Cape Peninsula University of Technology

A Framework for Developing Entrepreneurial Skills in the Fourth Industrial Revolution for Information & Communication Technology (ICT) Technical Vocational Education and Training (TVET) Students.

Rylyne Mande Nchu

213092638

Thesis submitted in fulfilment of the requirements for the degree of

PhD in Informatics

Faculty of Informatics and Design

Cape Peninsula University of Technology

Supervisor: Prof Johannes Cronje
Co-Supervisor: Prof Robertson K. Tengeh

District Six Campus
June 2024

DECLARATION

I, Rylyne Mande Nchu, declare that the contents of this thesis represent my own unaided work and that the thesis has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my opinions, not necessarily those of the Cape Peninsula University of Technology.

10/06/2024

Rylyne Mande Nchu
Student Number
213092638

Date

ABSTRACT

South Africa has transitioned into an emerging economy over the past three decades since the inaugural democratic elections. The government has underscored the importance of advancing Science, Technology, Engineering, and Mathematics (STEM) fields within tertiary institutions. Consequently, institutions such as Technical Vocational Education and Training (TVET) colleges must adapt their curricula to align with the contemporary landscape of rapid technological progress. Given that entrepreneurship and ICT are pivotal drivers of economic growth, it is essential for ICT students to possess both technical expertise and entrepreneurial acumen to meet the evolving demands of the 21st-century industry. Therefore, it is imperative for ICT programs at TVET colleges to remain abreast of the changing realities of the Fourth Industrial Revolution (4IR). Consequently, this study endeavours to develop a framework for nurturing entrepreneurial skills within Information, Communication, and Technology (ICT) programs by implementing Simulation-Based Learning (SBL) techniques.

Numerous scholarly sources indicate that student-centered learning approaches are more effective in nurturing entrepreneurial abilities in students. Accordingly, it is recommended that TVET colleges in South Africa integrate more student-centered teaching and learning methodologies into their ICT programs. These pedagogical approaches will cultivate the entrepreneurial skills sought after by the industry, thereby mitigating the unemployment rate among TVET graduates. Consequently, this study will concentrate on Simulation-Based Learning (SBL) to develop a framework for enhancing entrepreneurial skills among ICT students.

A mixed-method approach was employed to gather and analyse both quantitative and qualitative data. Three TVET colleges offering the Higher Certificate of Information and Communication Technology (HCICT) were chosen to fulfil the research objectives. Quantitative data were obtained from 164 students and 20 lecturers who participated in a survey. Qualitative data were gathered through interviews conducted with 41 entrepreneurs who are business owners. Self-administered questionnaires were distributed to lecturers and students to assess suitable teaching methods for acquiring entrepreneurial skills. Participants were selected using the non-probability sampling method of purposive sampling. Additionally, interviews were carried out with 41 entrepreneurs to identify relevant entrepreneurial skills for ICT students, with participants selected using the non-probability sampling method of snowballing. Through data triangulation, which involved integrating quantitative questionnaire data with qualitative interview data, eight components of a framework for entrepreneurial skills among ICT students were developed. Consequently, the study offers a framework for entrepreneurial skills tailored to ICT students.

Keywords: Entrepreneurial Skills, 4IR, ICT students, TVET College, 4IR Skills, Framework.

ACKNOWLEDGEMENTS

I wish to thank the following people sincerely:

- My Supervisor, Prof Johannes Cronje and Co-supervisor, Prof Robertson Tengeh, for their guidance, assistance, and mentorship towards completing this thesis.
- My husband, Prof Felix Nchu, for his continuous encouragement and support.
- My academic mentor, Prof Chux Iwu, for his continuous assistance and motivations
- Dr Onyinye Akunne for her statistical assistance
- Dr Justino Mateus, Kate Chmela-Jones and Ian Kennedy for the technical assistance in editing and reviewing the thesis.
- My fellow postgraduate students in the TERPS group should also be recognised for their support and assistance. Their views and tips were helpful indeed.
- Dr Errol Francke for his assistance, guidance and supervision while writing the proposal.
- I want to thank all my colleagues and others who have assisted on various occasions.
- Dr Retha de la Harpe for allowing me to pursue the PhD in Informatics at the department.
- I am grateful to my mother Sarah Elangwe and all my siblings, Emmanuel Elangwe, Late Chantal Sakwe Adeleye, Ule Esther, George Elangwe, Sally Eyanda, Mokube Glen, and Kappus Elangwe, for their prayers and encouragement.
- My children Tania, Daryle and Sarah-Christy for their understanding and comfort during my PhD journey.
- I thank God for His grace and countless blessings.

DEDICATION

This thesis is dedicated to my mother, Sarah Elangwe, my Husband, Felix and my Children, Tania, Daryle and Sarah-Christy.

TABLE OF CONTENTS

List of Tables

List of Figures

CHAPTER ONE
INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 Introduction

The transition from the Third Industrial Revolution to the Fourth Industrial Revolution (4IR) holds threats and opportunities for individuals worldwide. The 4IR appeals to multi-skilled and trained individuals/employees with technological skills and a wide range of skill sets needed for the 4IR world (Fathiyah et al., 2019; Abdullahi et al., 2020). It has been observed that the specialised technological skills currently taught to graduates seem to be devoid of the skillsets needed for the 4IR, such as entrepreneurial skills. Several authors assert that the actual technical and technological skills will not have much effect on 4IR if they are not combined with a mind-set shift in new ways of creating value and the ability to connect a wide range of technologies for problem-solving (Abdullahi et al., 2020; Oxford, 2021). Thus, the present study identifies the need to explore the complexities of entrepreneurial skills development within the 4IR. The present study investigates how entrepreneurial skills in Information and Communication Technology (ICT) for Technical Vocational Education and Training (TVET) students can be developed.

South Africa faces a myriad of socioeconomic issues, including unemployment, poverty, crime and inadequate skills training. For instance, the unemployment rate stood at 29.1% in 2020 (Statistics South Africa-StatsSA, 2020), with Youth unemployment accounting for 58% of the overall unemployment rate (Maas & Herrington, 2008; StatsSA, 2020). Many may argue that this is not an isolated event, given that few graduates find employment after graduation. In the Quarterly Labour Force Survey (QLFS), Statistics South Africa indicates that 40% (8.2 million) of South Africans aged between 15 and 34 years were not in employment, education or any training (StatsSA, 2022). Authors, including Orford (2004), Horn (2006), and StatsSA (2022), assert that South Africa continues to suffer from a flawed education system that inhibits technological and entrepreneurial development. Digitisation of specific industries has caused job losses, and graduates lack the skills to adapt to this changing job market.

TVET colleges seek to train students to master the skills needed for the workplace. Researchers like Powell (2012), Palmer (2014), Hasanefendic et al. (2016), and Suharno et al. (2020) opine that the better the implementation of the training at TVET colleges, the better and higher the industrial growth of a country. Therefore, there is a need to improve the quality of academic programs for students in technical and vocational programs such as the Higher Certificate in Information and Communication Technology (ICT). This reality is of great concern to the readiness of the 4IR for South African graduates, particularly for ICT TVET college graduates.

The hallmark of TVET colleges is to provide graduates with practical skills and who are work-ready (Cong & Wang, 2012). Researchers like Cong and Wang (2012); McGrath et al. (2020) concur that TVET colleges are a vital tool for economic development, job creation and providing lifelong learning for all. TVET colleges focus on acquiring practical skills through learning-by-doing through school-based workshops or hands-on experience in industry. However, the TVET colleges may face challenges in preparing their students for the 4IR environment. Research has shown that stimulation with virtual or augmented reality and other 4IR teaching and learning experiences are still new in the academic environment (McGrath et al., 2020).

In support of Mezied (2016), Mzekandaba (2019), and Waghid et al. (2019), it is imperative for South Africa's higher learning institutions to respond to the 4IR era and intensify the number of educational programmes that prepare students for the new dawn. Mzekandaba (2019) reports that only a few universities in South Africa offer courses in 4IR and related fields of robotics and artificial intelligence. These 4IR-related fields are very lucrative in the business sector and entrepreneurship domain, where new ventures are created to augment and complement various businesses in the marketplace. Young graduates' inability to compete in a disruptive and volatile market environment may lead to job loss, unemployment and poverty (Mzekandaba, 2019). Therefore, this research will seek to develop an entrepreneurial skills acquisition framework that integrates 4IR technological and entrepreneurial skills, specifically in ICT students at TVET colleges.

1.2 Background to the research

The 4IR calls for a wide range of technological skills for its identified technological sectors, including core technologies, enabling technologies and implementation domains (Ménière et al., 2017; Benassi et al., 2019). Prior research supports that most skills that provide viable solutions to 4IR technologies and inventions still have to be learned and taught (Oxford, 2021). Although ICT skills are critical for the success of the 4IR invention, many researchers assert that they need to be complemented with a multidisciplinary skills program (PricewaterhouseCoopers (PwC), 2017; Seet et al., 2018; Oxford, 2021).

As the 4IR is a nascent world with complex problems, there is a need to teach and train students to think logically and systematically and develop the uncanny abilities to gather the necessary resources for creative resolution and problem-solving (Naudé, 2017; Oxford, 2021). Many previous studies suggest that the core skills for the future workforce should be combined competencies in digital skills, project coordination and entrepreneurial skills (Subic & Gallagher, 2017; Seet *et al.*, 2018). Teaching and training students in entrepreneurial skills, aside from technical or digital skills, could enable them to possess entrepreneurial skills like creativity and innovation, which machines cannot replicate (PwC, 2017; Seet *et*

al., 2018). However, exploring and understanding the critical components contributing to developing entrepreneurial skills within 4IR students is also essential. Establishing innovative learning platforms has been recognised as necessary to enable students and the workforce to effectively participate in Industry 4.0 (Subic & Gallagher, 2017).

According to Corfe (2018), the emergence of 4IR has enabled various economies to be more dynamic to meet the fast-paced technological changes which will affect entrepreneurship. The TVET college system plays a vital role in developing and training the workforce. Like Mezied (2016), Fathiyah et al., 2019 and Khathu (2019) suggest that 4IR presents opportunities for countries like South Africa to enhance economic growth through innovation and technology. The dawn of 4IR is altering how society interacts and how businesses function. Job losses at financial institutions are accredited to digitisation, and 4IR is impacting the labour market in South Africa, in general.

This study will focus on developing 4IR Engineering Entrepreneurial Skills in Polytechnic Students. Their findings indicated that innovative and student-centred teaching methods like Problem-Based Learning, Project-Based Learning, and Design Thinking, among others, can potentially develop entrepreneurial skills for the 4IR. Abdullahi et al. (2020) found that the most relevant skills to be developed by entrepreneurs in the 4IR will include Problem-solving skills, Financial Management Skills, Critical thinking skills, Research/Information retrieval, Creativity/Innovation skills, Communication skills, and Life-long learning, among others.

1.3 Research problem

The shortage of an entrepreneurial skilled labour force could be attributed to the fact that there is a gap between the educational systems and the needs of the industry, meaning the learning and training acquired may not be appropriate for the current job market (Palmer, 2014; Nchu et al., 2017). Researchers like Hart and Barratt (2009), Weaver and Osterman (2016), Hasanefendic et al. (2016) and Nchu et al. (2017) concur that there is a mismatch between jobs and skills in the context of North America, Europe and Africa. These authors suggest that there is a need for educational institutions to match the training with the needs of the marketplace. There is a need to identify the appropriate skills to match academic training with the industry's needs (Tijdens et al., 2012; Oke & Fernandes, 2020). Powell (2012) agrees that TVET colleges are famous for their skilled-based training, training for employability and poverty alleviation.

There is a misalignment in students' skill sets at TVET colleges (Aderibigbe & Mosia, 2020). The massive development of entrepreneurial skill sets for the 4IR can still be driven by education and large technological institutions. However, Yang and Gu (2021) argue that the existence of a national strategic plan and governmental policies should also play a critical role in a technological revolution. Another author suggests that the skill development agenda for South African TVET institutions should also focus on the development of both the students and lecturers (Oketch, 2007; Kuehn, 2020). However, to deal with the complexities surrounding the entrepreneurial skills within the 4IR, this study explores the dissociation between the current ICT skills taught to TVET students in Cape Town and the entrepreneurial skill sets needed for the 4IR. That said, there is no entrepreneurial skills acquisition framework for ICT students at TVET colleges.

Africa's education and training system faces new challenges: productivity, growth and wealth creation must explore new markets (Schwab, 2014; Mezied, 2016). Simultaneously, the higher education institutes (HEIs) are under pressure to provide adequate training. Despite the government's effort to increase its participation in higher education, almost half of the adult population in Africa lacks the skills to succeed in innovation and 4IR-driven environments (OECD, 2013; Hasanefendic et al., 2016; GEM, 2020;). Some skills needed in an innovation environment include technical, entrepreneurial, and soft skills such as leadership and teamwork. There is a need for an entrepreneurial skilled labour force in the service and manufacturing sectors in many African countries, such as South Africa (Powell, 2012; McGrath, 2012; OECD, 2014a; StatSA, 2020). This misalignment in the training would mean the students are not trained to be self-reliant and lack the competitive skills to thrive in a disruptive environment.

McGrath (2012) argues that the current approach to TVET is grounded on an outdated development model in that there is a limitation in both its theoretical nature and its practical efficacy. McGrath (2012) and Palmer (2014) suggest that the goal of employability is too myopic; TVET colleges should instead focus on a lifelong process of acquisition of skills that can transcend the workplace, according to scholars such as McGrath (2011; 2012), Powell (2012), and Palmer (2014), the TVET system is considered to be flawed and unable to sustain itself amid significant global crises, such as the COVID-19 pandemic, the emergence of the Fourth Industrial Revolution (4IR), environmental degradation, and climate change. These researchers argue that the TVET system fails to adequately equip students with the necessary skills for the 4IR, technological entrepreneurship, or green jobs. Thus, there is a need for an entrepreneurial skills acquisition framework for ICT students at TVET colleges within the 4IR. Perhaps an entrepreneurial skills acquisition framework that integrates 4IR skills, especially in ICT Education for TVET colleges, could address the problem of the lack of 4IR readiness in TVET Colleges. Consequently, due to the lack of an entrepreneurial skills framework, there may be a shortage of entrepreneurial skilled workers, loss of jobs, unemployment and other socio-economic ills like poverty and crime.

Researchers like Abdullahi et al. (2020) think that there is a need to align the educational system to meet the changing environment, given that innovative entrepreneurs turn to succeed in the 4IR. This study seeks to develop a framework for acquiring entrepreneurial skills to prepare ICT students. Specifically, the study will investigate the use of simulation teaching strategy in facilitating entrepreneurial skills and competency development, the students' and teachers' willingness to uptake entrepreneurship and collect insights from experienced entrepreneurs (business owners) on the relevant skills and competencies for entrepreneurship. This information will be used to create the entrepreneurial skills acquisition framework.

1.4 Statement of the Research Problem

There is a misalignment of the skill sets needed for entrepreneurship within the 4IR for ICT students, as there is no reliable framework for developing entrepreneurial skills in the ICT programmes at TVET institutions.

1.5 Research aim

This study aims to develop a framework for acquiring entrepreneurial skills in improving entrepreneurial tendencies in ICT TVET students.

1.6 Objectives

1.6.2 Main objective

To develop an entrepreneurial skills framework for students in the ICT programme within the 4IR.

1.6.2 Sub-objectives

1. To determine experts' experiences and perceptions of using simulation-based learning in teaching and learning ICT.
2. To identify the simulation elements and processes of teaching and learning that could be used and followed for the teaching and learning entrepreneurial skills in ICT programmes.
3. To identify the most relevant entrepreneurial skills to be developed by ICT students within the 4IR.
4. To determine the best teaching methods to be employed for the development of entrepreneurial skills in ICT within 4IR.
5. To determine the best assessment methods to develop entrepreneurial skills in ICT students.

1.7 Research questions

1.7.1 Main research question

What are the most relevant entrepreneurial skills for students in the ICT programmes at TVET institutions, and how can these skills be developed?

1.7.2 Sub-research questions

1. What are the experts' experiences and perceptions of using simulation-based learning in teaching and learning ICT?

2. What simulation elements and learning processes could guide the development of an entrepreneurial skills framework in the ICT programme within the 4IR?

3. What are the most relevant entrepreneurial skills to be developed by ICT graduates in the 4IR?

4. What are the best teaching methods to be employed for the development of entrepreneurial skills in ICT?

5. What are the best assessment methods to develop entrepreneurial skills in ICT students?

1.8 Research design and methodology

1.8.1 Research Paradigm:

This research's philosophy is pragmatism, which consists of practical thinking and action as the truth and the reality. The pragmatism philosophy states that research should be carried out to know the facts and the reality and because the research questions will be best answered using a mixed method, both qualitative and quantitative. The triangulation of the mixed method will enable the researcher to know the facts and the reality of developing a 4IR entrepreneurial framework.

The research paradigm is how scholars believe or assume knowledge is developed. Researchers agree that the research philosophy or paradigm is the common belief and agreement on how problems should be understood and addressed (Kuhn, 1970; Kuhn, 1974; Saunders et al., 2007; Saunders et al., 2012). The research process has three main philosophies: Ontology, Epistemology and Axiology.

Ontology is the study of reality. Ontology sheds light on what is perceived as reality and how it affects human behaviour (Antwi & Kasim, 2015). Gray (2013) opines that ontology is learning about being, the nature of existence, and what makes reality. There are two philosophical positions under the ontological paradigm. They include objectivism and constructivist realism. Objectivism posits that there is an independent reality (Neuman, 2003). Constructivist realism believes that people construct their knowledge based on their own experiences. This research was based on the ontological worldview of constructivist realism because the students will build their knowledge based on their experiences and terms of reference. Constructivist realism acknowledges that social phenomena exist in communities independently of the researcher. So, the world we know and understand is constructed from our perspectives and experiences through what is observable.

Epistemology is the study of acceptable knowledge. Epistemology helps us address the facts based on the information and evidence provided. Epistemology includes positivism, interpretivism, and pragmatism (Tracy, 2010; Creswell & Clark, 2011; Bryman, 2012). The positivist worldview opines that there is a scientific explanation of the empirical data used to test the chosen theory to achieve the research objectives. The positivists believe that facts exist and are not influenced by personal ideas or thoughts. The interpretivism philosophy opines that knowledge can only be gained by deeply understanding the subject. The interpretivists highlight that reality is interpreted and experienced by an individual's interactions with the world (Tuli, 2010; Cronje, 2014). The epistemology for this research was based on the interpretivism philosophy, which states that reality is complex and multi-layered. A single phenomenon can have multiple interpretations. The research objectives were best answered using the interpretivist approach. The researcher's role is to offer their perspective and analyse the findings to provide insights.

1.8.2 Research Design:

The research design used was a mixed method, a combination of qualitative and quantitative research approaches, because these methods brought valuable information that answered the research questions and generated new ideas (Bryman, 2012; Petty et al., 2012). The mixed method was used for data collection, integrating quantitative and qualitative data collection and data analysis for improved findings and results (Creswell, 2013). Another reason for using the mixed method is that using one method would not satisfactorily answer the research questions (Dayana & Halim, 2016; Leavy, (2017). Together with the exploration of literature, these techniques will be used to triangulate the data to design a framework for entrepreneurial skills for TVET colleges with 4IR. The triangulation of methods complements each other to derive more précised and meaningful data (Leavy, (2017). Questionnaires were distributed to Lecturers and students in the ICT programme, and personal interviews were conducted with entrepreneurs

1.8.3 Methodology

The first part of the study pertained to secondary data collection, a literature review on the 4IR, entrepreneurial skills and the impact of 4IR in business. A document analysis was conducted to understand the current entrepreneurship education practices at TVET colleges and to evaluate how the curriculum utilises 4IR in its teaching. Then the second part was the primary data collection method, divided into three phases. Therefore, the research process was carried out in four stages: exploratory, instrument development and instrument administration to the sample or population (Creswell, 2013).

In the first phase, the researcher used the quantitative research approach by distributing a self-administrated five-point Likert Scale questionnaire to the lecturers and students in the ICT Programme at selected TVET colleges. The questionnaire answered the entrepreneurial skills focus in the curriculum and current practices. The researcher gathered information in this phase to answer the first and second research questions.

The second phase of the data collection was a qualitative research approach in the form of personal interviews with the ICT lecturers. During this phase, the information gathered was used to understand the skills taught, how they prepare them for the job market, and the challenges faced in teaching entrepreneurial skills to ICT students within the 4IR environment.

Based on the outcomes of the previous phases, the third phase used a qualitative research approach. The data collection method consisted of personal interviews with Small, Medium and Micro Enterprises (SMMEs) owners (entrepreneurs). In this phase, the third research question was answered. The interview questions will consist of open-ended questions that would enable the researcher to probe and have an in-depth understanding of the problem to determine their perspectives on entrepreneurial skills for ICT students within the 4IR and business opportunities in 4IR.

At the end of the process, the researcher answered the main research question of how an entrepreneurial skills framework can be developed for teaching ICT programmes through a refined compilation and development of a framework for entrepreneurial skills for ICT TVET students.

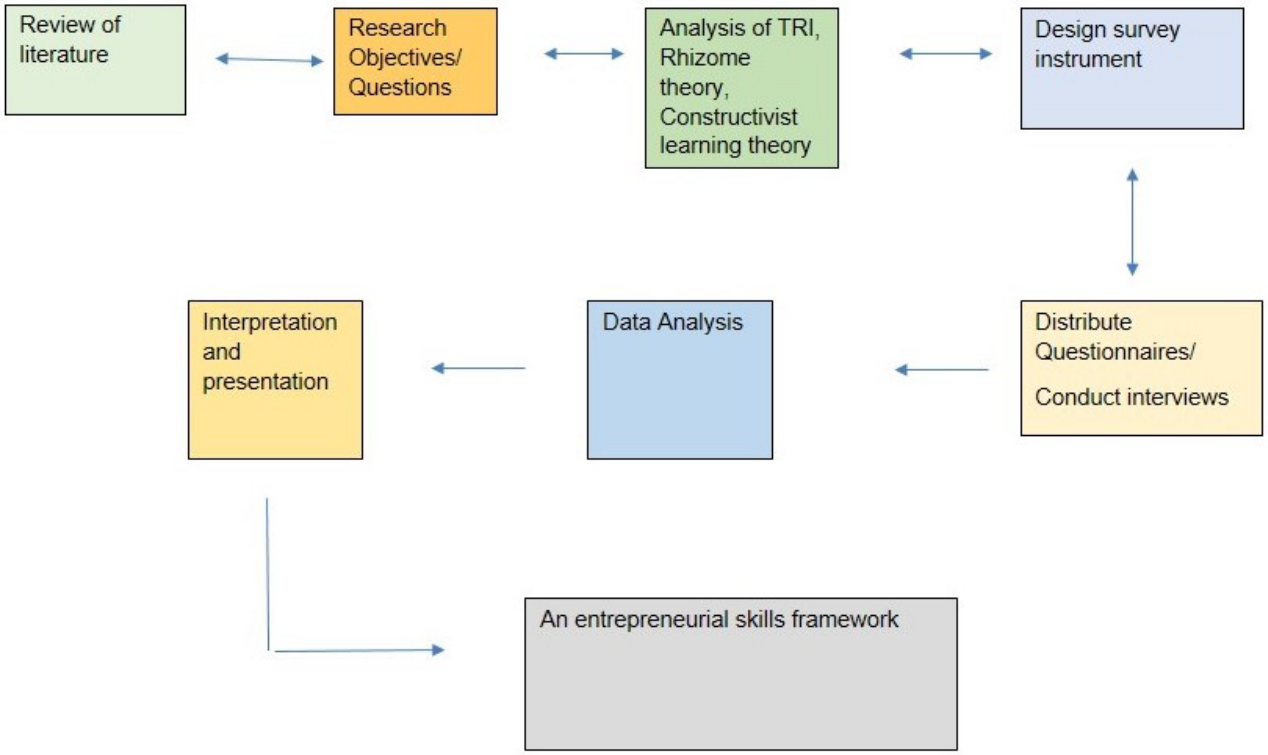


Figure 1.1: The methodological process of constructing the proposed framework

Source: Designed by the Researcher

Figure 1.1 illustrates how the data was collected and analysed in application with the research theories and model to develop the proposed framework.

1.8.4 Sample population and sample frame

The sample consisted of selected TVET colleges and SMMEs owners (entrepreneurs). The sample frame was the TVET colleges offering the CPUT Higher Certificate in Information and Communication Technology (HCICT), Small and Micro business owners who have been in operation for over three years. This research focused on the students and lecturers of the TVET colleges that CPUT offers the HCICT as the case study. Creswell (2013) defines a research population as all individuals, objects, events, or concepts concerned about the research.

1.8.5 Sampling method

Researchers like Bernard (2006) and Yin (2009) suggest that purposive sampling is suitable for selecting participants with credible and valuable knowledge and information about the study. Snowballing and purposive sampling as non-probability sampling methods were used in this study. The purposive sampling was chosen because of the exploratory nature of the research and the small population group of students and lecturers at the TVET colleges. At the same time, the snowballing sampling method was chosen because the sample population of entrepreneurs/business owners have unique traits and existing sample population and provided referrals for further sample subjects. The snowball technique was selected because it is a sampling method which involves identifying the most suitable participant, who, in turn, will introduce other eligible participants (Creswell, 2013; Fletcher & Marchildon, 2014; Habibi et al., 2014). Purposive sampling as a non-probability sampling method was used to select the TVET colleges in the Cape Town Municipality for the case study. The snowballing sampling method was used to choose the small business owners.

1.8.6 Sample Size

The sample size for the students at three TVET colleges was determined using a total-population purposive sampling technique because the total population falls within the acceptable sample size for a case study (Yin, 2009; Croswell, 2014). So, a total of 164 students participated in the study. The sample size for the entrepreneurs was determined when data saturation was attained where “no new information or themes are observed in the data”, and the interviews were stopped (Tengeh et al., 2011; Croswell, 2014). The participants were selected based on the number of employees, years of business existence, and the company's annual turnover. These criteria enabled the researcher to categorise the enterprises as micro or small. In the end, 41 entrepreneurs were interviewed for this study. The sample size for the lecturers at the three TVET colleges included all the lecturers, totalling 20 lecturers for the ICT programme.

1.8.7 Data Collection Instrument

The researcher used a predefined self-administered questionnaire and an interview guide to collect the data. The TRI and the Rhizome theory were used to inform the questions in the questionnaires, and the interview guide was then modified from a predesigned instrument used in the study of Abdullahi et al. (2020). Researchers like Saunders et al. (2007) and Silverman (2013) suggest that the mixed method design provides an in-depth understanding of the research questions. Hence, the findings from one method complemented the findings of the other. Another reason the researcher used mixed methods was that these methods offered valid and reliable data required for constructing an entrepreneurial skill framework within 4IR for ICT programmes at TVET colleges.

In the first phase of preliminary data collection, the instrument used was a self-administrated questionnaire administered to the students and lecturers in the Higher Certificate of ICT at TVET colleges. Open and closed-ended questions were used in the questionnaire to investigate entrepreneurial skills focus in the curriculum and the current practices.

In the second phase of preliminary data collection, the instrument used was an interview guide for lecturers of the Higher Certificate of ICT at TVET colleges. A personal interview session was conducted to investigate the entrepreneurial skills focus in the curriculum and the current practices of their teaching methods within 4IR.

The third phase for the data collection instrument was personal interviews conducted with entrepreneurs, which contained semi-structured questions which enabled the researcher to probe and have an in-depth understanding of the problem to determine their perspectives of 4IR technological skills, entrepreneurial skills and business opportunities within 4IR.

1.9 Reliability and validity

A pilot study was conducted to test and validate the data collection instruments (the predesigned questionnaire and interview guide). Research needs to be credible, trustworthy, reliable and valid. Researchers like Tuli (2010), Tracy (2010) and Petty et al. (2012) suggest that a study could be considered reliable, credible and valid when the findings and outcomes of the research depict reality. This study ensured credibility by using well-established research methods like mixed methods, both qualitative and quantitative methods (Creswell, 2014). To provide quality data and promote the validity and reliability of the data collected, the researcher used the principle of triangulation of data in both collection and analysis. One way to enhance methodological triangulation was using questionnaires and interview guides within multiple data collection methods. The use of mixed methods and triangulation techniques ensured fewer errors and increased the reliability and validity of the data (Mwangi, 2011; Creswell, 2014).

1.10 Data analysis

In this study, qualitative and quantitative data analysis techniques were used. Statistical and non-numerical analyses were used to analyse quantitative and qualitative data. Descriptive and inferential statistics, factor analysis, principal component analysis, and multivariate analysis, were used to analyse the quantitative data. A Cronbach Alpha test, Chi Square test and the Kaiser-Meyer Olkin test were performed to analyse the quantitative data. At the same time, thematic content and narrative analysis were used to analyse the qualitative data.

1.10.1 Statistical analysis

This study used Statistical Package for the Social Sciences (SPSS) software and other inferential analysis techniques such as Chi Test, Cronbach alpha Test and Multivariate factor analysis in analysing the data. Frequency distribution was used with tables, cross-tabulations and charts (graphs, histograms, bars and pie charts) to present and analyse the data. Kendall's Coefficient of Concordance, Alpha Cronbach analysis, and Factor analysis in SPSS were used to explore the research questions and develop an entrepreneurial skills acquisition framework for ICT programmes at TVET colleges.

1.10.2 Non-numerical Analysis

Non-numerical analysis was used to analyse the qualitative data. As Qualitative data analysis techniques, content analysis and narrative analysis were used to analyse data from the personal interviews.

1.11 Ethics

Permission was obtained from the TVET colleges to conduct the research, and consent letters were given to the participating colleges before data collection. Each SMME participant was given a consent letter to signed. The privacy of the participants' information and data was protected. Confidentiality, anonymity and the right to withdraw from the research was explained to the participants. This research conformed to all the ethical principles of the University and adhered to general research conduct procedures, of honesty, ensuring the privacy and protection of sensitive information of the participants. The Protection of Personal Information Act (POPIA) was referenced when preparing the consent letters. Approval was obtained from the Faculty Ethics Committee and the University Ethics Committee. All COVID-19 regulation protocols were observed in the field.

1.12 Delineation

This research covered only TVET colleges within the Cape Town Municipality that offered the Higher Certificate in ICT programme. This study did not include TVET colleges that do not provide the CPUT HCICT programmes. The small business owners in this study were those who have been operating for over three years in the ICT sector or any related sector. This study was limited to elements (skills) and

processes (teaching methods) of simulation-based learning in teaching and learning entrepreneurship in the ICT programmes within selected TVET colleges in Cape Town.

1.13 Outcomes, contribution, significance

1.13.1 Outcomes

The primary outcome was to develop a framework for developing Entrepreneurial Skills in ICT TVET students.

This research has produced and published one peer-reviewed papers, adding new knowledge in entrepreneurial skills and ICT. And six manuscripts will be derived from the thesis for publication and conference proceedings.

1.13.2 Contribution

1.13.2.1 Theoretical contribution

This study contributed to the body of knowledge and our understanding of the interplay between 4IR skills, entrepreneurial skills and ICT by providing a framework that integrates 4IR entrepreneurial skills in the teaching and learning of the ICT programme. This study also contributed to our understanding of how higher education institutions could strive to adapt to the challenges and opportunities of the 4IR.

1.13.2.2 Methodological contributions

A methodological contribution was adopting a conceptual framework that integrates the Constructive Learning Theory, Rhizome Theory, and TRI in developing the entrepreneurial skills framework with 4IR.

1.13.2.3 Practical contribution

The study would assist ICT curriculum designers of TVET colleges better align the content with integrating entrepreneurial skills required within the 4IR to produce better-equipped graduates and self-sufficient techno-entrepreneurs.

The value proposition of the study was that an entrepreneurial skills framework within 4IR will be developed for ICT TVET College education that would inform ICT educators, ICT practitioners, researchers, ICT policies, and higher education decision-makers on the best practices for ICT within the 4IR era.

1.13.3 Significance of the study

This study's conceptual and empirical significance was the design of an entrepreneurial skills framework for ICT students at TVET colleges within the 4IR. The findings of this study would rebound to society in that academic institutions that apply this approach would be able to prepare their students for the disruptive 4IR environment.

Administrators, policymakers, practitioners, and technologists would benefit from this study because it would assist ICT curriculum designers of TVET colleges align the content better to integrate 4IR entrepreneurial skills. Businesses could improve their operational yield since well-equipped graduates would be available to meet the market demands. This research would create a solution to a practical problem.

1.14 Clarification of basic terms

Curriculum: All the different courses/subjects of study that are taught at a college
DoE: Department of Education
DHET: Department of Higher Education and Training
Entrepreneur: A creative, innovative person who engages in entrepreneurship; they take calculated risks and are highly motivated to create jobs.
Entrepreneurship: Mobilising all economic resources to exploit a business opportunity, creating goods and services.
Entrepreneurial education: The teaching of entrepreneurship and entrepreneurial skills.
4IR: Fourth Industrial Revolution
GEM: Global Entrepreneurship Monitor – A study of entrepreneurial activities in 42 countries done by the Graduate School of Business of the University of Cape Town
Graduates: Students who have completed TVET College.
HCICT: Higher Certificate in Information and Communication Technology
ICT: Information and Communication Technology
IoT: Internet of Things
Students: Students refer to students in the TVET Colleges for this study.
TVET: Technical and Vocational Education and Training; the education system after High School, before university.

1.15 Chapter outline

The study is structured into eight chapters, as outlined below.

Chapter One: Introduction

This chapter introduces the main issues that underpin the study. It focused primarily on the introduction, background to the research problem, problem statement, research questions, objectives of the study, and rationale.

Chapter Two: Literature Review

Chapter Two reviewed existing literature under the headings of TVET education, 4IR in South Africa, entrepreneurial skills, ICT skills, simulation methods, and the theoretical framework and models underpinning the study.

Chapter Three: Literature review; the inclusion of entrepreneurship education in non-business programmes

Chapter Three reviewed existing literature on the importance of including entrepreneurship education in non-business programmes in TVET colleges in South Africa.

Chapter Four: Methodology

This chapter explained in detail the methodology used for the study and why a mixed-method approach is deemed the most suitable for data collection and analysis.

Chapter Five: Quantitative data collection and analysis from Teachers and students

This chapter presented and discussed the findings from the questionnaire surveys. In discussing the findings from the survey of TVET Students and Lecturers, constant reference is made to the theoretical literature review in Chapter Two.

Chapter Six: Qualitative and Quantitative data collection and analysis from entrepreneurs.

This chapter presents and discusses the findings from the interviews of business experts (entrepreneurs). In discussing the interview findings, reference is made to the theoretical literature review in Chapter Two.

Chapter Seven: Entrepreneurial Skills Framework

This chapter presents the final output of the study, an entrepreneurial skills framework.

Chapter Eight: Conclusion and Recommendations

This chapter concluded and provided recommendations from the key findings.

1.16 Chapter summary

This chapter focused on the introduction and background of the research, which aimed to develop a framework for entrepreneurial skills for ICT students at TVET colleges in Cape Town. The introduction elucidates the socio-economic situation in South Africa, and Cape Town in particular, of high unemployment amongst the youth, which warrants that graduates be trained in skills that match the market demand. With the advent of the 4IR, it is apparent that the skills students acquire should align with what is needed in the 4IR era. Students in ICT should also have entrepreneurial skills to compete in a challenging environment. To this effect, the study's main objective was to develop an entrepreneurial skills acquisition framework for the ICT programme.

A mixed methods approach, a blend of qualitative and quantitative methods, was employed to collect and analyse data. A sample of TVET students, lecturers, and entrepreneurs were selected using a purposive and snowball technique. The target population for this study was composed of the three TVET colleges that offered the CPUT HCICT programme, the students, and the lecturers (quantitative participants) and entrepreneurs (quantitative and qualitative participants). The collected data was analysed using SPSS, and the findings were presented in tabulated format. The next chapter discusses the literature review of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction:

The previous chapter introduced the main issues that underpin this study. It focused primarily on the introduction, background to the research problem, problem statement, research questions, research objectives and the research methodology of the study. This chapter reviews existing literature on TVET education and training, 4IR in South Africa, entrepreneurial skills, ICT skills, simulation methods, and the theoretical framework and models underpinning the study. Information was gather from various sources such as books, published and unpublished theses, peered reviewed journal articles, electronic articles and magazines.

2.8 Entrepreneurial skills

Entrepreneurs have unique skills and competencies. Researchers have classified these skills into three categories: personal, management and technical. Individual skills will include passion, patience, persistence, creativity, innovation and risk-taking; management skills will consist of planning, controlling, marketing, and accounting; and finally, technical skills will consist of organising skills, communication skills, leadership and management skills (Henry et al., 2005; Elmuti et al., 2012).

Entrepreneurial skills can be transferred through proper entrepreneurship education that incorporates what is required from the industry within the advent of the 4IR. Graduates with these skills may become successful entrepreneurs who recognise opportunities, start businesses, and manage and sustain these businesses (Rae, 2006; Nchu et al., 2017). Entrepreneurs are unique in their traits, skills and competencies, but what is dominant in all entrepreneurs is the ability to take calculated risks (Elmuti et al., 2012).

Entrepreneurship is critical in any economy because it can increase employment and improve the economic development of a country. Therefore, TVET students must be encouraged to partake in entrepreneurship education to become job creators upon graduation (North, 2002). In the advent of the volatile economic situation, entrepreneurship cannot be overstressed, so it is imperative to better entrepreneurial skills and abilities.

Research has proven that a person who has acquired education, especially entrepreneurship education, is likelier to start up business ventures than someone who has not received any entrepreneurship training (Nieuwenhuizen & Groenewald, 2008). Entrepreneurship is crucial in a country's economic growth and

gross domestic product (GDP) due to the creation of small and medium-sized businesses. Hence, entrepreneurship education must be highly quality and present in all higher education institutions (Rae, 2006; Mezied, 2016; Mzekandaba, 2019).

Entrepreneurship is a pivotal aspect of every economy in that the entrepreneur mobilises and coordinates all the factors of production to attain a profit. What differentiates an entrepreneurial venture from a business venture is creativity, innovation and the ability of the entrepreneurs to respond to change and identify new opportunities, whereby the bureaucracy in business causes them to miss such opportunities (Rae, 2006; UNESCO, 2008). Besides, entrepreneurship can also be found in co-operatives and public and government enterprises, not only in small and medium-sized businesses.

For entrepreneurship to thrive in any economy, there must be vision, creativity and innovation (Gouws, 2002; UNESCO, 2014). Small businesses in the United States of America are thriving, providing over 20 million jobs in the last decade. Entrepreneurship accounts for just about the nil unemployment rate in Indonesia. Many technologically advanced economies have revitalised their interest in entrepreneurship because of high unemployment rates and the economic recession. (Garavan & O'Cinneide, 1994).

2.2 Technical and vocational education and training (TVET)

Literature suggests that education, in general, is a way of acquiring knowledge and skills by an individual to promote social transformation (Giroux, 1992; Kaul, 1998; Nchu et al., 2017; McGrath, 2018). Education has a holistic approach to the development of an individual, while training has a specific approach to developing an individual's skill. The terms education and training mean skill formation but differ in occupation status. While education will be associated more with a professional occupation, training is related to manual occupations (McGrath, 2011).

General education contributes to a deeper understanding of a concept. In contrast, vocational or technical education contributes to the practical know-how of a particular skill and prepares the student for employment in a specific occupation (Hammersley-Fletcher & Brundrett, 2008; UNESCO, 2011). Technical education is defined as the teaching of handicrafts and trades. General education is the training of the mind, while technical education is the training of the hands. On the other hand, vocational education, which is of a specialised and practical approach, is aimed at training the youths and adults for a working life (Clarke & Winch, 2007).

According to The United Nations Educational Scientific and Cultural Organization (UNESCO), TVET's focal point is acquiring knowledge and skills for the job market (UNESCO, 2012). The aspects of training, vocational education, technical education and industry education have all been represented in the term TVET. The Department of Higher Education and Training in South Africa points out that vocational

education and training provide middle-level knowledge and skills for a person's entry into the industry (DHET, 2012a).

2.3 The Fourth Industrial Revolution (4IR)

The world has changed since the First Industrial Revolution, also known as the Industrial Revolution, which was all about the mechanisation of production. The growth of industries and manufacturing ushered in the Second Industrial Revolution, also called the Technology Revolution, which was characterised by the expansion of industries and the standardisation of the production process. Then there was the Third Industrial Revolution, also called the Technological Revolution, about Internet Technology and renewable energy. The Third Industrial Revolution changed how business is done and how we live. Globalisation brought economies, companies, people, technologies, and information closer. The interdependence of the world market in the advent of globalisation was an opportunity that brought changes in the business environment (Xu et al., 2018). Now, we are in the era of the 4IR, which is characterised using advanced technologies, the Internet of Things, and the digitisation of how we do things (Xu et al., 2018; Schwab, 2020).

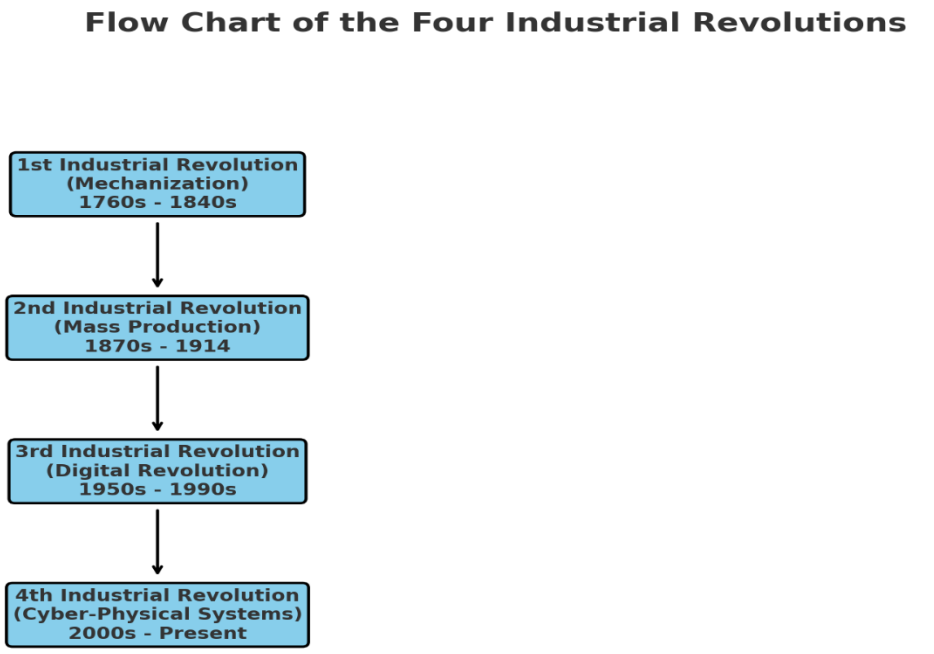


Figure 2.1: An Illustration of the timelines of the Four Industrial Revolutions
Source: Designed by the researcher.

The flow chart above illustrates the timelines of the four industrial revolution. The 1st Industrial Revolution involves Mechanization and was predominant in the Late 18th century to early 19th century. (1760s to

1840s). The 2nd Industrial Revolution revolves around Mass Production and was predominant in the Late 19th century to early 20th century (1870s to 914). And there was the 3rd Industrial Revolution focused on Digital Revolution and was prevalent in the Mid-20th century to early 21st century (1950s to 1990s). And finally, the 4th Industrial Revolution which focused on Cyber-Physical Systems and is currently the prevalent from the Early 21st century onwards (2000s to present).

There have been many signs of speedy growth in 4IR technologies, especially in supporting technologies such as 3D systems, artificial intelligence, blockchain and power supply. There has also been growth in the Industrial Internet of Things (IoT), as seen in the number of discoveries and innovative creations in smart connected objects (Chung & Kim, 2016). Over the years, there has also been a growth in manufacturing technologies and cyber-physical systems. The value of Industry 4.0 and digital transformation can be felt in the synergy between technologies, their tenacity and their purpose for the community (Chung & Kim, 2016).

Researchers like Chung and Kim (2016) concur that the evolutions in the space of 4IR have had a snowballing effect that affects several related technologies, thus enabling its application in diverse contexts, be it intelligent connected objects, the IoT, cyber-physical systems and other technologies of Industry 4.0, (Chung & Kim, 2016; Ménière et al., 2017) There are several layers of technologies in the IoT some of which will include sensors; actuators; such as electric motors, solenoids, and hard drive stepper motors; robotics and other embedded technologies. Briefly, Industry 4.0 involves interconnecting several technologies like Information Technology (IT) and Operational Technology (OT) to optimise the applications of smart connected objects (Chung & Kim, 2016; Owoo & Naude, 2017; Waghid et al., 2019).

The 4IR technology has been categorised into three technology sectors, which include (1) the core technology areas, (2) The enabling technologies, and (3) the actual applications (Ménière et al., 2017). The first 4IR technology sector, also known as the core technology area, consists of an industrial transformation of the intelligent connected objects and the IoT using hardware, software, and connectivity technologies. In this area, smart objects are created, for example, computer chips, core embedded software, memory chips, MEMS (micro-electromechanical systems), CPUs, operating systems and vital data technologies. The second 4IR technology sector, enabling technologies, involves the link between smart connected objects and the application. Some examples of allowing technologies include cyber security, extensive data analysis, artificial intelligence (AI), user interface, 3D, augmented reality, virtual reality and digital twin simulation (Schwab, 2016; Mpofu & Nicolaides, 2019, Schwab, 2020). These enabling technologies complement the core technologies and boost the use of smart connected objects. The third 4IR technology sector, also known as the actual applications, combines the first and second sectors to make it applicable in real-life situations (Owoo & Naude, 2017). Examples of the third 4IR

technology sector include smart houses, wearable smart watches, robotics, smart cities, smart cars, smart manufacturing or innovative businesses, and smart grids.

