THE IMPACT OF TECHNOLOGY INNOVATION ON HIGHER EDUCATION INSTITUTIONS

A case study of a Private and Public Universities in Johannesburg

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DECLARATION

I, George C. Iroha, do hereby declare that this thesis is my own work except as indicated in the references and acknowledgements. It is submitted in fulfilment of the requirements for the degree of Doctor of Philosophy in Management at Wits Business School, Johannesburg. This thesis has not been previously submitted before for any degree or examination in this or any other university.

(Signature)
Signed in Midrand
20th January 2023.

DEDICATION

I dedicate this thesis to my late dad, my beloved mom and my uncle who has always believed and supported me throughout my academic journey

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I would like thank my supervisor, Dr. Renee Horne for her patient, support and mentorship throughout my Ph.D. academic years. I would also say a big thank you to my supportive and understanding family, most especially my mom (Mrs. Patience Iroha) and my uncle (Prof. Dan Chimere-dan). I thank all academic staff of Wits Business School who directly or indirectly supported my PhD journey. Lastly, I thank my Lord and Saviour Jesus Christ, the author of all knowledge, without whom this thesis wouldn't have been possible.

ABSTRACT

Technology has demonstrated its disruptive potential in business and human activities, particularly in the service industry, as well as improving education and knowledge. Regardless of the growth of technology innovation in different industries, its impact on educational industry is often overlooked unnoticed, specifically in light of the current Industry 4.0 based technology innovation. The revolution of technology over the years has created possibilities for improving the teaching and learning method which were entirely lacking before the third industrial revolution. In contrast to many innovation research, including that of the fourth industrial revolution, which has concentrated primarily on computers and manufacturing, just a few studies have examined how technology innovation is revolutionising the service industry, particularly the education industry. The aim of this study focused on the impact of technology innovation on higher education institution in South Africa. First it investigated the effect of technology innovation on learning using the flipped classroom model. Secondly it analysed the impact of technology innovation on learning using the Moodle learning method. Thirdly it examined the influence of technology innovation on students' attitude. Fourthly it assessed the effect of technology innovation on students' satisfaction. Then lastly it examined if demographic factors (such as age and gender) have a moderating effect on the relationship between technology innovation and student satisfaction.

This study found a positive significant relationship between technology innovation and Moodle learning method of learning. Also, there is a positive significant relationship between technology innovation and students' attitude. There is also a positive significant relationship between technology innovation and students' satisfaction. However, the study shows no significant positive relationship between technology innovation and flipped classroom method of learning. Lastly, the study also found no significant positive relationship between technology innovation and students' satisfaction when demographic factors (age and gender) is a moderating variable. These findings will assist both government and educators in tertiary institution to develop a theoretical framework with the use of technology innovation tools to better prepare students for the fourth industrial revolution which will foster sustainable development drive for the future of education. The study adopted the positivist paradigm, and followed a quantitative approach in gathering data. The study made use of the survey research method and the data were analysed using regression analysis with SPSS statistical tool.

Keywords: technology innovation, industry 4.0, tertiary institution, flipped classroom method, Moodle learning Method, students' attitude, student satisfaction, age and gender

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LIST OF ABBREVIATIONS

AI	**Artificial Intelligence**
STEM	**Science, Technology, Engineering, and Mathematics**
E-learning	**Electronic Learning**
COVID 19	**Corona Virus Disease of 2019**
2IR	**Second Industrial Revolution**
3IR	**Third Industrial Revolution**
IoT	**Internet of things**
Industry 4.0	**Fourth Industrial Revolution**
ICT	**Information and Communications Technology**
3D printing	**Additive Manufacturing**
e-commerce	**Electronic Commerce**
IBM	**International Business Machines Corporation**
1IR	**First Industrial Revolution**
SDGs	**Sustainable Development Goals**
SDG4	**Sustainable Development Goal 4**
OER	**Open Educational Content**
MOOCs	**Massive Open Online**
R&D	**Research and Development**
FEA	**Finite Element Analysis**
AR	**Augmented Reality**
UaaP	**University-as-a-Platform**
EaaS	**Education-as-a-Service**
NECT	**National Education Collaboration Trust**

