5.2.3, TP2).

© Central University of Technology, Free State

5.5.5 Which educational improvements can be introduced to enhance the offering of Computer Applications Technology (CAT)?

The findings of this study indicated that there are some learners who do not have additional access to the school's computer laboratory. This lack of access forces them to attend extra classes, which aid in their revision and completion of assignments. This educational strategy helps learners engage consistently, ultimately improving their academic performance (cf. 4.5.1.3, LP10).s

Additionally, the findings revealed that using personal resources, such as smartphones, assists learners in achieving their educational objectives. They rely on their smartphones for research, especially during instances of load shedding or when access to the computer laboratory is unavailable. Furthermore, one principal noted that the Siyavula application is considered beneficial as it provides learners with learning materials for various subjects, including CAT, for which all Grade 12 learners are expected to register (cf. 4.6.2.1, PP1).

5.6 LIMITATIONS

The researcher's presence during the completion of the questionnaire may have affected the participants' ability to respond in a relaxed and natural manner, which could have led to uncertainty in the collected information. Additionally, factors such as participant availability and the rescheduling of appointments may have disrupted the study's progress. Moreover, the fact that CAT is not available in every school made it more challenging for the researcher to gather the desired amount of data.

5.7 RECOMMENDATIONS

These recommendations are aimed at learners, teachers, and principals who are involved in the effective learning, teaching, and oversight of CAT. They offer potential strategies for enhancing learners' acquisition of 21CS through CAT.

5.7.1 Recommendations based on the learners' findings

As indicated by the learners in this study, many learners do not have additional access to the computer laboratory to complete their revisions and assignments. This lack of access affects their academic performance, as some learners lack a background in CAT and find the subject more challenging compared to others. The researcher,

© Central University of Technology, Free State

therefore, recommends that all schools offering CAT consider providing an open laboratory for all CAT learners, for at least 1H30 minutes once a week per grade. This access would assist those who do not have personal resources to complete their CAT assignments and revisions, ultimately resulting in better performance and the attainment of the necessary 21CS.

Many learners expressed that the learning experience in CAT is more demanding than in other subjects, citing the distinct curriculum that CAT offers. To support their understanding, schools that provide CAT may often implement compulsory extra classes, which help learners familiarise themselves with the terminology and practical applications of the subject. These additional lessons will enable learners to develop essential skills in critical thinking, communication, collaboration, and technology, particularly since class time may be insufficient to cover all necessary content. A notable area where learners often seek support is Microsoft Excel, which is deemed crucial for enhancing their critical thinking and problem-solving abilities.

The findings of the study revealed that CAT teachers observed that, despite effective ICT instruction, the communication skills of CAT learners do not exceed those of their non-CAT peers. Moreover, these learners frequently struggle with English. Consequently, the researchers recommend that CAT teachers adopt presentation-based learning methods. Specifically, learners should undertake mini-research projects regarding computer software or hardware and present their findings using PowerPoint slides. This approach may enhance learners' confidence and improve their communication skills.

5.7.2 Recommendations based on the teachers' findings

The findings revealed that teachers have recognised a significant challenge in the CAT classroom, namely learners having difficulty with Microsoft Excel, particularly concerning formulas and calculations. To address this issue, the researcher recommends that teachers leverage social media platforms, such as WhatsApp, to establish groups with their learners. Through these groups, teachers can share educational links that provide detailed explanations of CAT concepts. Additionally, they can send instructional videos to further enhance learners' understanding of the subject. This approach aims to support learners in achieving their academic

© Central University of Technology, Free State

objectives, as some may require extra assistance to fully comprehend the concepts covered in class.

5.7.3 Recommendations based on the principals' findings

The findings suggested that one of the primary challenges hindering effective learning in CAT is the financial burden associated with providing necessary resources. The researcher recommends that schools offering CAT enhance their security measures and consider insuring their computer laboratories and equipment. This would help mitigate the frequent need to replace stolen devices, ensuring that learners do not fall behind due to financial limitations.

Furthermore, the research advocates for schools offering CAT to implement unlimited data plans to guarantee ongoing Internet access. This would enable CAT learners to view and download instructional videos, which they can utilise during their free time. Funds for unlimited data and equipment can be raised through school fundraising events.

5.8 SUGGESTIONS FOR FUTURE RESEARCH

The existing studies on this topic are quite limited, which indicates a need for further research to obtain comprehensive insights and a variety of perspectives on the effectiveness of CAT in promoting 21CS among learners. Consequently, the following proposals for additional research are presented:

- The research should aim to explore the integration of Microsoft Excel in CAT classrooms and its impact on enhancing learners' mathematical understanding to improve their critical thinking and problem-solving skills;
- The research should examine how 21CS acquired through the CAT subject influence the academic performance of progressed learners; and
- The research should focus on how communication skills acquired in the CAT classroom influence learners' capability to excel in digital marketing.

5.9 CONCLUSION

The primary objective of this study was to investigate the effectiveness of CAT as a means of promoting 21CS among learners in the Lejweleputswa District. By employing a mixed-methods research approach, the study successfully addressed the research

© Central University of Technology, Free State

question and fulfilled its objectives. The findings revealed that CAT effectively cultivates 21CS in learners through the use of various software applications, such as word processing, spreadsheet, and database, during lessons. Additionally, the study examined several challenges related to the teaching of this subject and provided recommendations for the DBE, schools, and areas for future research. The goal is that these insights will positively contribute to the enhancement of 21CS development in CAT learners.

© Central University of Technology, Free State

REFERENCES

Ababneh, M. M., 2020. Linking Ontology, Epistemology and Research Methodology. *Science & Philosophy,* 8(1), pp. 75-91.

Abudabbous, N., 2021. *Advantages and Disadvantages of Social Media and Its Effects on Young Learners,* Mexico: New Mexico State University,

Abulela, M A; Harwell, M M, 2019. Data Analysis: Strengthening Inferences in Quantitative Education Studies Conducted by Novice Researchers. *Educational Sciences: Theory & Practice,* 20(1), pp. 59-78.

Abutabenjeh, S. & Jaradat, R., 2018. Clarification of research design, research methods, and research methodology: A guide for public administration researchers and practitioners. *Teaching Public Administration,* 36(3), pp. 237-258.

Açikgül, K., 2020. The effect of technological pedagogical content knowledge game activities supported micro-teaching practices on preservice mathematics teachers' self-efficacy perception level. *İnönü University,* 13(2), pp. 157-173.

Ackerman, E., 2023. *CAT vs IT – everything you need to know,* Centurion: s.n.

Adam, A. & Salome, A. A., 2014. Factors affecting the choice of Science subject among female students in Jigawa Metropolis, Nigeria. *Creative Educators,* Volume 5, pp. 1296-1304.

Agustin, R. W. & Ayu, M., 2021. The impact of using Instagram for increasing vocabulary and listening skills. *Journal of English Language Teaching and Learning (JELTL),* 2(1), pp. 1-7.

Ahlberg, E., 2021. The Development of the Digital Nomad During the Course of the Pandemic. *Media and Communication Studies Culture, Collaborative Media, and Creative Industries,* 1(1), pp. 1-61.

Ahmad, S; Wasim, S; Irfan, S; Gogoi, S; Srivastava, A; Farheen, Z, 2019. Qualitative v/s Quantitative Research. *Journal of Evidence Medicine and Healthcare,* 6(43), pp. 22828-2832.

© Central University of Technology, Free State

Ahmed, A; Pereira, L; Jane, K, 2024. *Mixed Methods Research: Combining both qualitative and quantitative approaches.* [Online] Available at: https://www.researchgate.net/publication/384402328_Mixed_Methods_Research_Combining_both_qualitative_and_quantitative_approaches [Accessed 31 July 2025].

Ahmed, I. & Ishtiaq, S., 2019. Reliability and validity: Importance in Medical Research. *Medical research,* 71(10), pp. 2401-2406.

Ahmed, S. K., 2024. The pillars of trustworthiness in qualitative research. *Journal of Medicine Surgery and Public Health,* 2(1), pp. 1-4.

Akani, O., 2015. Laboratory Teaching: Implication on Students' Achievement In Chemistry In Secondary Schools In Ebonyi State of Nigeria. *Journal of Education and Practice,* 6(30), pp. 206- 113.

Akhtar, I., 2016. Research Design. In: J. M. Islamia, ed. *Research in Social Science: Interdisciplinary Perspectives.* Delhi, India: ResearchGate, pp. 68-84.

Akinmola , E. A., 2014. Developing Mathematical problem solving ability: A panacea for a sustainable development in the 21st Century. *International Journal of Education and Research,* 2(2), pp. 1-8.

Akrim, A. & Sulasmi, E., 2020. Student Perception of Cyberbullying in Social Media. *Talent Development & Excellence,* 12(1), pp. 322-333.

Alaab, M., Zaidan, A. A., Talal, M. & Kiah, M. L., 2017. A review of smart home applications based on Internet of Things. *Journal of Network and Computer Applications,* 97(1), pp. 48-65.

Alavi, S M; Borzabadi, D; Dashtestani, R, 2016. Computer literacy in learning academic English: Iranian EAP students' and instructors' attitude and perspective. *Teaching English with Technology,* 16(4), pp. 56-77.

Alba, P., Keane, T., Chen, W. S. & Kaufman, J., 2021. Immersive virtual reality as a tool to learn problem-solving skills. *Swinburne University of Technology,* 1(1), pp. 1-33.

Alemán-Saravia, A; Deroncele-Acosta, A, 2021. *Technology, Pedagogy and Content (TPACK framework): Systematic Literature Review.* Lima, IEEE, pp. 104-111.

© Central University of Technology, Free State

Al-Hariri, M. T. & Al-Hattami, A. A., 2017. 'Impact of students' use of technology on their learning achievements in physiology courses at the University of Dammam. *Journal of Taibah University Medical Sciences,* 12(1), pp. 28-25.

Aliyu, A A; Singhry, I M; Adamu, H; Abubakar, M M, 2015. *Ontology, Epistemology and Axiology in Quantitative and Qualitative Research: Elucidation of the research philosophical misconception.* Nigeria, University of Agric.

Almalki, S., 2016. Integrating Quantitative and Qualitative Data in Mixed Methods Research—Challenges and Benefits. *Journal of Education and Learning,* 5(3), pp. 288-296.

Alsaawi, A., 2014. A critical review of Qualitative interviews. *Business and Social Sciences,* 3(4), pp. 149-156.

Alsaleh, N. J., 2020. Teaching Critical Thinking Skills: Literature Review. *The Turkish Online Journal of Educational Technology,* 19(1), pp. 21-39.

Alsayed, S., Bano, N. & Alnajjar, H., 2020. Evaluating Practice of Smartphone Use Among University Students in Undergraduate Nursing Education. *Health Professions Education,* 6(2), pp. 238-246.

Alshenqeeti, H., 2014. Interviewing as a Data Collection Method: A Critical Review. *English Linguistics Research,* 3(1), pp. 39-45.

Alsubaie, M. A., 2016. Curriculum Development: Teacher Involvement in Curriculum Development. *Journal of Education and Practice,* 7(9), pp. 106-107.

Amrhein, V., Trafimow, D. & Greenland, S., 2019. Inferential Statistics as Descriptive Statistics: There Is No Replication Crisis if We Don't Expect Replication. *The American Statistician,* 73(1), pp. 262-270.

Apuke, O. D. & Iyendo, T. O., 2018. University students' usage of the internet resources for research and learning: forms of access and perceptions of utility. *Department of Communication Studies,* 1(1), pp. 1-37.

Arafat, Y., 2024. Research Ethics: Meaning And Principles. *International Journal of Academic Multidisciplinary Research (IJAMR),* 8(1), pp. 139-144.

Arevalo, J., 2019. Importance of Critical thinking of Filipino Students. *Term paper for college academic skills in English,* 1(1), pp. 1-8.

© Central University of Technology, Free State

Arifin, S. R., 2018. Ethical Considerations in Qualitative Study. *International Journal of Care Scholars,* 1(2), pp. 30-33.

Aspers, P; Corte, U;, 2019. What is Qualitative in Qualitative Research. *Qualitative Sociology,* Volume 42, pp. 139-160.

Aultman, J., Baughman, K. & Ludwick, R., 2018. A broader understanding of care managers' attitudes of advance care planning: A concurrent nested design. *journal of clinical nursing,* 27(19-20), pp. 3572 - 3582.

Azungah, T., 2018. Qualitative research: deductive and inductive approaches to data analysis. *Qualitative research jornal,* 18(4), pp. 383-400.

Bakhshi, H., Djumalieva, J. & Easton, E., 2019. *The Creative Digital Skills Revolution.* [Online]
Available at: https://pec.ac.uk/wp-content/uploads/2023/12/The-Creative-Digital-Skills-Revolution-the-PEC-and-Nesta-24-Oct-2019.pdf
[Accessed 27 July 2025].