The 4IR and its related technologies have evolved over the years. The 4IR combines digitisation, robotics, advanced technologies for science, big data, the Internet of Things, cloud storage and artificial intelligence. Wireless technologies have also improved from 2G to 3 G, 4G, Fibre and even 5G, which will soon be present in most economies. It is evident in the research by Fomunyam (2019) that the emergence of the 4IR has augmented our way of life; artificial intelligence and data automation ensure that we make innovative and effective choices. In the academic sector, blended learning and 4IR technologies were introduced into higher education (Fomunyam, 2019; Oke & Fernandes, 2020). There is a need for the current educational institutions to evolve in the courses they offer and in the way these courses are taught

The era of 4IR is an era of technological advancement that has changed how things are done (Mezied, 2016; Mzekandaba, 2019; Mpofu & Nicolaides, 2019; Waghid et al., 2019). Hence, Higher Education, in the wake of 4IR, should be of utmost importance to academics and business experts alike (Fomunyam, 2019). According to the World Economic Forum (Schwab, 2016), software and services shaping society include digitisation, the Internet of things, big data, computing, communications, cloud storage, robotics and artificial intelligence. In Deloitte's article on preparing tomorrow's workforce for the Fourth Industrial Revolution (2018), 4IR is likened to a thunderstorm that swiftly disrupts how things are done. Hence, the workforce must be well-equipped and prepared to thrive in this disruptive environment.

The South African Higher Education system should have the tools to face these changes and benefit from their effects (Fomunyam, 2019). The founder of the World Economic Forum, Klaus Schwab, describes 4IR as a synergy of technologies that narrows the gap between the physical, digital and biological sectors (Schwab, 2014). The impacts on how 4IR affects our lives will differ from country to country, as well as how prepared we are to interact with technology. Ménière et al. (2017) and Oxford (2021) posit a positive impact of technology in the business sector. Albeit there has never been a better time to have the unique skills like now, researchers like those with the Council of Chief State School Officers. (2013) have a negative view towards the advent of 4IR, in that it could create the loss of jobs since robots, computers and other technologies are now learning ordinary skills. Deloitte (2018) highlights 4IR skills that the 4IR workforce should have: Omniscience, which is to aspire to know everything; an entrepreneurial mindset, being focused; and ethical intelligence.

2.4 4IR Technologies

It is not a secret that information technology (IT) and information and communication technology (ICT) play a vital role in the success of a company, especially during indeterminate and tempestuous economic circumstances (Kuhn, 1970; Weaver & Osterman, 2016; Benassi et al., 2019). Since the events in the African economy, especially the South African economy, are essential and practical, the study of 4IR entrepreneurial skills is predominantly significant. Khathu (2019) posits that the current school curriculum does not prepare students with the necessary skills for the 4IR. Khathu (2019) also believes that internet access is limited and expensive in South Africa. As computer science is one of the top skills in the 4IR environment, most high schools and colleges do not have adequate access to computers (Khathu, 2019; Oxford, 2021). The author opines that coding is not a vital technical skill taught at high schools or TVET colleges.

Technology entrepreneurship entails entrepreneurial companies having a complete organisational restructuring that should be supplemented by implementing information technology (Oxford, 2021). This study explores how 4IR can be integrated into ICT training and how it helps graduates to be more competitive in the marketplace. The evolution of 4IR Technology has converged various Industry 4.0 technology levels, such as the convergence of additive manufacturing and intelligent sensors and convergence in smart manufacturing and innovative health.

Over the years, there has been a synergy between economic transformations and technological modernisation. Africa, particularly South Africa, has been instructive in its economic transformation, which has helped other African countries transform their economies. 4IR Technologies plays a significant role in most businesses' success and enables these businesses to compete in the global economy (Davies, 2001; Oxford, 2021).

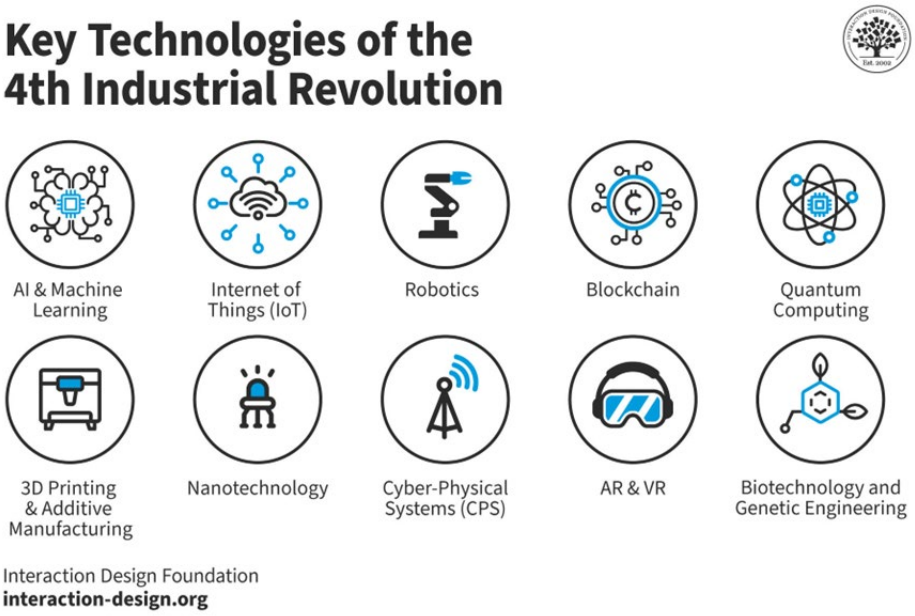


Figure 2.2. 4IR Key Technologies

Source interaction-design.org

2.5 4IR and education in South Africa

4IR has grown tremendously in the last few decades. The growth has profoundly influenced many aspects of human lives, including education. It has opened new markets and business opportunities and has driven economic growth (Schwab, 2016). Research has shown that the 4IR has created new opportunities for the education sector in South Africa to harness the potential of 4IR, albeit the education sector is unprepared for 4IR (Liu &Stephens, 2019; Oke & Fernandes, 2020) 4IR is the convergence of biology and the emergence of disruptive technologies such as internet of things (IoT), virtual reality (VR) that has changed the way we live, work and interact. Etc. ICT, innovation and 4IR are symbiotic, especially in teaching and learning. Research shows that 4IR can ease students' learning experience and transform businesses (Oke & Fernandes, 2020). ICT is one of the building blocks of 4IR, while 4IR can enhance ICT advancements. Interestingly, the ICT sector has also witnessed incredible advances, creating new opportunities for the application and development of 4IR. For example, digitally enabled 4IR, based on technological advances including AI, Business Intelligence (BI), IoT, Robotics, IoT, Data Analytics, Biotechnology and Nanotechnology, is experiencing massive growth (Schwab, 2016).

However, the rapid pace of growth of ICT and 4IR requires infrastructures, data access and affordability, digital skills, and innovation ecosystems. Institutions of higher learning, including TVETS colleges, have a critical role in advancing ICT students' training with 4IR and training the next generation of 4IR high-tech experts. A recent study demonstrated that 4IR can expedite students' learning experience. However, the

same study also noted the need to improve curricula and assess learning barriers to 4IR diffusion (Oke & Fernandes, 2020).

Many stakeholders and critics question the relevance of higher learning institutions in Africa (Kennedy, 2019; Kayembe & Nel, 2019; Pather, 2020). The high unemployment of graduates, low level of entrepreneurship and low uptake and use of 4IR are fuelling these criticisms. Higher learning institutions can improve responsiveness and become ICT and 4IR advancement centres. The education sector in South Africa has made some strides in using 4IR tools in its teaching and learning during the lockdown period (Mhlanga & Moloi, 2020). Examples of such tools will include live broadcasts of lessons on TV, Mobile phone platforms and learning applications, and educational and informational websites. Higher education uses Learning Management systems and live online sessions for teaching and learning. A recent study by Oke and Fernandes (2020) suggests that the efficiency of 4IR and technology in teaching and learning goes beyond using a computer and accessing electronic materials; it should be learner-centred to enhance the student learning experience. In that same light, Pather (2020) heralds that the educational sector must know how it uses 4IR technologies. Cyberbullying and Biotechnology techniques of gene editing (designer babies) could have negative impacts on our lives and values (Pather, 2020). Literature has indicated that some essential skills and values could be included in the curricula to enhance the prospects of students thriving in the 4IR environment (Schwab, 2016; Kayembe & Nel, 2019; Pather, 2020). These skills include creativity, innovation, critical thinking and problem-solving skills. From the literature, it is evident that South Africa faces challenges in fully embracing 4IR in the education and higher education sector due to inequality, exclusion, lack of funds, lack of infrastructure and inadequate skills (Kayembe & Nel, 2019; Mhlanga 2020; Mhlanga & Moloi, 2020; Pather, 2020). The education sector in South Africa has to evolve and embrace 4IR to benefit from the opportunities it brings.

2.6 Information technology (IT) employability skills

The Association for Computing Machinery and the IEEE Computer Society (2017) research emphasises that creativity and innovation are needed in the IT industry and all other sectors to provide new technologies and more job opportunities. Years later, IT has become entrenched in everything we do.

Over the past few years, there has been an increased use of mobile applications. In 2016, mobile applications as a leading digital platform catered for 75% of media time spent more than in 2014 (Singh & El-Kassar, 2019). The current social media platforms such as Facebook, Instagram, and Twitter account for integrating social media technologies with business have been significantly prevalent. The traditional way of doing things has been replaced by more technology-oriented skills such as user experiences, the

Internet of things, big data, cyber security, automation and robotics, among the top ten technology trends (Singh & El-Kassar, 2019).

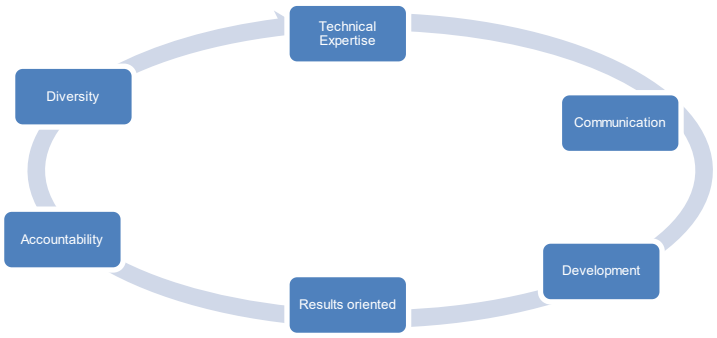


Figure 2.3: IT competencies

Source: Adapted from Yale Information Technology Annual Review 2020 (Yang & Gu, 2021).

Figure 2.1 illustrates that technical expertise is not the only skill required to be mastered by IT graduates; non-technical and soft skills such as communication, development, and diversity also need to be harnessed. The graduates should be able to make use of their technical expertise in the development of their communication skills, and they should be able to work and interact in a diverse market environment.

It is essential for students, as they prepare for their future, to consider their ability to shift from theory, which is more academic, to practice within a corporation (Jackson, 2014). Technical and non-technical skills are relevant for the graduates to harness to better align with industry demands and employability readiness. Most business experts agree that they consider a graduate with soft skills for an IT role or any other position in the workplace (Clear, 2017). The majority of the industry managers concur on the importance of both technical and non-technical skills. These soft skills often complement the technical skills. Soft skills are critical in the market because they enable the graduate to interact with their co-worker and show emotional intelligence in handling crises at the workplace (Clear, 2017). The IT (2017) reports highlight that 60% of the jobs in the future can be done by only 20% of today's skilled workforce. Soft skills are critical in the future.

Table 2.1: 10 top employability skills in order of importance.

Ten Top Employability Skills		
No.	In 2015	In 2020
1	Complex problem solving	Complex problem solving
2	Coordinating with others	Critical thinking
3	People management	Creativity
4	Critical thinking	People management
5	Negotiation	Coordinating with others
6	Quality control	Emotional intelligence
7	Service orientation	Judgement and decision-making
8	Judgement and decision-making	Service orientation
9	Active listening	Negotiation
10	Cognitive flexibility	Cognitive flexibility

Source: Future of Job Report, World Economic Forum Schwab (2020).

Table 1 demonstrates how employability skills have changed between 2015 and 2020. Complex problem-solving has remained the number 1 employability skill for the last decade. Creativity, which used to be the latest in the top 10 list in 2015, is now in the top position in 2020. Emotional intelligence, which was not among the top 10 skills in 2015, is now among the top 10 in 2020. Active listening is no longer a top 10 skill. Cognitive flexibility is now among the top ten skills in 2020. These emphasise the importance of baseline soft employability skills in the current workforce.

There has been a lot of emphasis on competence worldwide as Enterprise IT (EIT) and ICT are essential worldwide. A majority of academics (Kennedy et al., 2007; National Academies of Sciences, Engineering, and Medicine. 2016; Ménière et al. (2017) agree that success in and after college, university, and career readiness requires that students develop a range of qualities that can be differentiated into three categories: knowledge, skills, and dispositions. Knowledge will comprise the mastery of the content of knowledge and the transfer of learning. Skills will be capabilities and strategies for higher-order thinking (technical skills) and interactions with others and the world around them (soft skills) (National Research Council, 2012 & Council of Chief State School Officers, 2013).

The Information and Communications Technologies for Development (ICT4D) is intended to close the digital gap between the technologically rich and the technologically poor regarding geographical locations

and demographic groups (IT, 2017). ICT4D also aims to improve the economic development of a country by providing all the inhabitants access to the latest communication technologies. ICT4D is the practice of developing technology to support and help the poor and marginalised in the communities. The challenge for the higher education sector is to find opportunities and programs that enhance the efficacy of the graduates during this era of 4IR.

2.7 Entrepreneurship

Many researchers have different definitions of who an entrepreneur is. However, what is shared amongst all these definitions is that an entrepreneur takes calculated risks, is innovative and has an eye for business opportunities (Robinson 2002). A person could be considered an entrepreneur when they take the risk to start and manage a business. We are now in the 4th Industrial Revolution, whereby the world is changing technologically, and having the technological know-how alongside being risk savvy with an eye for opportunities is a pivotal trait of a successful entrepreneur. Therefore, one has to take advantage of the opportunities presented due to the advent of the 4IR to use technology in business better. Researchers like Davies (2001) and Nchu (2015) maintain that risk-taking and innovative entrepreneurs in the economy are the only way the South African economy may be revived and unemployment curbed. It is crucial to have proper academic and professional entrepreneurial skills training institutions. This study aims to design an entrepreneurial skills acquisition framework integrating 4IR technologies. In doing so, this study will also investigate the traits of successful entrepreneurs that will be used as a yardstick to propose a framework for equipping graduates with 4IR entrepreneurial skills.

Research has proven that entrepreneurship is a skill that can be learned. Davies (2001) and OECD (2012) agree with this and reiterate that developing countries can increase their rates of business start-ups by training people in entrepreneurship. Entrepreneurship goes beyond enterprise creation; it involves having an eye for opportunities, engaging in calculated risks and having the zeal to execute an idea into reality (North, 2002). As Kuratko (2003) affirms, entrepreneurship is a concept that integrates innovation in all business dealings.

Education is vital to every country's economic development by providing a skilled and knowledgeable workforce. There is a need for educational institutions in Africa and South Africa, in particular, to promote innovation and entrepreneurial education to increase the graduates' employability. The Economist Alan Blinder, Mezied (2016) emphasises that education in this information age should focus on the type of education received rather than the quantity. Education is about what you need to know rather than Just-in-case education, Mezied (2016). Govender (2008) and Nchu (2017), amongst other researchers, believe that entrepreneurship activities must be promoted and encouraged among the youth to instil an entrepreneurial mindset in them. Researchers recommend that a detailed study on the needs of the students alongside what is required in the marketplace to align the curricular and extracurricular activities

hence addressing the unemployment issue of the youth (Timmons & Spinelli, 2004; Govender, 2008; Cong & Wang, 2012)

According to the Deloitte Global report (2018), a third of the participants said they did not acquire the skills they needed at their colleges or universities. The Deloitte report also found that most participants (79%) said they had learned more skills informally for their jobs. More than half of the participants (54%) do not know what 4IR or Industry 4.0 is about.

Higher education needs to be more risk-savvy, innovative and open to change in a world of disruptive change. The impact of 4IR on education calls for a rethink of current teaching and learning models. The current Minister of Higher Education, Dr Blade Nzimande, sees 4IR as a game changer as it presents an opportunity to address inequality.

Africans and South Africans, in particular, need to be entrepreneurs, innovators and creators of new technology rather than consumers. The coronavirus in 2019 (COVID-19) has made higher education institutions look for innovative and creative ways of teaching and learning to inspire students to venture into entrepreneurship. Dr Blade Nzimande, during the 4IR virtual conference, emphasised that South Africa needs to go beyond smart gadgets to use simulations, automation, machine learning, and augmented reality in teaching and learning. With technological advancement, students must be trained to engage in entrepreneurship within this 4IR environment.

2.9 Simulation-based learning

Simulation-based learning is valuable in the Science, Technology, Engineering and Mathematics (STEM) fields (Howie & Blignaut, 2009). Simulation-based learning could provide students with real-life situations while enabling them to acquire practical skills. Literature indicates that learning cognitive, technical and behavioural skills can be achieved through simulation-based learning (Birch & Irvine, 2009; Kalogiannakis, 2010). ICT programmes would benefit from simulation-based learning because it is crucial for acquiring cognitive, technical, behavioural and communication skills (Howie & Blignaut, 2009). Literature indicates that simulation-based learning provides students practical skills (Birch & Irvine, 2009; Kalogiannakis, 2010).

2.10 Underpinning research model and theory

2.10.1. Technology Readiness Index model

The Technology Readiness Index (TRI), developed by Parasuraman and Colby (2001), is an instrument used to assess consumers' readiness for technology. The TRI comprised 36 qualitative variables categorised into four dimensions (Optimism, Innovativeness, Discomfort and Insecurity), used to

determine an individual's tendency to accept and use new technology as in the case of 4IR technological skills for techno-entrepreneurship. This model groups these four dimensions into two groups: Motivators and Inhibitors. Optimism and Innovativeness are considered the motivators of technology readiness, while Discomfort and Insecurity are the inhibitors to technology readiness (Parasuraman & Colby 2001). Optimism focuses on a positive relationship with technology and the benefits one gets from using technology. Innovativeness describes how technology can facilitate one's situation as a pioneer. At the same time, discomfort is the fear of not having control over technology. Insecurity portrays the distrust of Technology failing to work in any given situation and scepticism of one's ability to use technology (Parasuraman, 2000). This research will use the TRI model to construct the questionnaires that will be used to determine the level of readiness of TVET students for entrepreneurship in 4IR.

2.10.2. Rhizome Theory

The Rhizome theory by Deleuze and Guattari (1987) describes the learning process as having no beginning or end. The Rhizome theory explains that learning occurs constantly, like the rhizome stem that shoots up new plants as it grows. This theory focuses on six principles, namely connection, heterogeneity, multiplicity, a-signifying rupture, cartography, and decalcomania. Researchers like Mackness et al. (2015) and Cronje (2016) have explained the rhizome theory and their relevance to teaching and learning in that learning is self-replicating and open-ended. The connection and the heterogeneity principle of the Rhizome theory describe diversity in people and ideas. Learning can be applied in different contexts (Cronje, 2016). While the multiplicity and the rupture signify no hierarchy in learning, learning occurs in multiple ways. The cartography and decalcomania principle highlights that learning is like a map; learners create knowledge, which can happen and change at any time. The metaphor of the learning process as a rhizome highlights that learning is dynamic and self-replicating (Cronje, 2016). Rhizome learning explains that students acquire, and construct knowledge based on their experiences and the world around them. The rhizome theory will be used in this research to discuss the findings.

2.10.3. Constructivist Learning Theory

Constructivism is an educational learning theory that posits that learning is a cognitive process constructed based on a learner's experiences, beliefs and values. The learners assimilate and construct knowledge based on their experiences. A constructivist learning theory is a theory that supports simulation-based learning in that it is highly experiential; it requires mental and physical activity, which gives room for reflection (Harper, Squires & Mcdougall, 2000). So, each learner constructs their knowledge based on their own experiences.

Constructivism is the belief that people construct their knowledge based on their experiences. Wilson & Peterson (2006) suggest that constructivism is the most effective learning theory in developing professional competence. This research is based on the worldview of constructivism because the students will construct their knowledge based on their experiences and terms of reference. The constructivists define learning as the process in which students develop active meaning. This process involves students developing new knowledge in combination with existing knowledge and experiences (Kumar, 2016). This theory will be used to discuss the research findings and develop the 4IR entrepreneurial skills framework.

2.11 Conceptual framework

Simulation teaching and learning is experiential learning that promotes critical higher and self-directed thinking (Costin, O'Brien, & Slattery, 2018; Caniglia, 2019). Simulation teaching strategy is one of the most effective ways of facilitating learning, skills, and knowledge development in technology subjects (Caniglia, 2019; Chernikova et al., 2020). From the literature, it is evident that the simulation-based method best facilitates learning in that students get direct feedback, it involves repetitive practice, and it could be integrated into the curriculum (Costin et al., 2018; Caniglia, 2019; Chernikova et al., 2020). The relevance of using simulation-based learning in ICT programmes to acquire 4IR entrepreneurial skills is illustrated in Figure 2.4.

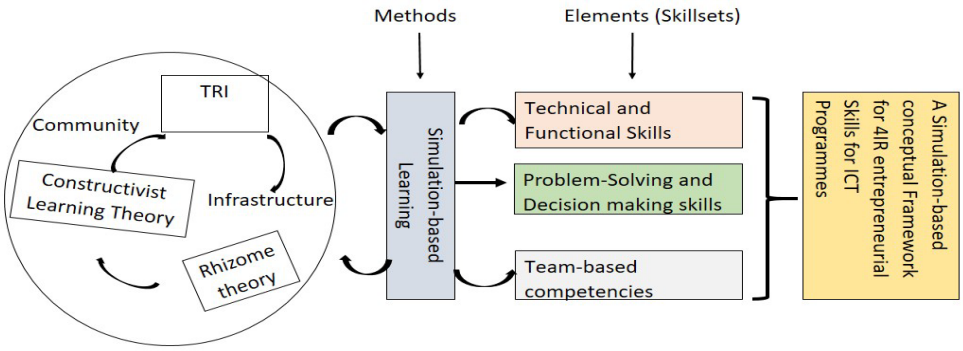


Figure 2.4: Theoretical framework for 4IR entrepreneurial skills for ICT programmes.
Source: Drawn and designed by the researcher

The development of a 4IR entrepreneurial framework for ICT programmes at TVET colleges will involve the analysis of the entrepreneurial skillsets, the ICT skillsets and the 4IR skillsets to propose a 4IR

entrepreneurial skillsets for ICT graduates at TVET colleges. Figure 2.5 illustrates this interplay between the various skill sets.

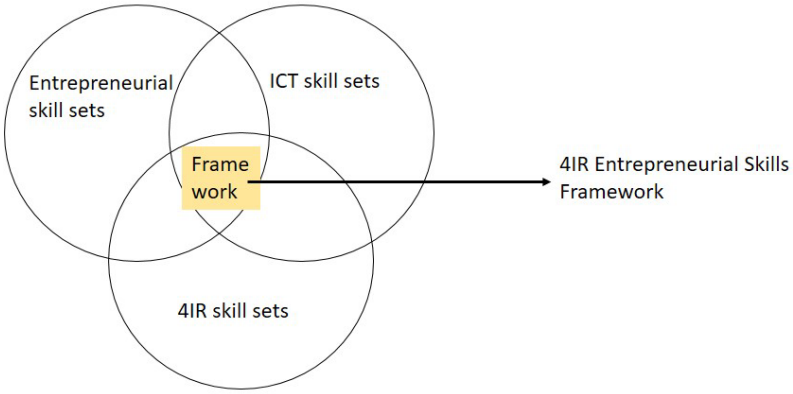


Figure 2.5: A conceptual framework for 4IR entrepreneurial skills for ICT programmes
Source: Drawn and designed by the researcher

2.12. Chapter summary

The main aim of Chapter Two was to review existing literature on the relevant entrepreneurial skills, ICT skills, the fourth industrial revolution (4IR) skills and the importance of equipping ICT with entrepreneurial skills to develop an entrepreneurial skills framework for ICT students within the 4IR era. Chapter two also looks at how the various theoretical frameworks can be applied to the instructional methods for developing and acquiring entrepreneurial skills.

This chapter covered various concepts, such as the definition of an entrepreneur and associated qualities. The definitions of entrepreneur and entrepreneurship differ from author to author. However, the authors agree that the terms concern starting and growing a successful enterprise.

Concerning entrepreneurs, it was established that an individual identifies a profitable business opportunity in the market and commits resources to exploit the market situation to satisfy market needs and create personal dividends. The entrepreneur relies on calculated risk-taking to get a profit. In terms of entrepreneurship, the studies and practice of an entrepreneur can be described as entrepreneurship.

Therefore, the behaviour of an entrepreneur or the way of living causes the phenomenon to manifest itself as entrepreneurship. Entrepreneurship is the heartbeat of every economy. Hence, entrepreneurial skills must be acquired by ICT students and all students in general. The next chapter discusses the importance of entrepreneurship education in non-business programmes at TVET colleges.

CHAPTER THREE

THE INCLUSION OF ENTREPRENEURSHIP EDUCATION IN NON-BUSINESS PROGRAMMES AT TVET COLLEGES IN SOUTH AFRICA.

3.1 Introduction

“The literature review was discussed in Chapter 2, where the research's fundamental concepts and the study's theoretical framework were discussed. Chapter three focused on the importance of including entrepreneurship education in non-business programmes at TVET colleges. This chapter is part of the literature review of the absence of entrepreneurship education in non-business courses at TVETs and the chapter emphasises on the importance of including entrepreneurship education in all the non-businesses courses.

3.2 The prevalence of entrepreneurship education in TVET colleges in South Africa.

Fifty public TVET colleges in South Africa operate on around 364 campuses spread across the rural and urban areas of the country. Public TVET Colleges are established and operated under the authority of the Continuing Education and Training Act 16 of 2006 and resort under the Department of Higher Education and Training. The state subsidises public TVET Colleges with approximately R8 billion annually. Each region has a DHET regional office that provides specialised professional support to the public TVET Colleges in provinces. These TVET colleges offer over one thousand and one courses in all the programmes. Only 424 out of the 1001 Courses, that is, 42%, indicated visible evidence of entrepreneurship/business studies included in them (see Table 3.1).

Table 3.1: Comparative analysis of the prevalence of entrepreneurship education in Public TVET colleges

Provinces	Number of Programmes/ Courses	Presence of Entrepreneurship/ Business Subjects	Percentage	Ranking in terms of prevalence
Eastern Cape	206	76	37%	7th
Free State	99	45	45%	3rd
Gauteng	151	64	42%	5th
KwaZulu Natal	121	58	48%	2nd
Limpopo	121	59	49%	1st
Mpumalanga	51	19	37%	7th
Northern Cape	44	20	45%	3rd
North West	41	18	44%	4th
Western Cape	167	65	39%	6th
Total	**1001**	**424**	**42%**	

Source: Conceived by the researcher

3.3 Discussion of the findings

With the current state of unemployment in South Africa, over 70% of the youth are unemployed. There is an urgent need for higher institutions like TVET colleges to look for innovative ways to equip their graduates to be job creators and not job seekers. TVET colleges have to be proactive in providing entrepreneurial skills to their graduates and encourage these graduates to be self-employed.

A few of these TVETs have made a significant effort to include business studies or entrepreneurship education in some of their courses, especially non-business ones. This effort will be vital because non-business graduates find it hard to become entrepreneurs due to their lack of business skills. The few forward-thinking TVETs have included Entrepreneurship education in their non-business disciplines.

This study reveals that TVET colleges in the Limpopo Province have over fifty-nine entrepreneurship courses across the seven TVETs in the province. Therefore, this shows that forty-nine per cent of these programmes have evidence of the prevalence of entrepreneurship education in their curricula. Researchers like Tengeh, Iwu and Nchu (2016) posit that entrepreneurship education should be available to all higher-level students irrespective of their primary programme.

It is imperative that the purpose of entrepreneurship education at higher institutions is to instigate the entrepreneurial mindset, develop entrepreneurial capabilities, and increase students' entrepreneurial

intentions. To achieve these, students must be taught that entrepreneurship is another form of becoming self-employed. Business start-ups, creativity and innovation must be encouraged in all graduates of higher institutions, European Commission, (2008). A change in the mindset of students about entrepreneurship will increase entrepreneurship amongst the youth.

It requires the intervention and commitment of all stakeholders for entrepreneurship to be embedded in all the programmes in higher institutions, including TVETs. As the main stakeholder, the government must implement policies and provide resources to support entrepreneurship programmes in all institutions.

3.4 Recommendations

Pre-emptively, education prepares learners for employment and, at the same time, for self-employment. Therefore, entrepreneurship education at all levels will optimise the graduate's chance at self-employment and improve their employability.

It is recommended that entrepreneurship education be included in non-business disciplines at all higher learning institutions, including TVETs. These higher learning institutions should maintain a solid and dedicated commitment to providing entrepreneurial education to their undergraduate and graduate students through curricular and co-curricular programs. Thus, all students must be introduced to the basic principles of entrepreneurship through their required core programmes. Co-curricular experiential options will be used to expose all students to entrepreneurship clubs, business plan competitions, workshops, internships, and entrepreneurship seminars.

Furthermore, this blended approach of curricular and co-curricular to entrepreneurship education could create innovative and skilled entrepreneurial graduates.

With the low rate (42%) of the prevalence of entrepreneurship education at TVET colleges across South Africa, these graduates may not perform effectively when it comes to creating businesses or being self-employed. It is highly recommended that entrepreneurship education be included in all programmes at TVET colleges. It is worth noting that the high rate of entrepreneurship in the United States of America is primarily a result of the surplus of training centres and higher-education institutions which offer entrepreneurship courses.

This advances the idea that the embeddedness of entrepreneurship education in non-business courses will involve two phases. The first phase will include integrating entrepreneurship education into the non-business courses. The second phase will consist of aligning the content and method of teaching to the non-business courses.

3.5 Chapter summary

This chapter focused on the prevalence and the inclusion of entrepreneurship education at TVET colleges. Most TVET colleges (48%) do not have entrepreneurship education in their non-business programmes. The next chapter discusses the research methodology utilised in this study."

CHAPTER FOUR

RESEARCH METHODOLOGY

4.1 Introduction

In chapter three, the literature on the importance of including entrepreneurship education in non-business programmes at TVET colleges was discussed. Chapter four discusses the methodology of the research. In this chapter the methodology for data collection, and the method for data analysis. This chapter also discusses the research design, the population of the study, sample size, the instrument for data collection validation, the reliability of instruments, the method of data collection, and a structured method of data analysis.

4.2 Research Paradigm:

The research paradigm/philosophy for this research is pragmatism, which consists of practical thinking and action as the truth and the reality. The pragmatism philosophy states that research should be carried out to know the facts and the reality and because the research questions will be best answered using a mixed qualitative and quantitative method. The triangulation of the hybrid method will enable the researcher to know the facts and the reality of developing a 4IR entrepreneurial framework.

The research paradigm is how scholars believe or assume knowledge is developed. Researchers agree that the research philosophy or paradigm is the shared beliefs and agreements on how problems should be understood and addressed (Kuhn, 1970; Kuhn, 1974; Saunders et al., 2007; Saunders et al., 2012). The research process has three main philosophies: Ontology, Epistemology and Axiology.

Ontology is the study of reality. Ontology sheds light on what is perceived as reality and how it affects human behaviour (Antwi & Kasim, 2015). Gray (2013) opines that ontology is learning about being, the nature of existence and what makes reality. There are two philosophical positions under the ontological paradigm. They include objectivism and constructivist realism. Objectivism posits that there is an independent reality (Neuman, 2003). Constructivist realism believes that people construct knowledge based on their experiences. This research is based on the ontological worldview of constructivist realism because the students will build their knowledge based on their experiences and terms of reference. Constructivist realism acknowledges that social phenomena exist in communities independently of the researcher. So, the world we know and understand is constructed from our perspectives and experiences through what is observable.

Epistemology is the study of acceptable knowledge. Epistemology helps us address the facts based on the information and evidence provided. Epistemology includes positivism, interpretivism, and pragmatism

(Tracy, 2010; Creswell & Clark, 2011; Bryman, 2012). The positivist worldview opines that there is a scientific explanation of the empirical data used to test the chosen theory to achieve the research objectives. The positivists believe that facts exist and are not influenced by personal ideas or thoughts. The interpretivism philosophy opines that knowledge can only be gained by deeply understanding the subject. The interpretivists highlight that reality is interpreted and experienced by an individual's interactions with the world (Tuli, 2010; Cronje, 2014). The epistemology for this research will be based on the interpretivism philosophy, which states that reality is complex and multi-layered. A single phenomenon can have multiple interpretations. The research objectives will be best answered using the interpretivist approach. The researcher's role is to offer their perspective and analyse the findings to provide insights.

4.3 Research Design:

The research design used was a mixed method, a combination of qualitative and quantitative research approaches because these methods bring valuable information that answers the research questions and generates new ideas (Bryman, 2012; Petty et al., 2012; Creswell, 2013). Another reason for using the mixed method was because using one method could not satisfactorily answer the research questions (Dayana & Halim, 2016; Leavy, (2017). Together with exploring literature, these techniques were used to triangulate the data to design a framework for entrepreneurial skills for ICT TVET programmes. The triangulation of methods complements each other to derive more precise and meaningful data Leavy, (2017). Questionnaires were distributed to 20 Lecturers and 164 students in the ICT programme, and personal interviews were conducted with the 40 entrepreneurs.

4.3.1 The quantitative approach

The quantitative approach uses statistical and computer spreadsheet methods to collect and analyse data. According to researchers like Rahi (2017), the quantitative approach is a scientific method that uses the positivist paradigm, and it is most efficient for collecting objective data from a large sample population void of the emotions and feelings of the sample participants. The instruments used for the quantitative approach were self-administered questionnaires. The quantitative approach was impartial, measured actions, and tested the objectives with empirical data.

Rudhumbu (2015) highlights that the quantitative approach is used to collect descriptive data, examine the relationship between variables and produce numerical data that are analysed statistically. One disadvantage of the quantitative approach is that it does not study the problem in detail; that is where the qualitative approach complements it.

A quantitative approach was used because the data from the ICT TVET students can be objectively and numerically analysed since these facts are independent of the researcher's values and experiences. With this approach, the researcher got independent views from the participants regarding the components and elements required for an entrepreneurial skills framework for ICT programmes. Most importantly, in the end, the researcher tested the rhizome theory with what was happening on the ground to formulate a simulation conceptual framework for entrepreneurial skills for ICT TVET students. The Statistical Package for the Social Sciences (SPSS) and a Microsoft Excel spreadsheet were used for data analysis and calculations to understand the research problems. The quantitative approach is linked with the deductive approach.

4.3.2 The Qualitative Approach

In this study, a qualitative approach was also used since it emphasises an in-depth understanding of the research objectives. Researchers like Rahi (2017) acknowledge that the qualitative approach interprets the research objectives with a grounding theory to understand the problem in-depth. Rahi emphasises that multifaceted data can be collected using the qualitative approach. The qualitative approach is linked to the inductive approach, which is systematic and subjective. Interpretivism and constructivism are associated with the qualitative approach. The researcher used the qualitative approach to understand better participants' viewpoints regarding their feelings and emotions towards the research problem. The researcher used an interview guide to collect the qualitative data, which were later classified into themes and transcribed. This approach is best with a smaller sample size. This approach was used to understand the participants' experiences and interpret their viewpoints.

4.3.3 Mixed Methods Approach

This study used quantitative and qualitative methods (Mixed methods). The mixed method was used to gain more profound knowledge and answer the research questions. The mixed method research approach was used in this study because when combined these methods complemented each other during data collection and analysis. The mixed method also assisted the researcher in answering the research questions and developing the entrepreneurial skills framework.

Most Researchers, like Rahman (2016), agree that using the mixed method will prevent bias towards one approach and thus provide an in-depth perspective of the research problem. The mixed method provides more information and uses both exploration and analysis in answering the research questions.

4.4 Methodology

The complex research problem in the study demanded that two research instruments be used, a questionnaire and an interview, to collect the data. Both instruments complemented each other, and The study was conducted in three TVET Colleges in Cape Town, namely, College of Cape Town, Northlink College and False Bay College. The first part of the study pertains to secondary data collection, exploring the literature on entrepreneurial skills and the simulation teaching processes used in transferring hands-on skills. A document analysis was conducted to understand the current entrepreneurship education practices at TVET colleges and to evaluate how the curriculum utilises simulation in teaching ICT programmes. This provided guidelines on the development of appropriate questions to ask the participants.

The primary data collection was divided into three phases. In the first phase, the researcher used the quantitative research approach by distributing a self-administrated five-point Likert Scale questionnaire to the lecturers and students in the ICT Programme at the selected TVET colleges. The researcher distributed the questionnaires to the participants and verbally explained the purpose and aim of the research. The researcher was available to clarify any questions. The questionnaires for the students and lecturers answered the entrepreneurial skills focus in the curriculum and the current practices and assessment methods used in transferring entrepreneurial skills to ICT students. In this phase, the researcher gathered data that answered the first, second, fourth and fifth research questions.

The second phase of the data collection was the qualitative research approach in the form of personal interviews with the ICT lecturers. During this phase, the information gathered will be used to understand the skills taught, how they prepare them for the job market, and the challenges faced in teaching ICT graduates within the 4IR environment.

Based on the outcomes of the previous phases, the third phase also used a qualitative research approach. The data collection method consisted of personal interviews with owners of Small, Medium and Micro Enterprises (SMMEs). In this phase, the third research question will be answered. The interview questions consisted of open-ended questions that enabled the researcher to probe and have an in-depth understanding of the problem to determine their perspectives on entrepreneurial skills for ICT students and business opportunities in 4IR.

At the end of the process, the researcher answered the main research question of how an entrepreneurial skills framework can be developed for teaching ICT programmes through a refined compilation and development of a framework of entrepreneurial skills for ICT TVET students.

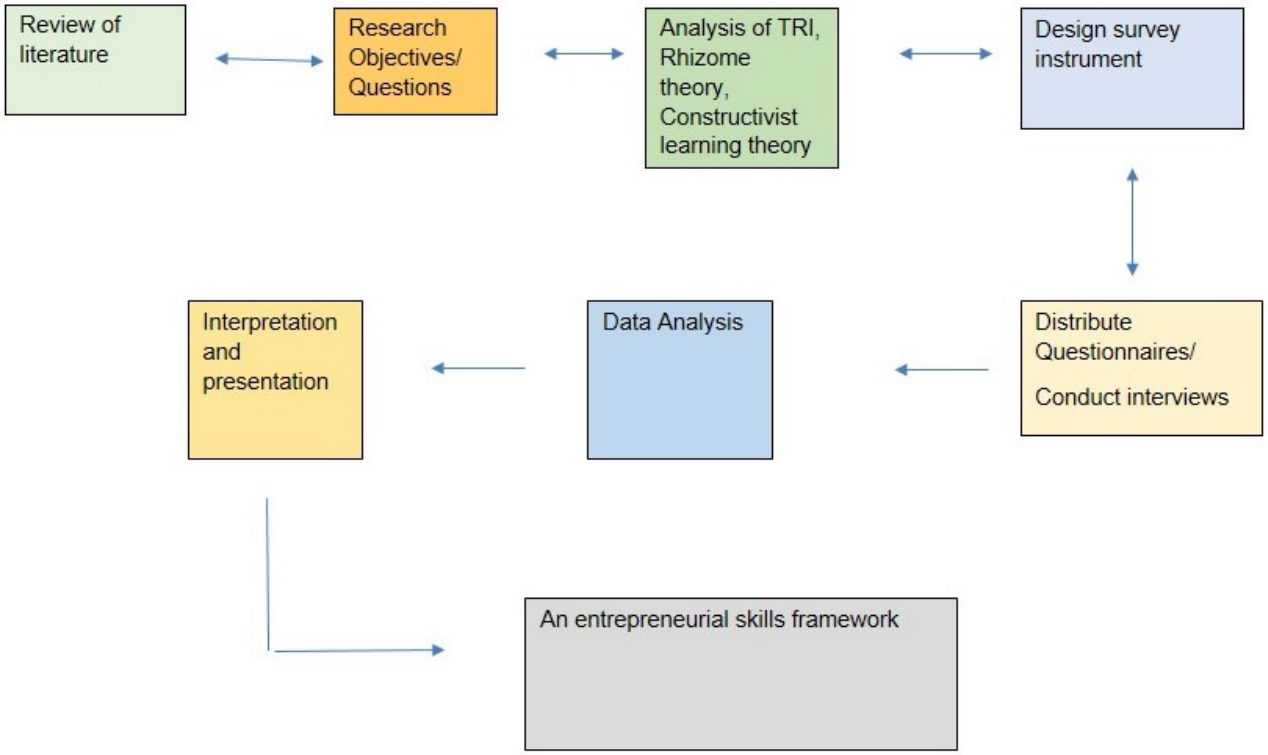


Figure 4.1: The methodological process of constructing the proposed framework

Source: Designed by the researcher

Figure 4.1 illustrates how the data will be collected and analysed in application with the research theories and model to develop the proposed framework.

4.4.1 Sample population and sample frame

The sample population consisted of selected TVET colleges, ICT lecturers and ICT students, and business owners (entrepreneurs). The sample frame was the TVET colleges offering the Cape Peninsula University of Technology (CPUT) Higher Certificate in Information and Communication Technology (HCICT), Small and Micro business owners who have been in operation for over three years. This research will focus on the TVET colleges that offer the CPUT HCICT as the case study. Creswell (2013) defines a research population as all individuals, objects, events, or concepts concerned about the research.

4.4.2 Sampling method

Researchers like Bernard (2006) and Yin (2009) posit that purposive sampling is suitable for selecting participants with credible and valuable knowledge and information about the study. Snowballing and purposive sampling as non-probability sampling methods were used in this study. Purposive sampling

was chosen because of the exploratory nature of the research and the small population group of TVET colleges, ICT lecturers, and ICT students. The snowballing sampling method was chosen because the sample population of business owners have unique traits, and the existing sample population will provide referrals for further sample subjects. The snowball technique was selected because it is a sampling method which involves identifying the most suitable participant, who, in turn, will introduce other eligible participants (Creswell, 2013; Fletcher & Marchildon, 2014; Habibi et al., 2014). Purposive sampling as a non-probability sampling method was used to select the TVET colleges in the Cape Town Municipality for the case study. The snowballing sampling method will be used to choose the small business owners.

4.4.3 Sample Size

The sample size of 164 students and 20 lecturers at TVET colleges included all the lecturers for the ICT programme. This sample size was determined using a total-population purposive sampling technique because the total population falls within an acceptable sample size for a case study (Yin, 2009; Croswell, 2014). The sample size of 41 business owners was determined when data saturation was attained where "no new information or themes were observed in the data", and the interviews were stopped (Tengeh et al., 2011; Croswell, 2014). The participants were selected based on the number of employees, years of business existence, and the company's annual turnover. These criteria enabled the researcher to categorise the enterprises as micro or small.

4.5 Data Collection Instruments

Research instruments collect information and data from research participants (Brynard and Hanekom, 2006). The research instruments form part of the techniques and strategies used to investigate a research problem and collect data. The research instruments used in this study are self-administered questionnaires and structured interview surveys.

4.5.1 Self-administered Questionnaires

The researcher used a predefined questionnaire to collect the data. The TRI and the Rhizome theory were used to inform the questionnaires and the interview guide, which will be modified from a predesigned instrument used in the study of Abdullahi et al. (2020). The researcher hand-delivered the questionnaires to the 20 lecturers and 164 students of the three selected TVET colleges. The researcher explained the study's purpose to each college's participants. The questionnaire used closed and open-ended questions and a five-point Likert scale to rate the questions. Researchers like Saunders et al. (2007) and Silverman (2013) suggest that the mixed method design provides an in-depth understanding of the research questions. Hence, the findings from one method could complement the findings of the other. Another

reason the research will use mixed methods is that these methods could offer valid and reliable data for constructing an entrepreneurial skill framework for ICT TVET students.

In the first phase of preliminary data collection, the instrument used was a self-administrated questionnaire administered to the students and lecturers in the Higher Certificate of ICT at TVET colleges. Open and closed-ended questions were used in the questionnaire to investigate the simulation components and processes in teaching and learning 4IR entrepreneurial skills in ICT programmes, focusing on the curriculum and current practices.

Table 4.1 Quantitative Population & Sample Size

Institutions	ICT Lecturers	ICT Students
TVET College 1	7 of 8	50
TVET College 2	4 of 6	53
TVET College 3	9 of 9	61
Total	20	164
Grand Total	184	

4.5.2 Structured Interview Survey.

In the second phase of preliminary data collection, the instrument used was an interview guide for lecturers of the Higher Certificate of ICT at TVET colleges. A personal interview session was conducted with the 20 Lecturers to investigate the entrepreneurial skills focus in the curriculum and the current practices of their teaching methods. The background of the participants was that of ICT academics in teaching and learning and an explanation of what simulation-based teaching and learning was introduced to the participants before the collection of data.

The third phase of the data collection instrument consisted of personal interviews with Small, Medium and Micro Enterprises (SMMEs) owners (40 entrepreneurs), which included semi-structured questions to enable the researcher to probe and have an in-depth understanding of the problem to determine their perspectives of entrepreneurial skills and business opportunities in 4IR.

Table 4.2 Qualitative Population and Sample Size (TVET College Lecturers and Entrepreneurs)

Participants	No. of Experts	Highest qualifications	Years of Experience
TVET 1 Lecturers	7	Masters	3 & Above
TVET 2 Lecturers	4	Masters	3 & Above
TVET 3 Lecturers	9	PhD	3 & Above
Entrepreneurs	41	PhD	3 & Above
Total	**61**		

4.6 Reliability and validity

Research needs to be credible, trustworthy, reliable and valid. Researchers like Tuli (2010), Tracy (2010) and Petty et al. (2012) suggest that a study could be considered reliable, credible and valid when the findings and outcomes of the research depict reality. A pilot study was conducted to test the data collection instruments (the predesigned questionnaire and interview guide). This study ensured credibility by using well-established research methods like mixed methods, both qualitative and quantitative methods (Creswell, 2014). To provide quality data and promote the validity and reliability of the data collected, the researcher used the principle of triangulation of data in both collection and analysis. One way to enhance methodological triangulation was by using questionnaires, interview guides and focus group guides within multiple data collection methods. Using mixed methods and triangulation techniques ensured fewer errors and increased the reliability and validity of the data (Mwangi, 2011; Creswell, 2014).