TAM	**Technology Acceptance Model**
TPB	**Theory of Planned Behaviour**
DIT	**Diffusion of Innovations Theory**
UTAUT	**Unified Theory of Acceptance and Use of Technology**
ODEL	**Open, Distant, and Electronic Learning**
USA	**United State of America**
HE	**Higher Education**
SPSS	**Statistical Package for Social Science**

CHAPTER 1

INTRODUCTION

CHAPTER ONE

1. INTRODUCTION

During the last decade, technological advancements have profoundly impacted every aspect of human life, corporate operation and the society at large. Technology has now demonstrated its disruptive potential in business and other human activities most especially within the service sector (Liu & Stephen, 2019), as well as improving teaching and learning (Brown, 2015; Chang, & Wills, 2019). For example, amazon.com constructed a system that recommends goods to its customers using a database of combined buying histories. This allows customer requirements and expectations to be matched through a specialized AI algorithm. Additionally, internet community platforms such as Instagram, Facebook etc. have had a profound effect on how we socialise and interact with one another, particularly among the expanding population of "digital natives" (Gleason, 2018; Davids, & Waghid, 2019). Also, professional platform such as LinkedIn, Massive Open Online Course (MOOC) are altering the transmission of skilled knowledge, as well as teaching and learning (Waghid, Waghid & Waghid, 2018). While digital technology is rapidly gaining traction across multiple industries, its epistemological, pedagogical and ethical effects, especially towards the educational industry, remain unnoticed, specifically in light of the current Industry 4.0 based technology innovation. Nonetheless, it is important to know the vital role of the previous industrial revolutions and the foundation it gave for modern advancements in technology and economic output, even though the recent development, involving the potential of the fourth industrial revolution breakthroughs, remains questionable. The early 1950s were the start of the third industrial revolution, although, the technological successes of the previous industrial revolutions had a major impact. Consequently, industrialisation gained a foothold in the world economy, and machines (computers) were introduced, to enable the channelling of modern and faster way of communication and information gathering especially, in the business community, including teaching and learning (Penprase, 2018).For example, the combination of the power of technology, most notably the third industrial revolution, computer and its advantage of world wide web (internet) has revolutionized the business community, including teaching and learning, from vast sluggish powered machinery to compact sleek smart machines (Johal, Castellano, Tanaka & Okita, 2018; Wang, 2018; Tymon, 2019). The transformation of technology has created prospects for improving the teaching and learning method by simulations of intricate, time-consuming, and sometimes dangerous scenarios which were totally absent before the third industrial revolution (Buckenmeyer, 2017). The Fourth Industrial

Revolution (4IR) provides countries with the opportunity to improve their economic prospects through the adoption of cutting-edge technologies that spur growth. South Africa is a participant in this transformation. This transformation is altering the way people engage with one another as well as the way businesses operate. The purpose of this research was to investigate university students' perceptions of how their schools are preparing them to thrive in the Fourth Industrial Revolution technology innovation age, which is powered by Artificial Intelligence and different learning routes. Learning about the students' perceptions of how South African universities are preparing them is essential for enabling the education fraternity to assess its level of effectiveness and efficiency, and thus improve its state of readiness to face the challenges of the Fourth Industrial Revolution. So, the investigation of educational policy makers and planners' levels of preparedness in light of 4IR challenges can help them to be better prepared, as well as develop strategies for removing obstacles and discrepancies that prevent students from acquiring necessary competencies and skills for the twenty-first century.