Bambale, A. J., 2014. Research Methodological Techniques as a Model for Quantitative Studies in Social Sciences. *British Journal of Economics, Management & Trade,* 4(6), pp. 862-879.

Barak, M., 2018. Are digital natives open to change? Examining flexible and resistance to change. *Computers & Education,* 121(1), pp. 115-123.

Barricelli, B. R., Cassano, F., Fogli, D. & Piccinno, A., 2019. End-User Development, End-User Programming and End-User Software Engineering: A Systematic Mapping Study. *Journal of Systems and Software,* Volume 149, pp. 101-137.

Bartholomew, S., Reeve, E., Veon, R. & Goodridge, W., 2017. Relationships Between Access to Mobile Devices, Student SelfDirected Learning, and Achievement. *Faculty Publications,* 29(1), pp. 2-24.

Bearman, M., 2019. Focus on Methodology: Eliciting rich data: A practical approach to writing semi-structured interview schedules. *A multi-proffessional journal,* 20(3), pp. 1-11.

Bell, D., 2016. Twenty-first Century Education: Transformative Education for Sustainability and Responsible Citizenship. *Journal of Teacher Education for Sustainability,* 18(1), pp. 48-56.

© Central University of Technology, Free State

Bell, R., Warren, V. & Schmidt, R., 2022. *The Application of Concurrent or Sequential Mixed Methods Research Designs and their Methodological Implications: Investigating Tacit Knowledge, its Use, and Application in Automotive Development.* Worcester: SAGE Publications.

Benade , L., Gardner , M., Teschers , C. & Gibbons , A., 2014. 21st century learning in New Zealand: leadership insights and perspectives. *Journal of Educational Leadership Policy and Practice,* 29(2), pp. 47-60.

Bengtsson, M., 2016. How to plan and perform a qualitative study using content analysis. *NursingPlus Open,* 1(1), pp. 8-14.

Berkowicz , J. & Myers , A., 2017. Spatial Skills: A Neglected Dimension of Early STEM Education. *journal of sciences,* 1(1), pp. 1-19.

Berkowitz, R., Moore, H., Astor, R. A. & Benbenishty, R., 2017. A Research Synthesis of the Associations Between Socioeconomic Background, Inequality, School Climate, and Academic Achievement. *Review of Educational Research,* 87(2), pp. 425-469.

Bhandari, P., 2020. *Scribbr.* [Online] Available at: https://www.scribbr.com/methodology/data-collection/ [Accessed 22 March 2022].

Bicen, H. & Kocakoyun, I., 2018. Perception of students for Gamification Approach: Kahoot as a Case Study. *Journal of Education Technology,* 13(2), pp. 72-93.

Biesta, G., 2015. On the two cultures of educational research, and how we might move ahead: Reconsidering the ontology, axiology and praxeology of education. *European Educational Research Journal,* 14(1), pp. 11-22.

Bigoni, M., Casari, M., Skrzypacz, A. & Spagnolo, G., 2015. Time Horizon and Cooperation in Continuous Time. *Econometrica,* 83(2), pp. 587-616.

Birgili, B., 2015. Creative and Critical Thinking Skills in Problem-based Learning Environments. *Journal of Gifted Education and Creativity,* 2(2), pp. 71-80.

Boonmoh, A; Jumpakate, T; Karpklon, S, 2021. Teachers' Perceptions and Experience in Using Technology for the Classroom. *Computer-Assisted Language Learning Electronic Journal,* 22(1), pp. 1-24.

© Central University of Technology, Free State

Boronat, B. C. & Choueiry, H., 2022. Transforming creativity skills into creativity habits. *Arab Economic and Business Journa,* 14(1), pp. 80-93.

Bourgeois , D. & Bourgeois, D. T., 2014. *Chapter 10: Information Systems Development.* 2014 ed. California: Biola University.

Boveda, M. & Weinberg, A., 2022. Centering Racialized Educators in Collaborative Teacher Education: The Development of the Intersectionally Conscious Collaboration Protocol. *Teacher Education and Special Education,* 45(1), pp. 8-26.

Brand, A; Allen, L; Altman, M; Hlava, M; Scott, J, 2015. Beyond authorship: attribution, contribution, collaboration and credit. *Learned Publishing,* 28(1), pp. 151-155.

Braun, V. & Clarke, V., 2006. Using thematic analysis in psychology. *Qualitative Research in Psycholog,* 3(2), pp. 77-101.

Brenner, N. & Schmid, C., 2015. Towards a new epistemology of the urban?. *Routledge,* 19(2-3), pp. 151-182.

Bruijne, M. & Wijnant, A., 2014. Mobile Response in Web Panels. *Social Science Computer Review,* 32(6).

Bulman, G. & Fairlie, R. W., 2016. Chapter 5 - Technology and Education: Computers, Software, and the Internet. *Handbook of the economics of Education,* 5(1), pp. 239-280.

Caird, S. & Lane, A., 2015. Conceptualising the role of information and communication technologies in the design of higher educcation teaching models used in the UK. *British Journal of Educational Technology,* 46(1), pp. 58-70.

Carnot, M. L., Bernardino, J., Laranjeiro, N. & Oliveira, H. G., 2020. Applying Text Analytics for Studying Research Trends in Dependability. *Department of Informatics Engineering,* 1(1), pp. 1-20.

Cassam, Q., 2016. Vice Epistemology. *The monist,* 99(1), pp. 159-180.

Chaamwe, N. & Shumba, L., 2016. ICT Integrated Learning: Using Spreadsheets as Tools for e-Learning, A Case of Statistics in Microsoft Excel. *International Journal of Information and Education Technology,* 6(6), pp. 435-440.

© Central University of Technology, Free State

Chaiyo, Y. & Norkham, R., 2017. The effect of Kahoot, Quizizz and Google forms on the student's perception in the classroom response system. *Digital Arts, Media and Technology (ICDAMT),* pp. 178-182.

Chalkiadaki, A., 2018. A Systematic Literature Review of 21st Century Skills and Competencies in Primary Education. *International Journal of Instruction,* 11(3), pp. 1-16.

Charleston, L J; George, P L; Jackson, J F; Berhanu, J; Amechi, M H, 2014. Navigating underrepresented STEM spaces: Experiences of black women in U.S. computing science higher education programs who actualize success. *Journal of Diversity in Higher Education,* 7(3), pp. 166-176.

Chege, K. & Otieno, O., 2020. Research Philosophy Design and Methodologies: A Systematic Review of Research Paradigms in Information Technology. *Global scientific journals,* 8(5), pp. 33-38.

Chen, X., Zou, D., Cheng, G. & Xie, H., 2020. Detecting latent topics and trends in educational technologies over four decades using structural topic modeling: A retrospective of all volumes of Computers & Education. *Computers and education,* 1(1), pp. 1-21.

Cherner, T., Dix, J. & Lee, C., 2014. Cleaning up that mess: A framework for classifying educational apps. *Contemporary Issues in Technology and Teacher Education,* 14(2), pp. 158-193.

Chiechi, T., 2022. *Investopedia.* [Online] Available at: https://www.investopedia.com/terms/s/sample.asp#:~:text=What%20Is%20a%20Sample%3F,all%20possible%20members%20or%20observations. [Accessed 10 April 2024].

Chigbu, U E; Atiku, S O; DU Plessis, C;, 2023. The Science of Literature Reviews: Searching, Identifying, Selecting, and Synthesising. *Publications,* 11(2), pp. 1-16.

Christensen, G. & Miguel, E., 2016. Transparency, reproducibility, and the credibility of economics research. *NBER Working paper series,* 1(1), pp. 1-94.

© Central University of Technology, Free State

Chu, S K; Reynolds, R B; Tavares, N J; Notari, M; Lee, C W, 2018. Twenty-First Century Skills and Global Education Roadmaps. In 21st Century Skills Development through Inquiry-Based Learning. *Creative Education,* 9(2), pp. 17-32.

Chuene, D. M. & Teane, F. M., 2024. Resource inadequacy as a barrier to effective curriculum implementation by life sciences teachers in South Africa. *South African Journal of Education,* 44(2), pp. 1-10.

Cizevska, A., 2025. *Overreliance on AI and Its Effects on Student Cognition: What Can Teachers and Students Do?.* [Online] Available at: https://www.researchgate.net/publication/397300205_Overreliance_on_AI_and_Its_Effects_on_Student_Cognition_What_Can_Teachers_and_Students_Do [Accessed 08 February 2026].

Clayton, K. & Murphy, A., 2016. Smartphone Apps in Education: Students Create Videos to Teach Smartphone Use as Tool for Learning. *Journal of Media Literacy Education,* 8(2), pp. 99-109.

Collin, S. C. & Stockton, C. M., 2018. The Central Role of Theory in Qualitative Research. *International Journal of Qualitative Methods,* 17(1), pp. 1-10.

Comert, M; Zill, J M; Christalle, E; Dirmaier, J; Harter, M; Scholl, I;, 2016. Assessing Communication Skills of Medical Students in Objective Structured Clinical Examinations (OSCE) - A Systematic Review of Rating Scales. *PLoS ONE,* 11(3).

Corona, C., 2016. *Templates and Turns in Qualitative Studies of Strategy and Management.* 1st ed. Bogotá: Universidad de los Andes.

Couldry, N. & Kallinikos, J., 2017. Ontology. In: J. a. M. A. a. P. T. Burgess, ed. *The SAGE Handbook of Social Media.* London: SAGE Publications, pp. 146-159.

Creswell, J. W., 2009. *Research design: Qualitative, Quantitative and Mixed Method Approaches.* 3rd ed. Los Angeles: SAGE.

Dahlin, E., 2021. Email Interviews: A Guide to Research Design and Implementation. *International Journal of Qualitative Methods,* 20(1), pp. 1-10.

Dakhi, O; Jama, J; Irfan, D; Ambiyar; Ishak, 2020. Blended learning: A 21st Century learning model at college. *International Jornal of multi science,* 1(7), pp. 50-65.

© Central University of Technology, Free State

Daniel, H. J., Leopold, S. & Le, W., 2016. *The Three I's of Public Schools: Irrelevant Inputs, Insufficient Resources and Inefficiency.* Bonn: Institute for the Study of Labor (IZA).

Dawadi, S., Shrestha, S. & Giri, R. A., 2021. Mixed-Methods Research: A Discussion on its Types, Challenges, and Criticisms. *Journal of Practical Studies,* 2(2), pp. 25-36.

De Bruijne, M. & Wijnant, A., 2014. Improving response rates and questionnaire design for mobile Web survey. *Oxford Journals,* 78(4), pp. 951-962.

Debusschere, B., 2018. How do we create more equitable, diverse, and inclusive organizations, and why does it matter? A white male's perspective.. *Computing in Science & Engineering,* 20(1), pp. 79-83.

Decuypere, M. & Belgium, K. L., 2019. Researching educational apps: Ecologies, technologies, subjectivities and learning regimes. *Learning, Media and Technology,* 1(1), pp. 1-17.

DeJonckheere, M. & Vaughn, L. M., 2019. Semistructured interviewing in primary care research: a balance of relationship and rigour. *Family Medicine and Community Health,* 7(2), pp. 1-8.

Dellos, R., 2015. Kahoot! A digital game resource for learning. *International Journal of Instructional technology and distance learning,* 12(4), pp. 49-52.

Dempsey, J., Snodgrass, R. T., Kishi, I. & Titcomb, A., 2015. *The emerging role of self perception in student intentions. In Proceedings of the 46th ACM Technical Symposium on Computer Science Education.* New York, NY:ACM.

Deng, F; Chai, C; So, H; Qian, Y; Chen, L, 2017. Examining the validity of the technological pedagogical content knowledge (TPACK) framework for preservice chemistry teachers. *Australasian Journal of Educational Technology,* 33(3), pp. 1-14.

Department of Basic Education, 2020. *Curriculum and Assessment Policy Statement Computer Applications Technology (CAT),* Cape Town: Government Printing Works.

Department of Basic Education, 2024. *Curriculum and Assessment Policy Statement: Computer Applications Technology Amendments,* Pretoria: Department of Basic Education.

© Central University of Technology, Free State

Dooly, M; Moore, E; Vallejo, C, 2017. Research ethics. *Qualitative approaches to research on plurilingual education,* 2(1), pp. 351-362.

Dougherty, M. R., Slevc, L. R. & Grand, J. A., 2019. Making research evaluation more transparent: Aligning research philosophy, institutional values, and reporting. *Perspectives in Psychological Science.*

Douglas, S. N. & Gerde, H. K., 2019. A Strategy to Support the Communication of Students With Autism Spectrum Disorder. *Intervention in School and Clinic,* 55(1), pp. 32-38.