Cronbach's alpha was used to determine the reliability and consistency of the questionnaire-the quantitative research instrument. Researchers like Creswell & Clark (2018) agreed that Cronbach's alpha can be used to determine the internal consistency of a quantitative research instrument. The questionnaire measured the components and processes to develop a simulation conceptual framework for entrepreneurial skills in ICT programmes.

Reliability, as described in terms of Cronbach's Alpha coefficient (α), varies between 0 and 1. The Cronbach's Alpha indicates that the reliability coefficient of a questionnaire item on a scale correlates with one another. The higher the coefficient level, the more reliable the scale. The Table below shows the acceptable Cronbach's Alpha.

Table 4.3 Cronbach Alpha's Benchmark Scale

Number	Cronbach's Alpha	Indicator
1	Greater than 0.9	Excellent
2	Greater than 0.8	Very Good
3	Greater than 0.7	Good
4	Greater than 0.6	Fair
5	Greater than 0.5	Acceptable
6	Less than 0.5	Unacceptable
7	Greater or equal to 0.7	Highly reliable
8	Greater or equal to 0.8	Excellent reliable index

Researchers suggest that Cronbach's Alpha value of 0.7 is a minor reliability indicator, but lower coefficients may be acceptable, but any coefficients lower than 0.5 may not be permitted (Bhattacherjee, 2012).

4.7 Methods of Data Collection

In this study, the data was collected in two phases, starting with qualitative data collection and continuing with quantitative data collection.

4.7.1 Qualitative Data Collection

The qualitative phase of the data collection involved personal interviews with entrepreneurs. Open-ended questions were asked based on the research objectives. The experts were identified using the snowballing technique. The qualitative data collection method was used to gather the experts' experience, opinions, and perceptions on the teaching and learning components and processes required to develop a conceptual entrepreneurial skills framework for ICT programmes.

4.7.2 Quantitative Data Collection

Self-administrated questionnaires were distributed to the students and lecturers of the ICT programmes. To maximise the response rate of the questionnaires, the researcher hand-delivered the questionnaires to the participants. The researcher also explained the purpose of the research to the participants and was present to clarify any questions.

4.8 Data analysis methods

In this study, qualitative and quantitative data analysis techniques were used. Statistical and non-numerical analyses were used to analyse quantitative and qualitative data. Descriptive and inferential statistics, factor analysis, principal component analysis, and multivariate analysis, were used to analyse the quantitative data. A Cronbach Alpha test, Chi Square test and the Kaiser-Meyer Olkin test were performed to analyse the quantitative data. At the same time, thematic content and narrative analysis were used to analyse the qualitative data.

The quantitative data collected to achieve objectives 2: To identify the simulation elements and processes of teaching and learning that could be used to develop entrepreneurial skills in ICT; were analysed using principal component analysis, and a Cronbach alpha test, Chi Square test and a Kaiser-Meyer Olkin test were performed to analyse the validity and reliability of the data.

While a descriptive analysis was performed to analyse the data collected to achieve objectives 3: To identify the most relevant entrepreneurial skills to be developed by ICT students; objective 4: To identify the most relevant teaching methods that could be used to develop entrepreneurial skills in ICT; objective 5: To determine the best assessment methods to develop entrepreneurial skills in ICT students. and objectives 1: To determine experts' experiences and perceptions of using simulation-based learning in teaching and learning ICT and the results were illustrated in charts and figures.

4.8.1 Quantitative Data Analysis Method

This study's quantitative data analysis method was made possible using SPSS version 28. An exploratory factor analysis (EFA) was done. Then, a confirmatory factor analysis (CFA) was performed later to confirm the skills and components required to develop a simulation conceptual framework for entrepreneurial skills in ICT programmes. The quantitative instrument (Questionnaires) was used to collect participant data and analysed using SPSS 28.

4.8.1.1 Statistical analysis

This study will use SPSS and other inferential analysis techniques such as Chi Test, T-Test and Multivariate analysis in analysing the data. Frequency distribution will be used with histograms, bars and pie charts to analyse the data. Kendall's Coefficient of Concordance, Alpha Cronbach analysis, and Factor analysis in SPSS were used to examine the research questions and develop a simulation conceptual entrepreneurial skills framework.

4.8.2 Qualitative Data Analysis Method

The qualitative data was transcribed, and the content was coded into themes. The respondents also answered some questions using the five-point Likert scale. The data was coded manually, and AtlasTi software was used to analyse the data.

Non-numerical analysis was used to analyse the qualitative data. Qualitative data analysis techniques such as content analysis and narrative analysis were used to analyse data from the personal interviews.

4.9 Ethics

All parties involved in any study need to observe the ethical considerations to respect the participants' identities, interests and, ultimately, the quality of the data obtained from the research. Permission was obtained from the head of the school at the TVET colleges to conduct the study, and consent letters were given to the participants before data collection. Each small business owner was given a consent letter to be signed. The privacy of the participants' information and data was protected. Confidentiality, anonymity and the right to withdraw from the research were explained to the participants. This research conformed to all the ethical principles of the University as well as adhere to general research conduct procedures, such as honesty, ensuring the privacy and protection of sensitive information of the participants. The Protection of Personal Information Act (POPIA) was referenced when preparing the consent letters. Approval was obtained from the Faculty Ethics Committee and the University Ethics Committee. All COVID-19 regulation protocols were observed in the field.

4.10 Chapter summary

This chapter presented the research methodology for this study by discussing the process used for the research, methods used for data collection and data analysis. The study employed an exploratory

personal interview survey to collect qualitative and part of quantitative data, and the questionnaire was used to collect quantitative data. A snowball purposive sampling was used to collect qualitative data from 41 entrepreneurs/business experts. In contrast, a total population purposive sampling was employed to collect the quantitative data from 184 respondents (164 students and 20 Lecturers). Questionnaires were distributed to obtain information from respondents on the most relevant simulation elements (skills) and processes (teaching methods) used to develop a conceptual framework for entrepreneurial skills in ICT programmes. Chapter five discusses and analyses the data quantitative data collected from the lecturers and the students.

CHAPTER FIVE

QUANTITATIVE DATA ANALYSIS AND DISCUSSION FROM LECTURERS AND STUDENTS

5.1 Introduction

This chapter presents and discusses the findings from the questionnaires distributed to the students and lecturers in the ICT programme. The qualitative data from the business owners will be discussed in chapter six. In discussing the findings from the questionnaires, constant reference was made to the research objectives and the theoretical review of the literature contained in Chapter Two.

This study aimed to develop an entrepreneurial skills acquisition framework for ICT students at TVET colleges. The research questions and objectives were formulated concerning the literature to determine the key components and processes of simulation teaching and learning in developing entrepreneurial skills for ICT students. The self-administrated questionnaire (see Appendix B and Appendix C) was used to collect data from the respondents in the study area. The data collected were analysed using the social sciences statistical software: SPSS 32.

5.2 Quantitative results for simulation elements (skills) and processes (teaching methods) in teaching and learning from Students and Lecturers

Research Objective 2: To identify the simulation elements and processes of teaching and learning that could be used to develop entrepreneurial skills in ICT.

Research Question 2: What simulation elements and learning processes could guide the development of an entrepreneurial skills framework in the ICT programme within the 4IR?

This objective was meant to determine the simulation elements (skills) and processes (teaching methods) used in teaching and learning to develop entrepreneurial skills in the ICT TVET students. These skills were used to determine how the influence of simulation in class could enable students to solve a problem in a real-life setting. To answer this research objective, the responses of the participants (the students and the lecturers) were coded, scored and used to perform the Cronbach's alpha test and the Kaiser Meyer-Olkin (KMO) test of adequacy to determine the reliability of the variables and an exploratory factor analysis test was conducted to assess the similarity of the variables.

5.2.1 Confirmed reliability measurement for simulation elements (skills) in teaching and learning from Students and Lecturers

The simulation elements were measured by a series of questionnaire statements and their responses were evaluated using Cronbach's alpha (CA) test of reliability, and the Kaiser Meyer-Olkin (KMO) test of adequacy. Responses of the statement that ranked above 0.5 showed satisfactory indicator reliability for the measurement model. The questionnaire statements evaluated showed above 0.7, which indicated an excellent reliability score. Five components were assessed in the study to examine the implementation of a simulation-based entrepreneurial skills framework for ICT students. These five elements include problem-solving ability, project-based activities, teamwork abilities, the role of the student in learning, and the role of the teacher in teaching and learning. These components were used to construct questionnaire questions. The results are presented in Table 5.1 and Table 5.2.

Table 5.1. Confirmed reliability measurement of the simulation elements from Students

Components	Cronbach's Alpha (α)	Kaiser-Meyer-Olkin (KMO)	Approx. Chi-Square (X2)	Degree of freedom (df)	Significance (P Value)
Problem	0.783	0.732	760.223	105	0.000
Project	0.885	0.778	1363.146	136	0.000
Teamwork	0.811	0.697	632.207	78	0.000
Student role	0.866	0.786	1190.021	136	0.000

Table 5.2. Confirmed reliability measurement of the simulation elements from Lecturers

Components	Cronbach's Alpha (α)	Kaiser-Meyer-Olkin (KMO)	Approx. Chi-Square (X^2)	Degree of freedom (df)	Significance
Problem	0.820	0.343	257.899	105	0.000
Project	0.870	0.343	309.560	136	0.000
Teamwork	0.832	0.362	245.394	78	0.000
Lecturer's role	0.895	0.410	367.902	136	0.000

From Table 5.1 and Table 5.2, the components analysed by students and lecturers indicated a high-reliability factor above 0.7. The results showed that both the lecturers and the students agreed that there should be simulation elements of problem-solving learning, project-based learning, and teamwork, and the teachers and students both play an essential role in developing and acquiring entrepreneurial skills.

The results, as indicated in Table 5.1, indicate that the responses from the student participants were very reliable and adequate, with a Cronbach alpha (α) of 0.783, which is above 0.7. Participants strongly agreed that integrating problem-solving learning in the teaching and learning in the ICT programme is vital. Table 5.2 shows the measurements of the fifteen questionnaire questions from the teachers, indicating that teachers agreed with problem-based teaching and learning for ICT programmes with a reliability score of 0.852.

It is important to note that Tables 5.1 and 5.2 both indicate that the students and lecturers agree that their respective roles are crucial for acquiring entrepreneurial skills in the ICT programme. There was a very high reliability score of 0.895 for the teacher's role and a very high reliability score of 0.866 for the student's role.

5.2.1.1. Problem-based teaching and learning components

The questionnaire questions measuring the problem-solving aspect of simulation components consisted of fifteen (15) questions for students and lecturers. The participants were asked to rate their level of agreement with the relevant qualities of problem-solving to develop a practical simulation conceptual framework for the teaching and learning entrepreneurial skills for ICT students at TVET colleges in South Africa. Some qualities with a high-reliability score were as follows: the problem-solving component should support peer evaluation with a score of .812 for the students and .942 for the teachers. Both the students, with a reliability score of .836, and the teachers, with a reliability score of .835, were in high agreement that the problem-solving component for the students should motivate the students to know and learn more.

Other qualities with satisfactory reliability scores will include that the problem-solving component should be realistic with the students' experiences, with students agreeing at a score of .689 and teachers agreeing at a score of .651. Both participants (the students and the teachers) highly agreed that the problem-solving component of any teaching and learning activity should also foster communication skills and be multidisciplinary (see Table 5.3). As indicated in Table 5.3, the responses from the student participants were very reliable and adequate, with a Cronbach alpha (α) above 0.5, of which the total reliability score of the students is 0.783 (Table 5.1), which is above the minimum of 0.5. Participants strongly agreed that integrating problem-solving learning in the teaching and learning in the ICT programme is vital. Table 5.3 shows the measurements of the questionnaire questions from the teachers; they are also in high agreement with problem-based teaching and learning for ICT programmes with a reliability score of 0.852 (table 5.2).

Overall, the items showed satisfactory reliability with Cronbach alpha (a) of 0.783 for Students and .852 for Teachers (see Table 5.1 and 5.2), which is more than the minimum of 0.5. There was 1 question item (Item 11) that was less than the minimum of 0.5. This still shows the analysis scores were of a good fit and very satisfactory.

Table 5.3: Rotated Component Matrix for problem-based teaching and learning

Questionnaire items	Principal Component analysis	
	Students	Lecturers
1. The problem supports peer evaluation	0.812	0.942
2. The problem should promote debate	0.796	0.612
3. The problem should be adapted to students‘ prior knowledge	0.620	0.932
4. The practical simulation problem should be complex	0.523	0.867
5. The problem should motivate students to know and learn	0.836	0.885
6. The problem should be realistic with students' experiences	0.689	0.651
7. The problem should be exciting and engaging	0.627	0.541
8. The problem engages students in the learning process, understanding	0.581	0.828
9. The problem should be ill-structured	0.827	0.883
10. The problem should be open-ended	0.722	0.911
11. The problem should support self-evaluation	0.441	0.595
12. The problem should allow the application of many concepts	0.741	0.660
13. The problem should foster communication skills	0.715	0.566
14. The problem should have more valid approaches	0.771	0.746
15. The problem should be multidisciplinary and build extensive knowledge	0.720	0.895

5.2.1.2. Project-based Teaching and Learning Component

The instrument measuring the Project aspect of the simulation teaching and learning component consists of 17 questions. Table 5.4 presents the reliability scores measuring the project-based teaching and learning components. The analysis results in Table 5.4 show a satisfactory reliability score, with the

majority above the minimum score of 0.5. However, item 6 for the students showed a reliability score of less than 0.5. The measurement omitted this item to obtain an adequate Cronbach alpha score.

Several qualities had a high reliability score above 0.7 from the students and the teachers (see Table 5.4). Some examples will include that the project should have clear objectives and expected results, and the project-based learning component should build the students' technical, decision-making, and leadership skills. As a result, the responses from both the students and the teachers regarding project-based components were very satisfactory, with scores of .870 and .885 (see Table 5.1 and Table 5.2). Some qualities with a good reliability score above 0.5 were as follows: the project-based teaching and learning component should guide students' logical reasoning, enhance creative and innovative skills, and build students' teamwork skills.

Table 5.4: Rotated Component Matrix for project-based learning

Questionnaire items	**Principal Component analysis**	
	Students	**Lecturers**
1. The project should have clear objectives and expected results	0.822	0.914
2. The project should have a completion timeframe	0.841	0.913
3. The project should be structured to build students' cooperative skills	0.557	0.561
4. The project must have justifiable reasons for its execution	0.790	0.538
5. The project should develop students' negation and dialogue skills	0.613	0.903
6. The project should inspire the students to share their vision	0.466	0.837
7. The project must have a budget estimate	0.748	0.741
8. The project must have a target audience	0.793	0.667
9. The project enables students' communication skills	0.694	0.883
10. The project should guide student's logical reasoning	0.669	0.769
11. The project should build their teamwork skills	.596	.685
12. The project should enhance creativity and innovation skills	0.782	0.583

13. The project should develop students decision making skills	0.726	.766
14. The project should develop students' accountability skills	0.583	0.697
15. The project should build their technical skills	0.709	0.895
16. The project should build their leadership skills	0.716	0.643
17. The project should have provisions for formative and summative evaluation	0.681	0.838

5.2.1.3. Students' role in teaching and learning

The instrument measuring the student's role in the simulation teaching and learning component consists of 16 questions. Table 5.5 presents the reliability scores. The analysis results in Table 5.5 show a satisfactory reliability score, with most scores above the minimum score of 0.5.

Several qualities had a high-reliability score above 0.7 from the student's role, with a score of .866 (see Table 5.1). Some examples of items with a high-reliability score include analysing the problem with current knowledge with a score of .834, fine-tuning the problem with a score of .834, and examining the learning objectives with a score of .752 (Table 5.5). Some qualities with a satisfactory reliability score above 0.5 were as follows: the student's role is to strategise with team members, encourage independent research, plan and assign tasks, respond to the given assessment and evaluation, and ensure the project is fully executed.

Table 5.5: Rotated Component Matrix for student's role in learning

Questionnaire items	**Principal Component analysis**
Student's role	**Students**
Q1.	0.834
Q2.	0.783
Q3.	0.718
Q4.	0.658
Q5.	0.752
Q6.	0.647

Q7.	0.645
Q8.	0.685
Q9.	0.563
Q10.	0.521
Q11.	0.867
Q12.	0.662
Q13.	0.599
Q14.	0.834
Q15.	0.829
Q16.	0.838

5.2.1.4. Lecturers' role in teaching and learning

The instrument measuring the student's role in the simulation teaching and learning component consists of 15 questions. Table 5.6 presents the reliability scores. The analysis results in Table 5.5 show a satisfactory reliability score, with most scores above the minimum score of 0.5.

Several qualities had a high reliability score above 0.7 from the lecturer's role, with a score of .895 (see Table 5.2). Some examples of items with a high-reliability score include the teacher's role in responding to the assessment given with a score of .921, generating analytical questions with a score of .829 and assessing student's performance with a score of .868 (Table 5.6). Some qualities with a satisfactory reliability score above 0.5 were as follows: the teacher's role is to provide feedback to the students and to prevent the students from straying off-topic (Table 5.6).

Table 5.6: Rotated Component Matrix for Lecturer's role in the learning

Questionnaire items	**Principal Component analysis**
Lecturer's role	**Lecturers**
Q1.	0.921
Q2.	0.868
Q3.	0.829
Q4.	0.818
Q5.	0.813

Q6.	0.761
Q7.	0.746
Q8.	0.868
Q9.	0.839
Q10.	0.806
Q11.	0.666
Q12.	0.812
Q13.	0.796
Q14.	0.643
Q15.	0.708

5.2.1.5. Teamwork component in teaching and learning

The instrument measuring the teamwork component of the simulation teaching and learning component consists of 13 questions. Table 5.6 presents the reliability scores measuring the teamwork aspect of teaching and learning. The analysis results in Table 5.7 show a satisfactory reliability score, with the majority above the minimum score of 0.5.

Several qualities had a high reliability score above 0.7 from the students and the teachers (see Table 5.7). Some examples include that teamwork should promote collaboration, trust, and intrinsic motivation among team members (see Table 5.7). Overall, the responses from both the students and the teachers regarding teamwork components were very satisfactory, with scores of .811 and .833, respectively (see Table 5.1 and Table 5.2). Some qualities with a good reliability score above 0.5 were as follows: teamwork should enhance multitasking and promote communication and persistence among members.

Table 5.7: Rotated Component Matrix for teamwork based learning

Questionnaire items	**Principal Component analysis**	
	Students	**Lecturers**
1. The teamwork should promote collaboration and trust	0.718	0.744
2. The teamwork should have the ability to carry out multitasks	0.674	0.756
3. The teamwork should create self-awareness among members	0.657	0.731
4. The teamwork members should have defined roles with common goals	0.628	0.851
5. The teamwork should promote intrinsic motivation of members	0.608	0.799

6. The teamwork should promote persistence among team members	0.604	0.753
7. The teamwork should have mutual accountability among members	0.595	0.653
8. The teamwork should have a clear sense of direction	0.579	0.825
9. The teamwork should encourage diverse opinions among members	0.553	0.939
10. The teamwork members should have defined roles	0.669	0.736
11. The teamwork should be open and honest communication	0.596	0.919
12. The teamwork number of team members drops as the students move to higher levels	0.782	0.926
13. The teamwork should provide room for debate among members	0.726	0.942

5.2.2 Simulation processes (teaching methods) in teaching and learning entrepreneurial skills from students and lecturers.

The survey questions were evaluated using a five-point Likert scale: one strongly disagree, two disagree, three neutral, agree, and five strongly agree. The responses were assessed using factor analysis, and Cronbach's four alpha (CA) test of reliability and Kaiser Meyer-Olkin (KMO) test of adequacy were performed. Reliability scores above 0.5 showed satisfactory indicators of reliability for the questionnaire items. The components evaluated showed above 0.7, which indicated a perfect reliability score. The study assessed six processes in teaching and learning to examine the implementation of an entrepreneurial skills framework for ICT students. These six processes in teaching and learning include problem orientation and analysis, project initiation and execution, project simulation and execution, learning objectives, learning outcomes, assessment methods and public presentation. These components were used to construct questionnaire questions. The confirmed reliability measurement analysis is presented in Table 5.8 and Table 5.9.

Table 5.8. Measurement of the processes for acquiring entrepreneurial skills viewpoint from Students

Processes	Cronbach's Alpha (α)	Kaiser-Meyer-Olkin (KMO)	Approx. Chi-Square (X^2)	Degree of freedom (df)	Significance (P Value)
Problem-orientation analysis	0.912	0.838	1334.714	120	0.000
Project initiation and execution	0.924	0.848	1941.838	190	0.000
Project simulation and execution	0.811	0.787	1853.3	160	0.000
Learning objectives	0.866	0.786	856.331	92	0.000
Public presentation	0.871	0.792	791.125	55	0.000

Table 5.9. Measurement of the processes of acquiring entrepreneurial skills viewpoint from Lecturers

Components	Cronbach's Alpha (α)	Kaiser-Meyer-Olkin (KMO)	Approx. Chi-Square (X^2)	Degree of freedom (df)	Significance (P Value)
Problem-orientation analysis	0.820	0.711	158.660	130	0.000
Project initiation and execution	0.939	0.875	194.838	96	0.000

Project simulation and execution	0.870	0.778	156.325	105	0.000
Learning objectives	0.951	0.759	188.254	88	0.000
Public presentation	0.987	0.797	781.125	120	0.000
Learning Outcomes	0.905	0.904	785.265	96	0.000
Assessment methods	0.963	0.850	178.524	155	0.000

From Table 5.8 and Table 5.9, the processes for acquiring entrepreneurial skills, as the teachers and lecturers analysed, indicated a high reliability factor above 0.7. Both the teachers and the students strongly agreed that it is essential to include problem orientation learning, simulation project learning, and adequate learning outcomes and assessment methods that will assist in developing entrepreneurial skills in ICT students. The results indicated that both the lecturers and the students strongly agreed that there should be simulation elements of problem orientation learning, simulation project-based learning, an aspect of public presentation, and the learning outcomes and the assessment methods play an essential role in developing and acquiring entrepreneurial skills.

As indicated in Table 5.8, the results suggest that the student participants' responses regarding problem orientation learning are very relevant, with a Cronbach alpha (α) of 0.912, above 0.7. Participants strongly agreed that integrating problem orientation learning in the teaching and learning in the ICT programme is vital. Table 5.9 shows the measurements of the fifteen questionnaire questions from the teachers, which also indicated teachers were in high agreement with problem orientation-based teaching and learning for ICT programmes with a reliability score of 0.820.

It is important to note that Tables 5.8 and 5.9 both indicate that the students and teachers strongly agree that learning outcomes (0.866 and 0.905, respectively), project simulation learning and assessment methods (0.811 and 0.963, respectively) play a crucial role in the acquisition of entrepreneurial skills in the ICT programme. There was a very high reliability score of 0.895 for the lecturer's role and a very high reliability score of 0.866 for the student's role.

The results obtained followed the guidelines of Hair et al. (2013) and Ringle, Wende and Will (2015). Which indicates that, the degree of freedom and corresponding chi-square and P-values are reported to

decide the extent of the relationship in this study. The P- P-value needs to be at least at the significance level of 0.05, Hair et al. (2013).

As presented in Table 5.8 and Table 5.9, the validated element and process of simulation-based learning (SBL) significantly aligned with the proposed model in this study. As represented in Table 5.8 and Table 5.9, all five factors of the SBL elements are related considerably; this can be confirmed by the statistical estimates, which show a significant difference with a p-value of < 0.05 in all the elements. This relationship showed a greater relationship between the SBL elements (entrepreneurial skills) and Process (teaching methods) and thus can be used to develop a framework for the study.

5.2.2.1. Problem-orientation and analysis process

The instrument measuring the problem-orientation analysis process of the simulation teaching and learning process consists of 16 questions. Table 5.10 presents the reliability scores measuring the problem-orientation and analysis process of teaching and learning. The analysis results in Table 5.10 show a satisfactory reliability score, with the majority above the minimum score of 0.5.

Some qualities had a high-reliability score above 0.7 from the students and the teachers (see Table 5.8 and Table 5.9). Some examples will include that problem-orientation analysis should investigate how the problem affects the target beneficiaries (Q4: 0.765), analyse the problem critically (Q6:0.501), decide the most effective solution for each problem (Q10:0.893) and revisit the problem where necessary (Q14:0.899) as seen in Table 5.10. The responses from both the students and the teachers regarding problem orientation and analysis were very satisfactory, with scores of 0.919 and 0.820, respectively (see Table 5.8 and Table 5.9). Most of the questionnaire items had a good reliability score above 0.5. Thus, the students and the lecturers strongly agree that problem orientation and analysis is an essential aspect to include in the teaching and learning of ICT students to develop entrepreneurial skills.

Table 5.10 Measurement Matrix for Problem Orientation & Analysis Process

Process	**Questionnaire items**	**Principal Component analysis factors**
Problem Orientation/Analysis	Q1	0.845
	Q2	0.784
	Q3	0.708
	Q4	0.765
	Q5	0.940
	Q6	0.501
	Q7	0.938
	Q8	0.715
	Q9	0.910

	Q10	0.893
	Q11	0.842
	Q12	0.950
	Q13	0.888
	Q14	0.899
	Q15	0.875
	Q16	0.862

5.2.2.2. Project Initiation and execution process

There were 20 questions with regards to project initiation and execution as a process to follow for the acquisition of entrepreneurial skill as shown in Table 5.11. Based on the study, the results suggested measuring the process of project initiation and execution as an aspect of the teaching and learning process. Sixteen items measuring showed loadings 0.7 and above, indicating satisfactory loading. However, four (4) items showed factor loadings of less than 0.7 but were still above 0.5 acceptable factor loadings. However, the item showed satisfactory reliability with the Cronbach alpha value of 0.924 from students and 0.939 from students and Lecturers, respectively, as shown in Table 5.8 and Table 5.9, which is more than the minimum of 0.7 higher than the requirement of 0.5.

Several qualities had a high-reliability score above 0.7 from the students and the teachers (see Table 5.8 and Table 5.9). Some examples will include that project initiation and execution should define the execution strategy (Q3: 0.708), should also provide extensive practice in the application of the skill (Q8: 715), and be able to use skills appropriately and effectively in response to challenging circumstances (Q10: 0.893) as shown in Table 5.11. Accordingly, the reactions from both the students and the teachers regarding project initiation and execution were very satisfactory, with scores of 0.924 and 0.939, respectively (see Table 5.8 and Table 5.9). Most of the questionnaire items had a satisfactory reliability score above 0.5.

Table 5.11 Measurement matrix for Project initiation and execution process

Process	**Questionnaire items**	**Principal Component analysis factors**
Project initiation and execution	Q1	0.845
	Q2	0.784
	Q3	0.708
	Q4	0.765

	Q5	0.940
	Q6	0.501
	Q7	0.938
	Q8	0.715
	Q9	0.910
	Q10	0.893
	Q11	0.542
	Q12	0.950
	Q13	0.656
	Q14	0.899
	Q15	0.875
	Q16	0.862
	Q17	0.798
	Q18	0.987
	Q19	0.515
	Q20	0.877

5.2.3. Project simulation and execution process

Table 5.12, presents the results based on the analysis, they measured the process of Project simulation and execution as an aspect of the teaching and learning process. 18 of the questions indicated 0.7 and above, indicating satisfactory loading. However, two (2) items showed factor loadings of less than 0.7 but were still above 0.5 acceptable factor loadings. In all, the questions showed satisfactory reliability with the Cronbach alpha value of 0.811 from students and 0.870 from students and Lecturers, respectively, as shown in Table 5.8 and Table 5.9, which is more than the minimum of 0.7 higher than the requirement of 0.5. Thus, the students and the lecturers strongly agree that project simulation and execution is an important aspect to include in the teaching and learning of ICT students to develop entrepreneurial skills.

Several qualities had a high reliability score above 0.7 from the students and the teachers (see Table 5.8 and Table 5.9). Some examples will include that project simulation and execution should define the execution strategy (Q3: 0.611), should also demonstrate skills step by step, provide extensive practice in the application of the skill (Q7: 925) and be able to use skills appropriately and effectively in response to challenging circumstances (Q10: 0.918) as shown in Table 5.12. Therefore, the reactions from both the students and the teachers regarding project simulation and execution were very satisfactory, with scores of 0.811 and 0.870, respectively (see Table 5.8 and Table 5.9). Most of the questionnaire items had a good reliability score above 0.5.

Table 5.12 Measurement matrix for Project simulation and execution process

Process	Questionnaire items	Principal Component analysis factors
Project simulation and execution	Q1	0.919
	Q2	0.920
	Q3	0.611
	Q4	0.952
	Q5	0.460
	Q6	0.933
	Q7	0.925
	Q8	0.500
	Q9	0.904
	Q10	0.918
	Q11	0.452
	Q12	0.908
	Q13	0.899
	Q14	0.507
	Q15	0.725
	Q16	0.770
	Q17	0.898
	Q18	0.787
	Q19	0.915
	Q20	0.987

5.2.4. Learning objectives process

The instrument measuring the learning objectives process of the simulation teaching and learning process consists of 21 questions. Table 5.10 presents the reliability scores measuring the learning objectives of the teaching and learning process. The analysis results in Table 5.13 show a satisfactory reliability score, with most scores above the minimum score of 0.5.

Several qualities had a high-reliability score above 0.7 from the students and the teachers (see Table 5.8 and Table 5.9). Some examples will include that learning objectives should investigate how the learning objectives should aim at addressing the root causes of the problem (Q2: 0.877), must focus on the desired outcome (Q3:0.901), should be challenging enough to give rise to innovation and fresh approaches

(Q7:0.987) and should be stated in quantifiable and measurable terms (Q9:0.905) as seen in Table 5.13. Hence, the responses from the students and the teachers regarding learning objectives were very satisfactory, with scores of 0.866 and 0.951, respectively (see Table 5.8 and Table 5.9). Most of the questionnaire items had an acceptable reliability score above 0.5. Thus, the students and the lecturers strongly agree that learning objectives are essential to include in the teaching and learning of ICT students to develop entrepreneurial skills.

Table 5.13 Measurement Matrix for Learning Objectives Items

Process **Learning objectives**	**Questionnaire items**	**Principal Component analysis factors**
	Q1	0.753
	Q2	0.877
	Q3	0.901
	Q4	0.927
	Q5	0.460
	Q6	0.933
	Q7	0.987
	Q8	0.887
	Q9	0.905
	Q10	0.979
	Q11	0.914
	Q12	0.789
	Q13	0.778
	Q14	0.706
	Q15	0.725
	Q16	0.770
	Q17	0.866
	Q18	0.787
	Q19	0.906
	Q20	0.987
	Q21	0.864

5.2.5. Public presentation process

The instrument measuring the simulation teaching and learning process's public presentation process consists of 11 questions. Table 5.14 presents the reliability scores measuring the public presentation

process of teaching and learning. The analysis results in Table 5.14 show a satisfactory reliability score, with the majority above the minimum score of 0.5.

Several qualities had a high-reliability score above 0.7 from the students and the teachers (see Table 5.8 and Table 5.9). Some examples will include that public presentation should ensure that there should be a series of practices and rehearsals before the main presentation (Q11: 0.917); the public presentation process should also ensure that the students prepare visual aids and keep the time for this limited as too many visuals may become distracting (Q8: 0.992). Students are given a transcript or an outline of the presentation (Q2: 991), as seen in Table 5.14. So, the responses from the students and the teachers regarding public presentation were very satisfactory, with scores of 0.871 and 0.987, respectively (see Table 5.8 and Table 5.9). Most of the questionnaire items had a good reliability score above 0.5. Thus, the students and the lecturers strongly agree that public presentation is an essential aspect to include in the teaching and learning of ICT students to develop entrepreneurial skills.

Table 5.14 Measurement Matrix for the Public Presentation Process

Process	**Questionnaire items**	**Principal Component analysis factors**
Public presentation	Q1	0.996
	Q2	0.991
	Q3	0.988
	Q4	0.605
	Q5	0.866
	Q6	0.933
	Q7	0.995
	Q8	0.992
	Q9	0.984
	Q10	0.979
	Q11	0.917

5.3. Quantitative Results for relevant entrepreneurial skills from Lecturers.

Research Objective 3: To identify the most relevant entrepreneurial skills to be developed by ICT students

Research Question 3: What are the most relevant entrepreneurial skills to be developed by ICT graduates in the 4IR?

This objective was meant to determine the most relevant entrepreneurial skills to be developed by ICT students at TVET colleges. These skills were used to determine how the influence of simulation in class could enable students to solve a problem in a real-life setting. The participants' responses (the lecturers and the business experts/entrepreneurs) were used to answer this research objective. They were coded, scored and used to perform the Cronbach's alpha test and the Kaiser Meyer-Olkin (KMO) test of adequacy to determine the reliability of the variables. An exploratory factor analysis test was conducted to assess the similarity of the variables. The results of the measurement models are presented in Table 4.15.

5.3.1 Learning Outcomes (skills) process

The learning outcomes process of the simulation teaching and learning process consists of 20 questions. Table 5.15 presents the reliability scores measuring the learning outcome process of teaching and learning. The analysis results in Table 4.15 show a satisfactory reliability score, with the majority above the minimum score of 0.5.

Several qualities had a high reliability score above 0.7 from the students and the teachers (see Table 5.8 and Table 5.9). Some examples will include that the learning outcomes should ensure that the students acquire problem-solving skills (Q1: 0.772), as well as Technology application skills (Q2: 0.820), Critical thinking skills (Q3:0.748), Creativity and Innovative skills (Q6: 0.859) and Interpersonal skills (Q12: 0.832) as shown in Table 5.15. Overall, the responses from the Lecturers regarding learning outcomes were very satisfactory, with a score of 0.905 (see Table 5.9). Most questionnaire items of the learning outcomes (skills) had a good reliability score above 0.5. Thus, the lecturers strongly agreed that the learning outcomes (Skills) stated are essential to include in the teaching and learning of ICT students to develop entrepreneurial skills.

Table 5.15 Measurement Matrix for Learning Outcomes Process

Process	Questionnaire items	Principal Component analysis factors
Learning outcomes	Q1	0.772
	Q2	0.820
	Q3	0.748
	Q4	0.927
	Q5	0.800
	Q6	0.859
	Q7	0.987
	Q8	0.887
	Q9	0.975
	Q10	0.820
	Q11	0.986
	Q12	0.832
	Q13	0.802
	Q14	0.807
	Q15	0.791
	Q16	0.870
	Q17	0.966
	Q18	0.721
	Q19	0.904
	Q20	0.807

5.4. Quantitative Results for the assessment methods to be used for the development of entrepreneurial skills in ICT students

Research Objective 5: To determine the best assessment methods to develop entrepreneurial skills in ICT students.

Research Question 5: What are the best assessment methods to develop entrepreneurial skills in ICT students?

This objective was meant to determine the simulation processes used in teaching and learning to develop entrepreneurial skills in the students. These processes were used to determine how the influence of simulation in class could enable students to solve a problem in a real-life setting and design an entrepreneurial skills acquisition framework. To answer this research objective, the responses of the

participants (the lecturers) were coded, scored and used to perform the Cronbach's alpha test and the Kaiser Meyer-Olkin (KMO) test of adequacy to determine the reliability of the variables and an exploratory factor analysis test was conducted to assess the similarity of the variables. The measurement model of the study's objectives was validated. The results of the measurement models are presented in Table 5.16.

5.4.1. Assessment Methods

In the questionnaire, 16 questions were asked to evaluate the assessment methods as a process of acquiring entrepreneurial skill. Table 5.16, presents the results measuring the assessment methods as part of the processes for acquiring entrepreneurial skills.

Based on the analysis, the results measured the Assessment Methods aspect of the simulation learning process in acquiring entrepreneurial skills. 15 questions measuring the assessment process showed loadings 0.7 and above, indicating satisfactory loading. Therefore, the question showed an acceptable reliability with the cronbach alpha value (a) of 0.963 which is more than the minimum of 0.7.

Several qualities (assessment methods) had a factor analysis score above 0.7 from both lecturers (see Table 5.8 and Table 5.9). Some examples will include that the assessment methods should involve assessment rubrics (Q4: 0.856), Self-reflections (Q2: 0.860), peer coaching (Q12:0.874) as well as Mastery classes (Q15: 0.899) and summative assessments (Q16:0.822) as seen in Table 4.13. Thus, the teachers' responses regarding assessment methods were very satisfactory, scoring 0.963 (see Table 5.9). Most of the questionnaire items had an acceptable reliability score above 0.5, the lecturers strongly agree that assessment methods are an essential aspect of teaching and learning ICT students to develop entrepreneurial skills.

Table 5.16 Measurement Matrix for Assessment Methods Processes

Process Assessment methods	**Questionnaire items**	**Principal Component analysis factor**
Self-assessment	Q1	0.856
Self-reflection	Q2	0.860
Student surveys	Q3	0.850
Self-assessment rubrics	Q4	0.856
Checklist	Q5	0.799
Peer assessment	Q6	0.898
Provide 10-Minute Peer Feedback System	Q7	0.879

Structured Feedback	Q8	0.627
3-2-1 Structure	Q9	0.705
See-Think-Wonder	Q10	0.679
Feedback Carousel	Q11	0.914
Peer Coaching	Q12	0.874
Advice Conference	Q13	0.847
Reflection Conferences	Q14	0.806
Mastery Conference	Q15	0.899
Summative assessment	Q16	0.822

5.5. Demographic data from the students and the lecturers

In this section, the demographic data such as the gender, age, race, highest qualifications, and years of service of the participants (students and teachers) will be discussed.

5.5.1. Gender of students

One hundred sixty-four students from 3 different public TVET colleges participated in this study; 70 % of the student participants were male, and 30 % were female. These results show that most participants were males, meaning more males than females are interested in ICT. The results are shown in Figure 4.1.

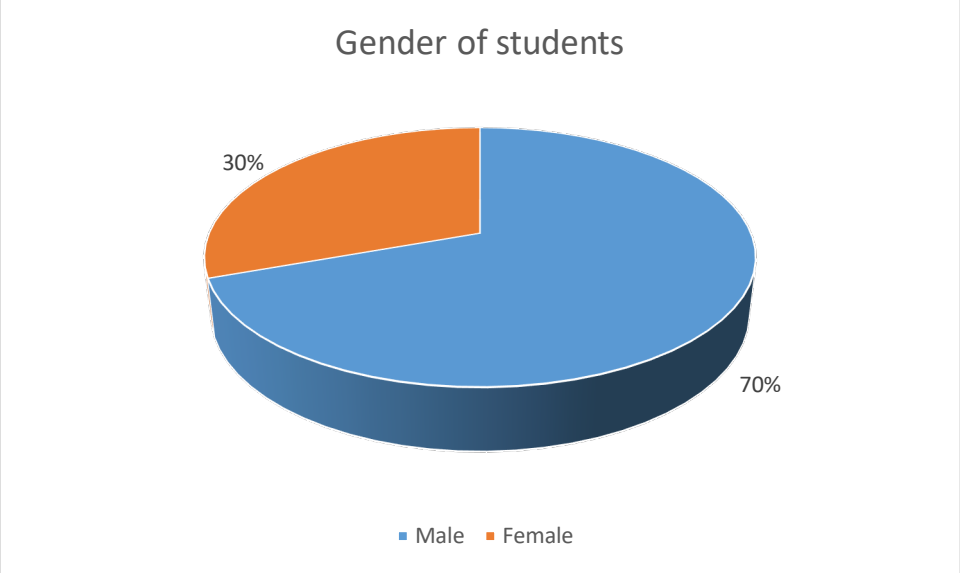


Figure 5.1: Gender of the students

5.5.2 Race of Students

The race distribution of the student respondents included 55% being coloured, 44% being black, and just 1% being white. This reflects the race population distribution in Cape Town, where the majority are the coloureds, followed by the blacks and then the whites. The results are demonstrated in Figure 4.2.

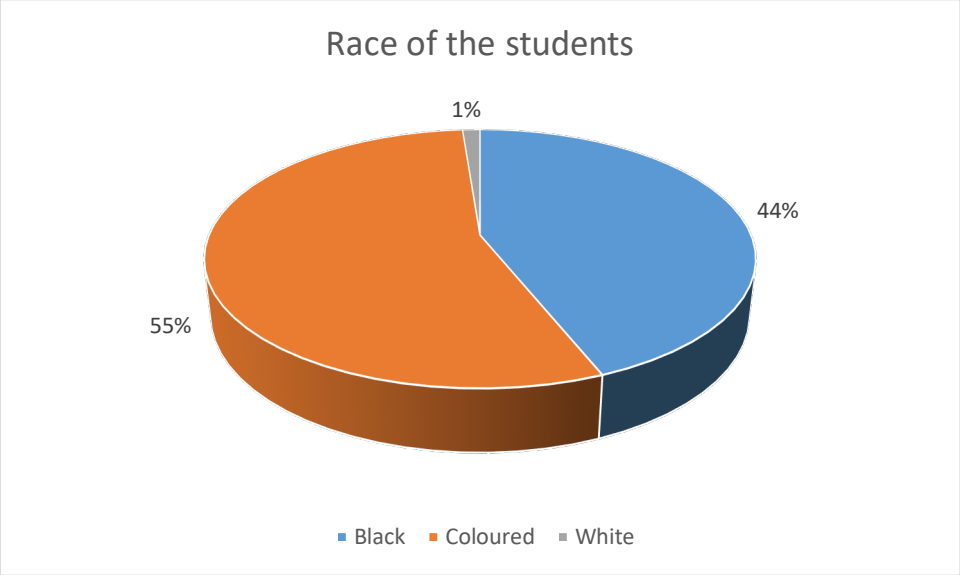


Figure 5.2: Race of the students

5.5.3 Highest qualifications of students

Most (96%) student participants had matric as their highest qualification. However, a few (2%) had obtained a higher national diploma in another programme and wanted to change to the ICT programme. The results are seen in Figure 5.3.

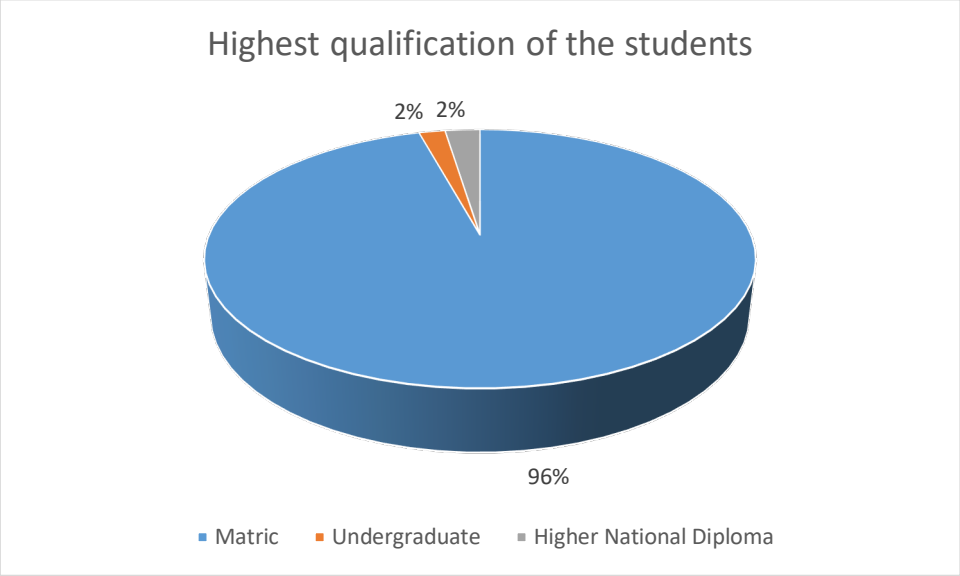


Figure 5.3: Highest qualifications of the students

5.5.4 Gender of Lecturers

There were 20 Lecturers from 3 different Public TVET colleges in Cape Town who also participated in this study. 70 % of the Lecturers were male, and 30% were female, as shown in Figure 5.4. This indicates that the ICT programme is still predominantly male rather than female.

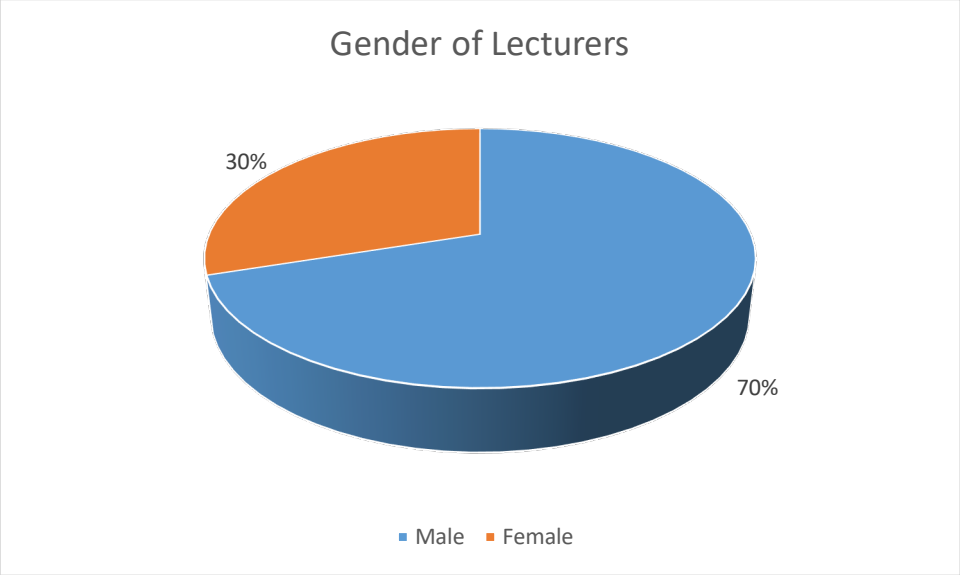


Figure 5.4: Gender of the Lecturers

5.5.5 Race of Lecturers

The race distribution of the lecturer respondents includes 60% black, 30% coloured, and 10% white. This reflects the race population distribution in South Africa, where the majority are blacks, followed by the coloureds and then whites. The results are demonstrated in Figure 5.5.