1.1.Background of the Study

In today's technologically transformed environment, graduates face significant opportunities and challenges for formal education systems presented by the Internet, cloud computing, and social media (Agarwal & Agarwal, 2017). Colleges face questions about their own futures, particularly employment, as students reflect on their post-graduation life. These AI-powered technologies are revolutionising the world to the point where social concepts like "post-work" are increasingly characterising the contemporary period (Badat, 2020). While the third industrial revolution was fuelled by information technology, the skills required now are distinct from those required then. Among these abilities are analytical thinking, interpersonal communication and emotional intelligence as well as negotiation skills and the ability to create and manage knowledge (Butler-Adam, 2018). Virtually every area of our lives is being transformed by the digital revolution, including the way we work, organise, and live. As a result of this revolution, homes in both developed and developing countries have seen significant changes in how children and adolescents' access and utilise information, interact, learn, and even play (Meyer & Gent, 2018). The educational landscape has not yet been completely transformed by this revolution, and it will take time for it to gain traction. Regardless, it is clear that teacher-led classes, where pupils are coached to repeat material in order to determine how much content they can remember, will never be the same again (Butler-Adam, 2018; Agarwal

& Agarwal, 2017). Sometimes, lecturers may not always motivate students, and that they would rather have options available to them. Mobile and tablet devices, as well as instructional technology, are advancing at a rapid pace, giving students more autonomy and freedom in accessing and sharing information. They allow instructors and professors to design new ways for capitalising on the degree of control students have, so improving their motivation to learn.

Teachers and students are forming new bonds as a result of new pedagogies, and teaching talents are being transferred to students faster as a result. The development of student autonomy in the creation and administration of their own learning experiences is also a major goal of contemporary educational approaches (Xu, David, & Kim, 2018). For students to make a meaningful contribution in the real world, they must use digital tools for purposes other than academics, as well as to uncover new information. At this point, students put their newly acquired information into practise, acquiring confidence and the proactive attitude needed to create value in today's technology-driven, knowledge-based societies.

The 4IR educational shift must be taken into account when rethinking how students are taught today. As a result of these new goals, learning environments must be redesigned and new tools must be created. Tools that keep track of students' academic progress, their learning objectives, and their level of involvement (Skilton & Hovsepian, 2018). Furthermore, the online classroom has become a primary means of delivering education, supplanting traditional classrooms as a primary form of delivering education. Higher education institutions are increasingly recognising the advantages of online educational programmes, largely to stay current in a quickly changing digital environment, but also to generate other revenue streams and provide students more freedom to work at their own speed. Students who are highly motivated can use online learning tools to learn in an isolated environment, but all students can benefit from more inclusive, socially connected learning when they are integrated into the official educational process (Xing & Marwala, 2017).

There are many different ways to describe the 4th Industrial Revolution, but Lee and colleagues (2018) define it as a combination of technological advancements and institutional innovations that improve working efficiency, including teaching, while also enhancing socioeconomic and environmental performance. When it comes to teaching STEM subjects such as physics and chemistry using robots that have been around for decades, the education sector has been slow to adapt to the use of technology for teaching and learning. (Tymon, 2019). Furthermore, technology has primarily been utilised to support a didactic method to teaching and learning, in which instruction is aided by using computer and the availability of electronic instructional materials. Nevertheless, in order to be effective in improving students' learning experiences, the use of “digital technology” to promote 4IR must go past the use of computers or e-materials and must be attuned with a student-centred approach.

We can only assume that the much-anticipated 4IR will have extensive repercussions not just for the economy, but also for our personal and social lives, as well as the manner we communicate and interrelate, given the exponential rate at which it is spreading. For example, technological advancements and widespread use of smart gadgets for different reasons, such as in the use of social media, may limit face-to-face social encounters while speeding up the acquisition of critical skills (Liu & Stephen, 2019; Saini & Abraham, 2019). This could inhibit the acquisition and development of important soft skills like “emotional intelligence, communication, and interpersonal skills, especially among the younger population”. However, the World Economic Forum (2018) reports that since the first industrial revolution, the way the world of labour is regarded has shifted. As a result of automation and the digitalization of operations processes, 4IR will result in a dramatic drop in demand for a variety of vocations, including those requiring manual skills and physical abilities. Additionally, Lee et al. (2018) proposed that job descriptions and professional abilities should evolve in tandem with 4IR's evolution in response to the difficulties and opportunities presented by digital transformation. Due to the complexity and multidimensionality of 4IR as it pertains to 21st century teaching and learning methodologies, it is critical to grasp its meaning from stakeholders' viewpoints (Tymon, 2019; Rubmann, Lorenz, Gerbert, Waldner, Justus, Engel, & Harnisch, 2015).