Doyle, A., 2022. *The balance.* [Online] Available at: https://www.thebalancemoney.com/creative-thinking-definition-with-examples-2063744
[Accessed 01 April 2023].

Drajati, N. A. & Sumardi, S., 2019. Discovering the teacher's beliefs in TPACK framework for teaching English in high school. *Indonesian Journal of Informatics Education,* 3(1), pp. 1-12.

Driscoll, M., 2017. *Are we a 21st century school?.* [Online] Available at: https://www.linkedin.com/pulse/we-21st-century-school-maxine-driscoll?trk=mp-reader-card

Duran, M. & Dokme, I., 2016. The effect of the inquiry-based learning approach on student's critical-thinking skills1. *Eurasia Journal of Mathematics, Science & Technology Education,* 12(12), pp. 2887-2908.

Eisele, M., Troost, c. & Berger, T., 2021. How Bayesian Are Farmers When Making Climate Adaptation Decisions? A Computer Laboratory Experiment for Parameterising Models of Expectation Formation. *Journal of Agricultural Economics,* 72(3), pp. 805-828.

Eisenhardt, K., 2021. What is the Eisenhardt Method, really?. *So!apbox Essay,* 19(1), pp. 147-160.

Eisenhardt, K. M., Graebner, M. E. & Sonenshein, S., 2016. Grand Challenges and Inductive Methods: Rigor without Rigor Mortis. *Academy of Management Journal,* 59(4), pp. 1113-1123.

© Central University of Technology, Free State

Engelbrecht, J., Llinares, S. & Borba, M., 2020. Transformation of the mathematics classroom with the internet. *Survey paper,* 52(1), pp. 825-841.

Enk, G. A. & Hart, S. L., 1985. An Eight-Step Approach to strategic problem solving. *Human Systems Management,* Volume 5, pp. 245-258.

Eranzo, G. N. & Esteve-Gonzalez, V., 2015. Teaching and learning in digital worlds: strategy and issues in higher education. *Universitat Rovira i Virgili,* Volume 1, pp. 1-213.

Erazo, G. N., Gonzalez, V. E. & Vaca, B., 2015. Making 3D objects in virtual learning environments. In: *Teaching and Learning in digital worlds: strategies and issues in higher education.* 1st ed. Tarragona: Publicacions Universitat Rovira i Virgil, pp. 129-136.

Etikan, I. & Bala, K., 2017. Sampling and sampling methods. *Biometrics & Biostatistics International Journal,* 5(6), pp. 215-217.

Fan, M. & Li, Y., 2020. The application of computer graphics processing in visual communication design. *Journal of intelligent & fuzzy systems,* 39(4), pp. 5183-5191.

Fernandez, K., 2019. Critically reviewing literature: A tutorial for new researchers. *Australasian Marketing Journal,* 27(3), pp. 187-196.

Ferreira, J., Sousa, P. F. & Tereso, A., 2024. Problem-solving practices in the automotive industry: an initial framework. *Procedia Computer Science,* Volume 239, pp. 429-436.

Finotelloa, A; Romarowski, R M; Gorlac, R; Bianchi, G; Bedogni, F; Auricchio, F; Morganti, S, 2021. Performance of high conformability vs. high radial force devices in the virtual treatment of TAVI patients with bicuspid aortic valve. *Medical Engineering and Physics,* Volume 89, pp. 42-52.

Fitriani, N., Suryadi, D. & Darhim, 2018. The students' mathematical abstraction ability through realistic mathematics education with VBA-Microsoft Excel. *Journal of Mathematics Education,* 7(2), pp. 123-132.

Foen, S; Hassan, N S; Mohannad, N H; Malek, N A;, 2017. The Relationship Between Smartphone Use and Academic Performance: A Case of Students in a Malaysian Tertiary Institution. *Malaysian Online Journal of Educational Technology,* 5(4), pp. 58-70.

© Central University of Technology, Free State

Forehand, J. W., Miller, B. & Carter, H., 2017. Integrating mobile devices into the nursing classroom. *Teaching and Learning in Nursing,* 12(1), pp. 50-52.

Francis, T. P., 2020. Pragmatism in Philosophy of Education: A Contemporary Outlook. *Tropical Journal of Arts and Humanities,* 2(1), pp. 64-72.

Gafour, W. A. & Gafour, A. S., 2020. Creative Thinking skills – A Review article. *Journal of Education,* 1(1), pp. 1-21.

Gannon, M., Taheri, B. & Azer, J., 2022. Contemporary Research Paradigms & Philosophies. In: F. Okumus, M. Rasoolimanesh & S. Jahani, eds. *Contemporary Research Methods in Hospitality and Tourism.* 1st ed. Edinburgh: Emerald Publishing, pp. 5-19.

García, J. M., Carmona, M. G., Torres, J. M. & Fernández, P. M., 2022. The integration of emerging technologies in socioeconomically disadvantaged educational contexts. The view of international experts. *Journal of Computer Assistant Learning,* 38(1), pp. 1185-1197.

Garner, R., Nicholas, M. & Rouse, E., 2021. Cross-sector early years teacher collaboration: using professional learning workshops as boundary objects for professional boundary crossing. *European Early Childhood Education Research Journal,* 29(5), pp. 764-779.

Gashe, A. D., Ferede, Y. A., Weldemichael, D. Z. & Endries, A. Y., 2025. Evaluation of a Sentinel Hypertension Surveillance System in Mojo, East Shewa Zone, Oromia, Ethiopia: Concurrently Embedded Mixed Design Study. *Online Journal of Public Health Information,* Volume 17.

Geisinger, K., 2016. 21st Century Skills: What Are They and How Do We Assess Them?. *Applied Measurement in Education,* 29(4), pp. 245-249.

Ghavifekr, S. & Wan Rosd, w., 2015. Teaching and Learning with Technology: Effectiveness of ICT Integration in Schools. *International Journal of Research in Education and Science,* 1(2), pp. 1-18.

Gholam, A., 2019. Inquiry-Based Learning:Student Teachers' Challenges and Perceptions. *Journal of Inquiry & Action in Education,* 10(2), pp. 112-133.

© Central University of Technology, Free State

Ghosh, A., Gupta, S., Dua, A. & Kumar, N., 2020. Security of Cryptocurrencies in blockchain technology: State-of-art, challenges and future prospects. *Journal of Network and Computer Applications,* 1(1), pp. 1-80.

Glassman, E. L., Kim, J., Monroy-Hernández, A. & Morris, M. R., 2015. *Mudslide: A Spatially Anchored Census of Student Confusion for Online Lecture Videos.* New York, Association for Computing Machinery, pp. 1-10.

Golubev, O. & Testov, V., 2015. Network Information Technologies as a Basis of New Educational Paradigm. *Social and Behavioral Sciences,* 1(1), pp. 128-134.

Greenhill, R; Miller, M; Papadavid, P; Scott, A; Stuart, E; Watson, D; Whitley, S, 2015. *A development agenda for China's G20 Presidency,* China: ODI Report.

Greeno, J. G., 2017. *Forms of understanding in mathematical problem solving.* 1st ed. England: Routledge.

Guetterman, T. & Fetters, M., 2018. Two Methodological Approaches to the Integration of Mixed Methods and Case Study Designs: A Systematic Review. *American Behavioral Scientist,* 62(7), pp. 900-918.

Guo, Y. & Lee, D., 2023. Leveraging ChatGPT for Enhancing Critical Thinking Skills. *Journal of Chemical Education,* 100(12), pp. 4876-4883.

Hadinugrahaningsiha, T., Rahmawati, Y. & Ridwan, A., 2017. *Developing 21st Century Skills in Chemistry Classrooms: Opportunities and Challenges of STEAM Integration.* Indonesia, AIP Publishing, pp. 1-9.

Haerazi & Kazemian, M., 2021. Self-Regulated Writing Strategy as a Moderator of Metacognitive Control in Improving Prospective Teachers' Writing Skills. *Journal of Language and Literature Studies,* 1(1), pp. 1-14.

Hammar, k., Wallin, E. O., Karlberg, P. & Hälleberg, D., 2019. The RealEstateCore Ontology. *18th International Semantic Web,* 1(1), pp. 1-17.

Haradhan, M., 2017. Two Criteria for Good Measurements in Research: Validity and Reliability. 17(3), pp. 1-32.

Hartikainen, S., Rintala, H., Pylvas, L. & Nokelainen, P., 2019. The Concept of Active Learning and the Measurement of Learning Outcomes: A Review of Research in Engineering Higher Education. *Education Science,* 1(1), pp. 1-19.

© Central University of Technology, Free State

Hassan, M., 2024. *Researchmethod.net.* [Online] Available at: https://researchmethod.net/quantitative-research/#sidr-main [Accessed 15 July 2025].

Helen, N. & Joanna, S., 2015. Issues of validity and reliability in qualitative research. 18(2), pp. 34-35.

Henriksen, D., Mishra, P. & Fisser, P., 2016. Infusing Creativity and Technology in 21st Century Education: A Systemic View for change. *International Forum of Educational Technology & Societ,* 19(3), pp. 27-37.

Henriksen, D., Mishra, P. & Mehta, R., 2015. Novel, Effective, Whole: Toward a NEW Framework for Evaluations of Creative Products. *Journal of Technology and Teacher Education,* 23(3), pp. 455-478.

HHains, M., 2019. *Computer Applications Technology.* [Online] Available at: https://matthewhains.online/computer-applications-technology/ [Accessed 18 April 2022].

Hirsh-Pasek, K; Zosh, J M; Golinkoff, R M; Gray, J H; Robb, M B; Kaufman6, J, 2015. Putting Education in “Educational” Apps: Lessons From the Science of Learning. *Psychological Science in the Public Interest,* 16(1), pp. 3-34.

Hummel, B., 2024. *What Are 21st Century Skills?.* [Online] Available at: https://www.icevonline.com/blog/what-are-21st-century-skills [Accessed 12 October 2024].

iCEV, 2024. *What Are 21st Century Skills?.* [Online] Available at: https://www.icevonline.com/blog/what-are-21st-century-skills [Accessed 08 February 2026].

Ifana, S., Hari, S. & Komang, A., 2021. The Effect of Problem Based Learning on Problem Solving and Scientific Writing Skills. *International Journal of Instruction,* 14(2), pp. 11-26.

Indeed, 2021. *Indeed Editorial Team.* [Online] Available at: https://www.indeed.com/career-advice/career-development/deductive-reasoning [Accessed 13 March 2022].

© Central University of Technology, Free State

Ivanov, D; Tang, C S; Dolgui, A; Battini, D; Das, A, 2021. Researchers' perspectives on Industry 4.0: multi-disciplinary analysis and opportunities for operations management. *International Journal of Production Research,* 59(7), pp. 2055-2075.

Jackson, A. Y., 2016. An Ontology of a Backflip. *Cultural Studies,* 1(1), pp. 1-10.

Jain, N., 2023. *IDEASCALE.* [Online] Available at: https://ideascale.com/blog/what-is-research/ [Accessed 02 April 2024].

Janghorban, R., Roudsari, R. L. & Taghipour, A., 2014. Skype interviewing: The new generation of online synchronous interview in qualitative research. *International Journal of Qualitative Studies on Health and Well-being,* 9(1), pp. 1-4.

Jansen , D. & Warren, K., 2020. *Quantitative Data Analysis 101: The lingo, methods and techniques, explained simply..* [Online] Available at: https://gradcoach.com/quantitative-data-analysis-methods/ [Accessed 17 April 2022].

Jansena, R. S., Leeuwena, A. V., Janssena, J. & Kestera, L., 2020. A mixed method approach to studying self-regulated learning in MOOCs: combining trace data with interviews. *Frontline Learning Research,* 8(2), pp. 35-64.

Johnson, A. M., Jacovina, M. E., Russell, D. E. & Soto, C. M., 2016. Challenges and solutions when using technologies in the classroom. *Adaptive educational technologies for literacy instruction ,* Volume 1, pp. 13-29.

Jugenheimer , D. W., Kelley , L. D., Hudson , J. & Bradley, S. D., 2014. *Advertising and Public Relations Research.* Oxfordshire : Routledge.

Kahn, R. R., 2021. An investigation of the assessments used to determine the content knowledge of Post Graduate Certificate in Education preservice teachers for FET Life Sciences teaching and their performance in those assessments: A case study. *Wits shool of education,* 1(1), pp. 1-125.

Kalu, M. E., 2019. Using Emphasis-Purposeful Sampling-Phenomenon of Interest–Context (EPPiC est–Context (EPPiC) Framework t amework to Reflect on T o Reflect on Two Qualitative Research Designs and Questions: A Reflective Process. *The Qualitative Report,* 24(10), pp. 2524-2535.

© Central University of Technology, Free State

Kantosalo, A. A., Toivanen, J. M. & Toivonen, H., 2015. *Interaction Evaluation for Human-Computer Co-Creativity : A Case Study.* United States, Brigham Young University.