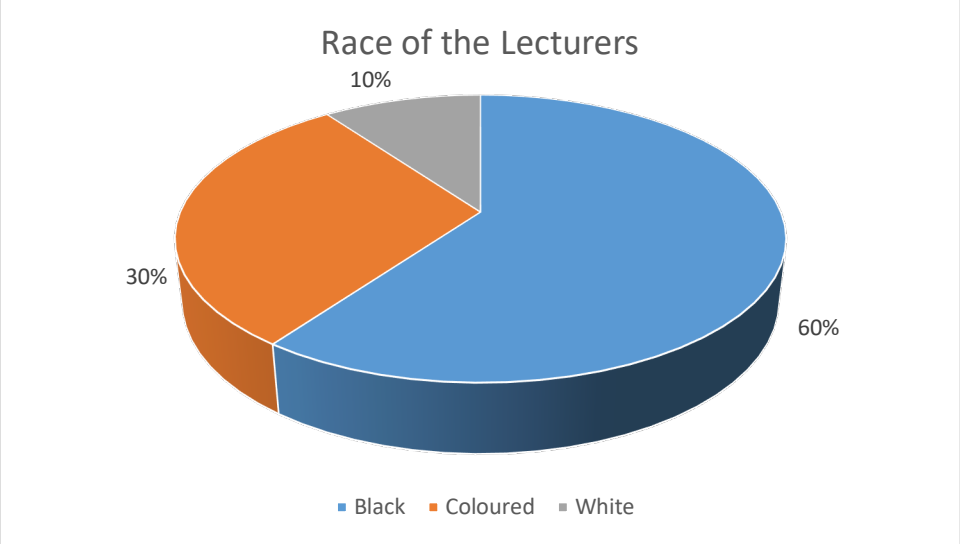


Figure 5.5: Race of the Lecturers

4.5.6 Highest Qualifications of the Lecturers

The majority (55%) of the Lecturer participants have a Bachelor's degree, 40% of the lecturers have a Master's degree, and 5% of the lecturers hold a PhD. This indicates the lecturers are well qualified to lecture in the programme, but having more PhD holders teaching at higher institutions like the TVET colleges will be recommended. The results are seen in Figure 5.6.

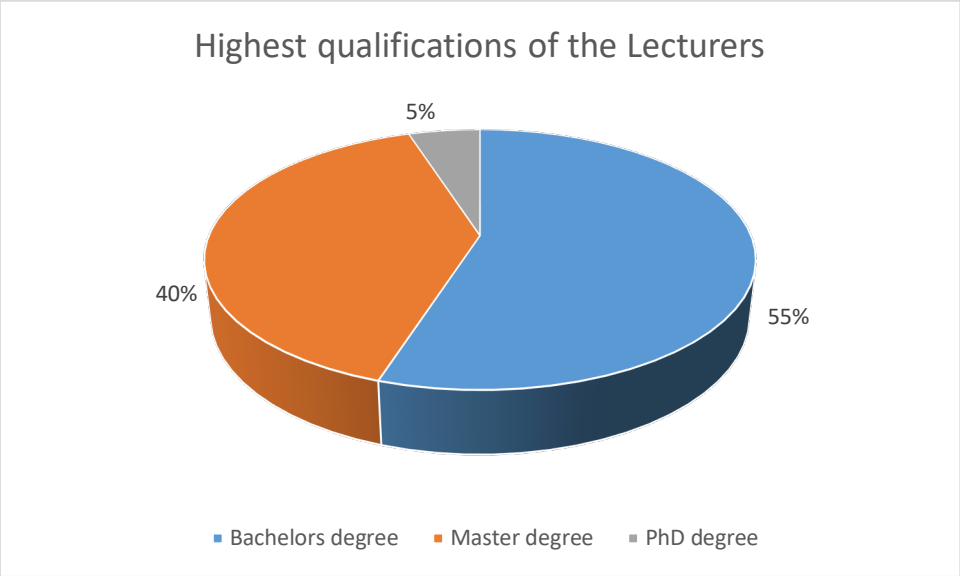


Figure 5.6: Highest qualification of the Lecturers

5.5.7 years in Service of the Lecturers

As shown in Figure 4.7, 40% of the lecturers have been teaching for about 1 to 3 years. And 30 % of the lecturers have prepared for the above six years. This shows the teachers have had a good number of years in service.

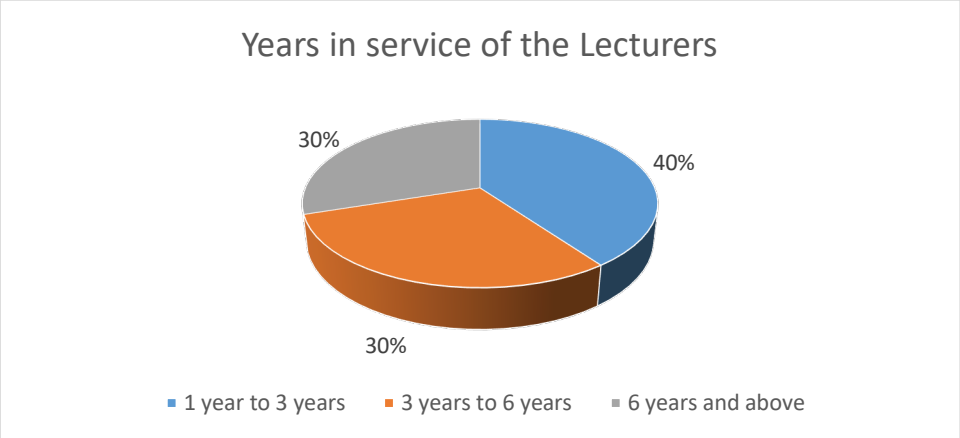


Figure 5.7: Years in service of the Lecturers

5.5.8 Rank or Position of the Lecturers

Of the 20 participants in the study, the most (77%) were lecturers, 11% were programme coordinators, and 12 were heads of department. The results are illustrated in Figure 5.8.

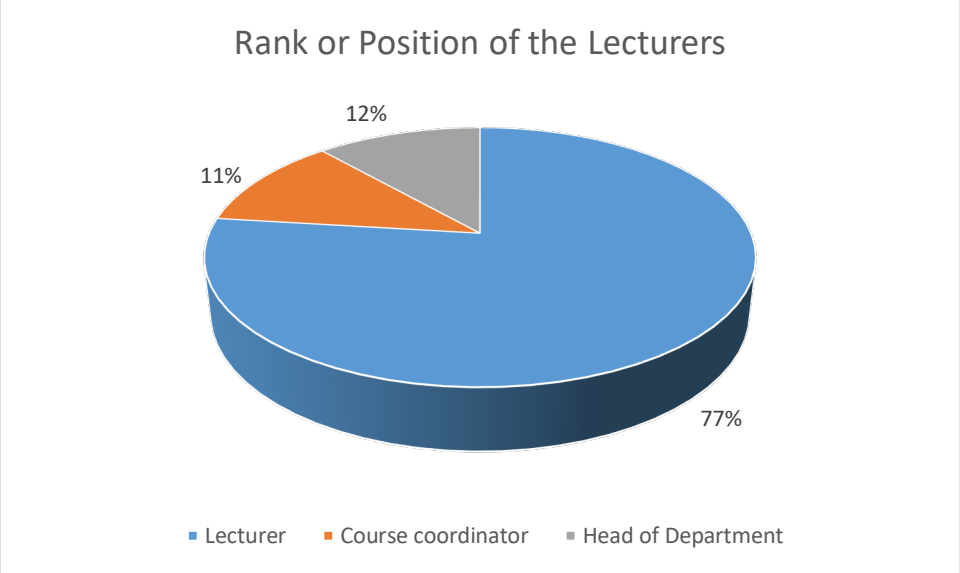


Figure 5.8: Rank or position of the Lecturer

5.6 Discussion of the Related Research Findings

The results of the quantitative data as presented in chapter 5, are based on four research objectives. The findings from the data indicated that five entrepreneurial elements and seven process stages of simulation-based learning (SBL) for the acquisition of entrepreneurial skills investigated in this research for the framework for entrepreneurial skills in ICT programmes in TEVT colleges in Cape Town, South Africa. The discussion on the results and findings for each of the five elements and seven processes of the entrepreneurial skills framework were reflected and presented. Based on the research objectives, these components and process stages were combined to arrive at an SBL framework for entrepreneurial skills in ICT programmes in TVET colleges in Cape Town, South Africa.

5.6.1 Discussion of findings on Experts' experiences and perceptions of the use of SBL in ICT Programmes (Objective 1)

Research Objective 1: To determine experts' experiences and perceptions of using simulation-based learning in teaching and learning ICT.

Research Question 1: What are the experts' experiences and perceptions of using simulation-based learning in teaching and learning ICT?

They are based on the quantitative findings from the lecturer's experiences using SBL for entrepreneurial skills in ICT programmes at TVET colleges. The demographic data showed that all the 20 lecturers have a bachelor's degree in ICT, some had a Master's, and a few had a PhD in that field. The lecturers have had a long experience teaching ICT programme for over six years. All the experts have been using and are knowledgeable in Problem-based learning (PBL), project-based learning (PjBL) as well as simulation-based learning (SBL) and related teaching methods hence, authenticating the information gathered from them valuable and relevant for the requirements in the development of an entrepreneurial skills acquisition framework for ICT programmes at TVET colleges.

The quantitative findings from the questionnaire on lecturers' perception of the use of SBL for entrepreneurial skills in ICT programmes in TVET colleges in Cape Town, South Africa. All the lecturers strongly agreed that using simulation-based learning is vital in developing entrepreneurial skills in ICT students. The findings showed that all the lecturers had positive feedback on simulation-based learning and its capabilities in developing entrepreneurial skills in high demand in this highly advancing technological era of 4IR. Although some of the lecturers had reservations about the demanding nature and time-consuming nature of SBL, they all agreed that the benefits of using simulation-based learning were more significant than the limitations, making this research worthy and relevant.

5.6.2 Discussion of Findings on the SBL elements that could be considered for the development of an entrepreneurial skills acquisition framework for ICT programmes (Objective 2)

Research Objective 2. To identify the simulation elements and processes of teaching and learning that could be used and followed for the teaching and learning entrepreneurial skills in ICT programmes.

Research Question 2. What simulation elements and learning processes could guide the development of an entrepreneurial skills framework in the ICT programme within the 4IR?

Based on the five SBL elements identified for the SBL conceptual framework for entrepreneurial skills in ICT programmes in Cape Town TVET colleges, various questionnaire statements or items were

placed under each of the five elements, which were then used to create the conceptual framework for entrepreneurial skills in ICT programmes. Fifty-nine statements were identified, with eleven from the problem, twelve from the project, thirteen from the students' role, twelve from the teacher's/Lecturer's role, and eleven from teamwork. These items were independently established and analysed as the bases for the discussion as follows:

5.6.2.1 Problem

This research revealed eleven items under the problem for the framework for entrepreneurial skills in South African TVET ICT programmes. These items include: problems should be complex, problems should be open-ended, it should motivate the students' need to know and learn, it should help to engage in the learning process based on their previous understanding; more of these statements can be found in the survey (see appendix on the questionnaires to students and Lecturers.). Some researchers like Bézivin (2017) and Akor et al. (2020) agree with these items or statements in that the problem should be the focal point of learning and a critical factor in ensuring that students challenge the conventional way of thinking and doing things. As Loyens et al. (2011) highlighted, problem-solving encourages and enables students to gain knowledge and skills from previous experiences and prior learning to apply them in subsequent scenarios. Within the technologically advanced era like the 4IR, most employers want or prefer employees who solve problems quickly. Thus, students need to have requisite skills-based not only on writing, reading, or mathematics but also on problem-solving and critical thinking skills.

Therefore, all stakeholders, especially the lecturers, should try to improve the students' professional problem-solving skills. This is very real in ICT programmes where the complexity of a given problem triggers the students' critical thinking, analysis, logical thinking, and innovation as they try to find a solution (De Fruyt, Wille, & John, 2015 & Kolmos, 2014).

Another item revealed in the findings is that a given problem should be able to motivate students to learn and learn at the same time while engaging in the learning process based on prior knowledge. This agrees with Brundiers & Wiek (2013), who suggest that real-life problems are given to students so they can work as a group to develop a solution. There is also the need for a problem to be multidisciplinary to build extensive knowledge and enable multidisciplinary solutions and hands-on abilities. Also, the problem to solve should be interesting, engaging students in discussion and supporting peer evaluation among the students.

Thus, SBL emerges as a more pertinent and efficient method for instructing design (Siig, Simon, & The, 2015). When challenges are captivating and hands-on, as in SBL, students are driven to engage, drawing on their interests and prior experiences, as noted by (Mcloone et al., 2014). Highlighting the advantages of debate in problem-solving, Rubiah (2016) remarked that students engaging in debate initiatives would unearth and enhance self-assurance, inquisitiveness, analytical abilities, communication, composure, inventiveness, and leadership qualities.

5.6.2.2 Project

Projects are a good learning tool for students to gain practical skills. In the survey instrument, various statements were made for the participants to indicate their level of agreement. Some statements include that a good project should enable students' communication skills. Effective communication is paramount in conflict resolution and managing people. This entails listening to all stakeholders to devise solutions for a specific issue. This aligns with Musa, Mufti, Latiff, & Amin's (2012) discovery that students significantly enhance their communication abilities when collaborating on a project as a team. It also corresponds with Nordin's (2013) findings indicating the necessity for technical communication skills to enable ICT graduates to meet their employer's expectations and fulfill their future career aspirations, including self-employment. Additionally, Nordin's findings from the same study demonstrated a direct correlation between the skills gained from technical communication courses and their practical application in workplace communication.

Another skill that students can learn from participating in a group project is the development of logical reasoning skills, enabling them to apply their knowledge constructively as they execute the project. As indicated by the results, critical thinking abilities enable students to comprehend material independently and expand upon their knowledge without constant direction. Furthermore, studies indicate that logical reasoning instils in students the understanding that knowledge is dynamic and accumulative. Consequently, the capacity to think critically and logically stimulates independent thinking, prompts questioning of hypotheses, fosters the development of alternative theories, and encourages testing these hypotheses against established facts. Evidence supports the notion that targeted instruction in logical reasoning equips students to delve deeper into their cognitive processes and gain a more thorough understanding of problem-solving techniques.

The study's findings indicate that a project fosters student's creativity and innovation skills. This is evident in trying to solve a problem through project execution; students develop creative and innovative skills in finding solutions to the problem and executing the project to the end. The literature

and findings underscore that fostering creativity and innovation enhances various aspects of students' involvement, interaction, morale, enthusiasm, drive, problem-solving abilities, efficiency, team cohesion, and cooperation. Concerning methodologies, strategies such as brainstorming, checklists, and mind mapping hold relevance for students in the field of ICT. ICT education emphasizes the systematic and logical resolution of societal challenges through the manipulation of technological tools. Cultivating creativity and innovation proficiencies can facilitate the identification of suitable resolutions to intricate issues. Additionally, creativity and innovation are recognized as pivotal competencies in continual learning and are essential for scientific inquiry and entrepreneurial endeavours. One method of cultivating creativity is through Simulation Based Learning (SBL).

Adams (2013) emphasizes the importance of establishing a clear timeframe for project completion, ensuring that it aligns with specific contextual requirements. This underscores the necessity for projects to adhere to defined timelines, as articulated by Adams (2013).The timeline forms part of the heartbeat of a project, which covers all essential tasks that need to be covered. While working on a problem, students will develop vital project management skills and leadership skills. A project schedule can vary widely in complexity, ranging from intricate plans detailing numerous tasks to simple outlines with minimal milestones and deadlines. However, irrespective of its complexity, a project timeline must include essential elements such as a task list, associated deadlines, estimated task durations, and interdependencies between tasks. ICT could create the timeline based on the proposed project draft, design, device selection, construction, and testing.

Another vital element of a project is that it must have a target audience, as revealed in the study. Given the pervasive influence of ICT and IT, a project may encompass diverse sectors such as education, communication, transportation, aviation, manufacturing, entertainment, healthcare, climate change, among others. The identification of a target audience holds paramount importance in project endeavours, as emphasized by Pease and Kuhn (2011), particularly in educational settings where students present their work to classmates, engaging the audience in observational tasks. Analyzing the target audience serves as a crucial insight for many projects, facilitating streamlined execution processes. This analytical approach empowers ICT students and graduates to strategically innovate and develop novel products and services tailored to address prevalent challenges within these target demographics, thereby meeting the evolving demands of diverse user groups.

Ultimately, any project should incorporate provisions for both formative and summative evaluation. Evaluation, whether formative or summative, increases the likelihood of achieving the initiative's goals and objectives by focusing on optimizing the project's effectiveness. Throughout the implementation

phase, formative evaluation endeavours to comprehend the project's progress, identifying areas of early success and strategies for enhancing ongoing success. Upon project completion, summative evaluation evaluates the extent to which project objectives were accomplished, identifying factors contributing to both high and low levels of success. This assertion is supported by Mora et al. (2018) in their exploration of "Project-oriented Problem-Based Learning to build skills linked with industrial controllers." Participants' feedback provides valuable insights into areas of progress warranting further attention and specific requirements for achieving optimal success.

5.6.2.3 Students' Role

The pivotal role of students within SBL cannot be overstated, as they assume primary responsibility for the entire process within this student-centered approach. According to the findings of the study, students are tasked with identifying, analyzing, categorizing, formulating hypotheses, and exploring relevant learning materials to address project-related issues. They are also responsible for devising solutions based on their existing knowledge, assessing their applicability, and identifying any gaps in understanding essential to resolving the problem. This aligns with Zhou's (2012) observation that Problem-Based Learning (PBL) places the onus of learning on students, thereby fostering a sense of ownership over their educational journey.

Part of the student's responsibility involves identifying learning needs, establishing learning objectives, and sharing them with team members. They strategize to facilitate independent research among team members, effectively disseminate newly acquired knowledge within the group, apply this knowledge to problem-solving, and evaluate both the knowledge gained and the problem-solving process. In the realm of ICT, students approach presented problems by dissecting them into software-related sub-problems for individual analysis. They then evaluate their competencies and knowledge, resorting to further research when necessary to address any gaps in understanding or skills.

In the context of ICT, this principle is relevant as tasks can be allocated to students according to their proficiency in various areas such as analogue, digital, software, technical theory, and so forth.

5.6.2.4 Teacher's Role

The teacher/lecturer, as a facilitator, plays a vital role in acquiring and developing entrepreneurial skills in ICT students. Therefore, it is incumbent upon the instructor/lecturer to offer assistance, display empathy, and instil inspiration; foster critical thinking, personal development, and active

involvement; devise classroom activities grounded in student comprehension; and cultivate an environment conducive to experimentation and free from rigid time constraints. Consequently, the educator is tasked with commencing with the end in mind, considering both the subject matter to be grasped by students and the culmination of the project, encompassing entrepreneurial skills, 21st-century competencies, or Fourth Industrial Revolution skills to be acquired. This process involves strategizing methods for imparting new information and determining the final product to be presented by students. Additionally, the instructor aids students in formulating inquiries by gauging their existing knowledge of the subject matter and discerning their informational requirements, allowing them to utilize these inquiries as templates for generating further questions. This practice entails comprehensive exploration of the topic and dissemination of findings among team members. For instance, in the context of a problem relating to information communication, students are encouraged to explore all relevant areas that can contribute to problem-solving and project execution, including digital, analogue, software, and ICT domains.

It is the responsibility of the teacher to maintain students' focus on the objectives and ensure that they adhere to them, thus attaining the designated learning or project goals. This can be accomplished through ongoing assessment as the objectives are pursued, with a requirement for these objectives to be quantifiable. Ultimately, the teacher must ascertain that the objectives set for the students are realistic and attainable.

The findings also underscored the teacher's role in evaluating students' performance and providing them with feedback. To fulfil these duties effectively, the teacher should carefully consider the timing and methods of assessment, ensuring students are adequately prepared for success. This entails consistently reminding students of the problem or project's objectives, including the relevant subject matter, expectations for the final product, and desired collaborative behaviours. Continuous feedback and adjustments are essential to keep students on the right path and enhance their performance, preparing them for success with the final product. Rather than employing summative evaluation, the teacher should opt for formative assessment methods, which can be conducted regularly throughout the learning process, thereby engaging students consistently.

5.6.2.5 Teamwork

Teamwork is one of the teaching and learning elements required to develop an entrepreneurial skills acquisition framework. Collaborating in a team offers numerous advantages, including the stimulation of creativity and learning, idea generation, equitable distribution of tasks, exposure to different perspectives, enhancement of enjoyment in work, inclusion of diverse personalities, and cultivation

of a robust work ethic and team camaraderie. According to the findings of this research, effective teamwork necessitates a clear direction, ensuring students grasp precisely what is expected of them. To achieve this, the lecturer, functioning as a facilitator, should convey information directly rather than through questioning. Instructions should be presented one at a time rather than as a series, and explanations should be straightforward. For example, students might be tasked with designing a website for a business using specific programming codes.

As shown in this study, encouraging diverse opinions among members is an essential factor in teamwork. Drawing from a diverse pool of professionals with varying levels of experience, expertise in different domains, and diverse cultural backgrounds enhances the breadth of inspiration and knowledge within each team. Studies indicate that teams embracing diverse work approaches can make decisions up to 60% faster (Kim, 2019). For entrepreneurs, collaboration within a team is indispensable for ensuring the smooth operation and success of their businesses.

Finally, there should be space for discussion within the team, as it is widely believed that such discourse enhances critical thinking abilities, cultivates refined poise, speech delivery, and public speaking prowess among students, augments retention of learned information, refines listening and note-taking skills, bolsters self-assurance, fosters effective teamwork, and encourages collaboration. Moreover, engaging in debate equips students with the confidence to challenge falsehoods or inaccuracies, teaches them to articulate their perspectives gracefully, facilitates identification of gaps in their reasoning, aids in crafting more well-rounded arguments, and enhances the organization of their thoughts. Objective and sincere debate among team members facilitates the attainment of consensus conclusions.

5.6.3 Discussion of Findings on the SBL Process Stages that could be used to develop a Framework for Entrepreneurial Skills in ICT Programmes.

The conceptual framework for entrepreneurial skills in ICT programs within TVET colleges delineates seven stages of the SBL process. Each stage encompasses a range of items, contributing to the final framework. A total of fifty-nine (59) items were delineated, with twelve (12) items attributed to Problem Orientation and Analysis (POA), ten (10) to Project Simulation and Execution (PSE), sixteen (16) to Learning Objectives (LOBJ), eleven (11) to Project Initiation and Execution (PJIE), fifteen (15) to Learning Outcomes (LOC), eleven (11) to Assessment Methods (ASM), and ten (10) to Public Presentation (PP). These items were identified based on recommendations from experts, relevant literature, respondents' preferences, and factor analysis. Each item was independently established and analysed in accordance with the discussed criteria.

5.6.4.1 Problem Orientation and Analysis (POA)

Problem-based learning is essential for acquiring entrepreneurial skills since entrepreneurship is all about solving societal problems. The initial phase in problem-solving entails orientation, which involves identifying the problem, followed by analysis to ascertain its nature and underlying causes. This foundational skill often provides entrepreneurs with a competitive advantage. By identifying and analyzing a problem, entrepreneurs unlock potential solutions, laying the groundwork for establishing objectives and selecting suitable strategies. In the realm of ICT, this skill is essential as it enables innovative students to recognize issues within society, industry, or existing technologies and seek resolutions accordingly. The study's findings, concerning the formulation of a SBL framework for entrepreneurial skills in ICT programs, revealed that problem identification (orientation) and analysis commence with identifying and defining the problem, exploring how it hindered the achievement of previous objectives, breaking down the problem into smaller components, and assessing the impacts of each component.

Upon attaining the necessary knowledge and skills, students convene with the lecturer to exchange and discuss their newfound expertise, conduct additional research as needed, pose inquiries, and deliberate on the next steps.

5.6.3.2 Project Simulation and Execution (PSE)

Once the problem has been analysed and its root causes identified, the subsequent stage involves students assessing their competency to address the issue. This evaluation may occur concurrently with problem analysis, triggered by directed recall, definition, or drawing upon significant past experiences or knowledge. Project simulation and execution can serve as a platform for integrating newly acquired expertise among group members (Krauss & Boss, 2013; Rios & Montero, 2010; Tan & Chapman, 2016). This process entails students evaluating their existing knowledge and skills within the simulated project context, identifying relevant knowledge and skills, determining sources for additional knowledge and skills, developing new competencies from available resources, sharing and discussing acquired expertise, conducting further research as needed, asking questions, deliberating, assigning roles based on individual and collective abilities, and collectively demonstrating knowledge and skills.

Assigning role-play assignments aids in fostering students' confidence by providing a secure environment for repeated practice, research, and experimentation. Moreover, it facilitates creative problem-solving, affording each team member valuable experience in navigating challenging scenarios. It is imperative for students to have a clear understanding of their objectives, level of commitment, and rationale for their role selection. Clearly outlining expectations for each role and emphasizing them as in any other assignment

is crucial. This aligns with the findings of Samsibar & Naro (2018) and Erturk (2015), which suggest that role-playing enhances students' engagement in learning and fosters motivation for learning and discourse.

5.6.4.3 Learning Objectives (LOBJ)

Following the initiation of project simulation and execution, the subsequent phase involves establishing learning or project objectives based on the analysed problem and the acquired knowledge and skills. The study identifies key attributes of effective objectives, which include addressing the root causes of the problem individually, emphasizing the desired outcome, and maintaining specificity without ambiguity. These objectives should directly tackle the underlying issues by clearly defining the core problem and articulating its manifestation comprehensively.

As Hussar (1996) suggests, learning objectives play a crucial role in organizing students' study material around a structured and clear approach to problem-solving. They provide students with a clear understanding of expectations, thereby enhancing the efficiency of problem-solving when centered around the issue. When aligned with the analysed problem, learning objectives enable students to anticipate outcomes.

Furthermore, effective objectives should foster the development of a comprehensive knowledge base, the cultivation of practical problem-solving abilities, and the acquisition of lifelong learning skills. To facilitate the construction of a broad knowledge base, objectives should guide students in abstracting concise representations from diverse knowledge sources, including unstructured documents, web data, and knowledge bases. This process results in the creation of a knowledge map that can enhance subsequent applications such as search engines and business analytics.
Additionally, objectives should promote the development of lifelong learning skills, given the dynamic nature of the evolving fourth industrial revolution (4IR) and the significant role of ICT within it. Equipping ICT students with these skills is advantageous as they endeavour to expand their knowledge and abilities over time to meet evolving demands. To achieve this, objectives should guide students in assessing their knowledge, skills, and social networks in relation to task requirements; identifying critical gaps to address in the early stages of their professional careers; establishing a checklist of learning and development tasks with time-based goals; periodically monitoring progress to ensure ongoing career advancement; and updating their plan to focus on essential entrepreneurial competencies and specialized technical training (Martínez-Mediano & Lord, 2012b). Martínez-Mediano & Lord (2012a) further categorize lifelong learning competencies into Individual Competencies, which enable effective interaction with the environment (Socio-cultural competencies such as language use and Physical competencies such as Information

Technology), and Relational Competencies, which facilitate engagement with others and interaction within diverse groups.

In conclusion, learning or project objectives should aim to enhance students' analytical reasoning abilities and facilitate the acquisition of new competencies. Proficiency in analytical reasoning is particularly crucial in ICT and related IT domains, as it enables individuals to gather data effectively, tackle complex problems, make informed decisions, condense information, and execute well-planned projects. Employers increasingly prioritize this skillset, as its integration with other relevant abilities enhances an employee's marketability and productivity. Supporting this notion, the findings of Chonkaew, Sukhummek, & Faikhamta (2016) indicate that STEM learning activities rooted in problem-based learning effectively cultivate analytical thinking skills and foster positive attitudes toward science education.

5.6.4.4 Project Initiation & Execution (PJIE)

Following the analysis of the problem and the delineation of objectives, a project is initiated to accomplish the established goals and objectives. As per the findings of this study, the process encompasses several steps, including project initiation and scheduling, formulation of execution strategies, identification of resources, proficient utilization of skills in response to challenges, project planning and scheduling, project monitoring, technical coordination, analysis of project outcomes, gathering client satisfaction feedback, comparing actual project schedules with estimated ones, and concluding the project.

Scheduling and timing of the project can occur concurrently with execution, as skills are applied. This entails creating a comprehensive project activity list detailing all tasks necessary for project completion, including activities required for each project phase. Subsequently, activity attributes are defined, comprising descriptions for each activity along with all necessary information to determine the sequence of work.

After result analysis, the next steps involve assessing client or audience satisfaction and concluding the project. Every project is aimed at a specific audience or clients who are the ultimate beneficiaries or users of the product or services. Failing to meet the expectations of these target individuals renders the project futile. To gauge customer satisfaction, the project manager or team can engage directly with the client or audience, posing questions regarding the progress of project management activities and gathering feedback to ascertain their level of satisfaction.

In alignment with this approach, Embry (2018) suggests thoroughly reviewing the project timeline to ensure no details are overlooked, scrutinizing notes and correspondence for any unresolved matters from this phase that could not be addressed or accommodated, issuing a concluding note to the team to

acknowledge the successful project launch, formally closing the client aspect of the project to communicate its conclusion, and scheduling a project retrospective session for future reference in subsequent projects.

5.6.4.5 Public Presentation (PP)

Following project initiation and execution, the study's findings reveal insights into public presentation assessments. The process entails team members revising crucial language aspects. Students are provided with a transcript or outline of the presentation, allowing them to identify key stages such as greetings, introductions, main points in order of significance, and conclusions. Subsequently, team members convene in smaller groups to establish aims and objectives. Students then organize key points sequentially, determine individual roles and responsibilities, prepare visuals while ensuring moderation to prevent distraction, engage in debates and anticipate audience inquiries, utilize professional presentation templates, and conduct a series of practice sessions and rehearsals ahead of the main presentation.

Preceding the presentation, students engage in debates and anticipate potential audience inquiries, and rigorous practice sessions are conducted to instil confidence and professionalism. This includes ensuring visibility of visual aids to the audience, maintaining eye contact predominantly with the audience rather than the visuals, avoiding reading directly from the aids, clearly articulating the purpose of the visuals, confidently addressing audience questions, and discreetly removing visual aids when no longer needed.

5.6.4.6 Learning Outcomes (LOC)

In Simulation-Based Learning (SBL) for entrepreneurial skills acquisition, learning outcomes refer to the skills and knowledge gained through addressing a problem via an initiated project. Multiple research studies have demonstrated the efficacy of Simulation-Problem Based Learning (SPBL) and similar methodologies in cultivating various entrepreneurial competencies such as problem-solving, creativity, critical thinking, communication, teamwork, among others (Dole et al., 2016; Noordzij, Spierenburg, Servant, & Frens, 2015; Ruhizan Muhammad Yasin et al., 2009; C. Zhou, 2012). The present study's findings corroborate the development of diverse entrepreneurial skills through SPBL. As evidenced in the research, these skills encompass problem-solving, technology application processes, critical thinking, information retrieval, creativity and innovation, teamwork, communication, active learning, reasoning, organization, interpersonal relations, leadership, self-directed learning, and presentation skills.

Problem-solving skills are instrumental in identifying the root cause of a problem and devising effective solutions. While problem-solving is often considered a distinct skill, it is complemented by various related abilities. Key problem-solving skills include active listening, analysis, research, creativity, communication,

reliability, decision-making, and team collaboration. Proficiency in problem-solving is essential across all professions and career levels. Effective problem-solving may also necessitate industry-specific technical expertise. For instance, as an ICT specialist, one requires critical thinking, creativity, research acumen, and technological proficiency to navigate circuit manipulation logically.

Also identified as a learning outcome within SBL for entrepreneurial skills acquisition is the cultivation of Creativity/Innovation skills, which are deemed crucial for the demands of the 21st century, particularly considering their potential to tap into the positive aspects of individuality. Creativity encompasses a range of factors including cognitive aspects, personality traits, familial and educational influences, as well as social and cultural factors. According to Nakano & Wechsler (2018), individuals demonstrating creativity often achieve self-actualization and exhibit qualities associated with mental well-being, such as subjective happiness, resilience, optimism, and overall quality of life, as emphasized in positive psychology.

On the other hand, Innovation involves applying creativity to generate novel and valuable ideas, products, or practices for the benefit of individuals, teams, organizations, or society at large (Nakano & Wechsler, 2018). As described by Márquez et al. (2016), innovation encompasses new perspectives, approaches, methods, or products that add value. The essence of innovation lies in the execution of these new ideas, which often demands perseverance and diligence, as many promising concepts fail to materialize without sustained effort. In the realm of ICT design, creativity and innovation are essential for developing practical devices and solutions, supported by experiential and constructivist learning theories (Jamaludin et al., 2012).

5.6.4.7 Assessment Methods (ASM)

Assessment serves the purpose of gauging the achievement of learning outcomes or objectives and holds significant importance in any educational setting as it serves as a barometer for continuity or review. Several studies have underscored that conventional assessment methods may not always be optimal for evaluating learning success (Audu, Kamin, Musta'Amal, & Saud, 2014; Struyven, Dochy, & Janssens, 2015). The findings of this study suggested that the most suitable assessment method for SBL is self-assessment, granting students the autonomy to establish and monitor their own objectives. Another viable assessment method is self-reflection, which enables students to engage in introspection by addressing reflective queries concerning their learning progress, areas of challenge, and necessary future steps.

The use of student surveys as an assessment tool blends both objective and subjective elements, aiding students in comprehending abstract concepts, while self-assessment rubrics facilitate the evaluation of progress across various categories, delineating the transition from novice to proficient. The checklist

method of assessment allows students to comprehend systems before, during, and after tasks. Peer assessment serves as another method, offering students exposure to alternative perspectives and incorporating a 10-minute peer feedback session per session to evaluate both the process and the product.

An innovative assessment approach is the 3-2-1 structure, where students articulate three strengths, two areas requiring improvement, and pose one question for clarification. Peer coaching can also be considered as an assessment strategy, involving students in reciprocal interviews about their learning process. Additional assessment methods include advisory conferences, empowering students to seek guidance from both educators and peers, and mastery conferences, enabling students to assess their mastery of the content autonomously.

In the context of formative assessment and feedback, self-reflection serves as a valuable tool for fostering students' development as independent learners adept at monitoring and regulating their own learning processes. The incorporation of self-assessment and reflection tools should seamlessly integrate into daily learning routines and practices, alongside other learning platforms, to maximize effectiveness. Dawson (2020) advocated for effective self-reflection by encouraging students to evaluate areas of success, identify areas requiring improvement, and plan subsequent tasks in a logical and systematic manner.

Rubrics represent potent self-assessment instruments, provided they are separated from grading and students are afforded sufficient time and support for revising their work. An integral component of formative assessment is feedback, yet time constraints often hinder teachers from providing timely feedback to all students. Fortunately, students themselves can offer valuable feedback under conducive circumstances. When appropriately implemented, student self-assessment yields accurate and constructive insights conducive to learning. Savant & Pawar (2018) underscored the role of rubrics in promoting transparency in performance evaluation, providing clear assessment guidelines, ensuring grading consistency and efficiency, guiding peer and group assessments, and mitigating issues related to plagiarism.

Moreover, fostering a culture of trust and collaboration is paramount, aiming to enhance teaching skills, enrich student learning experiences, and facilitate the sharing of classroom insights (Wai Yee, 2016). The study also recommends utilizing advice conferences to empower students to seek guidance from both teachers and peers, as well as employing mastery conferences to enable students to gauge their comprehension of course content.

5.7 Summary of the Quantitative Results from Students and Lecturers

This section outlines the synthesis and summary of results derived from the quantitative data collected from both students and lecturers participating in the study. The presentation of findings adheres to the research objectives and the survey questions, which structured the analytical framework.

5.7.1. Summary: quantitative results from students

Of all the 164 students who participated in the study, 70% were males. The quantitative result showed that the students were in high agreement with a Cronbach alpha value above 0.7 that problem-solving, project-based earning, teamwork, students' role, public presentation and project simulation are essential elements in developing entrepreneurial skills for ICT students.

5.7.2 Summary: quantitative results from the lecturers

All 20 lecturers have at least a Bachelor's degree, with 70% of them Males with over three years of experience. The quantitative result showed that the lecturers agreed with a Cronbach alpha value above 0.7 that problem-solving, project-based earning, teamwork, teachers' role, public presentation and project simulation are essential elements in developing entrepreneurial skills for ICT students.

The lecturers had an overwhelming consensus with a high Cronbach alpha value above 0.7 of all the processes involved in developing entrepreneurial skills for ICT students. The results from the questionnaire, as discussed in this chapter, indicated that Problem orientation & analysis, Learning Objectives, Project Initiation & Execution, Learning Outcomes, Assessment Methods, and Public Presentation are the best processes for developing entrepreneurial skills. Some relevant entrepreneurial skills that the lecturers strongly agreed on include problem-solving skills, emotional intelligence, technology application skills, creativity and innovation, and interpersonal skills, among others; these outcomes and learning objectives are crucial for acquiring entrepreneurial skills.

The next chapter discusses and analyses the qualitative data from the business owners. The business owners will answer the research objectives on the relevant entrepreneurial skills for ICT students and also shed light on the relevance of entrepreneurship education in the 4IR environment.

CHAPTER SIX
QUALITATIVE AND QUANTITATIVE DATA ANALYSIS AND DISCUSSION FROM BUSINESS EXPERTS (ENTREPRENEURS)

6.1. Introduction

The previous chapter discussed and analysed the quantitative data from lecturers and students. This chapter presents and discusses the findings from the interviews and surveys of business experts (entrepreneurs), see Appendix D and Appendix E. In discussing the interview findings, constant reference is made to the theoretical literature review in Chapters Two and Three. This study aimed to develop an entrepreneurial skills framework for ICT programmes in TVET colleges in Cape Town, South Africa. The study had one-on-one personal interviews to extract opinions from experts in ICT within Cape Town. The personal interview was to obtain information from experts on the most suitable components and processes of simulation learning that could be applied to develop an entrepreneurial skills framework. The experts' responses were used to create a five-point Likert scale instrument. The resulting instrument and the draft of the entrepreneurial skills framework were based on experts' opinions and the reviewed literature.

6.2. Qualitative Data Analysis and Result Interpretation

Qualitative data was the second phase of this research, where personal interviews were conducted to obtain information from selected business owners (entrepreneurs) who are considered experts in entrepreneurship and ICT. The semi-structured interview questions aimed at getting in-depth experts' perceptions and knowledge of entrepreneurial skills for ICT graduates. The forty-one business owners selected based on their specialisation, qualification and years of experience were coded as E1 – E41. The business owners' responses, alongside the results from the quantitative instrument, were used to develop a conceptual framework for acquiring entrepreneurial skills for teaching and learning ICT in South African TVETs.

6.2.1. Experts' Demographic Data

As elaborated in Chapter Four, the interview guide utilized for data collection commenced with a preliminary segment addressing the demographic profile of the respondents. After consulting experts in the relevant field, it was determined that several crucial demographic factors warranted consideration in this study, namely: (1) the ownership status of the businesses in which respondents were involved, distinguishing between owners and partners; (2) the highest educational qualifications attained by the respondents; (3) the gender distribution among the respondents; (4) the age distribution of the respondents; and (5) the racial composition of the respondents. The subsequent sections delve into the analysis of participant demographics.

6.2.1.1. Business ownership status

The question determined business ownership status: “Are you the business owner, or are you a manager in the business?” Among the 41 respondents, it was determined that the majority (95%) were proprietors, with only 5% serving in managerial roles. Figure 6.1 provides a visual representation of the ownership status of the respondents. The predominance of business owners among the respondents enhances the credibility of the study's findings, reinforcing the notion that micro and small businesses primarily serve as avenues for generating income for their owners, particularly in regions where employment opportunities are limited.

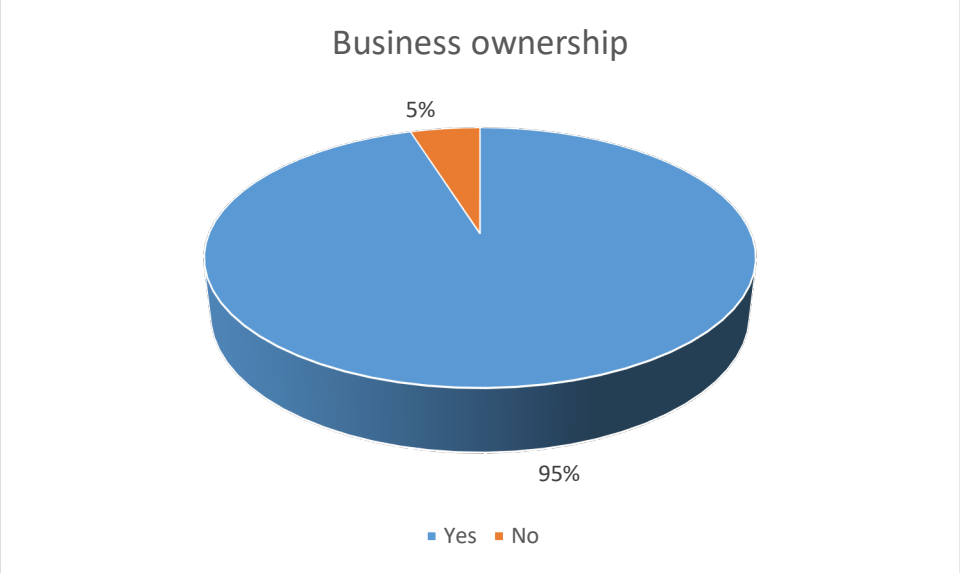


Figure 6.1: Business Ownership

6.2.1.2. Business expert’s highest qualification

The definitive objective of this study was to design an entrepreneurial skills framework for ICT students at TVET colleges. The educational levels of the business experts may serve as a significant factor to incorporate into establishing the framework. Subsequently, in the analysis phase, the study's ultimate findings could also be evaluated with regard to the educational background of the respondents. Of the total respondents, 27% were holders of an Honours degree. The data also shows that some entrepreneurs were holders of a postgraduate degree – PhD (15%), Masters/MTech (17%). As shown in Figure 6.2, the least respondents had a matric/A-level certificate (5%) and undergraduate (7%).

It is worth noting that the selection criteria for the study did not include education; the observation that the majority of the participants had an Honours degree and above, while few business experts were holders of a matric certificate, established the probability as highlighted by most researchers (Raposo & Do Paço, 2011, Millán, J.M., Congregado, E., Román, C., Van Praag, M., Van Stel, A.,2014, Hasan., Khan,

.and Nabi,.2017) that education could be a vital component in the start-up of a micro and small business venture.

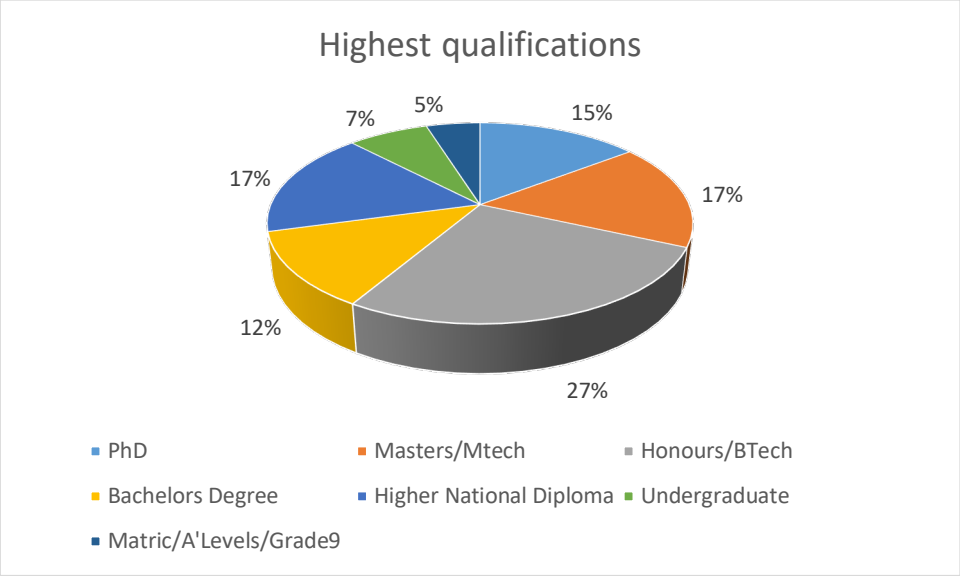


Figure 6.2: Business expert's highest qualification

6.2.1.3. Business experts (entrepreneurs) gender.

As depicted in Figure 6.2, the gender distribution of the participants contrasts with the findings of Turton and Herrington (2012:9) regarding entrepreneurship in South Africa. It indicates that males are marginally more inclined than females to engage in initiating business endeavours, with 3% of the total population compared to 2%. Female entrepreneurs comprised 54% of the full participants, while 46% were male entrepreneurs, as shown in Figure 6.3. Statistics South Africa, in their quarterly report. It was emphasized that South Africa advanced two positions in the Women Business Owner benchmark, securing the 44th spot, wherein 21.9% of all businesses were owned by women in 2021, marking an increase from 21.1% in 2020, as reported by STATSA (2022) and Radebe and Smith (2023). Over a decade, the data shows that more females directly engage in entrepreneurship. However, the ratio of female entrepreneurs to male entrepreneurs is still low at 1:3, GEM Global Entrepreneurship Monitor (2022). This indicates that males are generally more likely to participate in entrepreneurship than females.