1.2.Research Problem

The level of education in a society, region, or country is a significant factor in determining the advantages and disadvantages of those entities (Kehdinga & Fomunyam, 2019). In addition, Kehdinga & Fomunyam (2019) assert that the success of any society in the world is contingent upon the level of education, despite enormous advances in technology, economics, and industrial expertise. This is the case despite the fact that there have been a lot of advancements in these areas. Education is therefore a crucial factor in the ability of an economy to compete successfully in the international market. According to Gwata (2019), education is one of the factors that can help link individuals in the workplace and serves as a foundation for employment. Additionally, education is one of the factors that can help individuals find employment. The advancement of technology brought on by the so-called "fourth industrial revolution" (4IR) poses a threat to the traditional employment opportunities that have been available for decades, and it is causing some industries to decline (Moloi & Marwala, 2020). Simply taking this into consideration calls for a shift in how people generally think about getting an education. Throughout the years and decades, education has undergone a series of revolutions; each revolution required the implementation of a particular strategy in order to accomplish its stated objective, and 4IR is not an exception to this rule (Kehdinga & Fomunyam, 2019; Moloi & Marwala, 2020). Traditionally, education has followed a path that is limited to a single discipline, which requires students to limit their scope of understanding and concentrate their efforts as they advance through their studies. As a consequence of this, conventional education consisted of individuals acquiring a narrowly specialised skill from an educational institution in order to qualify for a particular trade or career. The 4IR, on the other hand, is having a significant impact on all aspects of life and society (Moloi & Marwala, 2020; Marwala, 2020). It is to be anticipated that developments in technology will bring about shifts in business, most notably in educational practises (Xing & Marwala 2017). New methods of educational transmission are being made possible thanks to the proliferation of social media apps like LinkedIn and other easily accessible online courses (Gwata, 2019; Kehdinga & Fomunyam, 2019). As a consequence of this, the methods by which teaching and learning are carried out are transformed by these platforms, particularly in terms of communication (Fomunyam, 2019; Oke & Fernandes, 2020). The way in which educators instruct and communicate with their students has been fundamentally transformed as a result of the proliferation of social media tools such as WhatsApp (Mhlanga, 2020). This exemplifies the degree to which the educational sector is being transformed by technological advancements. According to Manasia et al. (2020), despite the widespread implementation of technology in educational settings, there is still a lack of clarity regarding the pedagogical and epistemological effects of technology. Tymon (2013) argues further that, despite the fact that a variety of technologies can be utilised to facilitate teaching and learning, the education industry is still behind in terms of the adoption of technology for teaching and learning. The perception of high prices and a general lack of skills are two of the factors that are cited as being obstacles to the widespread adoption of technology in the educational sector. As a consequence of this, the efficacy of technology in education and the problems associated with it have not received sufficient attention (Manasia et al., 2020). Additionally, Masina et al. (2020) argue that the benefits and drawbacks of utilising technology in educational settings are not adequately documented. They state that this lack of documentation is a problem. Berendt et al., (2020) examined the benefits and risks of artificial intelligence in the education sector, with a particular emphasis on fundamental human rights. Guilherme, (2019) examined the current technologicalization of education and its impact on the relationship between a teacher and students in the classroom. Berendt et al., (2020) examined the benefits and risks of artificial intelligence in the education sector. Scepanovic (2019), on the other hand, noted that the technological revolution that is currently sweeping the world and South Africa in particular suggests that the education system should be prepared for future difficulties, given the sector's critical role in positively reshaping society. In addition, Kayembe & Nel (2019) attempted to analyse educational challenges and opportunities in the context of the fourth industrial revolution, with a focus on South Africa specifically. According to Kayembe & Nel's (2019), the challenges that South Africa's educational system is going to face as a result of the fourth industrial revolution include a deficiency in finances, an absence of adequate infrastructure, and a lack of human, technical, and financial capacity.