Kassab, M; DeFranco, J; Laplante, P, 2019. A systematic literature review on Internet of things in education: Benefits and challenges. *Journal of Computer Assisted Learning,* 1(1), pp. 1-14.

Katoch, S., 2020. MS-Excel Spreadsheet Applications in Introductory UnderGraduate Physics-A Review. *Journal of Science and Technology,* 5(3), pp. 48-52.

Kaushik, V. & Walsh, C., 2019. Pragmatism as a Research Paradigm and Its Implications for Social Work Research. *Social Sciences,* 8(255), pp. 1-17.

Kaware, S. S. & Sain, S. K., 2015. ICT Application in Education: An Overview. 2(1), pp. 25-32.

Kelly, L. M. & Cordeiro, M., 2020. Three principles of pragmatism for research on organizational processes. *Methodological Innovations,* pp. 1-10.

Kelp, C. & Simion, M., 2023. What is trustworthiness?. *COGITO, Philosophy,* 3(1), pp. 667-683.

Keyser, A., 2021. *Why is Reading Important?.* [Online] Available at: https://www.worksheetcloud.com/blog/why-is-reading-important/ [Accessed 10 September 2022].

Khalid, M; Saad, S; Hamid, A; Abdullah, M R; Ibrahim, H; Shahrill, M, 2020. Enhancing creativity and problem solving skills through creative problem solving in teaching mathematics. *Creativity studies,* 13(2), pp. 270-291.

Kiger, M. E. & Varpio, L., 2020. Thematic analysis of qualitative data: AMEE Guide No. 131. *Medical Tecaher,* 1(1), pp. 1-9.

Kivunja, C., 2014. Theoretical Perspectives of How Digital Natives Learn. *International Journal of Higher Education,* 3(1), pp. 94-109.

Kivunja, C. & Kuyini, A. B., 2017. Understanding and Applying Research Paradigms in Educational Context. *International Journal of Higher Education,* 6(5), pp. 26-41.

© Central University of Technology, Free State

Konak, A., Clark, T. K. & Nasereddin, M., 2014. Using Kolb's Experiential Learning Cycle to improve student learning in virtual computer laboratories. *Computer & Education,* 72(1), pp. 11-22.

Kortesi, P; Simonka, Z; Szabo, Z K; Guncaga, J; Neag, R, 2022. Challenging Examples of the Wise Use of Computer Tools for the Sustainability of Knowledge and Developing Active and Innovative Methods in STEAM and Mathematics Education. *Sustainability,* Volume 14, pp. 1-23.

Kuphanga, D., 2024. *Questionnaires in Research: Their Role, Advantages, and Main Aspect,* Malawi: ResearchGate.

Kurt, S., 2019. *TPACK: Technological Pedagogical Content Knowledge Framework.* [Online]
Available at: https://educationaltechnology.net/technological-pedagogical-content-knowledge-tpack-framework/
[Accessed 15 February 2021].

Kyngas, H., Kaarianen, M. & Elo, S., 2020. The Trustworthiness of Content Analysis. *The Application of Content Analysis in Nursing Science Research,* 1(10), pp. 41-48.

Lawless, C., 2019. *Learner-Centered Approaches: Why They Matter and How to Implement Them.* [Online]
Available at: https://www.learnupon.com/blog/learner-centered/
[Accessed 26 August 2022].

Lawrence, M., 2018. *How to Use Technology for Different Learning Styles.* [Online]
Available at: https://learnsafe.com/how-to-use-technology-for-different-learning-styles/
[Accessed 18 April 2022].

Lederman, N. G. & Lederman, J. S., 2017. What Is A Theoretical Framework? A Practical Answer. *Journal of Science Teacher Education,* pp. 593-597.

Leedy, P. D. & Ormrod, J. E., 2015. Practical research. Planning and design. *Journal of Applied Learning & Teaching,* 1(2), pp. 73-74.

Lehiste, P., 2015. A Study From Estonia. *Problems of Education in Th 21st Century,* 66(1), pp. 18-28.

© Central University of Technology, Free State

Leon, S. P. & Grarcia-Martinez, I., 2021. Impact of the provision of PowerPoint slides on learning. *Computers & Education,* 173(1), pp. 1042-1056.

Lisell, V., 2021. Open Pedagogy: A Systematic Review of Empirical Findings. 8(2), pp. 255-268.

Liu, S; Liu, H; Yu, Y; Li, Y; Wen, T, 2014. TPACK : A New Dimension to EFL Teachers ' PCK. *Journal of Education and Human Development,* 3(2), pp. 681-693.

Lohstroh, M., Menard, S., Bateni, M. & Lee, E., 2021. Toward a Lingua Franca forDeterministic Concurrent Systems. *ACM Trans. Embed. Comput. Syst,* 20(36), p. 27.

Maguire, M. & Delahunt, B., 2017. Doing a thematic analysis : A practical step by step guide for learning and tesching scholars. *Dundalk Institute of Technology,* Volume 3, pp. 3351-33514.

Mahato, S., Khan, D. A. & Yadav, D., 2020. A modified approach to data hiding in Microsoft Word documents by change-tracking technique. *Computer and Information Sciences,* 32(2), pp. 216-224.

Maher, C., Hadfield, M., Hutchings, M. & Eyto, A., 2018. Ensuring Rigor in Qualitative Data Analysis: A Design Research Approach to Coding Combining NVivo With Traditional Material Methods. *International Journal of Qualitative Methods,* 17(1), pp. 1-13.

Makena, B. & Yengwayo, P. Z., 2023. Computer Applications Technology teaching: A case of supporting secondary school curriculum imperatives. *International Journal of Innovative Technologies in Social Sciences,* 3(39), pp. 1-7.

Mann, S., 2016. *The Research Interview Reflective Practice and Reflexivity in Research Processes.* 1st ed. New York: Palgrave Macmillan.

Marais, M; Swart, A; Fourie, H; Berry, S D; Knoetze, R; Malan, A P, 2017. Techniques and Procedures. In: C. Springer, ed. *Nematology in South Africa: A View from the 21st Century.* South Africa: Springer international Publishing Switzerland, pp. 73-117.

Marcucci, G., Sanchis, R., Ciarapica, F. & Bevilacqua, M., 2022. Development of a semi-structured questionnaire to analyse supply chain of a semi-structured questionnaire to analys. *Department of Industrial Engineering and Mathematical Science,,* 55(10), pp. 1588-1863.

© Central University of Technology, Free State

Maree, K. & Pietersen, J., 2016. The Social Science Research Process: A New Model. In: K. Maree , ed. *The Quantitative Research Process.* 2nd ed. Pretoria: Van Schaik, pp. 162-173.

Martin, C. K., Nacu, D. & Pinkard, N., 2016. Revealing opportunities for 21st century learning: An approach to interpreting user trace log data. *Journal of Learning Analytics,* 3(2), pp. 37-87.

Mavellas, S., Wellington, M. & Samuel, F., 2016. Assessment Of The Availability And Utilization Of Icts For Teaching And Learning In Secondary Schools. *International journal of scientific & Technology research,* 5(5), pp. 282-288.

Mazo, G., 2021. *QuickFigures: A toolkit and ImageJ PlugIn to quickly transform microscope images into scientific figures.* [Online] Available at: https://doi.org/10.1371/journal.pone.0240280 [Accessed 10 February 2023].

McCombes, S., 2019. *Scribbr.* [Online] Available at: https://www.scribbr.com/methodology/sampling-methods/ [Accessed 23 July 2021].

McCombes, S., 2023. *Scribbr.* [Online] Available at: https://www.scribbr.com/methodology/sampling-methods/ [Accessed 10 April 2024].

McCusker, K. & Gunaydin, S., 2014. Research using qualitative, quantitative or mixed methods and choice based on the research. 1(1), pp. 1-6.

McKnight, K; O'Malley, K; Ruzic, R; Horsley, M `K; Franey, J; Bassett, K, 2016. Teaching in a Digital Age: How Educators Use Technology to Improve Student Learning. *Journal of Research on Technology in Education,* 48(3), pp. 194-211.

McLean, G., 2018. Examining the determinants and outcomes of mobile app engagement - A longitudinal perspective. *Computer in Human Behaviour,* Volume 84, pp. 392-403.

McLeod, S., 2014. *simplypsychology.* [Online] Available at: https://www.simplypsychology.org/interviews.html [Accessed 22 July 2021].

© Central University of Technology, Free State

McLoughlin, C., Patel, K., O'Callaghan, T. & Reeves, S., 2018. The use of virtual communities of practice to improve interprofessional collaboration and education: findings from an integrated review. *Journal of Interprofessional Care,* 32(2), pp. 136-142.

Melnikovas, A., 2018. Towards an Explicit Research Methodology: Adapting Research Onion Model for Futures Studies. *Journal of Futures Studies,* 23(2), pp. 29-44.

Mian, S., Lamine, W. & Fayolle, A., 2016. Technology Business Incubation: An overview of the state of knowledge. *Technovation,* 1(1), pp. 1-12.

Mine, A., 2017. Static Analysis of Embedded Real-Time Concurrent Software with Dynamic Priorities. *Electronic notes in Theoretical Computer Sciences,* 331(1), pp. 3-39.

Mishra, N N; Martynenko, A; Chemat, F; Paniwnyk, L; Barba, F; Jambrak, A r, 2018. Thermodynamics, transport phenomena, and electrochemistry of external field-assisted nonthermal food technologies. *Critical Reviews in Food Science and Nutrition,* 58(11), pp. 1832-1863.

Mishra, P. & Koehler, M. J., 2006. Technological Pedagogical Content Knowledge: A new framework for teacher knowledge. *Teachers College Record,* 108(6), pp. 1017-1054.

Mohamad, M. M., Sulaimanb, N. L., Sern, N. L. & Mohd, K., 2015. Measuring the Validity and Reliability of Research Instruments. *ScienceDirect,* 1(1), pp. 164-171.

Mojtahed, P; Nunes, M B; Martins, J T; Peng, A, 2014. Equipping the constructivist researcher: The combined use of semi-structured interviews and decision-making maps. *Electronic Journal of Business Research Methods,* 12(2), pp. 87-95.

Mpele, O. S., 2014. Grade 10-12 Educator's perceptions and experiences of safety at schools in Lejweleputswa District. *Education,* pp. 89-124.

Mukeredzi, T. G., 2016. The Nature of Professional Learning Needs of Rural Secondary School Teachers: Voices of Professionally Unqualified Teachers in Rural Zimbabwe. *SAGE open,* 1(1), pp. 1-12.

Mukhari, S. S., 2016. Teachers' experience of Information and Communication Technology use for Teaching and Learning in Urban Schools. *University of South Africa,* pp. 1-315.

© Central University of Technology, Free State

Munthe-Kaas, H., Nokleby, H., Lewin, S. & Glenton, C., 2020. The TRANSFER Approach for assessing the transferability of systematic review findings. *BMC Medical Research,* 20(11), pp. 1-22.

Mupa, P. & Chinooneka, T. I., 2015. Factors contributing to ineffectivene teaching and learning in primary schools: Why are schools i decadence?. *Journal of Education and Practice,* 6(19), pp. 125-132.

Nagy, J. T. & Bernschuitzs, M., 2016. The Impact of Webinar-Webcast System on Learning Performance. *Education and Information Technologies,* 21(6), pp. 1837-1845.

Nasution, M. K., 2018. Ontology. *International Conference on Science and Technology,* 1(1), pp. 1-7.

Ndalichako, J. L. & Komba, A. A., 2014. Student's subject choice in Secondary schools in Tanzania. *Amatter of Student ability & interest or Forced circumstances?,* Volume 2, pp. 49-56.

Ndukwu, D., 2020. *Kyleads.* [Online] Available at: https://www.kyleads.com/blog/questionnaire/ [Accessed 23 July 2021].

Newson, A. J. & Lipworth, W., 2015. Why should ethics approval be required prior to publication of health promotion research?. *Journal of Australia,* 26(1), pp. 170-175.

Newswire, 2023. *Kahoot! reaches milestone of 10 billion global participants since launch.* [Online] Available at: https://themalaysianreserve.com/2023/11/10/kahoot-reaches-milestone-of-10-billion-global-participants-since-launch/#google_vignette [Accessed 27 July 2025].

Nguyen, T. Q. & Nguyen, H. T., 2020. Factors Affecting Industry and University Collaboration in Education in the Hospitality Industry in Vietnam: A Business Perspective. *Journal of Asian Finance, Economics and Business,* 7(2), pp. 291-300.

Nichols, G., 2019. *21st Century Skills.* [Online] Available at: https://cohort21.com/garthnichols/category/21st-century-skills/

Nigar, N., 2020. Hermeneutic Phenomenological Narrative Enquiry: A Qualitative Study Design. *Theory and Practice in Language Studies,* 10(1), pp. 10-18.