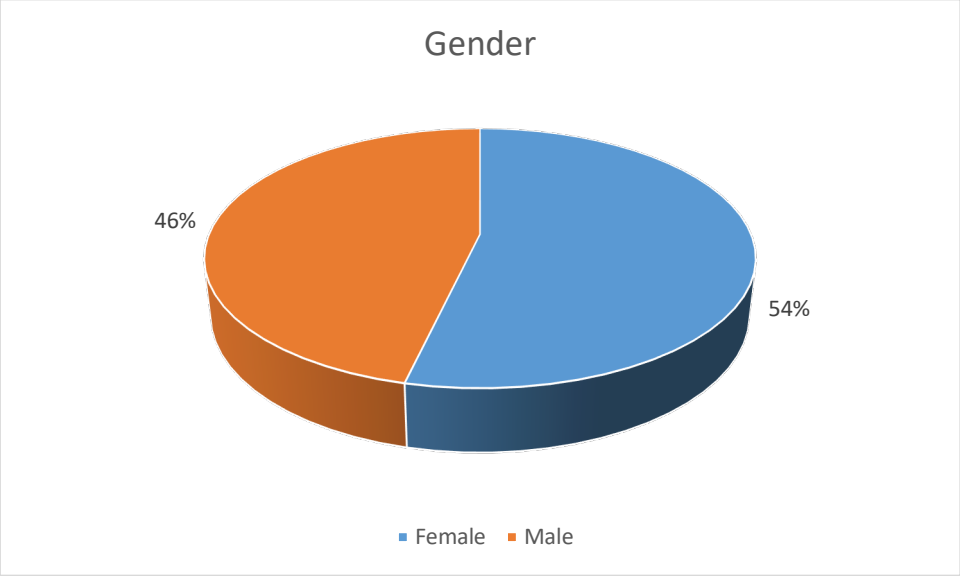


Figure 6.3: Gender of the business experts

6.2.1.4. Age range of Business experts

The majority (49%) of the business experts who participated in the study were in the 41-50 age group, as shown in Figure 6.4. This data aligns with Turton and Herrington's (2012) findings that indicate that entrepreneurship in South Africa peaked within the age group of 34 to 40 years. And now, over a decade, these entrepreneurs are in their 40s and 50s. 92% of the entrepreneurs are between the ages of 31 and 50, affirming that South Africa, like other African countries, has a young population. It is not surprising, as illustrated in Figure 6.4 that the lowest percentage (7%) of business experts is found in the 21-30 age group, which is the age group of most TVET college students. Hence, there is a dire need to develop and empower individuals in entrepreneurship, especially the TVET college students in this age group (21-30).

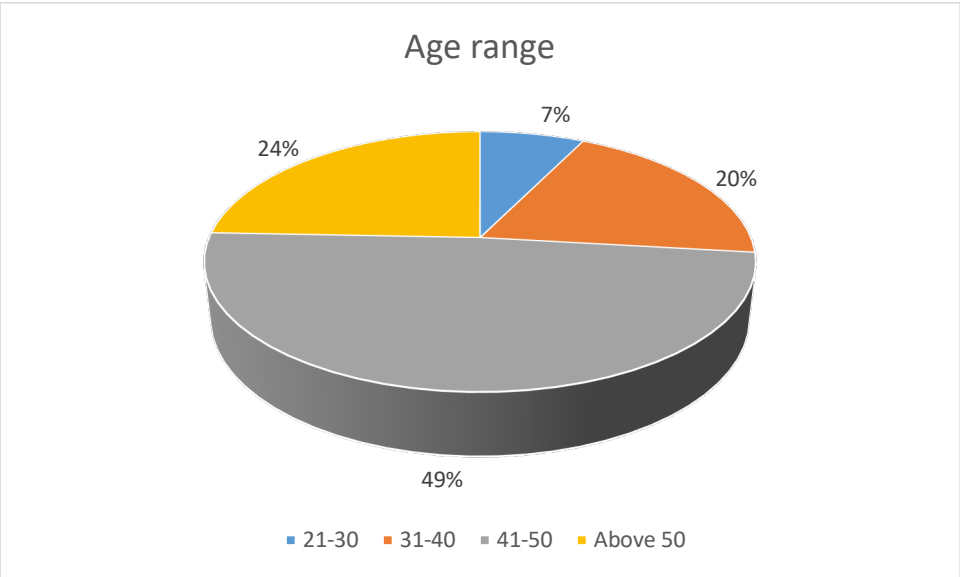


Figure 6.4: Age range of the business experts

6.2.1.5. Race of business experts

As shown in Figure 6.5, most respondents (81%) were Blacks, followed by Whites (12%). This gives a snapshot of the population distribution of South Africa, where the Blacks form the majority race.
Although not relevant to this study, many participants are Blacks, which may be because of the snowballing sampling method; the respondents were purposefully selected and asked to recommend other Business owners.

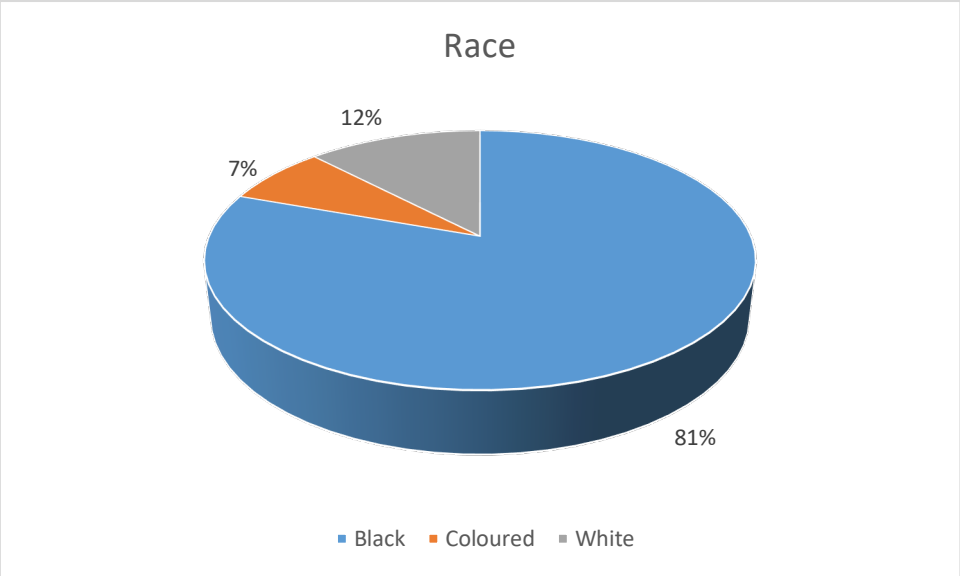


Figure 6.5: Race of business experts

6.2.2. Summary of the business experts' demographic analysis

Ninety-five percent of the business participants represented owners of micro and small businesses involved in the research. All these participants hailed from micro and small businesses with a tenure exceeding three years. Female respondents comprised 54% of the sample, whereas males constituted 46%. The largest proportion (69%) of participants fell within the 31–50 age bracket. Furthermore, 88% of the business participants had achieved a Bachelor's degree or higher. The majority (80%) of the business respondents were black.

6.2.3. Business profile

In this section, the business profiles of the participants are discussed. To understand the context of a successful business, the respondents were asked about the number of years in business, the number of employees, the types of business, and the number of years of existence of the current company.

6.2.3.1. Number of years in business

Figure 6.6 illustrates that most of the 41 business experts interviewed have been in business for 4-6 years (10 respondents - 24%). Nine respondents have been in business for 10-15 (22%), and eight have been in business for more than 15 years (20%). Figure 5.6 shows that four respondents (10%) have been in business for three years. This study focused on entrepreneurs or experts operating businesses for three years or more because 50% of small businesses fail within their first three years (GEM, 2022).

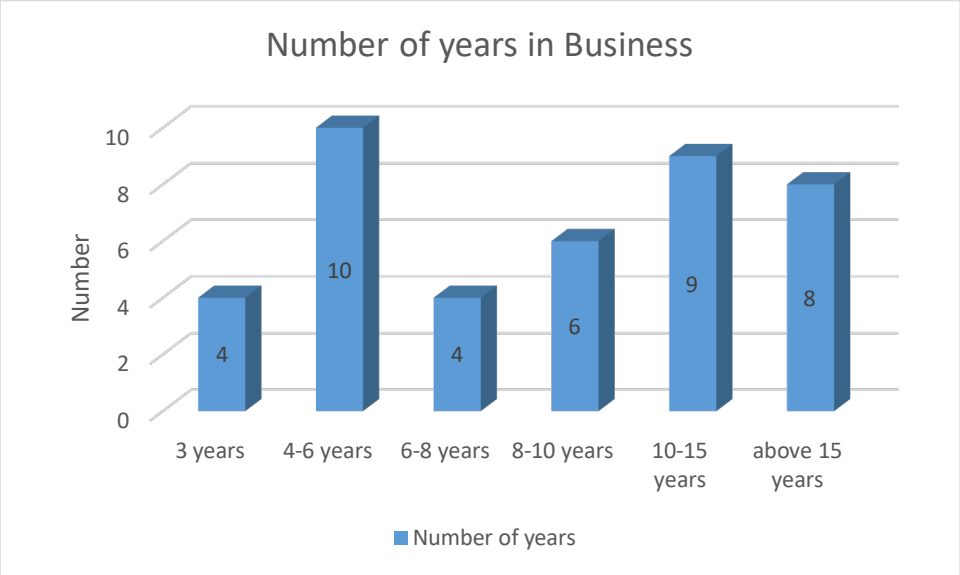


Figure 6.6: Number of years in business

6.2.3.2. Number of employees

The number of employees of most small and micro enterprises is usually between 1 to 10 employees. As shown in Figure 6.7, most businesses (44%) have less than five employees, and 42% have between 5 and 10 employees. This number of employees means that the respondents' businesses are micro and small in size. This suggests that small and micro-sized companies are essential in job creation, poverty alleviation, and economic growth in South Africa. This indicates that small and micro businesses play a crucial role in providing employment, thereby alleviating the high unemployment rate and stimulating the country's economic growth.

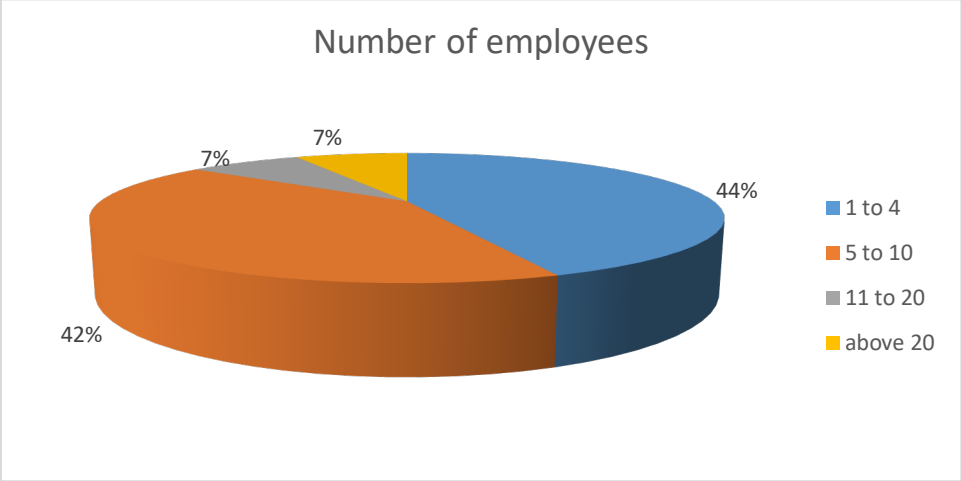


Figure 6.7: Number of employees

6.2.3.3. Type of business

This study investigated the entrepreneurial skills and processes in acquiring these skills to develop an entrepreneurial skills acquisition framework for ICT TVET graduates. Therefore, most (39%) businesses were in the IT and ICT industry, as seen in Figure 6.8. Figure 6.8 also shows that 20% of the companies were from the Marketing industry, and 17% were in the Food and Hospitality industry.

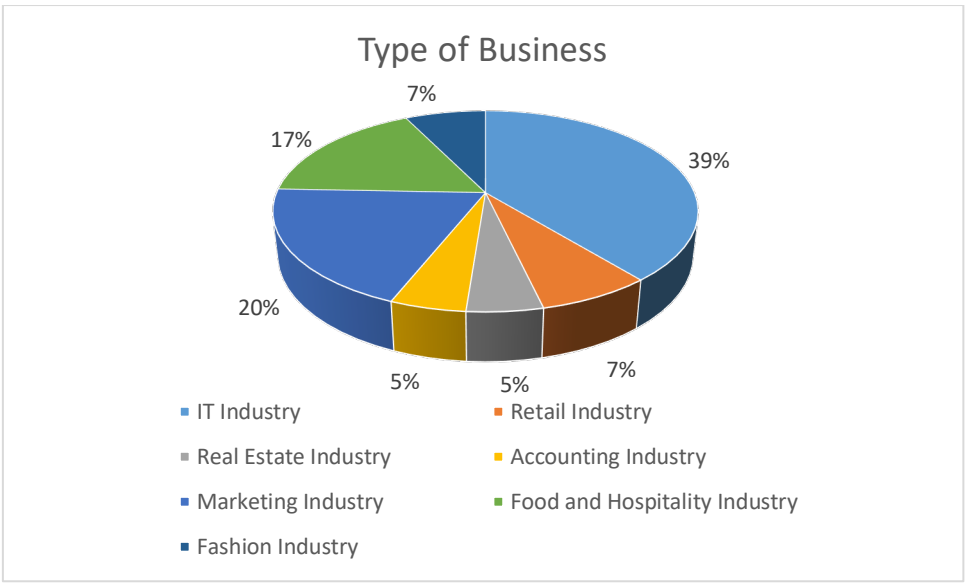


Figure 6.8: Type of business

6.2.3.4. Number of years in operation of the current business

The business experts were asked how long they had been operating their current business. As shown in Figure 6.9, most (63%) companies have been operating for over five years.

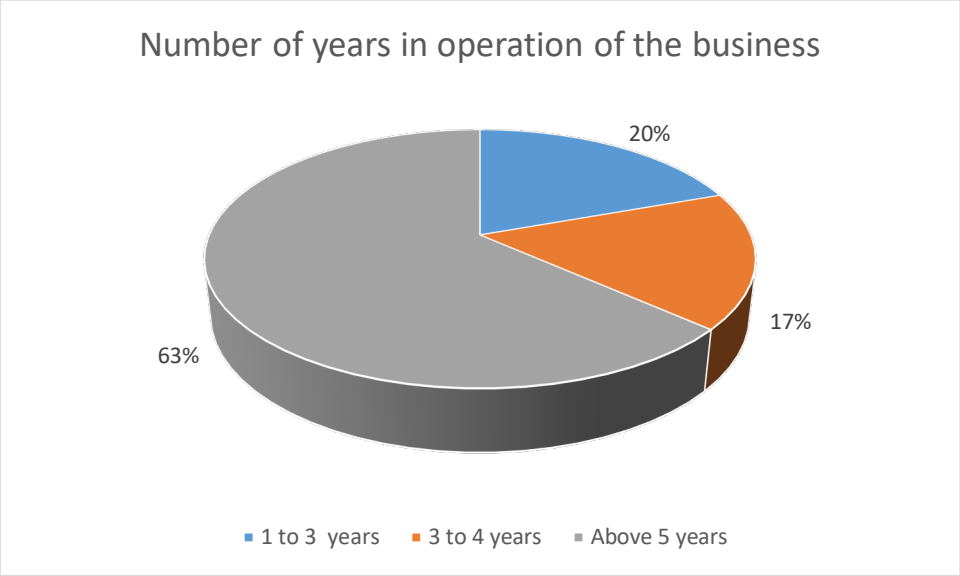


Figure 6.9: Number of years in operating the current business

6.2.4. Motivations for going into business

This study seeks to establish an entrepreneurial skills acquisition framework for ICT students at TVET colleges. In understanding the research problem, knowing the motivations and reasons behind starting a business is worth noting. This section explains the reasons behind starting up a business. As seen in the literature review, these reasons were included in the questionnaire and interview guide to discover whether they were relevant to creating ICT businesses.

Figure 6.10: Motivations for going into business.

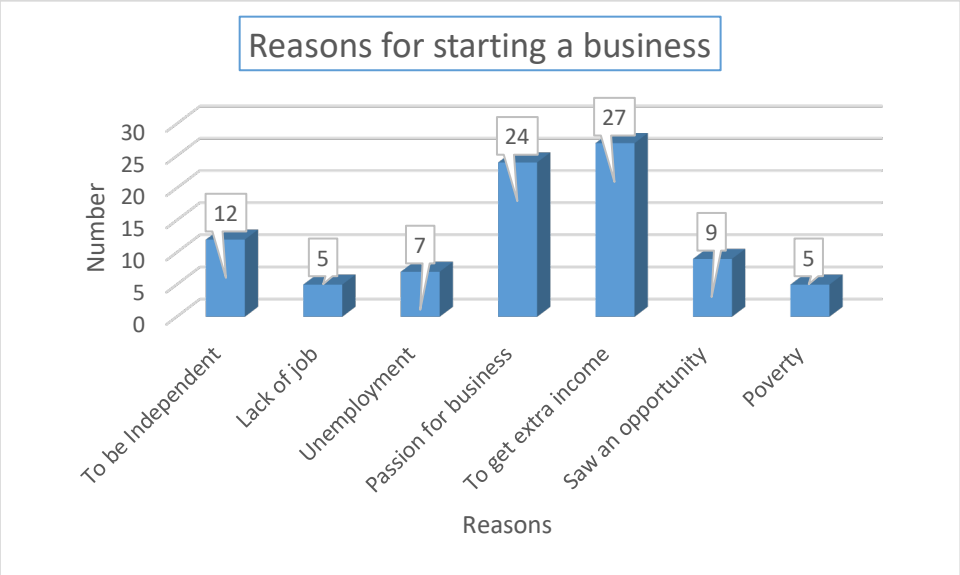


Figure 6.11: Reasons for starting a business

6.2.4.1. Business Opportunity

One of the characteristics of an entrepreneur is to be able to see a business opportunity and make use of the opportunity. In Figure 6.11, 7 (17%) of the entrepreneurs interviewed said they started their business because they saw an opportunity in the market. In Figure 6.10, the opportunity is the third largest word in the word cloud, indicating that most entrepreneurs saw an opening in the market. Participant E6 said, “There was a gap in the market of contemporary South Africans, and I decided to be the change and close that gap”.

6.2.4.2. Passion for business

Participants were asked to give reasons why they started their businesses. A majority of the participants, 24 (59%), said they started their business because of their passion for helping the community solve a problem (Figure 6.11). From Figure 6.10, passion is the second most significant word in the cloud figure, indicating that most respondents were driven by passion to start their businesses. In the words of Participant E10, “I think it is the passion for business”. Passion for business was the reason for starting their business.

6.2.4.3. Lack of job and unemployment

As shown in Figure 6.11, seven respondents (17%) indicated that the lack of jobs and unemployment pushed them to start a business. This implies that unemployment could be a driving force for starting a small or micro business. The finding should be taken in the context of the research problem, which is the high unemployment rate among the youth in South Africa. Thus, equipping these youths with

entrepreneurial skills will enable them to become self-employed and job creators. Participants E11, E12 and E16 said, “the lack of employment and the need for a source of income”. Another respondent, participants E16 and E18, said they were pushed to start a business because they “Couldn't find a job”.

6.2.4.4. To get extra income

As shown in Figure 6.10 and Figure 6.11, of the 41 respondents, a majority of 27 (68%) said the reason for starting a business is to get extra income to supplement their finances. Some respondents said, “Needed extra income because my family was growing”. Another respondent, like participants E17, E18, E25 and E30, said the hardship and economic situation of the country required them to start a business for additional income. In the words of respondent E25, “Wanting additional income to take care of my family, my 8 to 5 job wasn't enough”.

6.2.4.5. To be independent.

As indicated at the start of the study, the investigation focused on small and micro businesses. Figure 5.10 shows 12 respondents (29%) who said they started a business because they wanted to be independent and control their time. Respondents E33, E36, and E40 said, “I always wanted to be independent and have control over my time and my interest in business”. Most business owners are pulled towards starting a business to control their time and be financially independent.

6.2.4.6 Poverty

Economic hardship, high cost of living and poverty are some of the many societal ills in South Africa. There is no doubt that poverty is one of the reasons why some of the respondents started businesses. In the words of respondent E38, “the rising cost of living” pushed them to start their business. Another respondent indicated that they started their business because of “poverty”. In Figure 6.11, five respondents (12%) indicated that poverty was one of the reasons that pushed them to start a business.

6.2.4.7. Other motivations to start a business

The business experts had other reasons that pushed or pulled them to start a business. Some of them include the zeal to harness their knowledge and skills. As indicated in Figure 6.12, 29% of the respondents started a company to put their knowledge and skills acquired into use. One of the respondents said, “I studied IT in university and from a home of business owners, so I partnered with a former schoolmate to start creating apps and website designs”. Another respondent, E39, said, “I have to apply what I studied and had an interest in social media and online marketing”. A third respondent said E41, “To harness my skills and interests in computers, had no other jobs”. It is imperative that using your knowledge and skills

to start a business is what ICT TVET graduates should take advantage of as we move in a world of technological advancements and innovations.

Unhappiness at their current workplace was another reason some respondents started their businesses. 18% of the respondents started their businesses because they were unhappy at their current jobs see Figure 6.12. Another participant indicated that they started their business because they were not satisfied at their current place of work and did not like to be managed by others. A few other respondents mentioned being unhappy at their current jobs, pushing them to start a business and be their boss.

The family background could also influence whether an individual wants to start a business. If the person grew up in a family of business owners or entrepreneurs, they would be more inclined to follow in the footsteps of their parents or family members. Contrary to this scenario, the lack of family entrepreneurs and the sole breadwinner in the family pushed them into starting a business. Figure 6.12 shows that 29% of the respondents were pushed into starting a business because they were the family's breadwinners.

Another reason that motivated some respondents to start a business is their love for people; they wanted to help people and the community. Philanthropy is another reason that inspired some respondents to start their businesses. Thus, profits were secondary to their business goals. Figure 6.12 shows that 24% of the respondents started their businesses for philanthropic reasons.

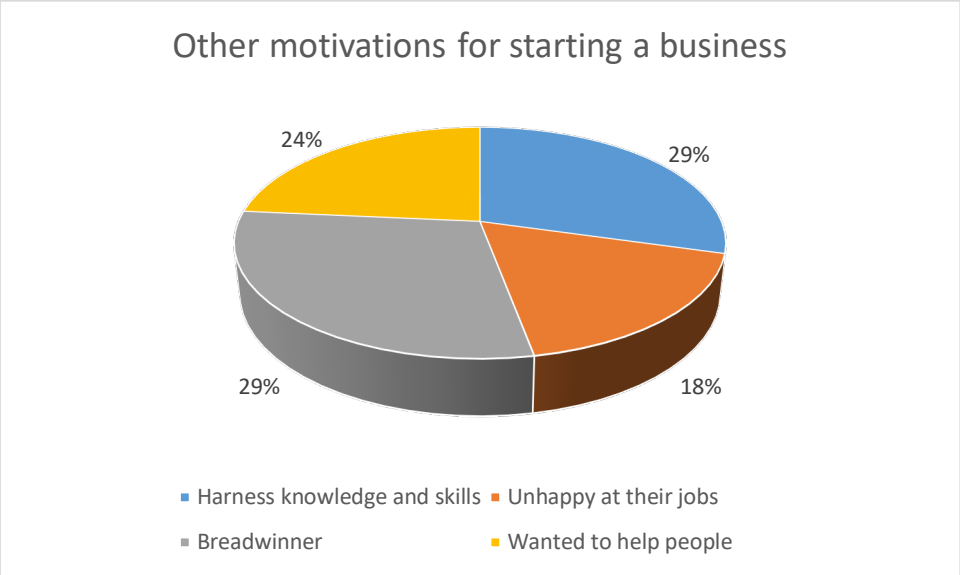


Figure 6.12. Other motivations for starting a business

6.2.5. Simulations components (skills) of teaching and learning of ICT at TVET

Research Objective 3: To identify the most relevant entrepreneurial skills that could be used to develop an entrepreneurial skills acquisition framework in ICT programmes.

Research Question 3. What are the most relevant entrepreneurial skills to be developed by ICT graduates in the 4IR?

This objective was to determine the simulation components (skills) used in teaching and learning to develop entrepreneurial skills in ICT TVET students. These components were used to determine how the influence of simulation in class could enable students to solve a problem in a real-life setting. To answer this research objective, the participants' responses (the students and the lecturers) were rated using a five Likert scale: 1 Strongly agree, 2 Agree, 3 Neutral, 4 Disagree, 5 Strongly disagree.

6.2.5.1 Most relevant entrepreneurial skills

As stated in Chapter One, the main objective of this study was to develop an entrepreneurial skills framework for ICT TVET students. The study is based on the supposition that this framework should be able to instil entrepreneurial skills and develop an entrepreneurial mind-set in ICT TVET students. In establishing an entrepreneurial skills acquisition framework for ICT TVET students, respondents were asked to rate the most relevant entrepreneurial skills to develop. As such, this section seeks to identify the most relevant entrepreneurial skills to have empirically. Based on the literature review, the study sought to establish the relative importance of ten entrepreneurial skills, namely (1) problem-solving skills, (2) technology application skills, (3) critical thinking skills, (4) group dynamics, (5) creative and innovative skills, (6) leadership skills, (7) time management skills, (8) emotional intelligence, (9) communication skills, and (10) interpersonal skills. The respondents were asked to indicate their level of agreement on the most relevant entrepreneurial skills. The findings on the significance of the level of agreement on the most pertinent entrepreneurial skills are discussed in the following section. Figure 6.12 indicates the respondents' level of agreement on the most relevant entrepreneurial skills.

In analysing this section, the theoretical and conceptual frameworks established in Chapter One can be restated to provide direction for analysing the components of an entrepreneurial skills acquisition framework. Table 6.13 below shows the conceptual framework of this study.

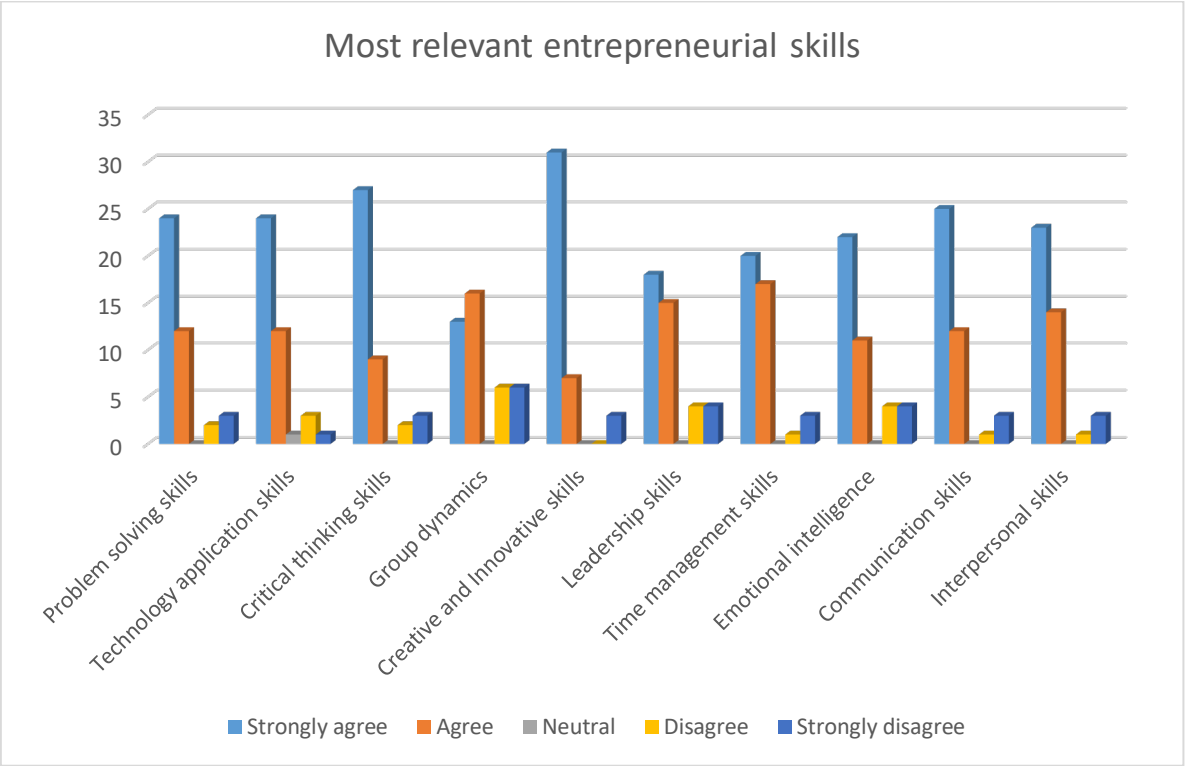


Figure 6.13: Most relevant entrepreneurial skills

6.2.5.1.1. Problem solving skills

The respondents were asked to rate their level of agreement that problem-solving skills are one of the most relevant entrepreneurial skills for ICT TVET students. As shown in Figure 6.13 and Figure 6.14, the majority of the respondents (59%) strongly agreed, and 29% agreed that problem-solving skills are relevant entrepreneurial skills to acquire by ICT TVET students. While 7% of the respondents strongly disagreed and 5% disagreed. Therefore, an overwhelming number of combined respondents (88%) agreed that problem-solving skills are among the most relevant entrepreneurial skills. This demonstrates that the whole essence of entrepreneurship is solving a problem, providing solutions and adding value to the economy. Hence, problem-solving skills are one of the components of the entrepreneurial skills framework.

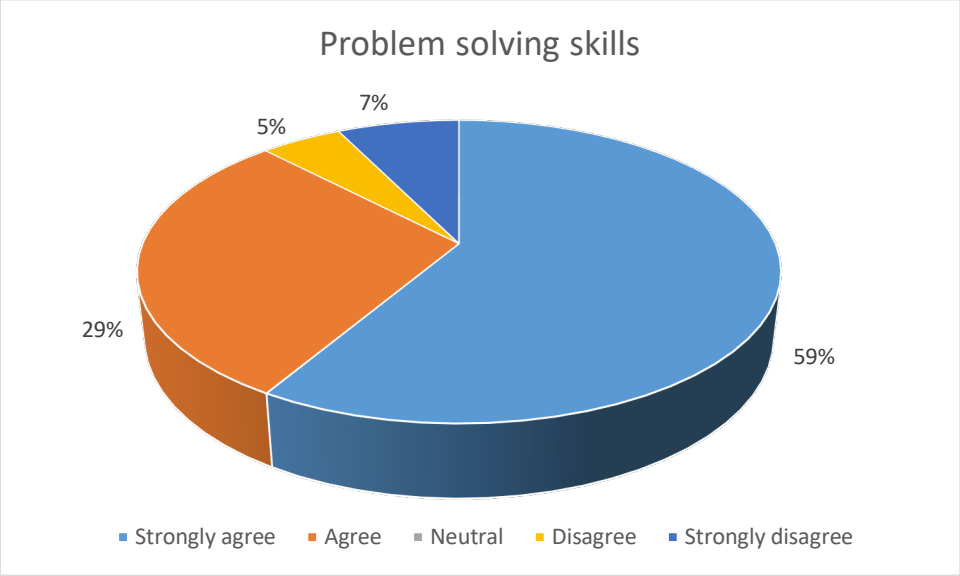


Figure 6.14: Problem-solving skills

6.2.5.1.2. Technology application skills

In a technologically advanced era, it is empirical that ICT students acquire technology application skills to be equipped to start up a business in the technology field or any field in general. Figure 6.13 and Figure 6.15 indicate that a majority of the respondents strongly agreed (59%) and agreed (29%) that technology application skills are relevant entrepreneurial skills for ICT students. This information shows that technology application skills are among the most pertinent entrepreneurial skills to acquire as an ICT student. The results are graphically represented in Figure 6.15. Technology application skills are relevant ICT skills that students can gain.

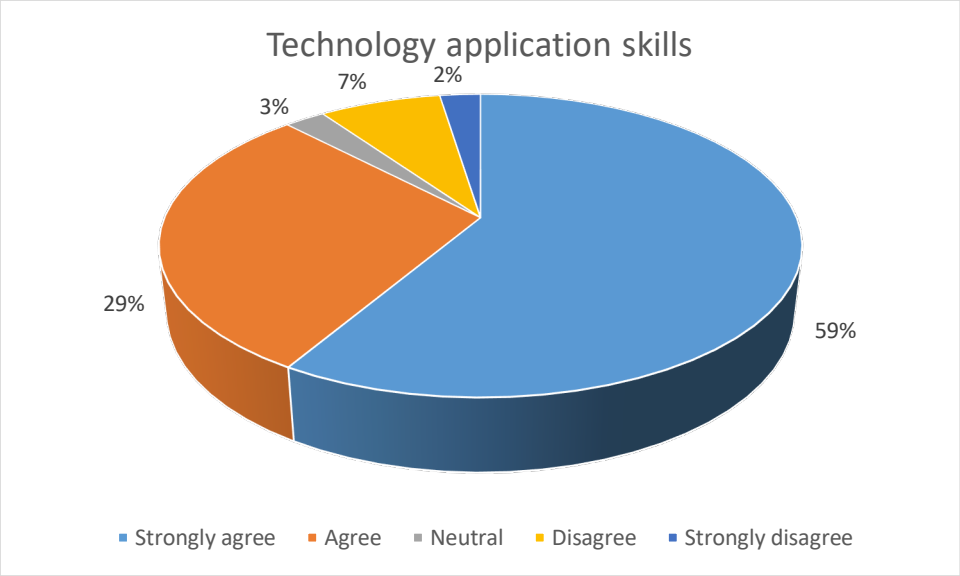


Figure 6.15: Technology application skills

6.2.5.1.3. Critical thinking skills

It is stated in the conceptual and theoretical framework that developing an entrepreneurial skills acquisition framework involves analysing the variables, including the entrepreneurial skills, ICT skills and teaching methods of these skills. Critical thinking is one of the most relevant entrepreneurial skills. As shown in Figure 6.16, 66% of the respondents strongly agreed that critical thinking is an essential entrepreneurial skill, and 22% agreed that critical thinking is a crucial skill to be gained. At the same time, 7% of the respondents disagreed.

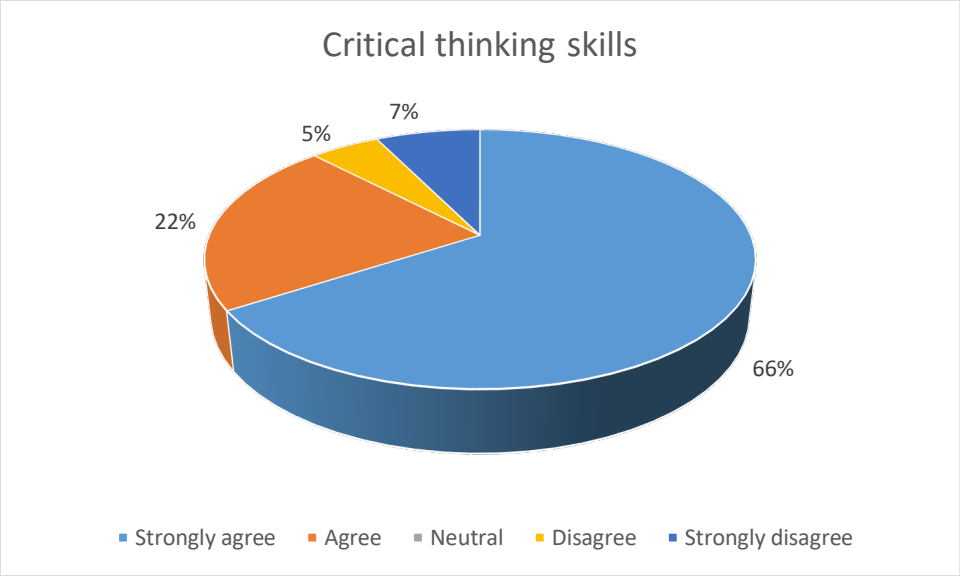


Figure 6.16: Critical thinking skills

6.2.5.1.4. Group dynamics

Group dynamics is also a critical entrepreneurial skill to gain, so to develop an entrepreneurial skills acquisition framework, the respondents were asked to rate their level of agreement with group dynamics as one of the most relevant entrepreneurial skills. Most respondents (32%) strongly agreed, (39%) agreed, 15% strongly disagreed, and 14% disagreed with group dynamics or teamwork as a relevant entrepreneurial skill. The results are graphically represented in Figure 6.17.

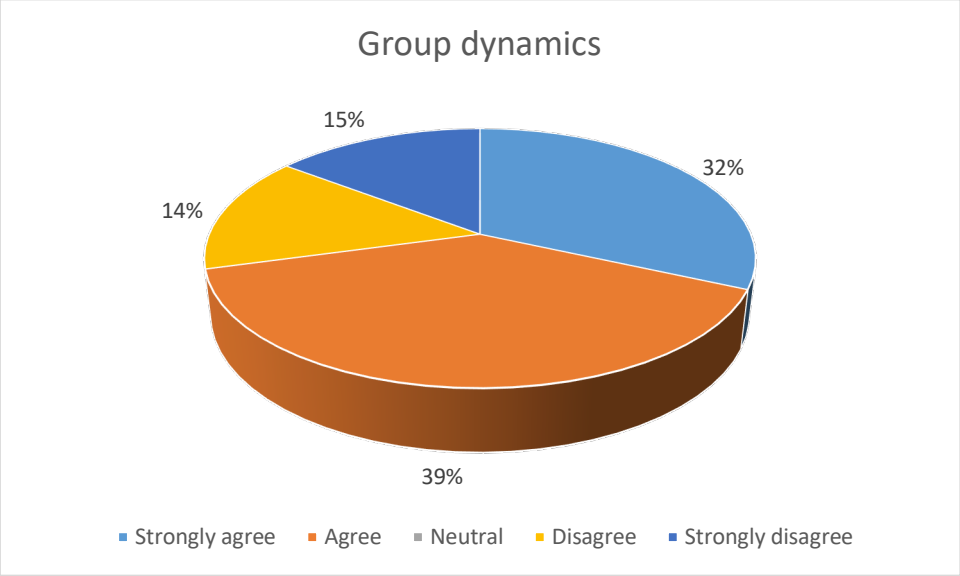


Figure 6.17: Group dynamics

6.2.5.1.5. Creative and innovative skills

Literature on entrepreneurial skills highlights that creative and innovative skills are among the vital entrepreneurial skills. Thus, the respondents were asked to rate their agreement with the statement that creative and innovative skills are among the most relevant entrepreneurial skills. As shown in Figure 6.18, a significant majority combined (82%) of respondents strongly agreed (41%) and agreed (41%) that creative and innovative skills are quintessential entrepreneurial skills. Of the remaining 41 respondents, just 3 (18%) strongly disagreed with the statement. The conclusion is that creativity and innovation form part of the core skills for entrepreneurs.

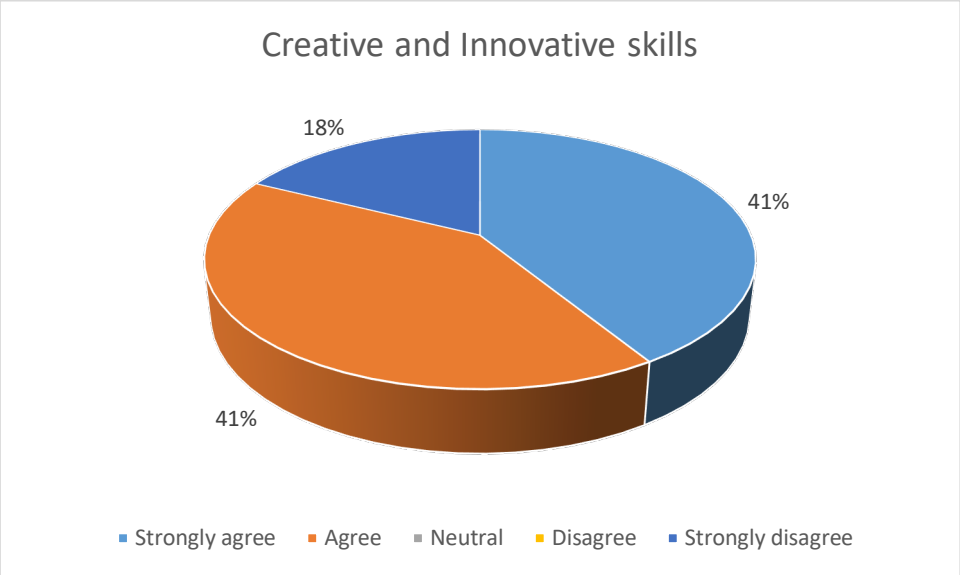
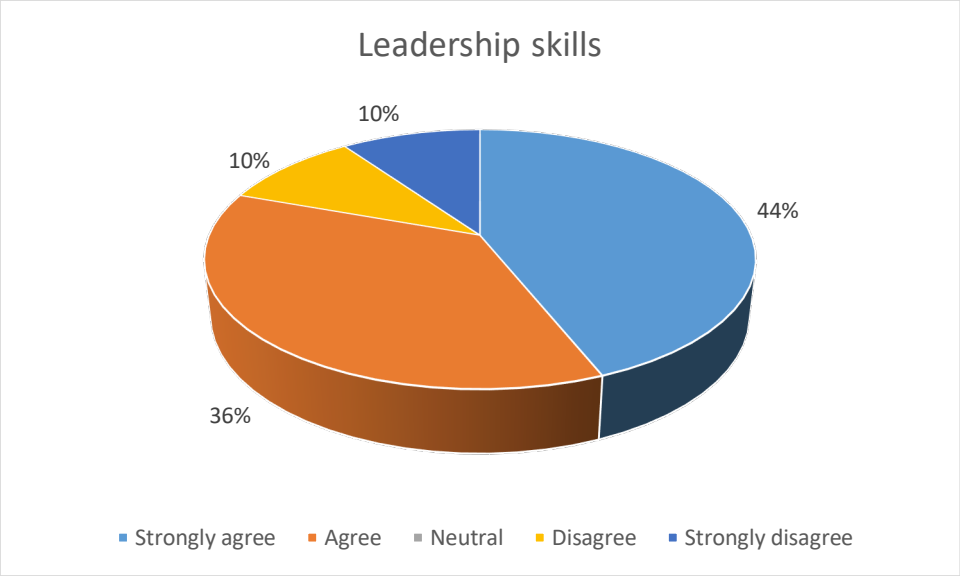


Figure 6.18: Creative and innovative skills

6.2.5.1.6. Leadership skills

A combined 80% of respondents strongly agreed (44%) and agreed (36%) that leadership is a relevant entrepreneurial skill, as seen in Figure 6.19. While 10% strongly disagreed, and another 10% (4respondents of the 41 respondents) disagreed with the statement. These results are graphically represented in Figure 6.18. Given the conceptual position earlier, leadership skills are critical for the entrepreneurial skills framework. The finding indicates that this factor must be considered in the proposed framework for growth.



6.19: Leadership skills

6.2.5.1.7. Time management skills

In the present study, Figure 6.20 shows that most respondents (a combined 91%) agree that time management is essential for entrepreneurs. As the adage goes, “Time is money”. Therefore, 49% of the participants strongly agreed that time management is a relevant skill, while 42% agreed.

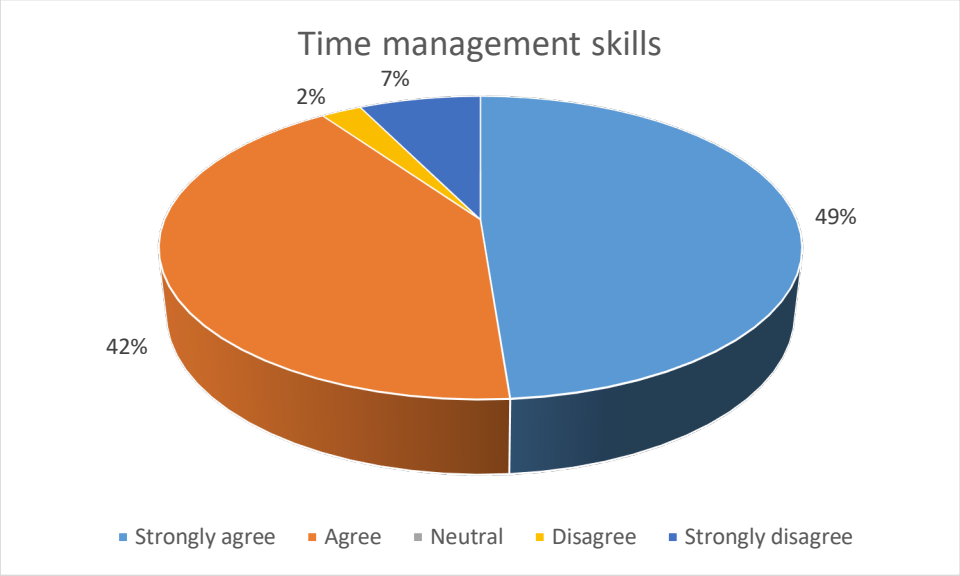


Figure 6.20: Time management skills

6.2.5.1.8. Emotional intelligence

Emotional intelligence in this age of advanced information technology is a paramount skill for entrepreneurs and individuals. An individual has to be emotionally intelligent in a world of globalisation, internationalisation, and the fourth industrial revolution. As illustrated in Figure 6.21, the majority (53%) of the participants strongly agreed that emotional intelligence is an essential skill for entrepreneurs within the fourth industrial revolution, and 27% of the respondents agreed. These results are illustrated in Figure 6.21.