The rapid progress of education and technology, particularly in the era of the fourth industrial revolution (4IR), holds profound implications for societies, economies, and the educational sector. Despite this transformative potential, challenges and knowledge gaps persist in understanding the impact and integration of technology in education, as well as in adequately preparing educational systems for future challenges. Addressing these issues is crucial to leverage the potential benefits and navigate obstacles in the dynamic educational landscape. The study focuses on specific sub-problems, including the significance of technology innovation in learning through the flipped classroom model, the direct implications of technology innovation using the Moodle learning method, the contribution of technology innovation to students' attitudes, the outcomes of technology innovation on students' satisfaction, and the influence of demographic factors (age and gender) on the effects of technology innovation and students' satisfaction. By addressing these facets, the research aims to contribute valuable insights and recommendations for enhancing the effectiveness of technology in education.

As a result, the purpose of the study was to investigate the influence that technological advancement has had on higher education institutions in South Africa. Because this is a descriptive study that will identify other research areas for further exploration, the findings of this study will address certain gaps while also making a modest contribution to knowledge. This is because the study will be a descriptive study.

1.3.Contextual Perspectives

Fourth Industrial Transformation (4IR) is a technology revolution that blurs the barriers between physical, digital, biological domains, according to the World Economic Forum (WEF, 2018). By using artificial intelligence, data analytics, and algorithms, innovation has the potential to enhance human skill by reducing the amount of time and effort required to do time-consuming and challenging tasks. This is especially true in the education sector. When it comes to our day-to-day lives, the fourth industrial revolution is more relevant than previous ones since it will affect everything from how we work to how we learn in school (Brown, 2015; Penprase, 2018). As a result of using computers to facilitate education and training and in particular e-learning, operating costs can be reduced as well as administrative concerns which are typically related with face-to-face classroom teaching being decreased. Student happiness and performance have been shown to increase by 15% when using a blended learning technique that incorporates both e-learning and classroom-based learning. Instead of relying solely on face-to-face classroom instruction, emerging technologies such as the internet and mobile devices allow students to learn competency-based and self-directed skills while also expanding their range of learning activities and the speed at which information is made available to them wherever they may be. Beetham & Sharpe (2019) claim that digital technology not only makes tutor-student interactions easier, but it also enhances and improve the teaching and learning method. Scholars and practitioners in the field of education are beginning to question the efficacy and efficiency of technology, particularly online teaching, in enabling teaching and learning. This is because technology is becoming increasingly accepted and used in a wide variety of manufacturing and service industries. (Henderson, Selwyn, & Aston, 2017).

Digital technologies haven't changed the mode of teaching and learning, especially in tertiary education, despite its good potential for improving teaching and learning through changing how students experience their studies (Beetham & Sharpe, 2019; Henderson, Selwyn, & Aston, 2017).

Education in South Africa has not altered much despite the prevalence of mobile (smart) gadgets and social media, which has had an impact on the way students and teachers interact. While the usefulness of technology to help teaching and learning was restricted to digitization until recently, this has all changed. In the education industry, many inventions and technologies are not protected by patents and exclusive rights, suggesting that academic institutions have no control over how they are designed and used. On the other side, Rashid & Asghar (2016) have shown that digital technology is useful in improving student involvement and self-directedness in the classroom. Digital technologies did not, however, have a significant impact on pupils' learning outcomes, according to the research team. As a result of technological advancements, the dynamics of teaching and learning have shifted, but it is still unclear if incorporating technology has a significant impact on teaching condition or improves student achievement and knowledge. Interactive e-learning has been shown to improve teaching and learning through five different interactive learning instances (Chang, 2016). Researchers found that students' personal competence, motivation, and satisfaction with their learning can be improved by working together as a team to develop and execute well-structured e-learning programmes. When face-to-face and online education are joined in a collective, intermingling, and flexible way, according to Chang (2016), electronic learning is more efficient. Nevertheless, the current level of dispersion of technology innovation is unparalleled and surpasses previous revolutions in terms of velocity (Ringel et al., 2018). Many industries are also trying to keep up with the high pace of digital innovation, especially those in the service and education sectors. Organisational learning in the education sector has not been proven to be feasible due to inconsistent use of digital technology in the teaching and learning process (Brown, 2015; Selwyn, 2020). Only a few studies have considered how 4IR alters the service sector, notably education, whereas the vast majority of study on innovations, including 4IR, has concentrated on computers, primarily in the industrial sector (Collins & Halverson, 2018; Kreijns, Van Acker, Vermeulen, & Van Buuren, 2017). 4IR adoption and diffusion in the education sector are not fully understood in terms of how they might help with teaching and learning. There are many factors at play here (Rashid & Asghar, 2016; Penprase, 2018).