© Central University of Technology, Free State

Njie, B. & Asimiran, S., 2014. Case Study as a Choice in Qualitative Methodology. *Journal of Research & Method in Education,* 4(3), pp. 35-40.

Nkosi, B., 2022. *The star news.* [Online] Available at: https://www.iol.co.za/the-star/news/no-fee-schools-drop-computer-applications-technology-as-subject-93ee60ad-f1d1-497b-8346-b812ad133735 [Accessed 12 October 2024].

Nordhaus, W., 2015. Are We Approaching an Economic Singularity? Information Technology and the Future of Economic Growth. *National bureau of economic research,* 1(1), pp. 1-49.

Nuzzo, R. L., 2016. The Box Plots Alternative for Visualizing Quantitative Data. *Statistically Speaking,* 8(1), pp. 268-272.

Nwana, S. E., Ofoegbu, T. O. & Egbe, C. I., 2017. Availability and Utilization of ICT Resources in Teaching Computer Education In Secondary Schools in Anambra S. *Mediterranean Journal of Social Sciences,* 8(5), pp. 111-116.

O'Keeffe, J; Buytaert, W; Mijic, A; Brozovic´, N; Sinha, R, 2016. The use of semi-structured interviews for the characterisation of farmer irrigation practices. *Hydrology and Earth System Sciences,* 1(1), pp. 1911-1924.

Onwuegbuizie, A. J. & Frels, R. K., 2015. Using Q Methodology in the Literature Review Process. *Journal of Education,* 1(2), pp. 90-109.

Onwuegbuzie, A. J. & Frels, R. K., 2013. Introduction: Toward a new research philosophy for addressing social justice issues: Critical dialectical pluralism 1.0. *International Journal of Multiple Research Approaches,* 7(1), pp. 9-26.

Orlando, J. & Attard, C., 2016. Digital natives come of age: the reality of today's early career teachers using mobile devices to teach mathematics. *Math Ed Res J,* 28(1), pp. 107-121.

Oyundoyin, B., Jacob, U. S., Oyundoyin, T. & Onasanya, O., 2023. Interpersonal Communication Skills and Proactive Stance to Life's Puzzles among Children: A Review. *International Journal of Home Economics, Hospitality and Allied Research,* 2(2), pp. 140-148.

Paniagua`, A. & Istance, D., 2018. *Teachers as Designers of Learning Environments.* 1st ed. Paris: OECD Publishing.

© Central University of Technology, Free State

Papadakis, S. & Kalogiannakis, M., 2017. Mobile educational applications for children: what educators and parents need to know. *Mobile Learning and Organisation,* 11(3), pp. 256-277.

Patel, H. R. & Joseph, J. M., 2016. Questionnaire Designing Process: A Review. *Journal of Clinical Trials,* 6(2), pp. 1-7.

Peel, K., 2020. A Beginner A Beginner's Guide t s Guide to Applied E o Applied Educational Resear ducational Research using ch using Thematic Analysis. *Practical Assessment, Research, and Evaluation,* 25(2), pp. 1-16.

Perifanou, M., Economides, A. A. & Tzafilkou, K., 2021. Teachers' Digital Skills Readiness During COVID-19 Pandemic. *International Journal of Engineering and Techniques,* 16(8), pp. 238-251.

Plump, C. & LaRosa, J., 2017. Using Kahoot! in the Classroom to Create Engagement and Active Learning: A Game-Based Technology Solution for eLearning Novices. *Management Teaching,* 2(2), pp. 1-14.

Potter, J., 2022. Critical analysis of critical thinking. *Journal of Media Literacy Education,* 14(1), pp. 108-123.

Pritchard, D., 2016. *Epistomology.* 2nd ed. New York: St Martin's Press LLC.

Puccio, G., 2017. From the Dawn of Humanity to the 21st Century: Creativity as an Enduring Survival Skill. *The journal of Creative Behaviour,* 51(4), pp. 330-334.

Rahman, A. & Muktadir, G., 2021. SPSS: An Imperative Quantitative Data Analysis Tool for Social Science Research. *International Journal of Research and Innovation in Social Science (IJRISS) ,* 5(10), pp. 300-302.

Rajadell, M. & Garriga-Garzon, F., 2017. Educational videos: After the why, the how. *OmniaScience,* 13(5), pp. 902-922.

Raja, R. & Nagasubramani, P. C., 2018. Impact of modern technology in education. *Journal of Applied and Advanced Research,* 3(1), pp. 33-35.

Ralph, P., 2021. Sampling in Software Engineering Research: A Critical Review and Guidelines. *Empirical Software Engineering manuscript,* 1(1), pp. 1-38.

Ramani, S., 2015. The internet and education in the developing world - hopes and reality. 2(8), pp. 1-16.

© Central University of Technology, Free State

Rambitan, V. M., 2015. The effect of smartphone on students' critical thinking skill in relation to the concept of biodiversity. *American Journal of Educational Research,* 3(2), pp. 243-249.

Randall, M. & Jane, A., 2015. Learner-Centered Pedagogy: Considerations for Application in a Didactic Course. *The Professional Counselor,* 5(3), pp. 379-389.

Ratheswarie, K., 2018. Information Communication Technology in Education. *Journal of Applied and Advanced Research,* 3(1), pp. 45-47.

Reilly, G., Souder, D. & Souder, R., 2016. Time Horizon of Investments in the Resource Allocation Process: Review and Framework for Next Steps. *Journal of Management,* 20(10), pp. 1-26.

Richards, K. A. & Hemphill, M. A., 2018. A Practical Guide to Collaborative Qualitative Data Analysis. *Journal of Teaching in Physical Education,* 1(1), pp. 1-20.

Richter, S. & Richter, A., 2020. Digital Nomads. *Business and information systems engineering,* 62(1), pp. 77-81.

Rock, M L; Schumacker, R E; Gregg, M; Howard, P W; Gable, R A; Zigmond, N, 2014. How Are They Now? Longer Term Effects of eCoaching Through Online Bug-In-Ear Technology. *Teacher Education and Special Education,* 37(2), pp. 161-181.

Rodriguez, A. I., Riaza, B. G. & Gomez, M. C., 2017. Collaborative learning and mobile devices: An educational experience in Primary Education. *Computers in Human Behavior,* 72(1), pp. 664-667.

Roger, S., 2019. *The Role Of Technology In The Evolution Of Communication.* [Online]
Available at: https://www.forbes.com/sites/solrogers/2019/10/15/the-role-of-technology-in-the-evolution-of-communication/?sh=b709f11493bf
[Accessed 18 April 2022].

Rogers, E. M., 2003. *Diffusion of Innovations, 5th Edition.* 5th ed. Mexico: Simon and Schuster, 2003.

Rosenburg, J. M. & Koehler, M., 2015. Context and Technological Pedagogical Content Knowledge (TPACK): A Systematic Review. *Journal of Research on Technology in Education,* 47(3), pp. 186-210.

© Central University of Technology, Free State

Roslaniec, A., 2018. *Seven essential 21st century skills for secondary learners.* [Online]
Available at: https://www.english.com/blog/21st-century-skills-for-secondary-learners/ [Accessed 18 April 2022].

Ruslin; Mashuri, S; Mashuri, M; Alhabsyi, F; Syam, H, 2022. Semi-structured Interview: A Methodological Reflection on the Development of a Qualitative Research Instrument in Educational Studies. *Research & Method in Education,* 12(1), pp. 22-29.

Sandhu, A. K., 2022. Big Data with Cloud Computing: Discussions and Challenges. 5(1), pp. 32-40.

Sanger, C. & Gleason, N., 2020. *Diversity and Inclusion in Global Higher Education.* Asia: Open access publication.

Santos, J. & Castro, R., 2021. Technological Pedagogical content knowledge (TPACK) in action: Application of learning in the classroom by pre-service teachers (PST). *Social Science & Humanities,* Volume 3, pp. 1-8.

Sanusi, I. T., Oyelere, S. S. & Omidiora, J. O., 2022. Exploring teachers' preconceptions of teaching machine learning in high school: A preliminary insight from Africa. *Computers and Education ,* 3(1), pp. 1-10.

Saubern, R., Henderson, M., Heinrich, E. & Redmond, P., 2020. TPACK – time to reboot. *Australasian Journal of Educational Technology,* 36(3), pp. 1-9.

Saunders, M. N., Lewis, P., Thornhill, A. & Bristow, A., 2019. Chapter 4: Understanding Research Philosophy and Approaches to Theory Development. In: M. N. Saunders, P. Lewis & A. Thornhill , eds. *Research Methods for Business Students.* 8 ed. Harlow: Pearson Education, pp. 128-171.

Sax, L J; Newhouse, K N; Goode, J; Skorodinsky, M; Nakajima, T M; Sendowski, M, 2020. *Does AP CS Principles broaden participation in computing? An analysis of APCSA and APCSP participants.In Proceedings of the 51st ACM Technical Symposium on Computer Science Education.* New York, NY:ACM.

Schlebusch, C. L., 2015. *An Exploration of Grade 10-12 Computer Applications Technology Teachers' Problem-Solving Skills and Computational Thinking Skills in the Free State ,* Welkom: Central University of Technology.

© Central University of Technology, Free State

Schloemer, T. & Schroder-Black, P., 2018. *National Center of Biotechnology Information.* [Online] Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6019740/ [Accessed 11 April 2024].

Schmidt, F., 2017. Beyond Questionable Research Methods: The Role of Omitted Relevant Research in the Credibility of Research. *Archives of Scientific Psychology,* 5(1), pp. 32-41.

Seobi, B. A. & Wood, L., 2016. Improving the instructional leadership of heads of department in under-resourced schools: A collaborative action-learning approach. *South African Journal of Education,* 36(4), pp. 1-14.

Shadiev, R. & Yang, M., 2020. Review of Studies on Technology-Enhanced Language Learning and Teaching. *Education Science,* 1(1), pp. 1-22.

Shafie, H., Majid, F. A. & Ismail, I. S., 2019. Technological Pedagogical Content Knowledge (TPACK) in Teaching 21st Century Skills in the 21st Century Classroom. *Asian Journal of University Education,* 15(3), pp. 24-33.

Shahin, S., 2016. A Critical Axiology for Big Data Studies. *Palabra Clave,* 19(4), pp. 972-996.

Shah, N. Z., Hamid, N. S. & Mariadass, M. E., 2024. Fostering Critical Thinking Skills in Tertiary-Level Students for Media and Information Literacy. *International Journal of Advanced Research in Education and Society,* 6(3), pp. 107-123.

Shah, T. R., 2020. Human capital of upper echelons: Ther influence on strategic change decisions involving digital transformation. 1(1), pp. 1-23.

Shan, G. & Gerstenberger, S., 2017. Fisher's exact approach for post hoc analysis of a chi-squared test. *School of Community Health Sciences,* 12(12), pp. 1-20.

Shatri, Z. G., 2020. Advantages and Disadvantages of Using Information Technology in Learning Process of Students.. *Journal of Turkish Science Education,* 17(3), pp. 420-428.

Shorten, A. & Smith, J., 2017. Mixed methods research: expanding the evidence base. *Evidence-based nursing,* 20(3), pp. 74-75.

© Central University of Technology, Free State

Showkat, N. & Parveen, H., 2017. Non-Probability and Probability Sampling. *Media and Communications Studies,* Volume 1, pp. 1- 9.

Siddiqui, S. & Singh, T., 2016. Social Media its Impact with Positive and Negative Aspects. *International Journal of Computer Applications Technology and Research,* 5(2), pp. 71-75.

Singh, M. K. & Samah, N. A., 2018. Impact of Smartphone: A Review on Positive and Negative Effects on Students. *Asian Social Science,* 14(11), pp. 83-89.

Siriwardhana, Y., Porambage, P., Liyanage, M. & Ylianttila, M., 2021. A Survey on Mobile Augmented Reality With 5G Mobile Edge Computing: Architectures,Applications, and Technical Aspects. *IEEE Communications survey and tutorials,* 23(2), pp. 1160-1191.

Skarupski, K A; Gross, A; Schrack, J A; Deal, J A; Eber, G B, 2018. The Health of America's Aging Prison Population. *Epidemiologic Reviews,* Volume 40, pp. 157-165.

Skinner, R., Nelson, R. R., Chin, W. W. & Land, L., 2015. The Delphi Method Research Strategy in Studies of Information Systems. *Communications of the Association for Information System,* 37(2), pp. 32-63.

Smith, G., 2017. *What is Learner-Centred? How To Teach 100% Better with a Learner-Centred Approach.* [Online] Available at: https://thisisgraeme.me/2017/03/06/approaches-what-is-learner-centred/ [Accessed 26 May 2022].