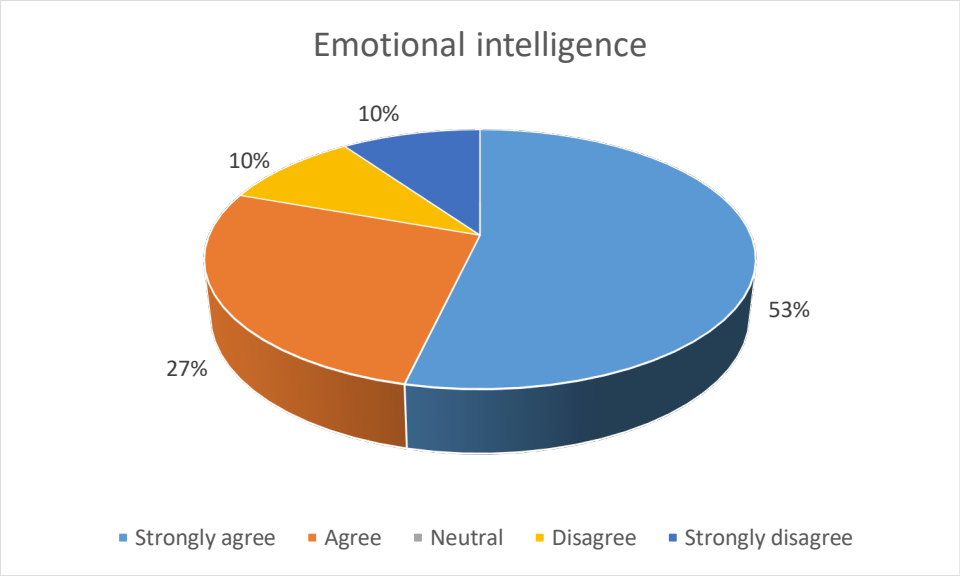


Figure 6.21: Emotional intelligence

6.2.5.1.9. Communication skills

Figure 6.22 shows that of the 41 respondents to the survey, 25 respondents (61%) strongly agreed that communication skills are one of the most relevant entrepreneurial skills. In contrast, 29% agreed, making a combined majority of 90% of the respondents agree. ICT TVET students need to have strong communication skills to be able to be entrepreneurs.

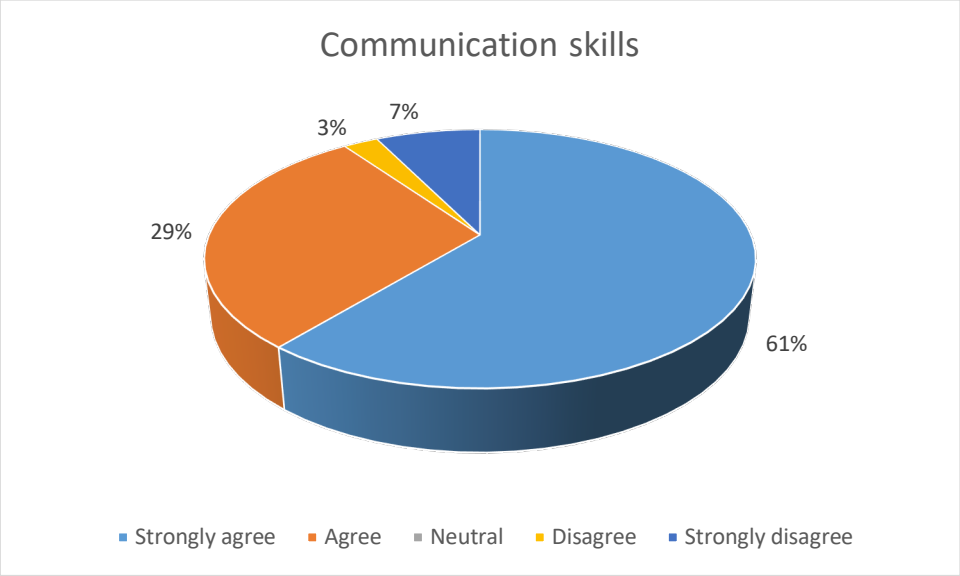


Figure 6.22: Communication skills

6.2.5.1.10. Interpersonal skills.

Figure 6.23 shows that 56% of the respondents strongly agreed that interpersonal skills are among the most relevant entrepreneurial skills. In comparison, 34% agreed, making a combined majority of 90% of the respondents agree with the statement. ICT TVET students need to have strong interpersonal skills to be able to be entrepreneurs.

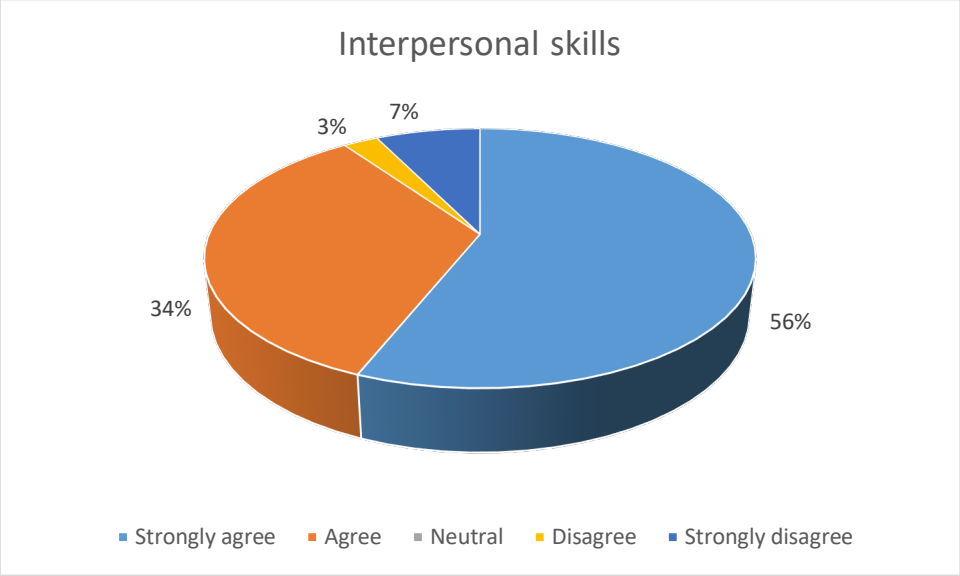


Figure 6.23: Interpersonal skills

6.2.5.1.11. Other relevant skills

A majority of the respondents, 25 out of the 41 respondents, strongly agreed (60%) that financial skills fall part of other skills that need to be mastered by entrepreneurs. Analytical skills were also mentioned by 10 of the participants. Then, a few participants noted that marketing and negotiation skills are other necessary skills an entrepreneur needs. The results are illustrated in Figure 6.24.

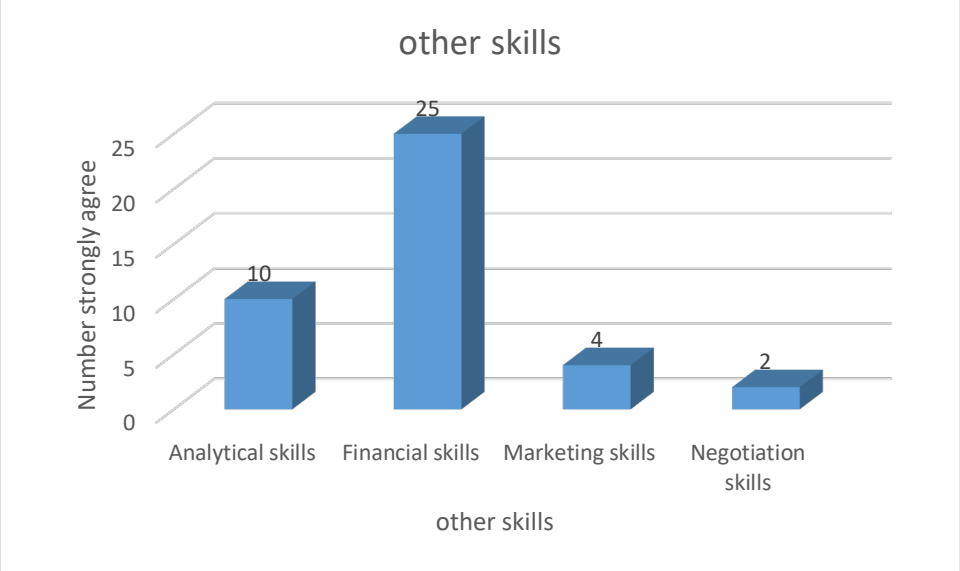


Figure 6.24: Other relevant skills

6.2.6. Simulations processes (teaching methods) of teaching and learning of ICT at TVETS

Research Objective 4: To identify the most relevant teaching methods that could be used to develop entrepreneurial skills in ICT.

Research Question 4. What are the best teaching methods to be employed for the development of entrepreneurial skills in ICT?

This objective was meant to determine the simulation processes (teaching methods) used in teaching and learning to develop entrepreneurial skills in the ICT TVET students. These components were used to determine how the influence of simulation in class could enable students to solve a problem in a real-life setting and develop an entrepreneurial skills framework. To answer this research objective, the participants' responses (the students and the lecturers) were rated using a five Likert scale: 1 Strongly agree, 2 Agree,3 Neutral, 4 Disagree, 5 Strongly disagree.

6.2.6.1. Simulation-based learning (SBL)

Simulation-based learning, also considered experiential learning, emphasises "learning by doing" and promotes active student engagement. Figure 6.26 indicates that an overwhelming number of respondents (80%) agreed that simulation-based learning or experiential learning is a suitable teaching method for enabling ICT students to acquire entrepreneurial skills. As shown in Figure 6.25, 60% of the respondents strongly agreed with the statement, and 20% agreed that SBL is a suitable teaching method for ICT students. At the same time, a mere 2% disagrees with the statement. Hence, integrating real-world experiences into the curriculum through internships, industry projects, and start-up simulations allows students to apply theoretical knowledge in practical settings, enhancing their entrepreneurial acumen. Simulation learning is a pedagogical approach that has gained prominence in entrepreneurship education, specifically for acquiring skills in the ICT sector.

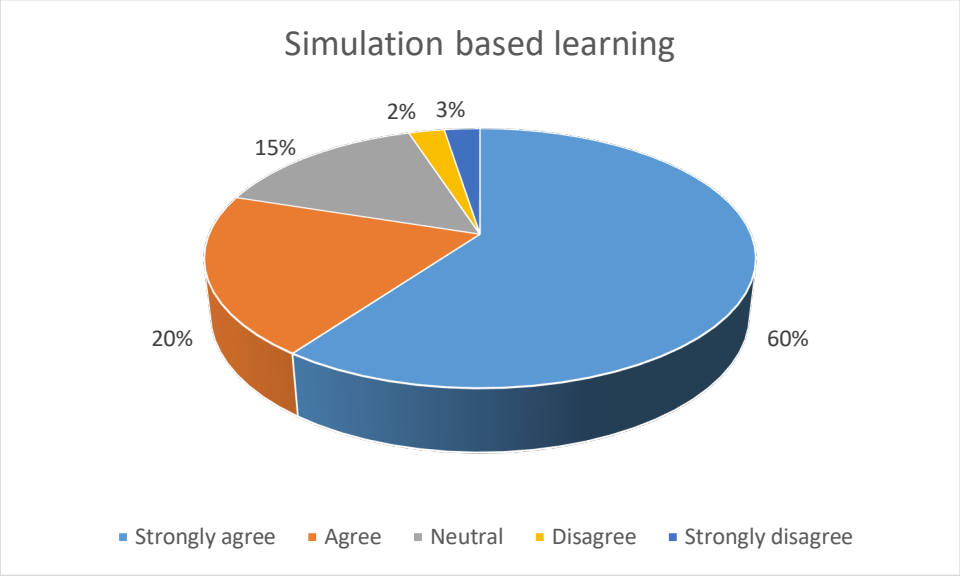


Figure 6.25: Simulation-based learning

6.2.6.2 Problem-based learning (PBL)

Problem-based learning -PBL challenges students with authentic, complex problems that mirror real-world scenarios. As shown in Figure 6.26, most respondents (56%) and (32%) agreed that PBL is a suitable teaching method to embed entrepreneurial skills in the students. Therefore, students develop critical thinking skills by collaborating in interdisciplinary teams and learning to approach challenges with an entrepreneurial mindset, identifying innovative solutions.

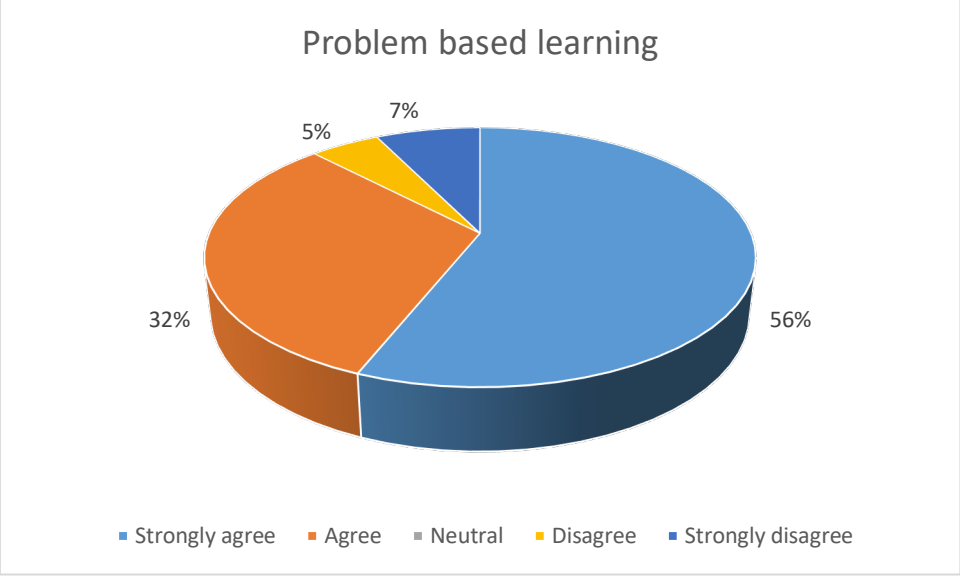


Figure 6.26: Problem-based learning

6.2.6.3 Project-based learning (PjBL)

Project-based learning is a very effective teaching method involving students carrying out a project and collaborating with industry partners on real-world projects. Thus, it exposes students to practical challenges and provides invaluable hands-on experience in entrepreneurship and ICT (Eckhoff et al., 2014; Powell et al., 2004). The respondents were asked to rate their level of agreement with PjBL as one of the most suitable teaching methods for ICT students to develop entrepreneurial skills and mindset. As illustrated in Figure 6.27, 49 % of the respondents strongly agreed, and 34% of the respondents agreed with the statement. While just 2% strongly disagreed and 5% opposed the statement.

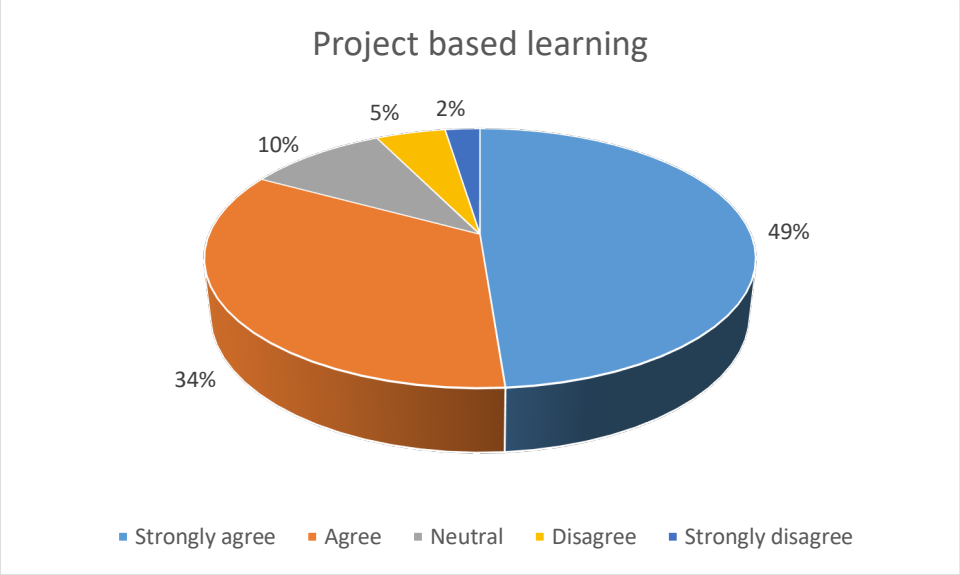


Figure 6.27: Project-based learning

6.2.6.4 Job shadowing

Job shadowing is another powerful teaching method that can be utilised to enable ICT students to gain hands-on experience. As indicated in Figure 6.28, most respondents (56%) strongly agreed, and 31% agreed that the students must be involved in job shadowing to experience entrepreneurship in real life.

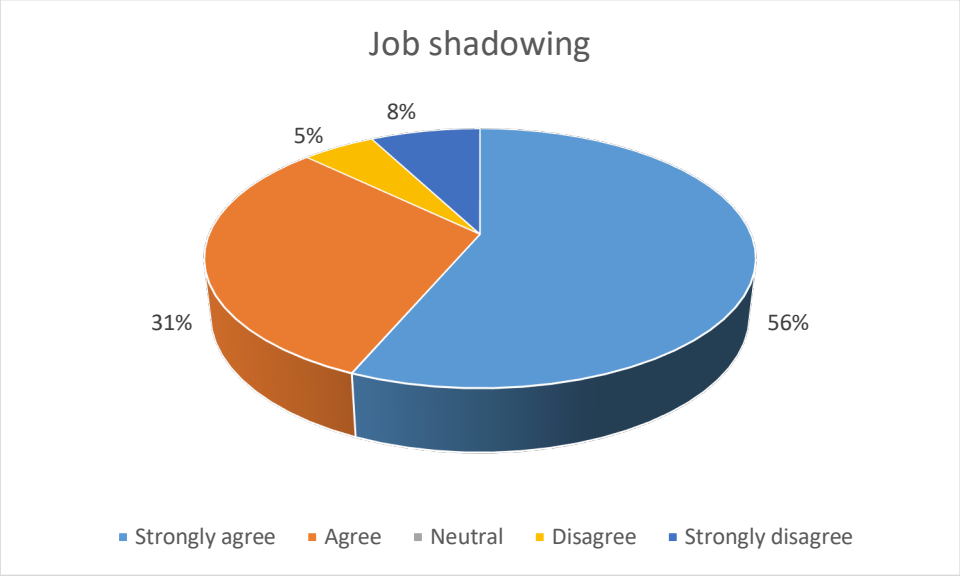


Figure 6.28: Job shadowing

6.2.6.5 Learnership and Internship

Learnerships and internships are valuable teaching methods for acquiring entrepreneurial skills, especially in Information and Communication Technology (ICT). Both approaches provide practical, hands-on experiences that complement theoretical knowledge, fostering a more holistic understanding of the entrepreneurial landscape. Most respondents strongly agreed (61%), and 27% agreed that citizenship and internship are suitable teaching methods for acquiring entrepreneurial skills. At the same time, 10% of the respondents disagreed with the statement. Hence, leadership and internships must be integrated into the curriculum. The results are illustrated in Figure 6.29.

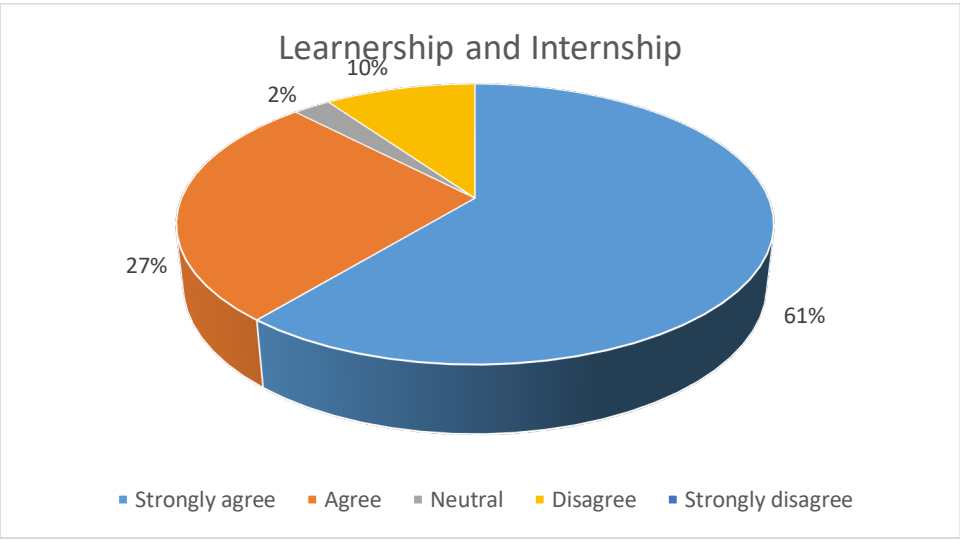


Figure 6.29: Learnership and internship

6.2.7 Other Suitable Teaching Methods

Some of the business experts mentioned some teaching methods that would be suitable for developing entrepreneurial skills. Examples of the methods include design thinking, entrepreneurship lab incubators, experiential learning, gamified learning and market days. One of the respondents indicated that inviting successful entrepreneurs to act as mentors and give talks to the students is another important teaching and learning method to improve entrepreneurial skills.

6.3 Experts' experiences and perceptions of the use of simulation-based learning.

Objective 1: To determine experts' experiences and perceptions of using simulation-based learning in teaching and learning ICT.

Research Question 1. What are the experts' experiences and perceptions of using simulation-based learning in teaching and learning ICT?

In this section, objective one will discuss the research study findings that indicate experts' experience and perceptions of using simulation-based learning in teaching and learning entrepreneurial skills to ICT students.

6.3.1 Experts' Experiences of the Use of simulation-based learning in the teaching and learning of entrepreneurship in ICT programmes

The business experts were asked if they agreed that simulation-based learning is a suitable teaching and learning method for acquiring entrepreneurial skills. A majority of the entrepreneurs (67%) strongly agreed with the statement, and 29% agreed with the statement. Just 2% of the participants strongly disagreed with the statement. The results are indicated in Figure 6.30.

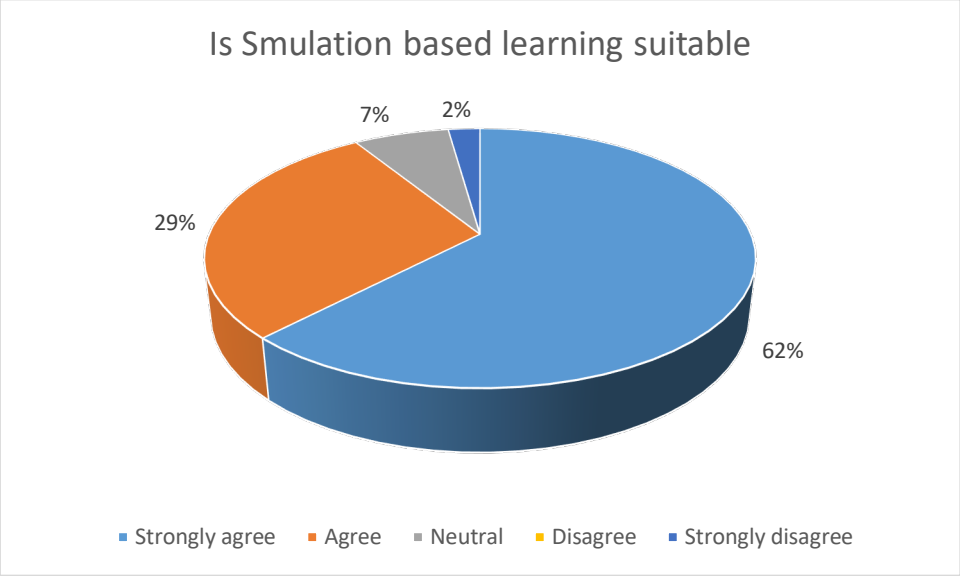


Figure 6.30: Experts' experiences of simulation-based learning in teaching entrepreneurship

6.3.2 Experts' perceptions of using simulation-based learning in teaching and learning entrepreneurship in ICT programmes.

The entrepreneurs who participated in this study were asked to give their perception of using simulation in the teaching and learning of entrepreneurship in ICT programmes. Below are some of their responses:

> "Good in that it brings in the practical aspect of the theory being taught. Students get first-hand experience on what to experience in the industry or real life. It opens their minds to the fact that theory and practical can differ."

> "In the IT field, it is always good to practice the theory learned. So with a simulation learning approach, students get to simulate what it is to build an app or to fix software or hardware".

Other business participants indicated that simulation-based learning in the teaching and learning of entrepreneurship in ICT programmes allows critical thinking and enables students to gain practical experience and experience the theory they learnt in practice. One participant indicated that simulation-based learning to acquire entrepreneurial skills enables students to have an experiential form of learning and develop real-life practical skills.

> "Simulation-based learning is good for the students in that I believe it is an engaged form of learning", says another participant.

Therefore, all the participants had a positive statement about using simulation-based learning in teaching and learning entrepreneurial skills in ICT programmes.

6.3.3 Simulation-based learning elements suitable for developing a framework for entrepreneurial skills for ICT programmes at TVET colleges.

This section will discuss the simulation-based learning elements suitable for developing a framework for entrepreneurial skills for ICT programmes. These elements were deduced from the literature and the quantitative data from the lecturers and students. The business experts showed the same level of agreement as the lecturers and students, affirming that these elements are suitable for developing an entrepreneurial skills framework. Figure 6.31 shows that the business expects to strongly agree to the following aspects: solution, teachers' role, students' role, continuous and alternate assessment, psychological motivation and self-control as suitable elements for developing entrepreneurial skills.

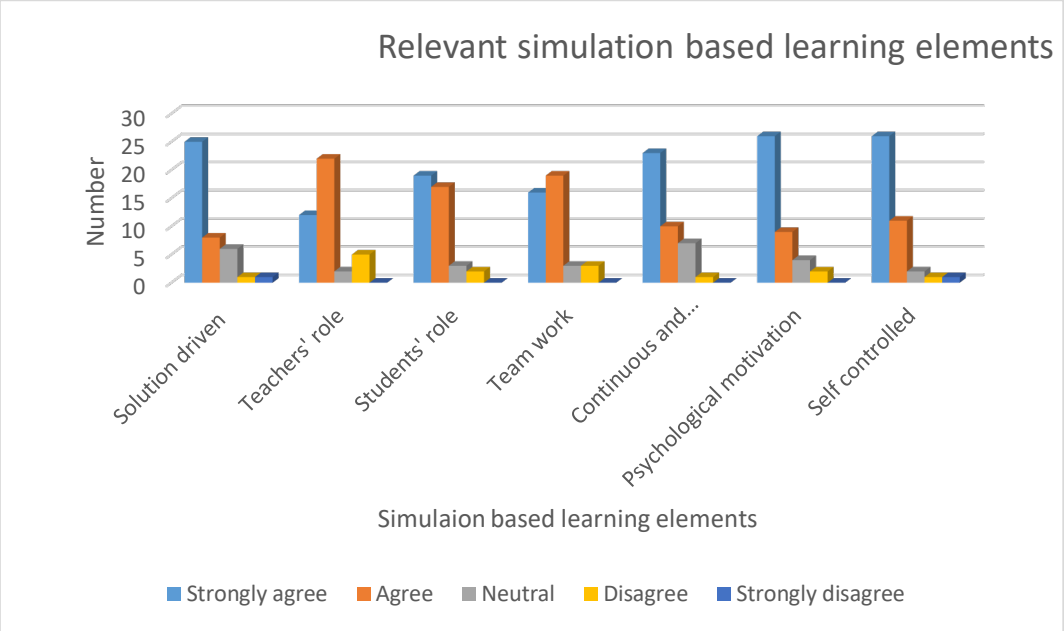


Figure 6.31: Relevant simulation-based learning elements

6.3.3.1 Solution-driven Teaching and Learning

Solution-driven as a teaching and learning process for developing entrepreneurial skills is vital because entrepreneurship is all about creativity, innovation and finding solutions to society's problems. Most business experts (61%) strongly agreed, and 20% agreed that solution driven as a teaching and learning process in acquiring entrepreneurial skills. The results are shown in Figure 6.32.

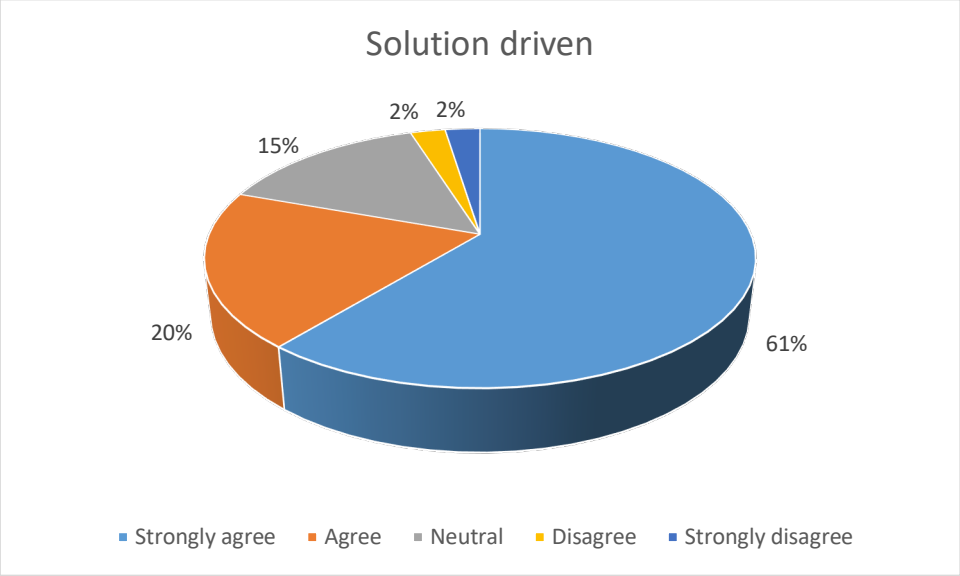


Figure 6.32: Solution driven

6.3.3.2 Teacher's Role

The teacher plays an essential role in the teaching and learning process for developing entrepreneurial skills. The lecturer acts as a facilitator in the development of entrepreneurial skills. Most of the business experts (54%) strongly agreed, and 29% agreed that the teacher's role is vital in the teaching and learning process in acquiring entrepreneurial skills. The results are illustrated in Figure 6.33.

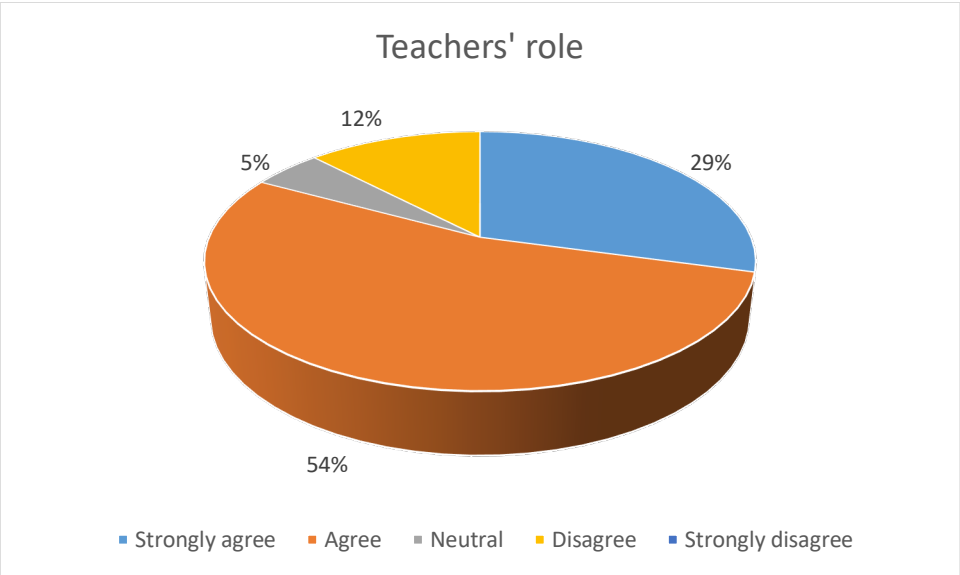


Figure 6.33: Teachers' role

6.3.3.3 Students' Role

The student plays an essential role in the teaching and learning process for developing entrepreneurial skills. The simulation-based learning process is a student-centric process that focuses on developing entrepreneurial skills for ICT students. Most business experts (46%) strongly agreed, and 42% agreed that the student's role is vital in the teaching and learning process in acquiring entrepreneurial skills. The results are illustrated in Figure 6.34.

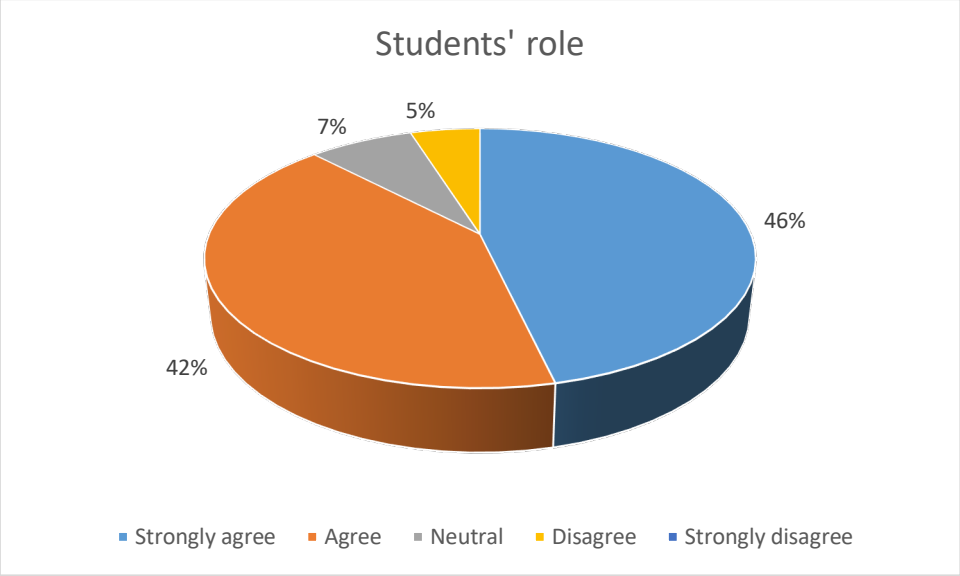


Figure 6.34: Student's role

6.3.3.4 Teamwork

The tea work is essential in the teaching and learning process for developing entrepreneurial skills. The simulation-based learning process ensures that students work in teams to foster their communication and critical thinking skills, thereby developing entrepreneurial skills. Most business experts (39%) strongly agreed, and 47% agreed that teamwork is essential in the teaching and learning process of acquiring entrepreneurial skills. The results are illustrated in Figure 6.35.

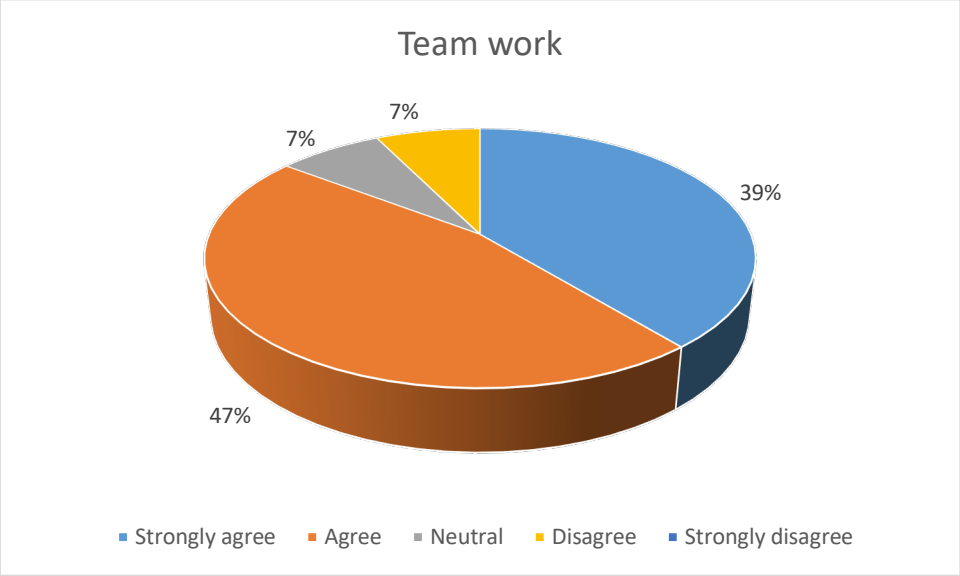


Figure 6.35: Teamwork

6.3.3.5 Continuous and Alternate Assessment

As part of the assessment methods, continuous and alternate assessment is necessary for the teaching and learning process to develop entrepreneurial skills. Most of the business experts (56%) strongly agreed, and 24% agreed that continuous and alternate assessment is vital in the teaching and learning process of acquiring entrepreneurial skills. The results are shown in Figure 6.36.

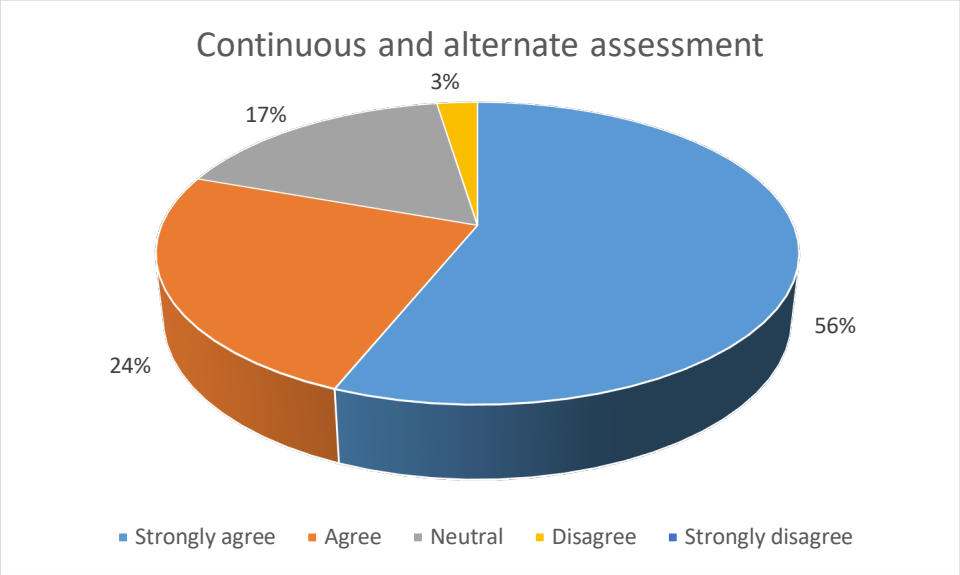


Figure 6.36: Continuous and alternate assessment

6.3.3.6 Psychological motivation

The students must be mentally and psychologically motivated to build resilience and stamina amid a problem-ridden society. Psychological motivation enables the students to be determined to achieve their goals. Thus, psychological motivation is essential in the teaching and learning process for developing entrepreneurial skills. The majority of the business experts (63%) strongly agreed, and 22% agreed that psychological motivation is vital in the teaching and learning process of acquiring entrepreneurial skills. The results are demonstrated in Figure 6.37.

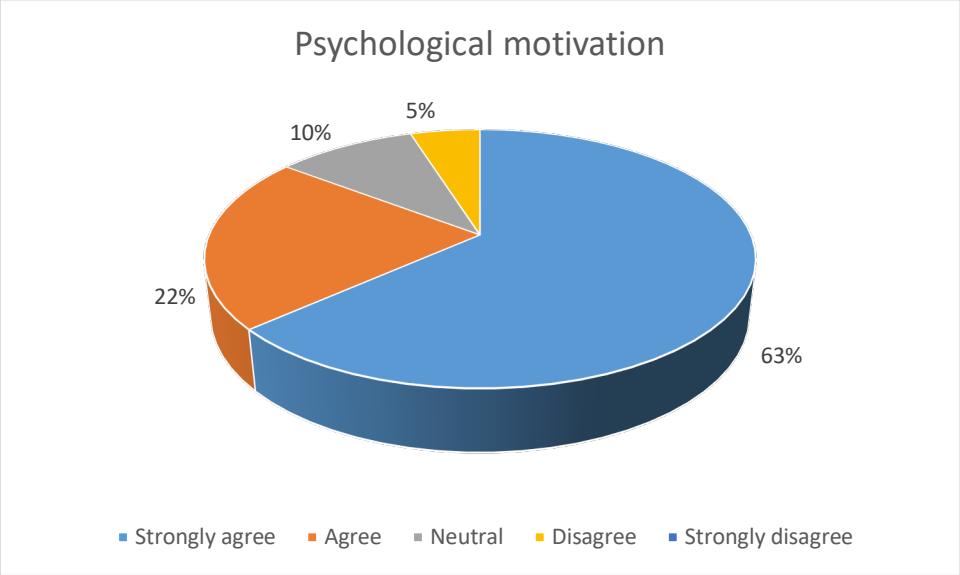


Figure 6.37: Psychological motivation

6.3.3.7 Self-controlled

The student must have self-control and discipline to develop entrepreneurial skills. Self-control plays an essential role in the teaching and learning process for developing entrepreneurial skills. The simulation-based learning process is a student-centric process that focuses on developing entrepreneurial skills for ICT students. Thus, students must be self-directed and self-motivated to complete all their tasks and engage in the teaching and learning process. The majority of the business experts (63%) strongly agreed, and 27% agreed that the student's self-control is vital in the teaching and learning process in acquiring entrepreneurial skills. The results are illustrated in Figure 6.38.

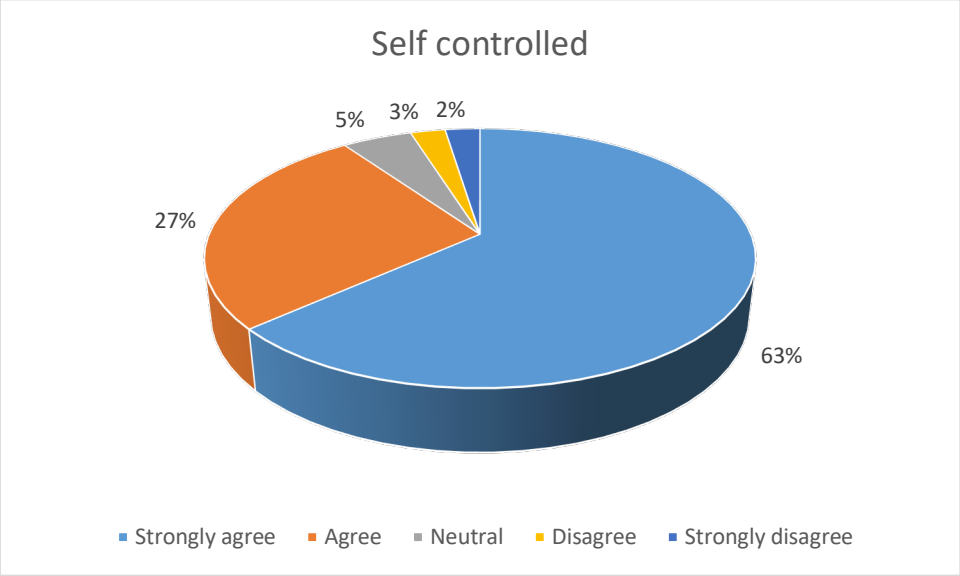


Figure 6.38: Self controlled

6.4. Chapter summary

Of the 41 business experts involved in the survey and interviews, 54% were female, and 46% were male. 27% hold a Bachelor's degree, and 63% have been in business for over five years. The quantitative and quantitative results showed that most entrepreneurs strongly agreed that problem-solving, project-based earning, teamwork, teachers' roles, and public presentation and project simulation are essential elements in developing entrepreneurial skills for ICT students.

The business experts/entrepreneurs had an overwhelming consensus with all the processes involved in developing entrepreneurial skills for ICT students. The survey and interviews indicated that, as discussed in this chapter, Problem orientation & analysis, Learning Objectives, Project Initiation & Execution, Learning Outcomes, Assessment Methods, and Public Presentation are the best processes for developing entrepreneurial skills. Some relevant entrepreneurial skills that the lecturers strongly agreed on include problem-solving skills, emotional intelligence, technology application skills, creativity and innovation, and interpersonal skills, among others; these outcomes and learning objectives are crucial for acquiring entrepreneurial skills. Chapter seven discusses the framework for entrepreneurial skills for ICT students at TVET College.

CHAPTER SEVEN:
AN ENTREPRENEURIAL SKILLS FRAMEWORK FOR INFORMATION COMMUNICATION AND TECHNOLOGY STUDENTS AT TVETS.

7.1. Introduction

This chapter unveils the study's conclusive results, showcasing the fulfilment of both the theoretical goals outlined in the literature review and the objectives explored in earlier chapters. The data gathered has been thoroughly analysed and discussed in preceding chapters. The data was analysed, and critical dimensions for a framework for entrepreneurial skills acquisition for ICT programmes emerged. Three data sets were used to arrive at the dimensions for the framework proposed in this chapter. The first set is quantitative data collected using student and lecturer questionnaires. The third data was qualitative and quantitative data collected from the business experts (entrepreneurs) using questionnaires and interview guides. The approach used in the data analysis followed an embedded triangulation style where the principle data analysis was quantitative and based on the questionnaires distributed to the Lecturers and students. These questionnaires generated certain propositions, which became the basis for further study. Then, Interviews were conducted with business experts, and the data collected was analysed. Subsequent analysis of the findings examined patterns to either confirm, challenge, or supplement the propositions initially formulated in the initial surveys. It was observed that the initial propositions remained prominent during further data scrutiny, leading to their incorporation into a framework proposed in this chapter.

The chapter starts with an exploration of the simulation components and procedures integral to shaping the framework for acquiring skills in ICT programs, followed by the unveiling and thorough elucidation of the framework. It is important to underscore that the primary objective of the study was to devise a framework specifically tailored for acquiring entrepreneurial skills within the ICT program.

This main objective was meant to address the overall problem of misaligning the skill sets needed for the 4IR for ICT students, as there is no reliable framework for developing entrepreneurial skills in ICT programmes at TVETs in South Africa. This chapter showcases the study's ultimate findings, encompassing the fulfilment of both the theoretical goals outlined in the literature review and the objectives achieved in the preceding chapters.

7.2 A framework for the development of entrepreneurial skills in ICT students.

At its formulation, the present study stemmed from a problem statement that can be restated as there is a misalignment of the skill sets needed for the 4IR for ICT students, as there is no reliable framework for developing entrepreneurial skills in the ICT TVET programmes. This problem led to the main objective: to create a conceptual framework for acquiring entrepreneurial skills in ICT programmes.

7.2.1 The teaching and learning elements for the development of an entrepreneurial skills framework

A significant part of the study was based on deducing the teaching and learning elements to be considered in developing the framework for entrepreneurial skills acquisition in ICT programmes. The literature review and the data analysis chapters were reviewed and discussed to provide direction to those simulation problem-based teaching and learning elements that would determine ICT students' acquisition of entrepreneurial skills. An overwhelming agreement was noted between the elements in the literature review and those in the data analysed. Owing to the merging of theoretical and empirical objectives, simulation problem-based elements and processes were identified and established in line with the goals set in Chapter One.