Nevertheless, we have little knowledge on the methodologies and procedures that the educational sector of the country can make use of in other for it to make sure that 4IR capacities are improved in classroom practises, particularly in Africa. No academic institution is listed among the world's top 50 most innovative firms despite the potential contributions made by technology to students' development such as collaborative learning (Ng'ambi et al., 2016; Kreijns, Van Acker, Vermeulen & Van Buuren, 2021). Also, no organisations from Africa are found in the list of the world's top 50 most innovative firms. Developing graduates with creative ideas and applicable abilities in this digital age while also contributing to organisational function and productivity will be challenging if the education industry does not respond to 4IR. This debate needs to move on from computer technology and focus on how digitalization and adoption of 4IR are transforming the educational business and the teaching and learning process. With this shift in focus, the education sector will not only benefit from the technological transformation, but it will also provide an opportunity to confront the riddle around the roles and usefulness of digital technology in education and learning.

The conceptual perspective plays a significant role in understanding the implications and potential of the Fourth Industrial Revolution (4IR) in the education sector. The conceptual perspective helps us grasp the underlying ideas and concepts behind the integration of technology in education. It acknowledges that innovations such as artificial intelligence, data analytics, and algorithms can enhance human skills by reducing the time and effort required for complex tasks. In the context of education, this means that technology can revolutionize the way we learn and teach, making it more efficient, personalized, and accessible.

One of the key aspects of the conceptual perspective is the recognition of blended learning, which combines traditional face-to-face classroom instruction with online and digital elements. Blended learning approaches, incorporating e-learning and classroom-based learning, have shown positive outcomes in terms of student happiness and performance. It allows for competency-based and self-directed learning, expanding the range of learning activities and the speed at which information is available to students. Digital technology facilitates tutor-student interactions and improves the overall teaching and learning process.

However, despite the potential benefits of technology in education, there are challenges and questions raised by scholars and practitioners. The effectiveness and efficiency of technology, particularly online teaching, are being scrutinized. The adoption and integration of digital technologies in education vary, and there is a need to assess their impact on teaching conditions and student achievement.

Furthermore, the conceptual perspective highlights the need for the education sector to keep pace with the rapid pace of digital innovation in other industries. While technology has the potential to contribute to students' development and improve collaborative learning, the education sector has lagged behind in terms of innovation and incorporation of 4IR capacities. This is evident in the absence of academic institutions from the list of the world's top 50 most innovative firms and the lack of representation from Africa.

To address these challenges and maximize the potential of 4IR in education, there is a call to shift the focus from computer technology to digitalization and the broader adoption of 4IR. This shift will not only benefit the education sector but also provide an opportunity to explore and understand the roles and effectiveness of digital technology in education and learning. It requires the development of methodologies and procedures that can improve classroom practices and ensure the integration of 4IR in the education sector.

In summary, the conceptual perspective emphasizes the transformative potential of 4IR in education and highlights the need to overcome challenges and leverage digital technologies for improved teaching and learning. By embracing this perspective, the education sector can harness the power of technology to prepare students for the digital age, enhance organisational function and productivity, and address the broader questions surrounding the role of technology in education.