Sousa, M. J. & Wilks, D., 2018. Sustainable Skills for the World of Work in the Digital Age. *Systems Research and Behavioral Science,* 35(1), pp. 399-405.

Spiteri, M. & Rundgren, C., 2018. Literature Review on the Factors Afecting Primary Teachers' Use of Digital Technology. *Technology, Knowledge and Learning ,* 25(1), pp. 115-128.

Sreeramana, A. & Shubhrajyotsna, A., 2016. Opportunities Challenges for Green Technology in 21st Century. *Munich Personal RePEc Archive,* 1(1), pp. 1-12.

Stahl, N. & King, J., 2020. Expanding Approaches for Research: Understanding and Using Trustworthiness in Qualitative Research. *Journal of Developmental Education,* 44(1), pp. 26-28.

© Central University of Technology, Free State

Stegehuis, F. J., 2021. Digital Immigrants and Digital Natives: an explorative study into the adaptivity of technology.. *Faculty of Behavioural, Management and Social Sciences*, 21 February, pp. 1-40.

Stern, C; Lizarondo, L; Carrier, J; Godfrey, C; Reiger, K; Salmon, S; Apostolo, J; Kikpatrik, P; Loveday, H, 2020. Methodological guidance for the conduct of mixed methods systematic reviews. *JBI evidence synthesis,* 18(10), pp. 2108-2118.

Supriyatnoa, T., Susilawati, S. & Hassan, A., 2020. E-learning development in improving students' critical thinking ability. 15(5), pp. 1099-1106.

Surabhi, S. & Singh, B., 2018. Computer Aided Drug Design: An Overview. *Journal of Drug Delivery and Therapeutics,* Volume 8, pp. 504-509.

Sutanapong, C. & Louangrath, P. I., 2015. “Descriptive and Inferential Statistics”. *International Journal of Research & Methodology in Social Science,* pp. 22-35.

Tagoe, M. & Abakah, E., 2014. Determining distance education students' readiness for mobile learning at University of Ghana using the Theory of Planned Behavior. *International Journal of Education and Development using Information and Communication Technology,* 10(1), pp. 90-100.

Taopan, L. L., Drajati, N. A. & Sumardi, 2020. TPACK framework: Challenges and opportunities in EFL classrooms. *Research and Innovation in Language Learning,* 3(1), pp. 1-22.

Thalheirmer, W., 2015. *Debunk This: People Remember 10 Percent of What They Read.* [Online]
Available at: https://www.td.org/insights/debunk-this-people-remember-10-percent-of-what-they-read
[Accessed 18 April 2022].

Thomas, R. & Vetter, M., 2017. Descriptive Statistics: Reporting the Answers to the Basic Questions of Who, What, Why, When, Where, and a Sixth, So What?. *International Anesthesia Research Society,* 30(30), pp. 1-6.

Thomson, P., 2015. *Patter.* [Online]
Available at: https://patthomson.net/2015/08/13/research-site-sample-andor-relationship/
[Accessed 22 July 2021].

© Central University of Technology, Free State

Tomas, L., Evans, N., Doyle, T. & Skamp, K., 2019. Are first year students ready for a flipped classroom? A case for a flipped learning continuum. *International Journal of Educational Technology in Higher Education,* 16(5), pp. 1-22.

Tour, E., 2015. Digital mindsets: Teachers' technology use in personal life and teaching. *Language Learning & Technology,* 19(3), pp. 124-139.

Tsai, M., Liang, J. & Hsu, C., 2021. The Computational Thinking Scale for Computer Literacy Education. *Journal of Educational Computing Research,* 59(4), pp. 579-602.

Tsumake, O. P., 2020. Assessing technology adoption at a universtiy of technology. *A case study of electronic response system,* 1(1), pp. 1-144.

Turhan, N. S., 2019. Karl Pearson's chi-square tests. *Educational Research and Reviews,* 15(9), pp. 575-580.

Turnbull, D., Chugh, R. & Luck, J., 2021. Learning management systems: a review of the research methodology literature in Australia and China. *International Journal of Research & Method in Education,* 44(2), pp. 164-178.

Vazire, S., 2018. Implications of the Credibility Revolution for Productivity, Creativity, and Progress. *University of California, Davis,* 1(1), pp. 1-18.

Vazquez-Cano, E., 2014. Mobile Distance Learning with Smartphones and Apps in Higher Education. *Education Science,* 1(1), pp. 1505-1520.

Venter, C., 2016. The challenge of authentic Computer Application Technology Education in practice. *University of Pretoria,* pp. 2-30.

Vishnu, B., Joao, A. S. & Camara, F., 2021. Open-Ended Versus Closed-Ended Responses: A Comparison Study Using Topic Modeling and Factor Analysis. *IEEE Transactions on Intelligent Transportation,* 22(4), pp. 2123-2132.

Vosloo, J. J., 2014. A sport management programme for educator training in accordance with the diverse needs of South african schools. *Philosophy in movement education,* 1(1), pp. 299-353.

Wang, A. I. & Tahir, R., 2020. The effect of using Kahoot! for learning – A literature review. *Computer & Education,* pp. 1-22.

© Central University of Technology, Free State

Wang, L., 2016. About the Development of Higher Vocational Computer Application Technology Curriculum System. *6th International Conference on Electronic, Mechanical, Information and Management,* 1(1), pp. 505-508.

Wang, Y., Kung, L. & Byrd, T. A., 2018. Big data analytics: Understanding its capabilities and potential benefits for healthcare organizations. *Technological Forecasting & Social Change,* 1(1), pp. 3-13.

Ward, P. & Ayvazo, S., 2016. Pedagogical Content Knowledge:Conceptions and Findings in Physical Education. *Journal of Teaching in Physical Education,* 35(1), pp. 194-207.

Wario, D. R., 2014. Attitudes towards computer usageas predictors of the classroom intergration of information and communication technology at a rural South African University. *University of thr Free State,* Volume 1, pp. 1-171.

Watson, V., Porteous, T., Bolt, T. & Ryan, M., 2019. Mode and Frame Matter: Assessing the Impact of Survey Mode and Sample Frame in Choice Experiments. *Medical decision making,* 39(7), pp. 827-841.

Wholey, J., Hatry, H. & Newcomer, K. eds., 2015. Conducting Semi-Structured Interviews. In: *Handbook of Practical Program Evaluation.* 4th ed. Washington: Jossey-Bass, pp. 492-505.

Widiaty, I., Riza, L. S., Abdullah, A. G. & Mubaroq, S. R., 2020. Multiplatform Application Technology – Based Heutagogy on Learning Batik: A Curriculum Development Framework. *Indonesian Journal of Science & Technology ,* 5(1), pp. 45-61.

Wijnveen, G. J., Rijst, R. M. & Driel, J. H., 2016. A questionnaire to capture students' perceptions of research integration in their courses. *High Education,* 71(1), pp. 473-488.

Wikijob, 2021. *Wkijob.co.uk.* [Online] Available at: https://www.wikijob.co.uk/content/interview-advice/interview-types/unstructured-interview
[Accessed 23 July 2021].

© Central University of Technology, Free State

Wu, J. L., Zhou, Z. Q., Xie, H. B. & Cheng, F., 2017. *Exploring a new Chinese model of tourism and hospitality education: Lessons learned from American counterparts.* Thailand, EESD, pp. 364-370.

Xia, Y. & Lin, Z., 2021. Application of Information Technology in Ecological Civilization Education. *Computer Aided Education,* 1(1), pp. 695-700.

Yan, F., Powell, R., Curtis, D. J. & Wong, N. C., 2020. From reads to insight: a hitchhiker's guide to ATAC-seq data analysis. *Genome biology,* 2(1), pp. 1-16.

Yang, W. & Chen, L., 2015. A steganographic method via various animations in PowerPoint files. *Multimedia tools and Applications,* 74(1), pp. 1003-1019.

Yao, S., 2017. Application of Computer-aided Translation in English Teaching2017. *Application of Computer-aided Translation in English Teaching,* 12(8), pp. 105-117.

Yelisieieva, S. V., 2018. *Information Technologies In Translation.* 1st ed. Mykolaiv: PMBSNU Publishing House.

Yengwayo, P. Z. & Makena, B., 2022. Computer Applications Technology Learning in Secondary Schooling: Challenges or Resourceful. *International Journal of Sciences and Research,* 78(2), pp. 62-67.

Youngshin, S., Youn-Jung, S. & Doonam, O., 2015. Methodological Issues in Questionnaire Design. *College of Nursing, Chungnam National University, Daejeo,* 45(3), pp. 323-328.

Zhang, X. & Vieira, L., 2021. CAT teaching practices: an international survey. *The Journal of Specialised Translation ,* 1(36), pp. 99-124.

Zhou, H; Sun, G; Shafu; Wang, L; Juanhu; Gao, Y, 2021. Internet Financial Fraud Detection Based on a Distributed Big Data Approach With Node2vec. *Digital Object Identifier,* 9(1), pp. 43378-43386.

Zhou, R., Wang, X., Zhang, L. & Guo, H., 2017. Who tends to answer open-ended questions in an e-service survey? The contribution of closed-ended answers. *Behaviour & Information Technology,* 36(12), pp. 1274-1284.

Zukauskas, P; Vveinhardt, J; Andriukaitiene, R, 2018. Philosophy and Paradigm of Scientific Research. In: J. Vveinhardt, ed. *Management Culture and Corporate Social Responsibility.* 1st ed. Kaunas: IntechOpen, pp. 121-139.

© Central University of Technology, Free State

© Central University of Technology, Free State

APPENDICES

Appendix A: Application to conduct research at schools

4490 Zwakala Section
Monyakeng
Wesselsbron
9680

Dear Sir/Madam

RE: APPLICATION TO CONDUCT RESEARCH STUDY AT YOUR SCHOOL

My name is Makhasane Winnie Madikgetho. I am a Master's degree student at the Central University of Technology (Welkom), and the topic of my study is:

The effectiveness of Computer Applications Technology as a vehicle to promote 21st-century skills in learners of the Lejweleputswa district.

I, therefore, request to conduct semi-structured interviews with the principal and mixed questionnaires with CAT teachers and CAT learners from your school.

The plan for the questionnaire and interview is as follows (with consent from the Provincial Department of Education):

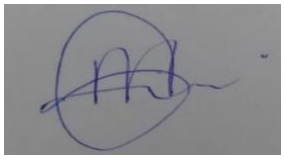
- The questionnaires and interviews will be conducted during the third term of 2023.
- The questionnaires and interviews will be conducted after school hours, thus not interfering with the daily school activities.
- Participants of the questionnaires and interviews will be free to consent and decline to participate and to pull out of the questionnaire or interview.
- Their participation will in no way cause them harm.
- Participant's identities will be kept anonymous. I assure you that the information they give will only be used for the purpose of the study and will not be disclosed to anyone.

Included are permissions from the Free State Department of Education as well as ethical clearance from the Central University of Technology.

Thank you for considering my request.

Sincerely

© Central University of Technology, Free State



Makhasane Winnie Madikgetho

083 509 7936

94makhasane94@gmail.com

© Central University of Technology, Free State

Appendix B: Protocol for learners' participation

4490 Zwakala Section

Monyakeng

Wesselsbron

9680

Dear Sir/Madam

RE: PARENT PERMISSION FORM FOR CHILD'S PARTICIPATION IN RESEARCH

My name is Makhasane Winnie Madikgetho. I am a Master's degree student at the Central University of Technology (Welkom), and the topic of my study is:

The effectiveness of Computer Applications Technology as a vehicle to promote 21st-century skills in learners of the Lejweleputswa district.

I, therefore, request your permission to work together with your child in conducting a structured questionnaire at the school.

The plan for issuing and answering the questionnaire will be as follows (with consent from the Provincial Department of Education):

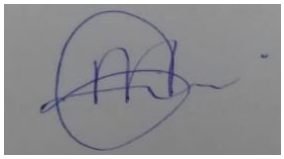
- The questionnaires will be issued and conducted during the third term of 2023.
- The questionnaire process will be conducted after school hours, thus not interfering with the daily school activities or any other arrangements (such as travel/bus/taxi).
- Learners will not be alone with the researcher, but in a group.
- A teacher of the school will be present during this process.
- Participants of the questionnaire will be free to consent and decline to participate in the process, with the right to pull out from the process at any time.
- Their participation will in no way cause any learner harm.
- Participant's identities will be kept anonymous. I assure you that the information they give will only be used for the study and will not be disclosed to anyone.

Included are permissions from the Free State Department of Education as well as ethical clearance from the Central University of Technology.

Thank you for considering my request.