To arrive at these elements and processes, the findings from the literature were merged with triangulated empirical findings. Both quantitative data from questionnaires were analysed, and interviews were conducted with qualitative data. The findings from these different data sets resulted in clear patterns emerging to arrive at the framework's elements and processes.

The subsequent sections delve into the components, procedures, and their interconnections before their integration into a framework is thoroughly examined. The convergence of elements and methodologies for an entrepreneurial skills acquisition framework, achieved through data triangulation involving three distinct respondent groups and incorporating both qualitative and quantitative data, substantiates the proposed framework convincingly. Chapter Three emphasized the adoption of a mixed-method design to enhance the reliability of the gathered data.

7.2.1.1 SPBL Elements Relationship

Based on the findings elucidated in Chapter Five and Chapter Six regarding the elements and processes crucial for formulating a framework for entrepreneurial skills within ICT programs, it is evident that students bear the responsibility to: Identify and analyse problems, classify data, formulate hypotheses, and delve into learning aspects; Endeavour to find solutions to identified problems utilizing existing knowledge while assessing its relevance; Categorize unidentified areas and all essential components necessary for problem resolution; Prioritize learning needs, establish learning objectives, and foster collaboration among team members; Strategize and empower team members for independent research endeavours; Utilize acquired knowledge to initiate and plan projects according to set objectives; Coordinate tasks, take action, and oversee project progress; Manage, monitor, regulate, and refine project activities; Allocate and utilize project resources efficiently; Evaluate and analyse project outcomes; Engage in self/peer evaluation processes; and Ultimately, execute the project comprehensively, thus integrating students' roles within the framework alongside other elements. This relationship is illustrated in Figure 7.1.

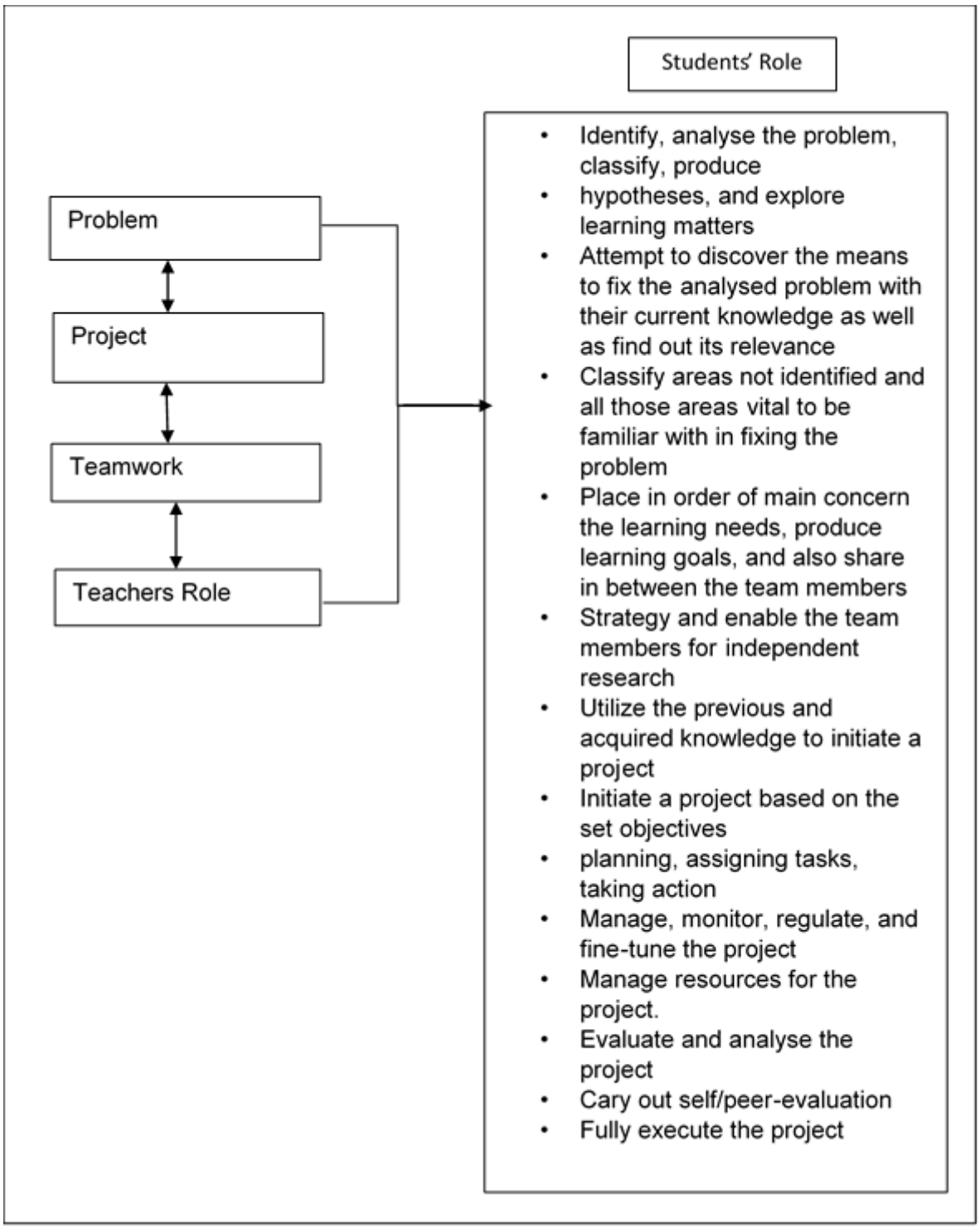


Figure 7.1 SBL Elements Relationship
Source: Conceived by the researcher

7.2.2 The teaching and learning processes for the development of an entrepreneurial skills framework

Main Objective: To develop an entrepreneurial skills framework for students in the ICT programme within the 4IR.

Main Research Question: What are the most relevant entrepreneurial skills for students in the ICT programmes at TVET institutions, and how can these skills be developed?

The study's objective is to design a framework for nurturing entrepreneurial skills within ICT programs. Chapters five and six discusses the study's findings, demonstrating that entrepreneurial skills emerge as the educational outcomes facilitated by Simulation Based Learning (SBL). These skills encompass problem-solving, technology application, critical thinking, research/information retrieval, creativity/innovation, teamwork, communication, active learning, higher-order thinking, organization, interpersonal, leadership, self-directed thinking, self-directed/lifelong learning, and presentation skills. The process entails formative assessment and evaluation at each stage to ascertain the achievement of objectives and learning outcomes. It culminates in a summative assessment and evaluation to gauge the overall accomplishment of project objectives and learning outcomes, which originated from a simulation problem. The interconnectedness between variables and processes is depicted in Figure 7.2.

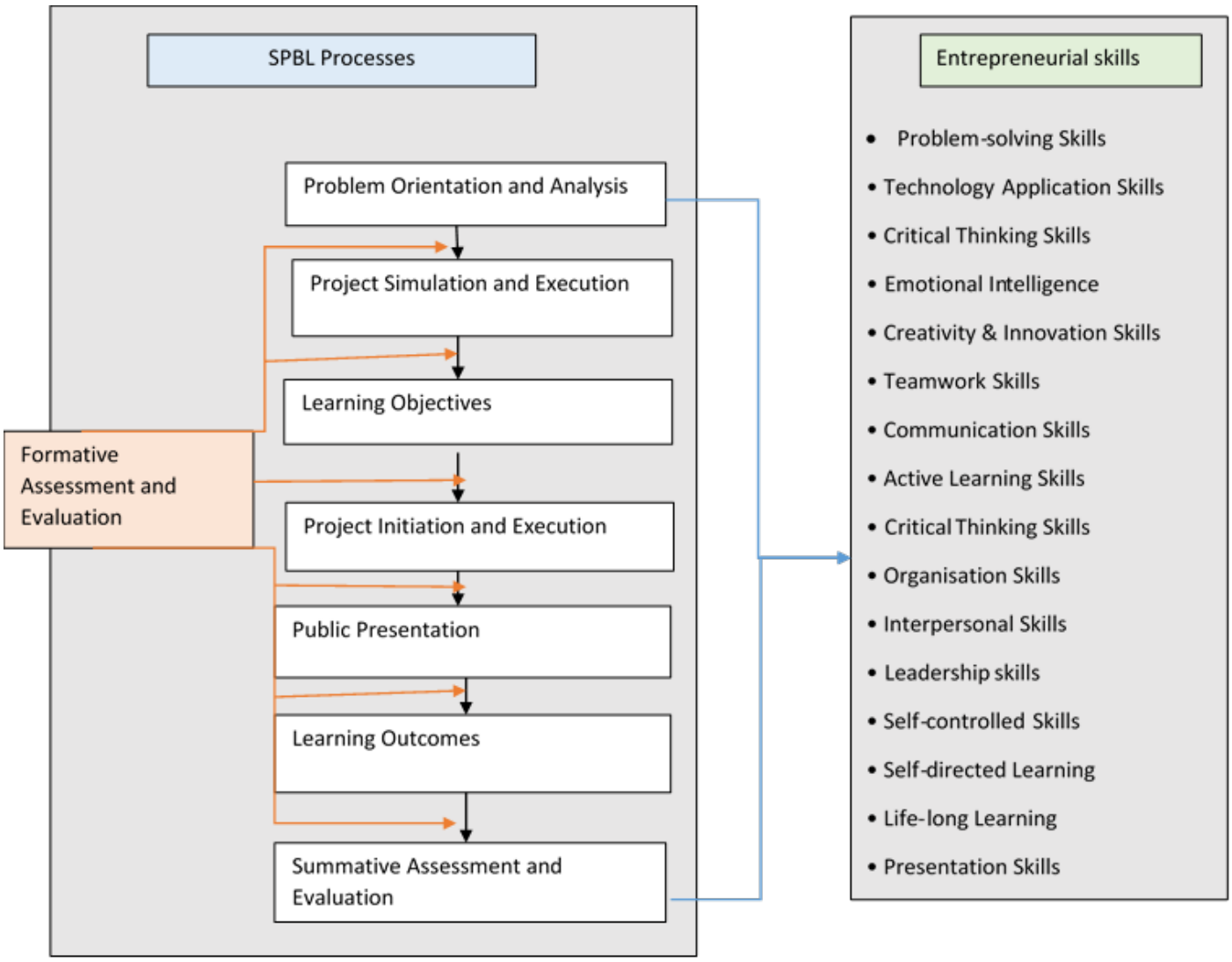


Figure 7.2 SBL Processes Relationship
Source: Conceived by the researcher

7.2.2 Discussion of Findings on the Development of a SBL Framework for Entrepreneurial Skills in ICT Programmes

Figure 7.3 illustrates the conceptual framework delineating entrepreneurial skills within ICT programs. The framework encompasses five SBL elements: problem, project, teamwork, students' role, and teacher's role, along with seven SBL process stages: problem identification and analysis, project simulation and execution, establishment of learning objectives, project initiation and execution, attainment of learning outcomes (entrepreneurial skills), public presentation, and assessment methods. The correlation between the variables of SBL elements and those of SBL/SPBL processes is established based on insights from preceding chapters and Figures 7.1 and 7.2. This framework is derived from insights gathered from existing literature, expert opinions, respondents' feedback, and confirmatory factor analysis.

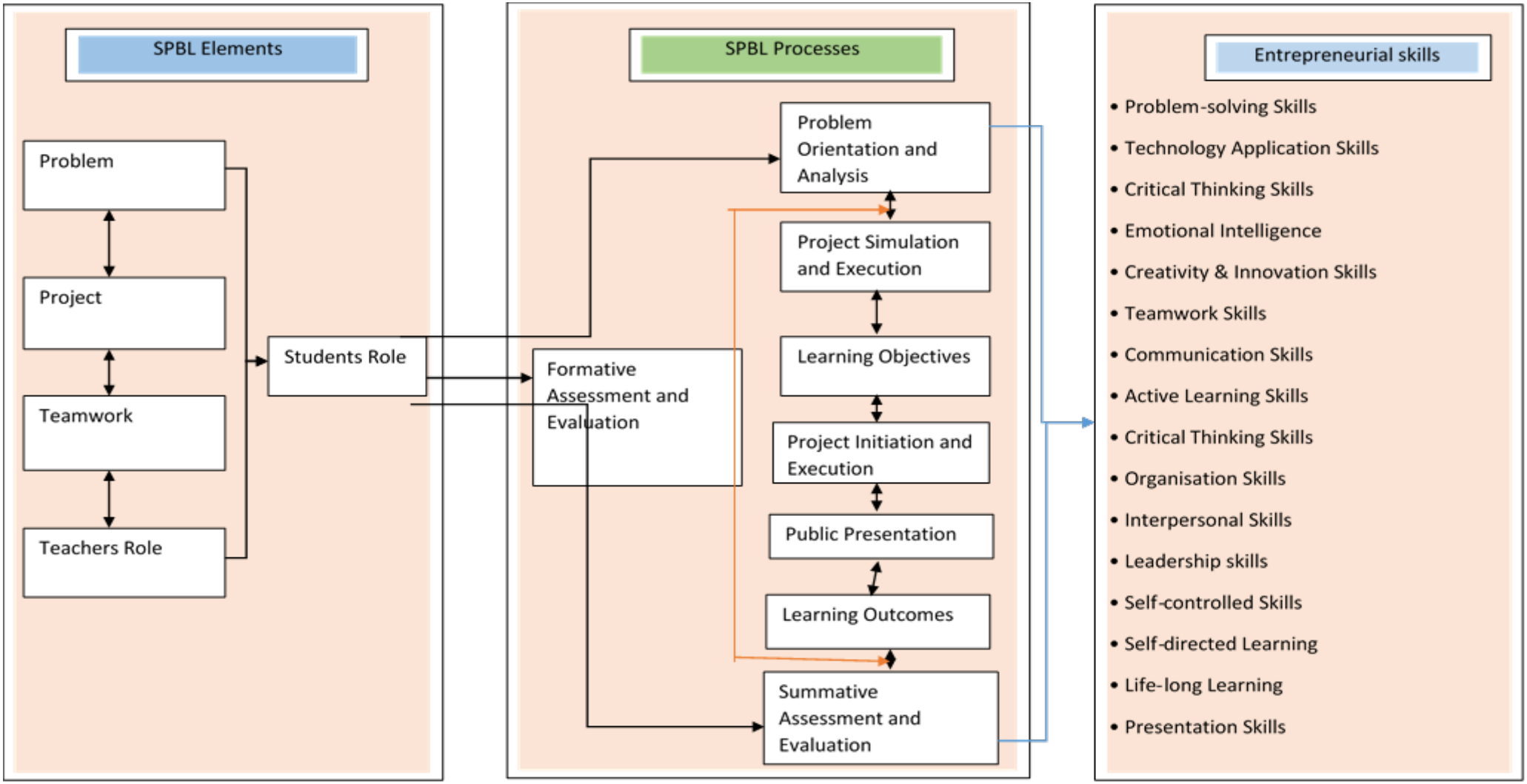


Figure 7.3 The Proposed Framework for Developing Entrepreneurial Skills in ICT Programmes

Source: Conceived by the researcher

As shown in Figure 7.3, the study's findings revealed that the student's role is vital in acquiring entrepreneurial skills; the students are a converging point between the other four elements, thus justifying the student-centeredness of the SBL. Therefore, the student assumes responsibility for the SBL procedures, encompassing problem identification and analysis, activation of prior knowledge alongside additional research, defining learning/project objectives, initiating and executing projects, assessing learning outcomes (entrepreneurial skills), and employing public presentation and assessment methods.

At the conclusion of each process stage, formative assessment, summative assessment, and evaluation are conducted to confirm the achievement of objectives and learning outcomes. If objectives are not fully met, the stage can be revisited to identify the reasons for any shortcomings. Students are responsible for these tasks, with the lecturer serving as the facilitator throughout the process.

7.3. Chapter summary

The SBL/SPBL process revolves around the student, emphasizing teamwork, communication, and public speaking, while also encouraging self-assessment and evaluation. Teachers play a monitoring and facilitating role throughout. This framework aims to facilitate learning by promoting a deep understanding of concepts and content. It serves as a catalyst, motivating students to engage actively in learning-by-doing activities, with teachers facilitating effective learning and guiding students' progression. By simulating real-world situations, the process fulfils the core objective of education: equipping learners to contribute meaningfully to society. Considering the study's insights into ICT education, it's evident that training ICT students in a SBL environment holds significant potential to positively impact society, particularly in the context of the Fourth Industrial Revolution.

CHAPTER EIGHT:
CONCLUSION AND RECOMMENDATIONS.

8.1. Introduction

The previous chapter illustrated the output of this research, the framework for entrepreneurial skills acquisition for ICT TVET students. The aim of this chapter was to consolidate and derive conclusions from the principal findings. By offering conclusions and recommendations, the study consistently addresses the initial problem that inspired the research and aligns with the objectives to propose solutions for addressing the situation. This research aimed to develop an entrepreneurial skills acquisition framework for South African TVETs' ICT programmes. There were four objectives and four research questions that guided the research process. The results and findings of the research were based on the qualitative and quantitative data from students, lecturers and entrepreneurs (business experts) on five components and seven processes of Simulation-based learning (SBL) for developing entrepreneurial skills in ICT programmes in TVET colleges in Cape Town, South Africa. The five elements are problem, project, teamwork, teacher's and students' roles. At the same time, the seven process stages include problem orientation and analysis, project simulation and execution, learning objectives, project initiation and execution, learning outcomes, assessment methods, and public presentation.

This chapter will cover the research findings, their implications, conclusions, recommendations, and the necessity for future research. These aspects were derived from the study's findings, commencing with a summary of the findings based on the five research questions, which in turn led to the identification of the five components and seven processes of the SBL conceptual framework for entrepreneurial skills acquisition in South African TVET colleges' ICT programs. Finally, the identified variables under the five elements and processes were graphically presented to illustrate the framework representing "An Entrepreneurial Skills Acquisition Framework in South African TVET colleges' ICT programmes".

8.2 Conclusion of the Related Research Findings

The outcomes and findings of this study, outlined in Chapter Five and Chapter Six, stem from five research questions that directed the inquiry. These results unveiled the variables (statements) associated with each of the five elements and seven processes of SBL

explored in this research, focusing on the SBL conceptual framework for entrepreneurial skills in ICT programs within TVET colleges in Cape Town, South Africa. The discussion regarding the outcomes and findings for each of the five elements and seven process stages of the conceptual framework was thoroughly examined and presented. The interconnected discourse surrounding the five elements and seven process stages was combined to formulate a conceptual framework for entrepreneurial skills.

8.2.1 Conclusion of Findings on the SPBL elements that could be considered for the development of a framework for entrepreneurial skills in ICT programmes

From the five Simulation Based Learning (SBL)/ Simulation Problem Based Learning (SPBL) elements identified for the conceptual framework aimed at fostering entrepreneurial skills in ICT programs within TVET colleges, a range of components were allocated to each element, concluding in the completion of the framework. A total of fifty-nine (59) items were identified, comprising eleven from problems, twelve from projects, thirteen from students' roles, twelve from teacher's roles, and eleven from teamwork. Each of these items was meticulously established and scrutinized individually.

8.2.2 Conclusion of Findings on the SBL Process Stages that could guide the Development of a Framework for Entrepreneurial Skills in ICT Programmes

Derived from the identification of the five SPBL process stages aimed at structuring the conceptual framework for entrepreneurial skills within ICT programs at TVET colleges, a variety of elements were assigned to each of the seven process stages, thereby constituting the final framework. In total, fifty-nine (59) items were identified, with twelve (12) items attributed to Problem Orientation and Analysis (POAA), ten (10) to Project Simulation and Execution (PSE), sixteen (16) to Learning Objectives (LOBJ), eleven (11) to Project Initiation & Execution (PJIE), fifteen (15) to Learning Outcomes (LOC), eleven (11) to Assessment Methods (ASM), and ten (10) to Public Presentation (PP). These elements were determined through recommendations from experts, pertinent literature, respondents' preferences, and factor analysis. Each of these items underwent independent establishment and analysis.

8.2.3 Conclusion of Findings on the Development of a Framework for Entrepreneurial Skills in ICT Programmes

The proposed framework for entrepreneurial skills in ICT programs is illustrated in Figure 7.3. It encompasses five SPBL elements: problem, project, teamwork, students'

role, and teacher's role, along with seven SBL process stages: problem orientation (identification) and analysis, project simulation and execution, learning/project objectives, project initiation and execution, learning outcomes (entrepreneurial skills), public presentation, and assessment methods. The correlation between the variables of the SBL elements and those of the SBL processes is established based on the preceding chapter and Figures 7.1 and 7.2.

As explained in the previous chapters, the findings of this study showed that entrepreneurial skills are the learning outcomes produced through the SBL process. These include Problem-solving skills, Technology application skills, Critical thinking skills, Research and Information retrieval, Creativity/Innovation skills, Teamwork skills, Communication skills, Active learning skills, emotional intelligence, Organization skills, Interpersonal skills, leadership skills, Self-motivation, Self-control/life-long learning, and Presentation skills.

8.3 The Implications of the Research Findings

This study aimed to develop a conceptual framework for entrepreneurial skills in Cape Town's TVET ICT programmes. The research findings have beneficial implications for the Ministry of Higher Education in South Africa, the Western Cape Department of Education, curriculum planners and policymakers, ICT lecturers, ICT students, and society and industries (employers of labour).

8.3.1 Implications of the Study to Curriculum Planners and Policymakers

This research offers insights that can empower curriculum planners and policymakers to advocate for and incorporate the utilization of Simulation Problem-Based Learning (SPBL), a blend of simulation-based learning and problem-based learning, recognized as an effective active learning approach. It provides valuable guidance for reviewing and shaping curriculum content within TVET colleges and higher education institutions overall. Hence, it falls upon curriculum planners and policymakers to devise curricula and formulate policies that align with the skill demands of the industry, the contemporary era, the Fourth Industrial Revolution (4IR), and the national requirements to ensure the success of ICT programs. The vital role of curriculum planners and policymakers on accreditation and policy formulation in ICT programmes calls for the need to have appropriate infrastructural facilities and instructional materials to implement SPBL effectively. Before granting full accreditation to the

program, it is imperative that all stakeholders, including the government, curriculum planners, and policymakers, ensure the provision of sufficient tools and equipment for practical work in laboratories and business incubators. This is essential for the efficient and effective implementation of programs. Additionally, there is a pressing need for more workshops aimed at training lecturers and laboratory (IT/ICT) technologists in the practical application of SPBL in ICT.

8.3.2 Implication of the Study to ICT Lecturers

The findings indicates that lecturers play a pivotal role in implementing the SBL process as facilitators of learning. This research underscores the transformation of teachers' roles from instructors to facilitators, which simplifies their responsibilities. According to the study's results, in an SBL environment, the lecturer's role involves guiding students in problem identification, fostering active participation among group members, maintaining focus on the topic, and ensuring the group attains relevant learning objectives. The facilitator's role encompasses assessing student performance, offering feedback, overseeing group discussions, monitoring research strategies, resolving conflicts, refining problems, guiding the formulation of analytical questions, and aiding students in identifying learning resources. This redistribution of responsibilities leads to a lighter workload for lecturers while maximizing student achievement. Notably, assessment methods like peer assessment and self-assessment, which involve high student engagement, alleviate the teacher's workload. To proficiently adopt and embrace SPBL, ICT teachers should actively seek opportunities to enhance their knowledge and skills, procure necessary materials and resources, and create an environment conducive to successful SBL implementation.

8.3.3 Implication of the Study to ICT Students

The primary objective of this study was to devise a conceptual framework tailored to enhance entrepreneurial skills among ICT students. As a result, ICT students stand to gain the most from this investigation due to its student-centric nature. According to the survey findings, within an SPBL environment, ICT students are tasked with various responsibilities. They are expected to identify, analyse, and classify problems, formulate hypotheses, and explore relevant learning materials. Moreover, students are required to address unidentified areas crucial for problem-solving, prioritize learning needs, establish goals, and collaborate with team members. Additionally, they must strategize for independent research, utilize acquired knowledge to initiate and manage projects, allocate

resources efficiently, evaluate project outcomes, and conduct self/peer assessments. This active involvement guides students through the SPBL process, fostering their entrepreneurial skills and enhancing their employability in the 21st century and the Fourth Industrial Revolution by nurturing their abilities as entrepreneurs and job creators.

8.3.4 Implication of the Study to the Society

The broader society stands to gain significantly from the outcomes of this study, particularly considering the impact of entrepreneurial skill development on ICT students immersed in an SPBL setting. As underscored by the findings, the cultivation of entrepreneurial skills equips students with traits such as creativity, innovation, critical thinking, effective negotiation abilities, and adeptness in technology usage. These attributes render students not only self-employable but also valuable assets to government bodies, industries, and educational institutions, particularly within the context of the technologically advanced Fourth Industrial Revolution (4IR) era. Moreover, fostering entrepreneurial skills empowers students to become proficient entrepreneurs and catalysts for job creation, thereby contributing to overall employment generation. Given the pervasive nature of information communication technology (ICT) and information technology (IT) in contemporary society, graduates who undergo SPBL training in ICT possess the potential to drive innovation across various domains within the 4IR landscape, including artificial intelligence, Internet of Things (IoT), big data analytics, 3D design and and manufacturing, biomedical technology, and advanced automation and controls.

8.3.5 Implication of the Study to the Industry

The 21st-century industry is characterised by technological advancement and the 4IR, whereby entrepreneurial skills are more in demand by the industry with less emphasis on technical skills. This is so because, with the advent of the 4IR and advanced technology, machines can now handle technical skills with better accuracy and efficiency than humans. As a result, industries currently seek abilities such as creativity, innovation, critical thinking, effective communication, emotional intelligence, research proficiency, and other attributes that surpass the capabilities of machines. ICT graduates to be trained in entrepreneurial skills will be employable and help develop various industries with diverse capacities and create jobs. The entrepreneurial skills gained through SBL will equip employees in the industry with the ability to identify challenges arising from society, existing technologies, and the industry itself, and

endeavour to devise suitable solutions. This advantage will position the sector favourably ahead of its competitors. Therefore, the industry stands to gain significantly with these graduates on board as their workforce, collaborators, and partners.

8.3.6 Implication of the Study on Future Research

This study investigated the elements and processes in developing an entrepreneurial skills acquisition framework for ICT TVET programmes in South Africa. However, this study focused only on ICT Programmes in TVET colleges in Cape Town, and future research can be carried out in the other provinces in South Africa and Africa at large. Also, this study focused on ICT programmes; further research can be carried out on STEM programmes like Science and engineering within Higher education institutions in South Africa and Africa. Nevertheless, the SBL conceptual framework for entrepreneurial skills in ICT programs presented characteristics essential for its implementation, yet without exhaustive examinations of the diverse elements and process stages that might be essential for its integration into a comprehensive ICT curriculum. The study's distinctive qualities underscored its scholarly significance for future research endeavours in South Africa and beyond.

8.4 Conclusion

An education system can be successful if the teaching and learning are high quality. Accordingly, the teaching methods, the quality of delivery, and other teaching and learning resources play a significant role in the education system's success. Therefore, the teaching and learning of ICT should be characterised with high quality. This study emphasises that ICT programmes at TVETs must ensure that the students acquire technical skills and develop entrepreneurial skills to thrive in this technologically disruptive environment. Entrepreneurship is the backbone of every economy. Thus, ICT students with entrepreneurial skills will positively impact the country's economy. ICT education is unique and versatile in that its study involves integrating knowledge and cognitive and practical skills to solve a problem or render services to society. In the 21st century, the 4IR demands entrepreneurial skills, savvy individuals and graduates who can use their technology application skills, innovative skills and other skills to solve a problem or perform technical tasks.

The conceptual skills framework prioritizes self-assessment and student evaluation, with teachers overseeing and facilitating the process. The model is centred on fostering learning with a comprehensive grasp of concepts and content; it acts as a catalyst, inspiring and motivating each student to learn through practical experience, while teachers facilitate effective learning among all students, guiding them towards higher levels of achievement through this step-by-step approach. The SPBL process emphasizes comprehension over rote memorization. Students are encouraged to apply previously acquired knowledge and conduct further research as needed, enabling them to collaborate and share knowledge and skills in problem-solving through project-based work. Moreover, the process simulates real-world scenarios in the learning environment, effectively fulfilling the primary aim of education: to equip students to contribute positively to society. Given the study's findings regarding the teaching and learning of ICT, it is evident that training ICT students in an SPBL environment holds significant potential for positive global impact, particularly in the context of the Fourth Industrial Revolution (4IR), where information technology serves as a key driver. The full integration of this process into the ICT curriculum can play a pivotal role in guiding the economy towards increased employability and job creation.

8.5 Recommendations

Based on the findings of this study, the following recommendations that would lead to the effective implementation of a conceptual framework for entrepreneurial skills at the TVET level in South Africa were proposed:

1. The State and Provincial governments organise regular workshops to train and retrain teachers on using SPBL and entrepreneurship.

2. The Curriculum developers and policymakers should integrate entrepreneurship as an instructional method for teaching and learning ICT programmes.

3. The Department of Higher Education and the National Education Council should ensure that acquiring entrepreneurial skills becomes a requirement for the accreditation of ICT programmes.

4. The Department of Higher Education should include entrepreneurship education as a required instructional method to qualify for registration as an ICT specialist in South Africa.

5. TVET colleges, Universities and other higher institutions should encourage the society to consult the ICT department with ICT-related problems as a challenge and encouragement for the use of SPBL in the department

6. Government and related agencies should be encouraged to consult the departments of ICT for projects to encourage and promote entrepreneurship at the TVETs.

7. Entrepreneurship should be introduced as a course in ICT and the ICT teacher training program at the university level.

8.6 Suggestion for Further Studies

Considering the maiden nature of this research in ICT in South Africa, further research can be carried out on:
1. Effects of Simulation Problem-based Learning (SPBL) on developing entrepreneurial skills in ICT programmes.
2. Effective implementation of entrepreneurial skills framework in ICT programmes at the TVET and university level.

In conclusion, these recommendations provide ICT stakeholders and affiliated organizations with a foundation for exploring the potential implementation of the Entrepreneurial Skills Framework in various fields and educational programs. The researcher anticipates that the recommendations stemming from this study will serve as a catalyst for ICT education to align with contemporary practices and the demands of the Fourth Industrial Revolution (4IR). These suggestions aim to improve the learning environment and foster the development of graduates capable of fulfilling the objectives of ICT in South Africa and beyond.

REFERENCES

Abdullahi, I.M., bin Jabor, M.K. & Akor, T.S. (2020). Developing 4IR engineering entrepreneurial skills in polytechnic students: a conceptual framework. *International Journal of Innovative Technology and Exploring Engineering*, *9*(3):2636-2642.

Aderibigbe, O. and Mosia, M. (2020). Understanding the nature of learning and opportunities created by work-integrated learning: a perspective in vocational education. Perspectives in Education, 37(1). https://doi.org/10.18820/2519593x/pie.v37i1.6

Afolabi, M. O; Kareem, F. A; Okubanjo, I. O; Ogunbanjo, O. A; Aninkan, O. (2017). Effect of Entrepreneurship Education on Self-Employment Initiatives among Nigerian Science & Technology Students. *Journal of Education and Practice*, 8(15) 44-51.

Allais, S., Schoer, V., Marock, C., & Kgalema, V. (2021). Rethinking 'supply and demand' of Technical and Vocational Education and Training: Insights from a company survey in three manufacturing sectors in South Africa. *Journal of Education and Work,* 34(5/6), 649-662.

Antwi, S.K. & Kasim, H. (2015). Qualitative and quantitative research paradigms in business research: A philosophical reflection. *European Journal of Business and Management*, 7(3): 215–225

Bauman, A. and Lucy. C (2021). Enhancing entrepreneurial education: Developing competencies for success. The International Journal of Management Education, 19, (1). 1-10.

Bawuah, K., Buame, S., Hinson, R. (2006). Reflections on entrepreneurship

Benassi, M., Grinza, E. & Rentocchini, F. (2019). The Rush for Patents in the Fourth Industrial Revolution: *An Exploration of Patenting Activity at the European Patent Office*. https://ssrn.com/abstract=3414338 or http://dx.doi.org/10.2139/ssrn.3414338

Benassi, M., Grinza, E. & Rentocchini, F. (2019). The Rush for Patents in the Fourth Industrial Revolution: *An Exploration of Patenting Activity at the European Patent Office*. https://ssrn.com/abstract=3414338 or http://dx.doi.org/10.2139/ssrn.3414338

Bernard, H.R. (2006). Research methods in anthropology: qualitative and quantitative approaches. Oxford: Alta Mira Press. [Online] Available:

http://www.antropocaos.com.ar/Russel-Research-Method-in-Anthropology.pdf [Accessed: 13 May 2021].

Besterfield-Sacre, M, Ozaltin N.O, Shartrand, A, Shuman L.J, Weilerstein, P. (2011)

Birch, A., & Irvine, V. (2009). Preservice teachers' acceptance of ICT integration in the classroom:

Bryman, A. (2012). Social Research Methods (5th ed.). Oxford: Oxford University Press.

Buthelezi, Z. (2017). Lecturer experiences of TVET College challenges in the post-apartheid era: a case of unintended consequences of educational reform in South Africa. Journal of Vocational Education & Training. 70 (3), 364-383. https://doi.org/10.1080/13636820.2018.1437062

Byers, T., Seelig, T., Sheppard S. & Weilerstein. (2013) Entrepreneurship: its role in

Caniglia. J. (2019). Simulations as a Teaching Strategy. Kent State University Center for Teaching and Learning. Retrieved [Accessed: 27 July 2021] from https://www.kent.edu/ctl/simulation-teaching-strategy.

Center for Enterprise & Development (CDE). (2013) Graduate Unemployment in centres in schools, colleges and universities. http://indiatrust.org/Policy%20Paper%20Guidelines.html [Accessed on 22 July 2022]

Chernikova, O., Heitzmann, N., Stadler, M., Holzberger, D., Seidel, T., & Fischer, F. (2020). Simulation-Based Learning in Higher Education: A Meta-Analysis. *Review of Educational Research*, *90*(4), 499–541. https://doi.org/10.3102/0034654320933544

Chimucheka, T. (2014) Entrepreneurship Education in South Africa. *Mediterranean*

Chung, M. & Kim, J. (2016). The Internet Information and Technology Research Directions based on the Fourth Industrial Revolution. *KSII Transactions on internet and information systems,* 10(3): 11-20 DOI: 10.3837/tiis.2016.03.020.

Clarke, L. & Winch, C. (2007). Vocational Education, International Approaches, Developments and Systems. London: Routledge.

Clear, T. (2017). Thinking Issues: Meeting Employers Expectations of DevOps Roles: Can Dispositions Be Taught? *ACM Inroads,* 8(2): 19-21; https://doi.org/10.1154/3078298.

Co, MJ & Mitchell, B. 2006. Entrepreneurship education in South Africa: a nationwide survey. *Education and Training, 48 (5),* 348-359. Conference, Lagos, Nigeria,http://www.africaeec.org/thepresentation.php.[Accessed on 05 July 2022]

Cong S., & Wang X. (2012). A Perspective on Technical and Vocational Education and Training. In: Zeng D. (eds) *Advances in Computer Science and Engineering. Advances in Intelligent and Soft Computing, 141*. 67-75. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-27948-5_10

Corfe, S. (2018). 4IR in the workplace: Ensuring employers and employees benefit. The Social Market Foundation. 1-44

Costin, Y., O'Brien, M. P., & Slattery, D. M. (2018). Using simulation to develop entrepreneurial skills and mind-set: an exploratory case study.
Council of Chief State School Officers. (2013). *Knowledge, Skills, and Dispositions: The Innovation Lab Network State Framework for College, Career, and Citizenship Readiness, and Implications for State Policy*.

Council of Chief State School Officers. (2013). *Knowledge, Skills, and Dispositions: The Innovation Lab Network State Framework for College, Career, and Citizenship Readiness, and Implications for State Policy*.

Creswell, J W. (2013). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. In *Research design Qualitative quantitative and mixed methods approaches*. https://doi.org/10.1007/s13398-014-0173-7.2

Creswell, J.W. & Clark, V.P. (2011). *Designing and conducting mixed methods research*. 2nd ed. Thousand Oaks, CA: SAGE.

Cronje J.C. (2016). Twenty-first-Century Learning, Rhizome Theory, and Integrating Opposing Paradigms in the Design of Personal Learning Systems. In: Spector M., Lockee B., Childress M. (eds) *Learning, Design, and Technology*. Springer, Cham. https://doi.org/10.1007/978-3-319-17727-4_49-1

Cronje, F. (2014). Research design and paradigms should be led by research questions: A mixed method approach. [Online] Available: http://iiespace.iie.ac.za/bitstream/handle/11622/48/2014%20CronjeF%20Research%20Paradigms%20should%20follow%20Research%20 [Accessed: 09 August 2020].

Cronje, J.C., (2021). Covid-19 Policy Implications for Blended Learning in Higher Education in the Fourth Industrial Revolution. *Progressio: South African Journal for Open and Distance Learning Practice*, [online] 41(1), 1–16. https://doi.org/10.25159/2663-5895/8315

Davies, T.A. (2001). Entrepreneurship development in South Africa: redefining the role of tertiary institutions in a reconfigured higher education system. South African Journal for Higher Education, 15(1): 32-39.

Dayana, N., & Halim, A. (2016). *Application of Mixed Method Research Methodology By: Steps for Conducting a Mixed Methods Study*.

Deleuze, G., & Guattari, F. (1987). A thousand plateaus: Capitalism and schizophrenia. London: Athlone Press

Deloitte Global Business Coalition For Education. (2018). Preparing Tomorrow's Workforce for the Fourth Industrial Revolution; Deloitte: London, UK, 1–58. [Online] Available from: https://www.voced.edu.au/content/ngv: 85595 [Accessed: 15 May 2020].

Deloitte Global Business Coalition For Education. (2018). Preparing Tomorrow's Workforce for the Fourth Industrial Revolution; Deloitte: London, UK, 1–58. [Online] Available from: https://www.voced.edu.au/content/ngv: 85595 [Accessed: 15 May 2020]..

Department of Higher Education and Training. (2012a). Further Education and Training (FET) Amendment Bill 2012. Pretoria: Department of Higher Education and Training.

Eckhoff, A., Lømo, B., & Kaasbøll, J. (2014). Creating real-world projects in higher education: Consulting in a university-based management curriculum. Journal of Management Education, 38(5), 724-750.

Elmuti, D., Khoury, G., & Omran, O. (2012). Does entrepreneurship education have a role in developing entrepreneurial skills and ventures' effectiveness? Journal of Entrepreneurship Education, 15: 83-98.

Entrepreneurial Graduate. *Accelerating Campus Entrepreneurship*. Dundalk

European Commission, (2013) Entrepreneurship Education: A Guide for Educators. Bruxelles. Entrentrepreneurship@ec.europa.eu.

Fathiyah M. Kamaruzaman, Roszilah Hamid, Azrul A. Mutalib & Mohamad S. Rasul. (2019). Conceptual framework for the development of 4IR skills for engineering graduates. *Global Journal of Engineering Education.* Bangi, Malaysia, 21(1): 54-61

Fletcher, A. J., & Marchildon, G. P. (2014). Using the delphi method for qualitative, participatory action research in health leadership. *International Journal of Qualitative Methods*, *13*(1), 1–18. https://doi.org/10.1177/160940691401300101

Fomunyam, K.G. (2019). Education and Fourth Industrial Revolution: challenges and possibilities for engineering education. *International Journal of Mechanical Engineering and Technology (IJMET),* 10(08): 271-284.

Garavan, T.N. & O'Cinneide, B. (1994). Entrepreneurship Education and Training Programmes: A review and evaluation. Part 1. *Journal of European Industrial Training,* 18(8): 3-12

GEM 2013. South African Report: 20 Years of Democracy.

GEM, 2012. Global Entrepreneurship Monitor South Africa.

Gibb, A., Haskins, G., Hannon, P., Robertson, I. (2012) Leading the entrepreneurial university: meeting the entrepreneurial needs of higher education institutions. *The National Center for Entrepreneurship in Education (NCCE)*.http://eureka.bodleian.ox.ac.uk/4861/1/EULP_-LEADERS_PAPER_final_dec_19.pdf [Accessed on 19 July 2022]

Giroux, H. A. (1992). Border Crossings. Workers and the politics of education. New York: Routledge.

Global Entrepreneurship Monitor. (2022). *GEM South Africa 2021–2022 report*. *https://www.gemconsortium.org/report/gem-south-africa-2021-2022-report*

Global Entrepreneurship Monitor-GEM. (2012). [Online] Available from http://www.gemconsortium.org/ [Accessed:12 February 2020].

Global Entrepreneurship Monitor-GEM. (2020). [Online] Available from http://www.gemconsortium.org/ [Accessed: 15 June 2020].

Gouws, E. (2002). Entrepreneurship education: implications for teacher training. South African Journal for Higher Education, 16(2): 41-48

Govender, K. (2008). Addressing employability and fostering entrepreneurship among university students in South Africa: an analysis of the 'junior enterprise concept'.[Online] Available from www.sabinet.co.za [Accessed:15 April 2020].

Gumede,BT & Uleanya, C (2019). Factors impacting entrepreneurship education in TVET colleges: A case of South Africa. Journal of Entrepreneurship Education, 22(3), 1-12.

Habibi, A., Sarafrazi, A., & Izadyar, S. (2014). Delphi Technique Theoretical Framework in Qualitative Research. *The International Journal Of Engineering And Science*, *3*(4), 2319–1813. https://doi.org/10.1016/S0169-2070(99)00018-7

Hammersley-Fletcher, L. & Brundrett, M. (2008). Collaboration, collegiality and leadership from the head. The complexities of shared leadership in primary school settings. British Educational Leadership, Management & Administration Society (BELMAS). 22(2):11- 16.

Harper, B., Squires, D. & Mcdougall, A. (2000). Constructivist Simulations: A New Design Paradigm. *Journal of Educational Multimedia and Hypermedia, 9*(2), 115-130. Charlottesville, VA: Association for the Advancement of Computing in Education (AACE). Retrieved August 11, 2021 from https://www.learntechlib.org/primary/p/8080/. Association for the Advancement of Computing in Education (AACE). Retrieved August 11, 2021 from https://www.learntechlib.org/primary/p/8080/.

Hasan, S.M., Khan, E.A. and Nabi, M.N.U. (2017), "Entrepreneurial education at university level and entrepreneurship development", *Education + Training*, 59 (7/8) 888-906. https://doi.org/10.1108/ET-01-2016-0020

Hasanefendic, S., Heitor, M. & Horta, H. (2016). 'Training students for new jobs: The role of technical and vocational higher education and implications for science policy in Portugal', *Technological Forecasting and Social Change*, 113, 328–340. doi: 10.1016/j.techfore.2015.12.005.

Henry, C., Hill, C. & Leitch, C. (2005). Entrepreneurship Education and Training: Can entrepreneurship be taught? Part 1. Education and Training, 47(2): 98-111.

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? Educational Psychology Review, 16(3), 235-266.

Horn, G. (2006). Educational solutions to improve the employability of senior high school learners. South African Journal of Education, 26(1): 113-128.

Human Resource Development Council, (2013) Enabling Entrepreneurship Technical Task Team Final report for the Basic Education work stream. http://www.jasa.org.za/HRDC%20Report%20on%20Enabling%20Entrepreneurship%20in%20Basic%20Education.pdf [Accessed 11 July 2022]

India Trust. (2014) Policy paper and guidelines to set up entrepreneurship education

Information Technology (2017). Final Curriculum Report. Curriculum Guidelines for Baccalaureate Degree Programs in Information Technology. A Report in the Computing

Curricula Series Task Group on Information Technology Curricula Association for Computing Machinery (ACM) IEEE Computer Society (IEEE-CS). 1-163.
Isaacs, E, Visser, K, Friedrich, C., Brijlal, P. (2007) Entrepreneurship education and training at the Further Education and Training (FET) level in South Africa. *South African Journal of Education,* (27), 613–629.

Jackson, D. (2014). Testing a model of undergraduate competence in employability skills and its implications for stakeholders. *Journal of Education and Work,* 27(2): 220-242, DOI: 10.1080/13639080.2012.718750
James, W. (2012) Youth entrepreneurship is the key to future growth.

Journal of Social Sciences, 5 (2), 403-416.

Kaul, R. (1998). 'Disorders in Education: Private Enterprise and the State' in S.Shukla and R.Kaul (eds.). Education, Development and Underdevelopment. New Delhi: Sage.
Kayambe, C & Nel, D. (2019). Challenges and opportunities for education in the Fourth Industrial revolution. African Journal of Public Affairs, 11(3), 79-94.
Kennedy, D., Hyland, Á., & Ryan, N. (2007). *Writing and using learning outcomes: a practical guide*. Cork: University College Cork.

Kennedy, K. (2019). Another Industrial Revolution: What schools need to know. Daily Maverick [online]. Available at: https://www.dailymaverick.co.za/opinionista/2019-02-25-another-industrial-revolution-whatschools-need-to-know/

Keogh, W., Galloway, L. (2004) Teaching enterprise in vocational disciplines:

Khathu, R. (2019). 4IR and the SA education system https://www.bizcommunity.com/Article/196/371/193213.html [Accessed: 20 April 2020]

Kuehn, M. (2020). The South African Technical and Vocational Education and Training System from a German Perspective. In *Balkan Region Conference on Engineering and Business Education*, 1(1):226-234. https://doi.org/10.2478/cplbu-2020-0026

Kuhn, T. (1974). Second Thoughts on Paradigms, in Frederick Suppe (ed.), The Structure of Scientific Theories. Urbana: University of Illinois Press, pp. 459-482.

Kuhn, T.S. (1970). The structure of scientific revolutions. 2nd Edition, Chicago Uni. The University of Chicago Press.

Kumar, D. D. (2016). Analysis of an Interactive Technology Supported Problem-Based Learning STEM Project Using Selected Learning Sciences Interest Areas (SLSIA). *International Journal of Education in Mathematics, Science and Technology*, *5*(1), 53. https://doi.org/10.18404/ijemst.69590

Kuratko, D. F. (2003). Entrepreneurship Education: Emerging Trends and Challenges for the 21st Century. The Entrepreneurship Program, College of Business, Ball State University, Muncie, IN.