Sincerely

© Central University of Technology, Free State



Makhasane Winnie Madikgetho

083 509 7936

94makhasane94@gmail.com

© Central University of Technology, Free State

Appendix C: Protocol for principals to participate

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

TO BE FILLED BY THE PARTICIPANTS (Principal)

I _____ the principal of

_____ in the Lejweleputswa District agrees to participate in the following research project.

The effectiveness of Computer Applications Technology as a vehicle to promote 21st-century skills in learners of the Lejweleputswa district.

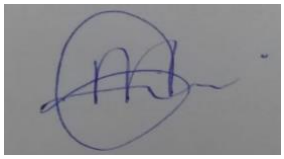
1. I have read and understood the information about the research.
2. I understand my role/participation in this research.
3. I understand that I can stop participating in this research project at any given moment.
4. I voluntarily agree to participate in the study.
5. I acknowledge that the information I provide will be used for the purpose of the study.

Signature Date

_____ _____

Researcher's Name: Makhasane Winnie Madikgetho

Signature



© Central University of Technology, Free State

© Central University of Technology, Free State

Appendix D: Protocol for teachers to participate

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

TO BE FILLED BY THE PARTICIPANTS (Teacher)

I _____ a teacher at

_____ in the Lejweleputswa District agrees to participate in the following research project.

The effectiveness of Computer Applications Technology as a vehicle to promote 21st-century skills in learners of the Lejweleputswa district.

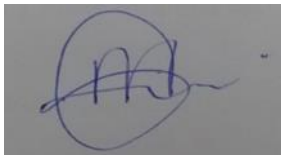
6. I have read and understood the information about the research.
7. I understand my role/participation in this research.
8. I understand that I can stop participating in this research project at any given moment.
9. I voluntarily agree to participate in the study.
10. I acknowledge that the information I provide will be used for the purpose of the study.

Signature Date

_____ _____

Researcher's Name: Makhasane Winnie Madikgetho

Signature



© Central University of Technology, Free State

© Central University of Technology, Free State

Appendix E: Protocol learners to participate

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

TO BE FILLED BY THE PARTICIPANTS (Learners)

I _____ a learner at

_____ in the Lejweleputswa District agrees to participate in the following research project.

The effectiveness of Computer Applications Technology as a vehicle to promote 21st-century skills in learners of the Lejweleputswa district.

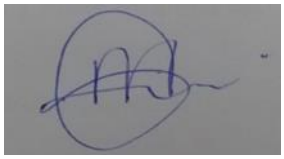
11. I have read and understood the information about the research.
12. I understand my role/participation in this research.
13. I understand that I can stop participating in this research project at any given moment.
14. I voluntarily agree to participate in the study.
15. I acknowledge that the information I provide will be used for the purpose of the study.

Signature Date

_____ _____

Researcher's Name: Makhasane Winnie Madikgetho

Signature



© Central University of Technology, Free State

© Central University of Technology, Free State

Appendix F: Research ethics approval

Central University of Technology, Free State

RESEARCH ETHICS APPROVAL

Date: 12 February 2020

This is to confirm that ethical clearance has been provided by the Faculty Research and Innovation Committee **[01/06/16]** in view of the CUT Research Ethics and Integrity Framework, 2016 with reference number **[D. FRIC 15/19/04]** to:

Applicant's Name and student number	Makhasane, W.M 213088894
Supervisor's Name for Student Project	Dr L Schlebusch
Level of Qualification for Student's Project	M.Ed
Tittle of research project	*The effectiveness of Computer Application Technology as a vehicle to promote 21st century skills in learners in the Lejweleputswa district.*

All conditions as set out below have to be met as set out in your LS 262 a form.
As this research focuses primarily on human beings you will be ethically responsible for:

- protecting the rights and welfare of the participants;
- gaining the trust and co-operation of all the participants with the assurance that the information collected will be kept confidential;
- informing the participants from the outset that their participation will be voluntary, and that the data collected will be conducted with the consent of the Free State Department of Education, the principal(s) of the sample school(s), the teachers, and the learners;
- adhere to the principles of rigorous data collection, analysis and interpretation consistent with the design of the study;
- keeping a data trail for possible auditing purposes and safe-keeping of raw data for a period of three years after publication of the results/findings;
- respecting the confidentiality of the data.

We wish you success with your research project.

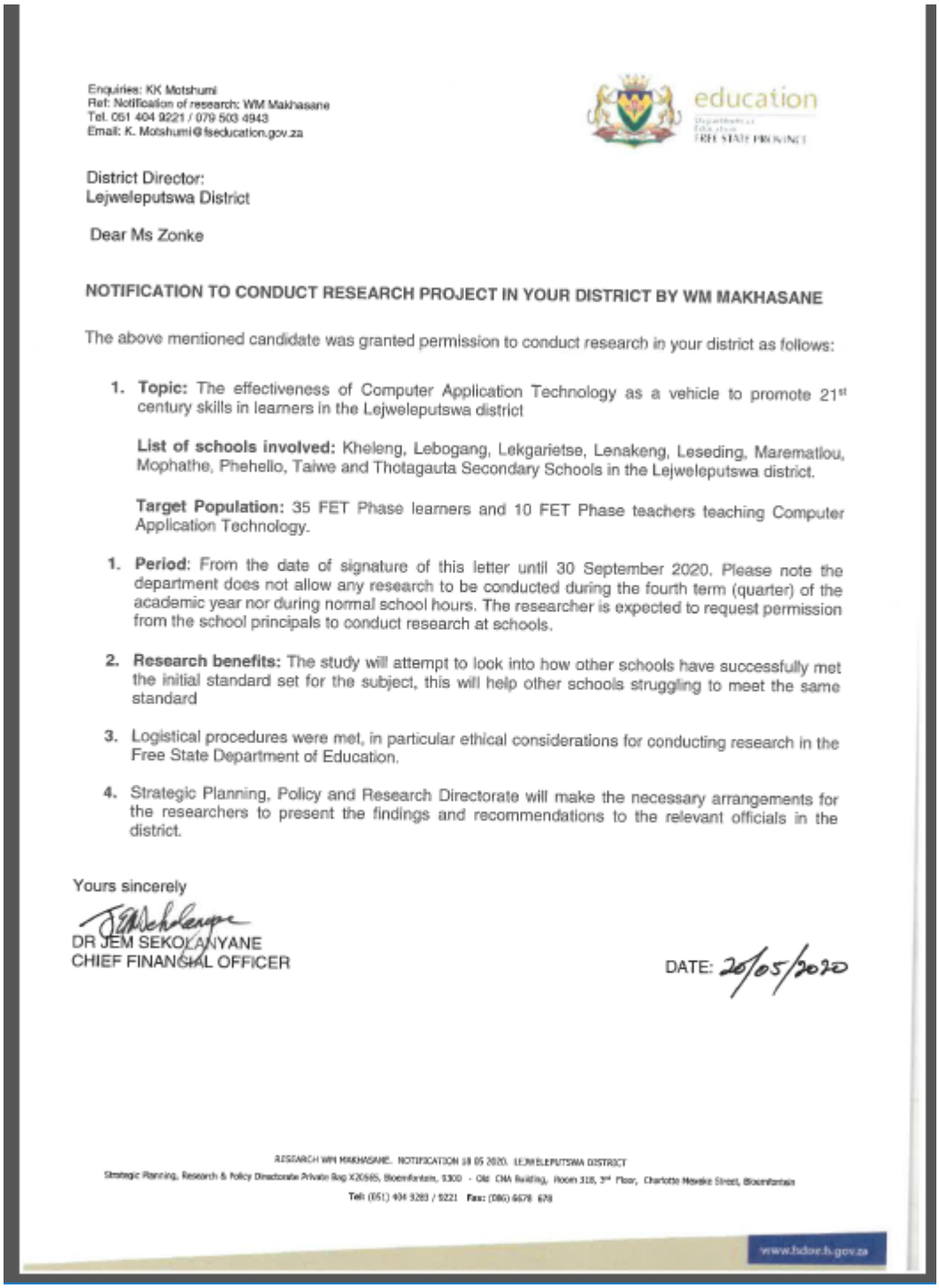
Regards

Prof JW Badenhorst
(Chairperson representative: Research with humans)

(On behalf of the Faculty of Humanities Ethics Committee)

© Central University of Technology, Free State

Appendix G: Approval to conduct research in the Lejweleputswa District



Enquiries: KK Motshumi
Ref: Notification of research: WM Makhasane
Tel. 051 404 9221 / 079 503 4943
Email: K. Motshumi@fseducation.gov.za

education
FREE STATE PROVINCE

District Director:
Lejweleputswa District

Dear Ms Zonke

NOTIFICATION TO CONDUCT RESEARCH PROJECT IN YOUR DISTRICT BY WM MAKHASANE

The above mentioned candidate was granted permission to conduct research in your district as follows:

1. **Topic:** The effectiveness of Computer Application Technology as a vehicle to promote 21st century skills in learners in the Lejweleputswa district

   List of schools involved: Kheleng, Lebogang, Lekgarietse, Lenakeng, Leseding, Maremaliou, Mophathe, Phehello, Taiwe and Thotagauta Secondary Schools in the Lejweleputswa district.

   Target Population: 35 FET Phase learners and 10 FET Phase teachers teaching Computer Application Technology.

1. **Period**: From the date of signature of this letter until 30 September 2020. Please note the department does not allow any research to be conducted during the fourth term (quarter) of the academic year nor during normal school hours. The researcher is expected to request permission from the school principals to conduct research at schools.

2. **Research benefits:** The study will attempt to look into how other schools have successfully met the initial standard set for the subject, this will help other schools struggling to meet the same standard

3. Logistical procedures were met, in particular ethical considerations for conducting research in the Free State Department of Education.

4. Strategic Planning, Policy and Research Directorate will make the necessary arrangements for the researchers to present the findings and recommendations to the relevant officials in the district.

Yours sincerely

DR JEM SEKOLANYANE
CHIEF FINANCIAL OFFICER

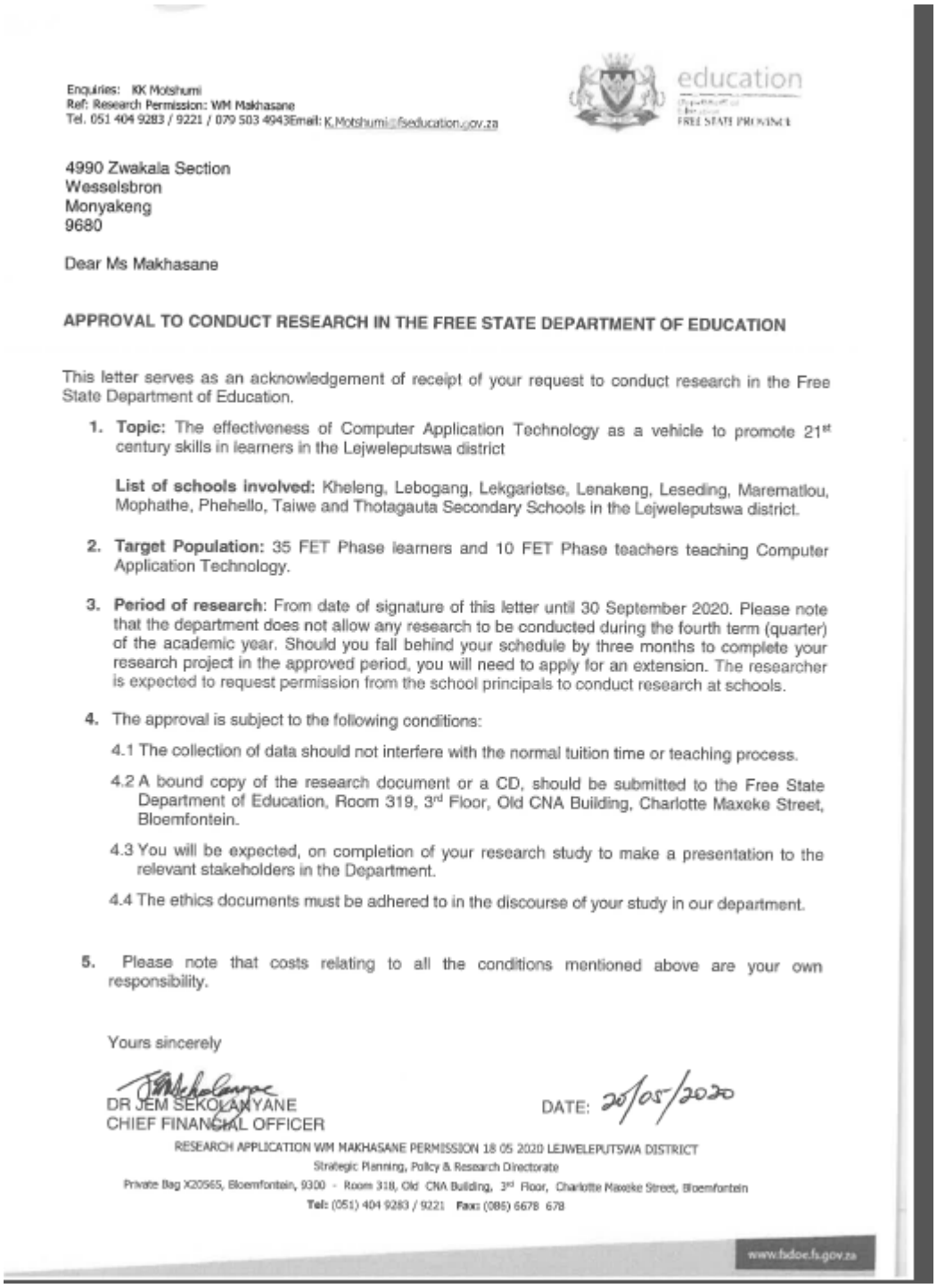
DATE: 20/05/2020

RESEARCH WM MAKHASANE. NOTIFICATION 18 05 2020. LEJWELEPUTSWA DISTRICT
Strategic Planning, Research & Policy Directorate Private Bag X20565, Bloemfontein, 9300 - Old CNA Building, Room 318, 3rd Floor, Charlotte Maxeke Street, Bloemfontein
Tel: (051) 404 9283 / 9221 Fax: (086) 6678 678

www.fsdoe.fs.gov.za

© Central University of Technology, Free State

Appendix H: Approval to conduct research in the Free State Department of Education



Enquiries: KK Motshumi
Ref: Research Permission: WM Makhasane
Tel. 051 404 9283 / 9221 / 079 503 4943Email: K.Motshumi@fseducation.gov.za

education
FREE STATE PROVINCE

4990 Zwakala Section
Wesselsbron
Monyakeng
9680

Dear Ms Makhasane

APPROVAL TO CONDUCT RESEARCH IN THE FREE STATE DEPARTMENT OF EDUCATION

This letter serves as an acknowledgement of receipt of your request to conduct research in the Free State Department of Education.