Leavy, P. (2017). *Research Design: Quantitative, Qualitative, Mixed Methods, Arts-Based, and Community-Based Participatory Research Approaches*. Retrieved fromhttps://books.google.com.my/books?id=hxyDDgAAQBAJ&dq=research+design&source=gbs_navlinks_s

Mackness, J., Bell, F., & Funes, M. (2015). The Rhizome: A problematic metaphor for teaching and learning in a MOOC. *Australasian Journal of Educational Technology, forthcoming,* 32(1), 78–91. doi:10.14742/ajet.v0i0.2486.

McGrath, S, Ramsarup, P.; Zeelen, J.; Wedekind,V.; Allais, S.; Lotz-Sisitka, H.; Monk, M.; Openjuru, G. & Russon, J. (2020). Vocational education and training for African development: a literature review, Journal of Vocational Education & Training, 72(4): 465-487, DOI: 10.1080/13636820.2019.1679969.

McGrath, S. (2012). Vocational Education and Training for Development. *International Journal of Educational Development*, 32(5): 623–631. doi:10.1016/j.ijedudev.2011.12.001.

McGrath, S. (2018). Education and Development. Abingdon: Routledge.

McGrath, S., (2011). Where to now for vocational education and training in Africa?

McGrath, S., Ramsarup, P., Zeelen, J., Wedekind, V., Allais, S., Lotz-Sisitka, H., Monk, G., Openjuru, G. & Russon, J. (2020) Vocational education and training for African development: a literature review, Journal of Vocational Education & Training, 72 (4), 465-487, DOI: 10.1080/13636820.2019.1679969

McLeod, S. (2020). Maslow's Hierarchy of Needs. https://www.simplypsychology.org/maslow.html [Accessed 10 November 2020]

Ménière, Y., Rudyk, I. & Valdes, J. (2017). *Patents and the Fourth Industrial Revolution: The inventions behind digital transformation*. European Patent Office: Munich.

Mezied, A. (2016). What role will education play in the Fourth Industrial Revolution? https://www.weforum.org/agenda/2016/01/what-role-will-education-play-in-the-fourth-industrial-revolution/. [Accessed: 20 April 2020]

Mhlanga, D. & Moloi, T. (2020). COVID-19 and the Digital Transformation of Education: What are we learning on 4IR in South Africa? *Journal of Education Sciences,* 10(7), 180-191. http://dx.doi.org/10.3390/educsci10070180

Millán, J.M., Congregado,E., Román, C., Van Praag, M., Van Stel, A. (2014). The value of an educated population for an individual's entrepreneurship success. Journal of Business Venturing, (29) 5, 612-632, ISSN 0883-9026, https://doi.org/10.1016/j.jbusvent.2013.09.003. (https://www.sciencedirect.com/science/article/pii/S0883902613000943)

Mpofu, R. & Nicolaides, A. (2019). Frankenstein and the Fourth Industrial Revolution (4IR): Ethics and Human Rights Considerations. African Journal of Hospitality, Tourism and Leisure. 8(5): 1-25

Mwangi, S.M. (2011). The contribution of entrepreneurship education courses in enhancing management skills of information entrepreneurs. Journal of Education and Vocational Research, 2(3): 86–92. https://doi.org/10.22610/jevr.v2i3.28

Mzekandaba, S. (2019). SA universities must lead the Industry 4.0 curriculum. https://www.itweb.co.za/content/PmxVE7KXLopMQY85. [Accessed: 20 April 2020]

National Academies of Sciences, Engineering, and Medicine. (2016). *Supporting Students' College Success; Assessment of Intrapersonal and Interpersonal Competencies.* Washington, DC: The National Academies Press. https://doi.org/10.17726/24697.

Naudé, W. (2017). *Entrepreneurship, Education and the Fourth Industrial Revolution in Africa*. IZA Discussion Paper No. 10855, SSRN: https://ssrn.com/abstract=2998964

Nchu, R.M, Tengeh, R.; Hassan, S.L.; & Iwu, C. G. (2017). High school learner's interest and readiness to start a business: evidence from South African schools. WSEAS Transactions on Business and Economics. 14: 1-13

Nchu, R; Tengeh, R. & Hassan, S. (2015). High school learner's perception of the efficacy of entrepreneurship education: Case study South African High schools. *Socioeconomic – The Scientific Journal for Theory and Practice of Socio-economic Development,* 4(8): 507-526.

Ndedi, A. A. (2009) Entrepreneurship training and job creation in South Africa: Are Tertiary Institutions Filling the Gap? *Journal of Contemporary Management*, (6), 463-470.

Needs of Industry and Society. *The Bridge*, 43(2), 31-34.

Neuman, W. L. (2003). Social Research Methods: Qualitative and Quantitative Approaches (5th ed.). Boston: Allyn and Bacon.

Nieuwenhuizen, C. & Groenewald, D. (2008). Entrepreneurs' learning preferences: A guide for entrepreneurship education. *Acta Commercii*. 8: 128-144

North, E. (2002). A decade of entrepreneurship in South Africa. South African Journal of Education, 22(1): 24-27

OECD, (2012). Skills indicators for employment and productivity in low-income countries: an initial framework and approach. In: Third International Congress on Technical and Vocational Education and Training, Building Skills for Work and Life, Shanghai, May 13–16, 2012, In: http://www.unesco.org/education/ TVET2012/roundtable/3/Mark-Keese.pdf.

OECD, (2013). OECD Skills Outlook 2013: First Results from the Survey of Adult Skills. OECD Publishing, Paris.

OECD, (2014a). OECD Science, Technology and Industry Outlook 2014. OECD Publishing, *of Educational Development*, 32(5): 623–631. doi:10.1016/j.ijedudev.2011.12.001.

Oke, A. & Fernandes, F.A.P. (2020). Innovations in Teaching and Learning: Exploring the Perceptions of the Education Sector on the 4th Industrial Revolution (4IR). *Journal of Open Innovation: Technology, Market, and Complexity. 6*(2): 1-22

Oketch, M.O. (2007). To vocationalise or not to vocationalise? Perspectives on current trends and issues in technical and vocational education and training (TVET) in Africa. *International Journal of Educational Development,* 27: 220–234

Orford, J. (2004). The environment for entrepreneurship in South Africa. Global Entrepreneurship Monitor Report. [Online] Available from www.gemconsortium.org [Accessed: 15 May 2020]

Owoo, N. and Naude, W. (2017). Spatial Proximity and Firm Performance: Evidence from Non-Farm Rural Enterprises in Ethiopia and Nigeria. Regional Studies, (51): 688-700.

Oxford, A. (2021). Skills and the Fourth Industrial Revolution: What skills should we be teaching South African students so that they can reap the benefits of the 4IR? https://businessmediamags.co.za/skills-education/sunday-times-skills/skills-and-the-fourth-industrial-revolution/ [10 June 2021].

Palmer, R. (2014). Technical and vocational skills and post-2015: Avoiding another vague skills goal? *International Journal of Educational Development*, 39(June 2013), 32–39. doi: 10.1016/j.ijedudev.2014.08.007.

Parasuraman, A. (2000). Technology readiness index (TRI): a multiple-item scale to measure readiness to embrace new technologies. Journal of Service Research, 2(4): 307-320.

Parasuraman, A., & Colby, C. (2001). Techno-ready marketing: how and why your customers adopt Paris.

Pather, M. R. (2020). Education in South Africa: The Impact of Fourth Industrial Revolution. *Journal of Education and 4IR*, 83, 19-23.

Petty, N. J., Thomson, O. P. & Stew, G. (2012). Ready for a paradigm shift? Part 2: Introducing qualitative research methodologies and methods. Manual Therapy, 17, 378-384.

Powell, L. (2012). Reimagining the purpose of VET - Expanding the capability to aspire in South African Further Education and Training students. *International Journal of Educational Development*, 32(5), 643–653. doi: 10.1016/j.ijedudev.2012.01.008.

PricewaterhouseCoopers (PWC). (2017). Digital factories 2020: shaping the future of manufacturing. https://www.pwc.de/de/digitale-transformation/digital-factories-2020-shaping-the-future-of-manufacturing.pdf [16 June 2021]. Publishing, Paris.

Radebe, T. N., & Smith, M. (2023). WOMEN'S REPORT 2023: PAPER 1 The current state of women's entrepreneurship in South Africa. PAGE 12 Online available www.womensreport.africa women entrepreneurs. [Accessed 19 October 2023].

Rae, D. (2006). Entrepreneurial learning: a conceptual framework for technology based enterprise. Technology analysis and strategic management. 18(1), 39-56.

Raposo M, do Paço A. (2011). Entrepreneurship education: the relationship between education and entrepreneurial activity. Psicothema. 23 (3):453-457.

Raposo, M.., Do Paço, A. (2011) Entrepreneurship education: Relationship between

Robinson, D. (2002). A phenomenological study of how South African entrepreneurs experience and deal with Ethical dilemmas.[Online] Available from www.cput.ac.za. [Accessed: 05 June 2020]

Saunders, M., Lewis, P. & Thornhill, A. (2012). Research Methods for Business Students, 4th ed. Harlow: Pearson Education Ltd.

Saunders, M., Lewis, P., & Thornhill, A. (2007). Research Methods for Business Students, 6th ed. London: Pearson.

Schwab, K. (2016). The Fourth Industrial Revolution, The World Economic Forum. Available from **http://www.weforum.org/pages/the-fourth-industrial-revolution-by-klaus-schwab**.

Schwab, K. (2020). The Fourth Industrial Revolution, The World Economic Forum. Available from **http://www.weforum.org/pages/the-fourth-industrial-revolution-by-klaus-schwab**

Schwab, K. (Ed.). (2014). The Global Competitiveness Report 2014–2015.World Economic

Science pedagogy in secondary schools. The Journal for *Education and Information Technologies. 14*, 345-363.

Seet, P., Jones, J., Spoehr, J. & Hordacre, A. (2018). *The Fourth Industrial Revolution: the implications of technological disruption for Australian VET*. Adelaide: NCVER

Silverman, D. (2013). Doing Qualitative Research: A practical handbook. London: Sage.

Singh, S. K. and El-Kassar, A. N. (2019) 'Role of big data analytics in developing sustainable capabilities', *Journal of Cleaner Production*, 213, pp. 1264–1273. doi: 10.1016/j.jclepro.2018.12.199.

Statistics South Africa. (2020): Latest key indicators. [Online] Available from www.statssa.gov.za [Accessed: 25 March 2020].

Statistics South Africa. (2022). *Quarterly Labour Force Survey 2022: Q2.* Republic of South Africa. *https://www.statssa.gov.za/wp-content/uploads/2022/08/quarterpic2.jpg*

Statistics South Africa.2022. Quarterly labour force survey. Quarter 2, 2019. [10 September 2022].

Stemler, S.E., (2015). Content analysis. *Emerging trends in the social and behavioural sciences: An Interdisciplinary, Searchable, and Linkable Resource*, 1-14.

Stephen, R. (2013) Aligning Engineering Education and Experience to Meet the

Streeter, D.H., Jaquette, J.P. (2004) University –Wide entrepreneurship education:

Subic, A. & Gallagher, S. (2017). Industry 4.0 *Testlabs in Australia - Preparing for the Future*. A report of the Prime Minister's Industry 4.0 Taskforce. ISBN 978-0-9806708-6-8.

Suharno, Pambudi, N. A. and Harjanto, B. (2020). 'Vocational education in Indonesia: History, development, opportunities, and challenges', *Children and Youth Services Review*, 115(January), p. 105092. doi: 10.1016/j.childyouth.2020.105092.

Tengeh, R.K., Ballard, H. & Slabbert, A. (2011). A framework for acquiring the resources vital for the start-up of a business in South Africa: An African immigrant's perspective. *Munich Personal RePEc Archive*, Paper No. 34211.

Tengeh. R; Iwu,C.G. Iwu and Nchu, R. (2015). *Embeddedness of entrepreneurship education in the curricula of non-business university programmes: Preliminary evidence from South African universities of technology*. Socioeconomic – The Scientific Journal for Theory and Practice of Socio-economic Development, 4(7), 111-126

Terblanche, T.E. (2017). Technical and Vocational Education and Training (TVET) colleges in South Africa: A framework for Leading Curriculum Change. Thesis (PhD). Stellenbosch University.

Tijdens, K.G., De Ruijter, J., & De Ruijter, E. (2012). Measuring work activities and skill requirements of occupations: Experiences from a European pilot study with a web survey. *European*

Timmons, J.A & Spinelli, S.S. (2004). New Venture Creation. Entrepreneurship for the 21st Century. 6th ed. New York. McGraw Hill.

Tracy, S.J. (2010). Qualitative quality: Eight “big-tent” criteria for excellent qualitative research. *Qualitative Inquiry*, 16(10): 837–851.

Tuli, F. (2010). The Basis of Distinction Between Qualitative and Quantitative Research in Social Science: Reflection on Ontological, Epistemological and Methodological Perspectives. Ethiopian Journal of Education and Sciences. 6(1): 97-108.

UNESCO ICT Competencies Framework for Teachers. (2011). https://en.unesco.org/themes/ict-education/competency-framework-teachers. [Accessed on 20 April 2020]

UNESCO. (2014). The Muscat Agreement. In: Global Education for All Meeting, Muscat, Oman. May 12–14, 2014.

United Nations Educational, Scientific and Cultural Organisation. (2008). Education for All Global Monitoring Report 2007. Paris: United Nations Educational, Scientific and Cultural Organisation.

United Nations Educational, Scientific and Cultural Organisation. (2012). Youth and Skills: Putting education to work. Paris: United Nations Educational, Scientific and Cultural Organisation.

Waghid, Y., Waghid, Z. and Waghid, F. (2019). ‘The fourth industrial revolution reconsidered: On advancing cosmopolitan education’, *South African Journal of Higher Education*, 33(06), 1–9. doi 10.20853/33-6-3777.

Weaver, A. & Osterman, P. (2016). Skill Demands and Mismatch in U.S. Manufacturing. SAGE Journals. Cornell University, USA. 70(2): 275-307. https://doi.org/10.1177/0019793916660067 [Accessed on 20 November 2020].

Wilson, S. M., & Peterson, P. L. (2006). *Theories of Learning and Teaching: What Do They Mean for Educators? Theories of Learning and Teaching*. (July).

Xu, M., David, J.M., & Kim, S.H. (2018). The Fourth Industrial Revolution: Opportunities and Challenges. International Journal of Financial Research. 9(2): 90-95

Yang, F. & Gu, S. (2021). Industry 4.0 is a revolution that requires technology and national strategies. *Complex & Intelligent Systems*, 7:1311–1325. https://doi.org/10.1007/s40747-020-00267-9

Yin, R.K. (2009). Case Study Research Design and Methods, 4th ed. London: SAGE Inc.

APPENDICES

Appendix A: Informed Consent Letters for Data Collection

Dear Participant,

Informed Consent Letter for Data collection

I am a PhD Student from Cape Peninsula University of Technology (CPUT) in the Department of Information Technology. I am conducting a research to design a framework for developing Fourth Industrial Revolution (4IR) Entrepreneurial Skills in ICT Programmes in selected TVETs". Hence, I am approaching you to be part of this study. I realise you need to make an informed decision whether or not to be part of this study, thus I have provided below further details with regards to the research to assist in your decision process.

Working Title of Research Project:
"A Framework for developing Fourth Industrial Revolution Entrepreneurial Skills in ICT Programmes in TVETs".

Researcher:
Mrs Rylyne Nchu Tel: 072 557 1875 (CPUT)

Supervisor:
Prof Johannes Cronje Tel: 082 558 5311 (CPUT)

Co- Supervisor:
A/Prof Robertson Tengeh Tel: 021 460 3450 (CPUT)

Purpose of the Research
The purpose of this study is to develop a 4IR entrepreneurial skills acquisition framework in improving entrepreneurial tendencies in ICT TVET students.

Description of the Research:
Self-administrated Questionnaires will be handed over to Students studying the CPUT Higher Certificate of Information and Communication Technology (HCICT) to be completed. Personal interviews will be conducted with the Lecturers in the HCICT programme. These parameters will be used to develop a framework of 4IR entrepreneurial skills acquisition in the training of the youths to prepare them to be sustainable amidst the 4th Industrial revolution. An analysis of documents, syllabus, and curriculum and assessment instruments will also be used for the framework design.

Personal interviews will be conducted with technology entrepreneurs to determine the traits that make successful technology entrepreneurs. Interviews conducted will be used to assess factors that drive technology entrepreneurs to start a sustainable business. And also to determine the relevant skills needed in a 4IR environment for ICT students.

Potential Benefits:
This research will develop a 4IR entrepreneurial skills framework and provide recommendations to improve ICT education in TVET colleges in Cape Town area as well as South Africa. This framework will include but not limited to current trends of information technology and entrepreneurship and the parameters of what is required to become a successful techno-entrepreneur during the 4th Industrial era. Participants will have the satisfaction of knowing they have assisted with this research.

Confidentiality:
Confidentiality will be respected and no information that discloses the identity of the participants will be released or published in accordance with the POPI Act. All Covid19 regulations and protocols will be observed.

Participation:
Participation in this research is voluntary. If you choose to participate in this study you may withdraw at any time. All information and data collected will be used for academic purposes only.

Contact
Thank you for your understanding. If you have any questions about this study, please contact:

Rylyne Nchu Tel: 072 557 1875

Consent:
By signing this form, I agree that:

1. The study was explained to me and all my questions answered.
2. I have the right to participate and the right to stop at any time.
3. I have been told that my personal information will be kept confidential.

I hereby consent to participate in this study:

Name of Participant (TVET College)……

Signature.....
Date ….....

Appendix B: Survey Questionnaire to Lecturers

Quantitative Instrument

QUESTIONNAIRE FOR HCICT TVET LECTURERS IN CAPE TOWN METROPOLITAN

TOPIC: A Framework for developing Fourth Industrial Revolution (4IR) Entrepreneurial Skills in ICT Programmes in TVETs.

INSTRUCTIONS

This questionnaire is designed to solicit information from HCICT Lecturers at selected TVET colleges. Respondents are expected to give opinions on areas to be considered for the effective development of a 4IR entrepreneurial skills framework for ICT programme at selected TVETs in Cape Town using a 5-point Scale. The description of the scale is shown below:

PERSONAL INFORMATION

Please provide the following information, be honest in your responses. All your responses will be treated with ***Confidentiality***. Check (√) the most appropriate answer of your choice.

DEMOGRAPHIC DATA
Please Indicate Your Profession: i. Lecturer ☐ ii. Head of Department ☐ iii. Head of Programme ☐
Gender: i. Male ☐ ii. Female ☐

Rank:

_____

Years of service:

_____

Highest Qualification:

i. Undergraduate ☐

ii. HND ☐

iii. Bachelor's Degree ☐

iv. Master's Degree ☐

v. PhD ☐

vi. Others ☐

If others please specify_____

Research Question 2: To identify simulation elements and processes for the development of a simulation conceptual framework for 4IR Entrepreneurial skills in ICT programme.

i. SD (1) = Strongly disagree

ii. D (2) = Disagree

iii. N (3) = Neutral

iv. A (4) = Agree

v. SA (5) = Strongly agree

A. To arrive at an effective simulation conceptual model for the teaching of 4IR Entrepreneurial skills in ICT, a chosen **Problem** must have the following relevant qualities:

S.N	ITEMS	SD(1)	D(2)	N(3)	A(4)	SA(5)
1	Problems should be complex,					
2	Problem should be ill-structured					
3	Problem should be open-ended					
4	They must also be realistic with the students' experiences					
5	Should support self-evaluation among the students					
6	It should motivate the students' need to know and learn					
7	It should help to engage in the learning process based on their previous understanding					
8	the problem should allow for the application of many concepts					
9	the problem should foster communication skills as students present their plans to the rest of their class					
10	The problem should be multidisciplinary in nature to help build extensive knowledge & give room for multidisciplinary solutions					
11	be adapted to the students' level of prior knowledge					
12	be interesting and engage students in discussion					
13	Should support peer evaluation among the learners					
14	problems should also promote debate among students					
15	It should have more than one valid approach					

B. To arrive at an effective simulation conceptual model for the teaching of non- technical skills in ICT, a chosen **Project** must have the following relevant qualities:

S.N	ITEMS	SD(1)	D(2)	N(3)	A(4)	SA(5)

1	A project should structure to build students cooperative skills					
2	It should enable students' communication skills					
3	It should guide students' logical reasoning					
4	It should build their leadership skills					
5	The project should develop students' decision-making skills					
6	It should be able to build their technical expertise					
7	It should inspire students to share their vision					
8	It should build their teamwork skills					
9	A project should develop students' negation and dialogue skills					
10	It should enhance their creativity and innovation skills					
11	It should develop students' accountability skills					
12	It must have justifiable reasons for its execution					
13	The project must have clear objectives and expected results					
14	It must have a completion time frame					
15	There must be a target audience					
16	The project must have a budget estimate					
17	There should be provision for formative and summative evaluation					

C. To arrive at an effective simulation conceptual model for the teaching of 4IR entrepreneurial skills in ICT programmes, the following aspects of **Teamwork** must be considered:

S.N	ITEMS	SD(1)	D(2)	N(3)	A(4)	SA(5)
1	There should be a clear sense of direction					
2	There should be open and honest communication					
3	Members should have defined roles					
4	There should be mutual accountability among members					
5	Members should have defined roles with common goals					
6	Encourage diverse opinions among members					
7	There should be collaboration and trust among team members					
8	There should be self-awareness among members					
9	Intrinsic motivation of members					

10	Ability to be carryout multitasks					
11	Promote persistence among team members					
12	Size of the project determines the number of members per team.					
13	The should be room for debate among members					
14	Number of team members drop as the students move to higher levels					

D. To arrive at an effective simulation conceptual model for the development of 4IR entrepreneurial skills in ICT programmes, the **Teacher's Role** must include the following:

S.N	ITEMS	SD(1)	D(2)	N(3)	A(4)	SA(5)
1	Guide students to identify a problem					
2	Encourage all group members to participate					
3	Prevent the group from straying off topic					
4	Ensure that the group achieves appropriate learning objective					
5	Assess student performance					
6	Provide feedback to students					
7	Monitor effective group discussion					
8	Monitor research strategies					
9	Monitor resolving conflicts					
10	Monitor revising problems					
11	Monitor generating analytical questions					
12	Facilitate the learning process					
13	Help students to identify learning resources					
14	Help students to collect information using variety of resources					

S.N	ITEMS	SD(1)	D(2)	N(3)	A(4)	SA(5)
15	Encourage students to take an active critical part in their learning					
16	Put the problem in context and help groups prioritize issues					

C. For effective simulation conceptual framework for 4IR entrepreneurial skills in ICT programmes, the following stages of **Problem-Orientation and Analysis** must be followed by the team members (students):

S.N	ITEMS	SD(1)	D(2)	N(3)	A(4)	SA(5)

1	Identify and define the problem					
2	Investigate the root cause or causes of the problem					
3	Investigate how the problem prevented the attainment of previous goals.					
4	Investigate how the problem affects the target beneficiaries					
5	Dissect the problem into smaller sections					
6	Analyse each section critically					
7	Identify the effects of each individual section					
8	Investigate the root cause of each section					
9	Attempt to provide one or more solutions to each of the sections					
10	Decide the most effective solution for each of the section					
11	Apply the best solutions to each of the problem sections					
12	Merge the solutions together					
13	Check if the problem has been resolved					
14	Revisit the problem where necessary					
15	Try alternative solutions where necessary					
16	Arrive at a possible final solution					

F. For effective simulation conceptual framework for the development of 4IR entrepreneurial skill in ICT programmes, **Learning Objectives** must be set with the following considerations by the team members:

S.N	ITEMS	SD(1)	D(2)	N(3)	A(4)	SA(5)
1	The objectives must aim at addressing the root causes of the problem					
2	Must try to address the individual root causes of the problem					
3	Must focus on the desired outcome and result					
4	Must be specific and unambiguous					
5	Should be stated in terms of a time frame within which they should be attained					
6	There should be room for altering an objective should the environment change					
7	Should be challenging enough in that they give rise to innovation and fresh approaches					
8	Should be achievable with not too much increase in recourses.					
9	Should be stated in quantifiable, measurable terms					

10	The number of objectives must balance the effects since most problems have numerous effects					
11	Must construct an extensive knowledge base					
12	It must develop effective problem-solving skills					
13	Should enable the development of lifelong learning skills					
14	Help Students learn heuristics of expert performance.					
15	Should develop students' critical thinking					
16	Develop students' creativity and innovation					
17	Build students collaborative learning skills					

S.N	ITEMS	SD(1)	D(2)	N(3)	A(4)	SA(5)
18	Develop students' constructive and logical reasoning					
19	Should enhance students' negotiation and dialogue skills					
20	Develop students' analytical reasoning					
21	Must support the development of new competencies.					

G. For effective simulation conceptual framework for the development of 4IR entrepreneurial skill in ICT programmes, **Project Initiation & Execution** must be carried out through the following stages:

S.N	ITEMS	SD(1)	D(2)	N(3)	A(4)	SA(5)
1	Project commencement and timing scheduling					
2	Evaluation of Order & Review					
3	Define Execution Strategy					
4	Resource Identification					
5	Communication Protocol					
6	Identify the target skills, and share with the learners					
7	Demonstrate skills step-by-step					
8	Provide extensive practice in the application of the skills					
9	Using the skills appropriately and effectively in response to new circumstances					
10	Using the skills appropriately and effectively in response to challenging circumstances					
11	Preparation of Project Execution Plan					
12	Project Planning & Scheduling					
13	Protect Monitoring					
14	Re-planning & Reporting					

15	Technical Coordination					
16	Analysing the Project s Result					
17	Client Satisfaction Input & Report					
18	Project Schedule (Actual Vs Estimated)					
19	Lesson Learned from the project					
20	Project Closeout					

Research Question 4: To identify the most relevant entrepreneurial skills to be developed by ICT graduates in the 4IR.

H. For effective simulation conceptual framework for the development of 4IR entrepreneurial skill in ICT programmes, the following **Learning Outcomes** must be achieved:

S.N	ITEMS	SD(1)	D(2)	N(3)	A(4)	SA(5)
1	Problem-solving skills					
2	Technology application skills					
3	Critical thinking skills					
4	Group dynamics					
5	Research/Information retrieval					
6	Creativity/Innovation skills					
7	Team working skills					
8	Communication skills					
9	Active learning skills					
10	High Order Thinking skills					
11	Organisation skills					

S.N	ITEMS	SD(1)	D(2)	N(3)	A(4)	SA(5)
12	Interpersonal skills					
13	leadership skills					
14	Self-directed thinking					
15	Self-directed/life-long learning					
16	Time management skills					
17	Resources management					
18	Presentation skills					
19	Critical evaluation of literature					
20	Respect for colleagues' views					

Research Question 5: To determine the best teaching methods to be employed for the development of 4IR entrepreneurial skills in ICT.

J. For effective simulation conceptual framework for the developments of 4IR entrepreneurial skills in ICT programmes, the **Assessment Methods** must involve the following:

S.N	ITEMS	SD(1)	D(2)	N(3)	A(4)	SA(5)
1	Self-assessment to allow students create their goals and keep track of the goals					
2	Self-reflection to allow students answer reflective questions about what they are learning, where they are struggling, and what they need to do next					
3	Student surveys where provide a blend of the objective and the subjective to help students make sense out of abstract concepts					
4	Self-assessment rubrics to enable students look at the progression from emerging to mastering with specific descriptions in various categories					
5	Checklist to allow students make sense out of systems before, during and after the task					
6	Peer assessment to enable students se new perspectives					
7	Provide 10-Minute Peer Feedback System per session to assess both the process and the product					
8	Structured Feedback to guide students provide diagnostic, clarifying, or critical feedback					
9	3-2-1 Structure where students provide three strengths, two areas of improvement and one question that they have					
10	See-Think-Wonder where students give peer feedback by pointing out what they see in another product, what they think about it, and, finally, what questions they have					

S.N	ITEMS	SD(1)	D(2)	N(3)	A(4)	SA(5)
11	Feedback Carousel where each group gets a stack of sticky notes and offers anonymous feedback as they move from group to group					
12	Peer Coaching where students interview each other about the process					

13	Advice Conference to empower students to ask for advice from the teacher and peers					
14	Reflection Conferences to empower students to reflect on their learning					
15	Mastery Conference to allow students judge their own mastery of the content					
16	Summative assessment to measure the students' overall achievement					

Thank you

Appendix C: Survey Questionnaire to Students

Quantitative Instrument

QUESTIONNAIRE FOR HCICT TVET STUDENTS IN CAPE TOWN METROPOLITAN

TOPIC: A Framework for developing Fourth Industrial Revolution (4IR) Entrepreneurial Skills in ICT Programmes in TVETs.

INSTRUCTIONS

This questionnaire is designed to solicit information from HCICT students at selected TVET colleges. Respondents are expected to give opinions on areas to be considered for the effective development of a 4IR entrepreneurial skills framework for ICT programme at selected TVETs in Cape Town using a 5-point Scale. The description of the scale is shown below:

PERSONAL INFORMATION

Please provide the following information, be honest in your responses. All your responses will be treated with ***Confidentiality***. Check (√) the most appropriate answer of your choice.

DEMOGRAPHIC DATA

Please Indicate Your Profession:

i. HCICT Student ☐

Gender:

iii. Male ☐

iv. Female ☐

Highest Qualification:

vii. Matric ☐

viii. Undergraduate ☐

ix. HND ☐

iv. Bachelor's Degree ☐

Race:

I. Black ☐

II. Coloured ☐

III. Indian ☐

IV. White ☐

V. Others ☐

Research Objective 2: To identify simulation elements and processes for the development of a simulation conceptual framework for 4IR entrepreneurial skills in ICT.

vi. SD (1) = Strongly disagree

vii. D (2) = Disagree

viii. N (3) = Neutral

ix. A (4) = Agree

x. SA (5) = Strongly agree

A. To arrive at an effective simulation conceptual model for the teaching of 4IR entrepreneurial skills in information and communication technology (ICT) a chosen **Problem** must have the following relevant qualities:

S.N	ITEMS	SD(1)	D(2)	N(3)	A(4)	SA(5)
1	Problems should be complex,					
2	Problem should be ill-structured					
3	Problem should be open-ended					
4	They must also be realistic with the students' experiences					
5	Should support self-evaluation among the students					
6	It should motivate the students' need to know and learn					
7	It should help to engage in the learning process based on their previous understanding					
8	the problem should allow for the application of many concepts					
9	the problem should foster communication skills as students present their plans to the rest of their class					

10	The problem should be multidisciplinary in nature to help build extensive knowledge & give room for multidisciplinary solutions					
11	be adapted to the students' level of prior knowledge					
12	be interesting and engage students in discussion					
13	Should support peer evaluation among the learners					
14	problems should also promote debate among students					
15	It should have more than one valid approach					

B. To arrive at an effective simulation conceptual model for the teaching of 4IR entrepreneurial skills in ICT, a chosen **Project** must have the following relevant qualities:

S.N	ITEMS	SD(1)	D(2)	N(3)	A(4)	SA(5)
1	A project should structure to build students cooperative skills					
2	It should enable students' communication skills					
3	It should guide students' logical reasoning					
4	It should build their leadership skills					
5	The project should develop students' decision-making skills					
6	It should be able to build their technical expertise					
7	It should inspire students to share their vision					
8	It should build their teamwork skills					
9	A project should develop students' negation and dialogue skills					
10	It should enhance their creativity and innovation skills					
11	It should develop students' accountability skills					
12	It must have justifiable reasons for its execution					
13	The project must have clear objectives and expected results					
14	It must have a completion time frame					
15	There must be a target audience					
16	The project must have a budget estimate					

17	There should be provision for formative and summative evaluation					

D. To arrive at an effective simulation conceptual model for the teaching of 4IR entrepreneurial skills in ICT, following aspects of **Teamwork** must be considered:

S.N	ITEMS	SD(1)	D(2)	N(3)	A(4)	SA(5)
1	There should be a clear sense of direction					
2	There should be open and honest communication					
3	Members should have defined roles					
4	There should be mutual accountability among members					
5	Members should have defined roles with common goals					
6	Encourage diverse opinions among members					
7	There should be collaboration and trust among team members					
8	There should be self-awareness among members					
9	Intrinsic motivation of members					
10	Ability to be carryout multitasks					
11	Promote persistence among team members					
12	Size of the project determines the number of members per team.					
13	The should be room for debate among members					
14	Number of team members drop as the students move to higher levels					

D. To arrive at an effective simulation conceptual model for the development of 4IR entrepreneurial skills in ICT, the **Students' Role** must include the following:

S.N	ITEMS	SD(1)	D(2)	N(3)	A(4)	SA(5)
1	Identify, analyse the problem, classify, produce hypotheses, and explore learning matters					
2	Attempt to discover the means to fix the analysed problem with their current knowledge as well as find out its relevance					
3	Classify areas not identified and all those areas					

	vital to be familiar with in fixing the problem					
4	Place in order of main concern the learning needs, produce learning goals, and also share in between the team members					
5	Strategy and enable the team members for independent research					
6	Efficiently reveal the acquired new knowledge with all of participants the data collected throughout the group					
7	Utilize the previous and acquired knowledge to initiate a project					
8	examine the learning/ project objectives					
9	Initiate a protect based on the set objectives					
10	planning, assigning tasks, taking action					
11	Manage, monitor, regulate, and fine-tune the project					
12	Manage resources for the project.					
13	Evaluate and analyse the project					
14	Cary out self/peer-evaluation					
15	Respond to given assessments and evaluation					
16	Fully execute the project					
17	Publicly present the project to the audience					

E. For effective simulation conceptual framework for 4IR entrepreneurial skills in ICT programmes, the following stages of **Problem-Orientation and Analysis** must be followed by the team members:

S.N	ITEMS	SD(1)	D(2)	N(3)	A(4)	SA(5)
1	Identify and define the problem					
2	Investigate the root cause or causes of the problem					
3	Investigate how the problem prevented the attainment of previous goals.					
4	Investigate how the problem affects the target beneficiaries					
5	Dissect the problem into smaller sections					
6	Analyse each section critically					
7	Identify the effects of each individual section					
8	Investigate the root cause of each section					

9	Attempt to provide one or more solutions to each of the sections					
10	Decide the most effective solution for each of the section					
11	Apply the best solutions to each of the problem sections					
12	Merge the solutions together					
13	Check if the problem has been resolved					
14	Revisit the problem where necessary					
15	Try alternative solutions where necessary					
16	Arrive at a possible final solution					

F. For effective simulation conceptual framework for the development of 4IR entrepreneurial skills in ICT programmes, **Project Initiation & Execution** must be carried out through the following stages:

S.N	ITEMS	SD(1)	D(2)	N(3)	A(4)	SA(5)
1	Project commencement and timing scheduling					
2	Evaluation of Order & Review					
3	Define Execution Strategy					
4	Resource Identification					
5	Communication Protocol					
6	Identify the target skills, and share with the learners					
7	Demonstrate skills step-by-step					
8	Provide extensive practice in the application of the skills					
9	Using the skills appropriately and effectively in response to new circumstances					
10	Using the skills appropriately and effectively in response to challenging circumstances					
11	Preparation of Project Execution Plan					
12	Project Planning & Scheduling					
13	Protect Monitoring					
14	Re-planning & Reporting					
15	Technical Coordination					
16	Analysing the Project s Result					
17	Client Satisfaction Input & Report					
18	Project Schedule (Actual Vs Estimated)					
19	Lesson Learned from the project					
20	Project Closeout					

G. For effective simulation conceptual framework for the development of 4IR entrepreneurial skills in ICT programmes, **Public Presentation** must be carried out with the following considerations by the team members:

S.N	ITEMS	SD(1)	D(2)	N(3)	A(4)	SA(5)
1	Revision of key language areas by team members					
2	Students are given a transcript or outline of the presentation					

3	Students identify key stages of the example presentation – greeting, introduction, main points in order of importance, conclusion					
4	Focus on linking and signalling words by underlining them in the transcript and placing them in the correct order					
5	Team members regroup into smaller groups and write down aims and objectives					
6	Students then write down key points which they order, as in the example					
7	Students decide who is going to say what and how					
8	Students prepare visuals and keep the time for this limited as too many visuals become distracting					
9	Debate and ask questions that are likely to be asked by audience					
10	A professional presentation template should be used					
11	There should be series of practice and rehearsals before the main presentation					

Research objective 1: To determine the use of simulation and 4IR technologies in the teaching and learning of ICT.

H. For effective simulation conceptual framework for the development of 4IR entrepreneurial skills in ICT programmes, **Project Simulation & Execution** must be carried out through the following stages:

S.N	ITEMS	SD(1)	D(2)	N(3)	A(4)	SA(5)
1	Project commencement and timing scheduling					
2	Evaluation of Order & Review					
3	Define Execution Strategy					
4	Resource Identification					
5	Communication Protocol					
6	Identify the target skills, and share with the learners					
7	Demonstrate skills step-by-step					
8	Provide extensive practice in the application of the skills					
9	Using the skills appropriately and effectively in response to new circumstances					

10	Using the skills appropriately and effectively in response to challenging circumstances					
11	Preparation of Project Execution Plan					
12	Project Planning & Scheduling					
13	Protect Monitoring					
14	Re-planning & Reporting					
15	Technical Coordination					
16	Analysing the Project s Result					
17	Client Satisfaction Input & Report					
18	Project Schedule (Actual Vs Estimated)					
19	Lesson Learned from the project					
20	Project Closeout					

Thank you

Appendix D: Interview Guide for Entrepreneurs

Instruments for Qualitative study

(a) Interview Protocol

Objective	Research guide	Category	Checklist and interview guide
Opening	**1.** May I begin by expressing our profound gratitude on the behalf of my supervisors; Prof J Conje and Prof R Tengeh for honouring our request to serve as a participant in this research		
Introduction	**Demographic profile**	As an introduction, can you explain a little bit of your background of experience with regards to your 1. Full name: 2. Highest qualification: 3. Rank: 4. Years of service:	
Transition		1. (a). What is your experience in the use of SBL as an instructional method for entrepreneurial skills in ICT at TVET colleges? (b). What is your Perception of the use of SBL as an instructional method for entrepreneurial skills in ICT at the TVET colleges? 2. From your experience, which of the following SBL processes or procedure do is more suitable for the development of entrepreneurial skills in ICT?	

Key	Which among the following elements of SBL you consider appropriate for the development of a framework for entrepreneurial skills in ICT?	1. Problem 2. Driving Question 3. Teachers' Role 4. Students' Role 5. Team work 6. Continuous and Alternative Assessment 7. Psychological Motivation 8. Self-Regulated
	From your experience, which of the following SBL processes or procedure do is more suitable for the teaching of entrepreneurial skills in ICT?	i. Problem Identification, Problem Analysis, Activation of Prior Knowledge, Project Initiation, Project Implementation, Public Presentation ii. Problem Formulation, Problem Orientation, Information Gathering, Project Commencement, Project Execution, Public Presentation
Closing	Apart from the processes in 'a' above, to you have any other process that could be a more suitable process that could be applied for the development of a framework for teaching Entrepreneurship education for ICT programmes?	

Comments

Appendix E: Survey Questionnaire for entrepreneurs

(b) Quantitative Instrument

May I begin by expressing our profound gratitude on the behalf of my supervisors; Prof J Conje and Prof R Tengeh for honouring our request to serve as a participant in this research. This questionnaire is designed to solicit information from entrepreneurs and business experts. Respondents are expected to give opinions on areas to be considered for the effective development of a 4IR entrepreneurial skills framework for the ICT programme at selected TVETs in Cape Town. This research has received ethical clearance from the IT department and the Faculty. And by completing the survey you give consent to participating in the research. Anonymity will be observed and your personal data will be protected.

1. As an introduction, can you explain a little bit of your background and experience with regards to your

Highest qualification: _____

Gender: Male _____
Female_____

Age Range: Below 20_____
21-30_____
31-40_____
41-50_____
Above 50_____

Ethnic group: Black_____
Coloured_____
White_____

Are you the owner: Yes_____?
No _____
Position in the Business: _____

How many years in business?_____

What sector are you operating in?
_____

How many employees do you have?_____

2. What motivated you to go into business

_____
_____
_____
_____
_____
_____
_____

3. What are the most relevant entrepreneurial skills to have in this era of fourth industrial revolution (4IR)?

_____
_____
_____

4. What are the challenges you faced in the business?

_____
_____
_____
_____

5. How did you overcome these challenges?

_____
_____
_____
_____

6. What are some of the personal characteristics that you possess that made you successful in your business?

_____
_____
_____
_____

7. What teaching methods will be most suitable in teaching entrepreneurial skills to ICT students?

8.

Items	**Not suitable**	**Less suitable**	**Moderately suitable**	**Very suitable**	**Highly suitable**
Simulation-based learning					
Problem based learning					
Project based learning					
Job shadowing					
Learnership/Internship					

9. On a scale of 1 to 10, with 1 being strongly disagreed and 10 being strongly agreeing, Is simulation-based learning a suitable method of teaching entrepreneurship?

10. What is your perception of the use of simulation learning as an instructional method for entrepreneurial skills in ICT students?

_____
_____
_____
_____

11. Which among the following elements of simulation learning do you consider appropriate for the development of a framework for entrepreneurial skills in ICT students?

Items	**Not Relevant**	**Less Relevant**	**Moderately Relevant**	**Very Relevant**	**Highly Relevant**
Solution Driven Question					
Teachers' Role					
Students' Role					
Team work					
Continuous and Alternative Assessment					
Psychological Motivation					
Self-Regulated					

12. Apart from the processes in '9' above, do you have any other process that could be a more suitable process that could be applied for the development of a framework for teaching entrepreneurial skills?

13. What is the Teacher's role in the development of entrepreneurial skills in the students

14. Any other comments on how entrepreneurial skills can be developed by students?

15. Any other comments of the role of students in developing entrepreneurial skills?

16. What are the most relevant entrepreneurial skills to have in this era of the fourth industrial revolution (4IR)?

	Not relevant	Less relevant	Moderately relevant	Very relevant	Highly relevant
Problem-solving skills					
Technology application skills					
Critical thinking skills					
Group dynamics					
Creativity/Innovation skills					
Leadership skills					

Time management skills					
Emotional intelligence					
Communication skills					
Interpersonal skills					

17. Any other additional relevant entrepreneurial skills to have?

Thank you

Appendix F: Faculty of Design and Informatics Ethics Committee Approval Letter

Cape Peninsula University of Technology
creating futures

PO Box 1906, Bellville,7535 Symphony Way, Bellville, Cape Town, South Africa
+ 27 (0)21 959 6767 www.facebook.com/cput.ac.za info@cput.ac.za www.cput.ac.za

Office of the Research Ethics Committee
Faculty of Informatics and Design
Room 2.09
80 Roeland Street
Cape Town
Tel: 021-469 1012
Email: ndedem@cput.ac.za
Secretary: Mziyanda Ndede

21 February 2022

Mrs Rylyne Mande Nchu
c/o Department of Information Technology
CPUT

Reference no: 213092638/2022/2

Project title: A Framework for developing Fourth Industrial Revolution Entrepreneurial Skills in ICT Programmes in TVETs

Approval period: 21 February 2022 – 31 December 2023

This is to certify that the Faculty of Informatics and Design Research Ethics Committee of the Cape Peninsula University of Technology conditionally approves the methodology and ethics of Mrs Rylyne Mande Nchu (213092638) for PhD in Informatics.

Any amendments, extension or other modifications to the protocol must be submitted to the Research Ethics Committee for approval.

The Committee must be informed of any serious adverse event and/or termination of the study.

Dr Blessing Makwambeni
Acting Chair: Research Ethics Committee
Faculty of Informatics and Design
Cape Peninsula University of Technology

Appendix G: Published Articles from the thesis

Published Article

RM Nchu, RK Tengeh, J Cronje, 2023. A call for more entrepreneurship education in non-business programs at South African TVET College. Eureka Journal: Social and Humanities. 3: 67-78

Manuscripts in preparations

RM Nchu, RK Tengeh, J Cronje, ER Francke. Entrepreneurial Skills for ICT Students: Teaching Techniques and assessment Methods

RM Nchu, RK Tengeh, J Cronje. Training students for fourth industrial revolution environment: The role of technical and vocational education and training in South Africa.

RM Nchu, RK Tengeh, J Cronje. Student's role in developing entrepreneurial skill: The case of ICT TVET students in South Africa.

RM Nchu, RK Tengeh, J Cronje. Prospects of simulation Based Learning for ICT Programmes in South African TVETS.

RM Nchu, RK Tengeh, J Cronje, The teachers' role in the development of entrepreneurial skills in ICT TVET students

RM Nchu, RK Tengeh, J Cronje, Chux Iwu. A pedagogic strategy to implement entrepreneurial skills to South African TVET colleges borrowing from experiences from different continents.

Appendix H: Conference attendance and presentations.

DLAC2020: Digital Learning Annual Conference. Held in Austin, Texas – USA, from 24 February - 26 February 2020. Rylyne Mande Nchu, Robertson Tengeh, and Chux Iwu. Lack of blended learning in entrepreneurship education and its impact on the perception of learners towards entrepreneurship. Contribution: Oral presentation.

UNESCO-UNEVOC International Centre for TVET 2022.
The Hybrid International Conference on the Launch of UNESCO's new strategy for TVET 2022-2029. Held in Bonn, Germany from 25 October – 26 October 2022.Rylyne Mande Nchu, Robertson Tengeh, and Johannes Cronje. Contribution: Poster Presentation.

International Conference on Entrepreneurship Education and Development ICEED 2023 London, UK. 21 October -22 October 2023. Rylyne Mande Nchu, Robertson Tengeh, and Chux Iwu. The impact of blended learning on the perception of TVET students towards entrepreneurship. Contribution Oral presentation.

UIIN South Africa Forum: University-Industry Engagement for Innovation and Impact. Held in Johannesburg, South Africa on 20 February- 21 February 2024, hosted in partnership with SARIMA. Contribution: Participant.