1. **Topic:** The effectiveness of Computer Application Technology as a vehicle to promote 21st century skills in learners in the Lejweleputswa district

   List of schools involved: Kheleng, Lebogang, Lekgarietse, Lenakeng, Leseding, Maremalou, Mophathe, Phehello, Taiwe and Thotagauta Secondary Schools in the Lejweleputswa district.

2. **Target Population:** 35 FET Phase learners and 10 FET Phase teachers teaching Computer Application Technology.

3. **Period of research**: From date of signature of this letter until 30 September 2020. Please note that the department does not allow any research to be conducted during the fourth term (quarter) of the academic year. Should you fall behind your schedule by three months to complete your research project in the approved period, you will need to apply for an extension. The researcher is expected to request permission from the school principals to conduct research at schools.

4. The approval is subject to the following conditions:

   4.1 The collection of data should not interfere with the normal tuition time or teaching process.

   4.2 A bound copy of the research document or a CD, should be submitted to the Free State Department of Education, Room 319, 3rd Floor, Old CNA Building, Charlotte Maxeke Street, Bloemfontein.

   4.3 You will be expected, on completion of your research study to make a presentation to the relevant stakeholders in the Department.

   4.4 The ethics documents must be adhered to in the discourse of your study in our department.

5. Please note that costs relating to all the conditions mentioned above are your own responsibility.

Yours sincerely

DR JEM SEKOLANYANE
CHIEF FINANCIAL OFFICER

DATE: 20/05/2020

RESEARCH APPLICATION WM MAKHASANE PERMISSION 18 05 2020 LEJWELEPUTSWA DISTRICT
Strategic Planning, Policy & Research Directorate
Private Bag X20565, Bloemfontein, 9300 · Room 318, Old CNA Building, 3rd Floor, Charlotte Maxeke Street, Bloemfontein
Tel: (051) 404 9283 / 9221 Fax: (086) 6678 678

www.fsdoe.fs.gov.za

© Central University of Technology, Free State

Appendix I: Learners' questionnaire questions

Central University of Technology, Free State

THE EFFECTIVENESS OF COMPUTER APPLICATIONS TECHNOLOGY AS A VEHICLE TO PROMOTE 21ST CENTURY SKILLS TO LEARNERS OF THE LEJWELEPUTSWA DISCTRICT.

QUESTIONNAIRE FOR LEARNERS

Surname and initials	
Age	
Grade	
Name of the school	

1. Why did you choose CAT as a subject? Select all that apply

I am interested in the subject	
I want to pursue a career in IT/ Computer Science	
I like the teacher	
My parents forced me to	
My friends took the subject	
Other, please specify……	

2. Do you enjoy CAT?

Yes		No	

2.1 Please motivate your answer to Question 2

_____

3. What do you enjoy most about CAT?

_____

4. What do you find challenging about CAT?

_____

5. Has CAT improved your 21st century skills:

Creativity skills: The use of imagination or original ideas to create something; inventiveness.		
My own creativity skills have improved since taking CAT	yes	no

© Central University of Technology, Free State

My creativity skills are better than my peers who don't have CAT	yes	no
Critical thinking skills: The ability to analyse information and form reasoned judgement.		
My own critical thinking skills have improved since taking CAT	yes	no
My critical thinking skills are better than my peers who don't have CAT	yes	no
Communication skills The process of sending and receiving messages through verbal or non-verbal means, this includes speech, oral communication, writing, signals, behaviour, and graphical presentation.		
My own communication skills have improved since taking CAT	yes	no
My communication skills are better than my peers who don't have CAT	yes	no
Collaboration skills A joint effort of multiple individuals who are able to communicate views and contribute to the accomplishment of the task.		
My own collaboration skills have improved since taking CAT	yes	no
My collaboration skills are better than my peers who don't have CAT	yes	no
Technological skills The abilities and knowledge needed to interact with computer-based technologies and perform technical tasks.		
My own technological skills have improved since taking CAT	yes	no
My technical skills are better than my peers who don't have CAT	yes	no

6. Do you think having CAT improves your chances of going to university?

Yes		No	

6.1 Please motivate your answer to Question 6

_____

7. Would you recommend CAT to your peers?

Yes		No	

7.1 Please motivate your answer to Question 7

_____

8. Does your school have a computer laboratory?

Yes		No	

8.1a If yes to question 8, does your computer laboratory have the following equipment:

Working computers	yes	no

© Central University of Technology, Free State

Student no:213088894

Necessary software	yes	no
Internet access	yes	no
Data projector	yes	no
Other equipment, please specify _____		

8.1b Do you have additional access to the computer lab to do assignments/ revision?

Yes		No	

If no, when and how do you do your assignments/ revision?

_____

9.2 If your school does not have a computer laboratory, how are you taught CAT?

_____

10 How would you compare your learning experience in CAT compared to other subjects?
Select only one

CAT's learning experience is better than other subjects	
CAT's learning experience is the same as other subjects	
CAT's learning experience is worse than other subjects	

10.1 Please motivate your selection for question 10

_____

© Central University of Technology, Free State

Appendix J: Teacher's questionnaire questions

Central University of Technology, Free State

THE EFFECTIVENESS OF COMPUTER APPLICATIONS TECHNOLOGY AS A VEHICLE TO PROMOTE 21ST CENTURY SKILLS TO LEARNERS OF THE LEJWELEPUTSWA DISCTRICT.

QUESTIONNAIRE FOR TEACHERS

Surname and initials	
Qualification	
Years of experience as a CAT teacher	
Name of your school	

1. Have you received any training/ mentorship in how to teach CAT?

Yes		No	

2. Does your school have a computer laboratory?

Yes		No	

2.1a If yes to question 2, does your computer laboratory have the following equipment:

Working computers	yes	no
Necessary software	yes	no
Internet access	yes	no
Data projector	yes	no
Other equipment, please specify _____		

2.1b Do learners have additional access to the computer lab to do assignments/ revision?

Yes		No	

If no, when and how are they expected to do assignments/ revision?

_____

2.2 If your school does not have a computer laboratory, how do you teach CAT?

© Central University of Technology, Free State

3. Would you advise a learner to take CAT as a subject?

Yes		No	

3.1 Please motivate your answer to question 3

4. Does CAT improve learners 21st century skills:

Creativity skills The use of imagination or original ideas to create something; inventiveness.		
CAT learners' creativity skills have improved	yes	no
CAT learners' creativity skills are better than their peers who do not have CAT	yes	no
Critical thinking skills The ability to analyse information and form reasoned judgement.		
CAT learners' critical thinking skills have improved	yes	no
CAT learners' critical thinking are better than their peers who do not have CAT	yes	no
Communication skills The process of sending and receiving messages through verbal or non-verbal means, this includes speech, oral communication, writing, signals, behaviour, and graphical presentation.		
CAT learners' communication skills have improved	yes	no
CAT learners' communication skills are better than their peers who do not have CAT	yes	no
Collaboration skills A joint effort of multiple individuals who are able to communicate views and contribute to the accomplishment of the task.		
CAT learners' collaboration skills have improved	yes	no
CAT learners' collaboration skills are better than their peers who do not have CAT	yes	no
Technological skills The abilities and knowledge needed to interact with computer-based technologies and perform technical tasks.		
My own technological skills have improved since taking CAT	yes	no
My technological skills are better than my peers who don't have CAT	yes	no

5. What do learners enjoy most about CAT?

© Central University of Technology, Free State

6. What do learners most often struggle with in CAT?

_____

_____

7. What learning barriers are you faced in the CAT classroom?

_____

_____

8. Do you think CAT is also used to teach learners 21st century skills? Please motivate your answer

_____

_____

© Central University of Technology, Free State

Appendix K: Principal's interview questions

Central University of Technology, Free State

THE EFFECTIVENESS OF COMPUTER APPLICATIONS TECHNOLOGY AS A VEHICLE TO PROMOTE 21ST CENTURY SKILLS TO LEARNERS OF THE LEJWELEPUTSWA DISCTRICT.

NOTE: These questions will be directed to the principals of schools that still offers CAT and that no longer offers CAT as one of their subjects.

QUESTIONS FOR THE PRINCIPALS' (INTERVIEW)

Surname and initials	
Years of experience as a principal in this school	
Name of the school	

1. When CAT was introduced and implemented in schools, your school become one of the schools that were able to offer the subject to the learners. Kindly differentiate the state in which your school was then and the state in which your school is now, in terms of its readiness to offer the subject to the learners.

2. For how long did your school offer the subject under your supervision?

3. What were the main challenges associated with offering this subject?

4. Did you notice the difference between the learners who were offered the subject and those whom this subject was not offered to? Please motivate.

5. Were the classrooms and/or the computer laboratory fully resourced for quality administration of this subject?
   I. If yes, where are those resources now?
   II. If no, which resources were lacking?

© Central University of Technology, Free State

6. Which specific aspects lead your school to completely stop offering this subject?

7. What do you think you could have done differently to ensure that your school continues offering this subject?

8. How do you feel when you see that other schools are still able to offer this subject regardless of the challenges, they face with offering this subject while your school could not continue?

9. What procedure was taken by the school and the department of education when this subject was terminated?

10. What advice would you like to give to the schools that still continuing with offering this subject?

11. Would you confidently say that without this subject in your school your learners will be able to fit in and adjust just fine in this digital world like those learners who were offered this subject in their schools? Please motivate your answer.

© Central University of Technology, Free State

Appendix L: Editorial letter

Marielle Tappan
Simmetrie & Kegel Street
Meyerspark, Pretoria
Tel 072 474 1158
Email mteditorialinfo@gmail.com

MT EDITORIAL
EDITING | PHOTOGRAPHY | DESIGN

Date of Edit: 20 June 2025

Edit: W.M Makhasane

THE EFFECTIVENESS OF COMPUTER APPLICATIONS TECHNOLOGY AS A VEHICLE TO PROMOTE 21ST CENTURY SKILLS TO THE LEARNERS OF THE LEJWELEPUTSWA DISTRICT

To whom it may concern,

I, Marielle Tappan, trading under the name MT Editorial, hereby confirm that I am a language editor.

I have extensive experience in the field of language and publishing and received my Bachelor of Information Science in Publishing from the University of Pretoria. I am also a registered member of the Southern African Freelancers' Association.

I hereby declare that the editing done for any client is done with the utmost diligence and the full appreciation of the English language and all of its intricacies, as was done for edited sections of this document. My involvement was restricted to the main body of text's language use, spelling, consistency and completeness, alongside general formatting of the document's layout. I did not restructure any content that would influence the academic outcome in any way. I cannot take responsibility for any changes made by the client once the paper was returned after the above-mentioned 'Date of Edit'.

If there are any other queries, please do not hesitate to contact me.

Kindest Regards,

Marielle Tappan
Owner, MT Editorial
Chairperson, SAFREA Gauteng North
Full member: SAF03058
(BIS) Publishing

Marielle Tappan

© Central University of Technology, Free State