1.4.Statement of Purpose

The purpose of this study is to explore how educators in tertiary institutions can develop a framework using innovative technology and Fourth Industrial Revolution (4IR) tools to effectively prepare students for the upcoming changes in the workforce driven by artificial intelligence. The fourth industrial revolution is characterized by a shift towards human-centered work and the convergence of man and machine, which will bridge the gap between social sciences and humanities, as well as science and technology. To adapt to these changes, multidisciplinary education, research, and innovation are crucial. This study aims to leverage the potential of higher education in the 4IR to positively impact society.

1.5.Research Objectives and Questions

For this study, the following research objectives have been formulated:

- To investigate the effect of technology innovation on learning using the flipped classroom model.
- To analyse the impact of technology innovation on learning using the Moodle learning method.
- To examine the influence of technology innovation on students' attitude.
- To assess the effect of technology innovation on students' satisfaction.
- To examine if demographic factors (such as age and gender) have a moderating effect on the relationship between technology innovation and student satisfaction.

For this study, the following research questions have been formulated:

- Does technology innovation have a significant positive effect on learning using the flipped classroom model?
- Does technology innovation have a significant positive effect on learning using the Moodle learning method?
- Does technology innovation have a positive significant effect on students' attitude?
- Does technology innovation have a significant positive effect on students' satisfaction?
- Do demographic factors (age and gender) moderate the relationship between technology innovation and students' satisfaction?

1.6.Significance of the Study

This research is crucial because there is insufficient knowledge with regards to the impact of 4IR (technology innovation) on higher education institution in South Africa. Its effects on South African education and the consequences for the future as students prepare for the twenty-first century have not been fully examined in South Africa. The public will also benefit from the study since it will inform them about the significant role that 4.0 industrialisation may play in raising the educational standards of South African students, creating job opportunities for our youth, and reducing social vices to the bare minimum through the effective application of technology and innovation. More importantly, the research will serve as a useful reference for future research students who are looking for information to fill in gaps in the literature and improve their work. Finally, the study will assist the government in reviewing some of its policies that are incompatible with the development and acceptance of the Fourth Industrial Revolution (Industry 4.0 technology innovation) in the educational sector, which will serve as the foundational pillar of the nation.

Empirical significance of this study is rooted in the possible impact that the study's findings may have on educational researchers and practitioners. The development of appropriate teaching and learning approaches, such as robotics, flipped courses, Moodle, and others, could have a potential impact on learning outcomes in the educational sector. In order to improve the learning and education sector in South Africa, consideration could be given to the need of creating and implementing sufficient policies related to the Fourth Industrial Revolution (Industry 4.0 technology innovation) in the educational sector.

Theoretical significance of the study focused on a particular theoretical approach that is used for this study in responding to the impact of the fourth industrial revolution (technology innovation) on learning and educational outcomes in South Africa. As a result, it is expected that the findings of this study will address certain gaps while also contributing modestly to knowledge, as this is a descriptive study that will identify other research areas for further exploration.

Methodological significance of this study is that it addresses a variety of planning and operational issues. It facilitates decision-making. It entails the investigation of cause-and-effect linkages between various factors in order to uncover behaviours, patterns, and trends in specific variables in relation to the influence of technology innovation on South African tertiary institutions. The main objective is to find-tune the broad problem into a specific problem statement and generate possible hypothesis that will be tested. This will provide legitimacy and wider acceptance to the research work as different methods will be used for different purposes

1.7.Delimitation

This study only looked at a few areas of the fourth industrial revolution's impact on the learning and education sector in South Africa, such as technological innovation's impact, level of preparedness, perception and impact of technological innovations. However, there are other additional elements of the 4IR that could have resulted in different outcomes.

There are many universities and colleges of higher learning in South Africa, however this study will just focus on a public university (The University of Witwatersrand Johannesburg) and a private university (Eduvos Midrand) and can be assumed to be generalizable to other universities. In the future, data from other universities should be used. All data collection will be handled in accordance with social distancing owing to COVID 19, which limits contact with respondents and may result in some confusing responses from people who did not completely understand the question.

1.8.Research Framework

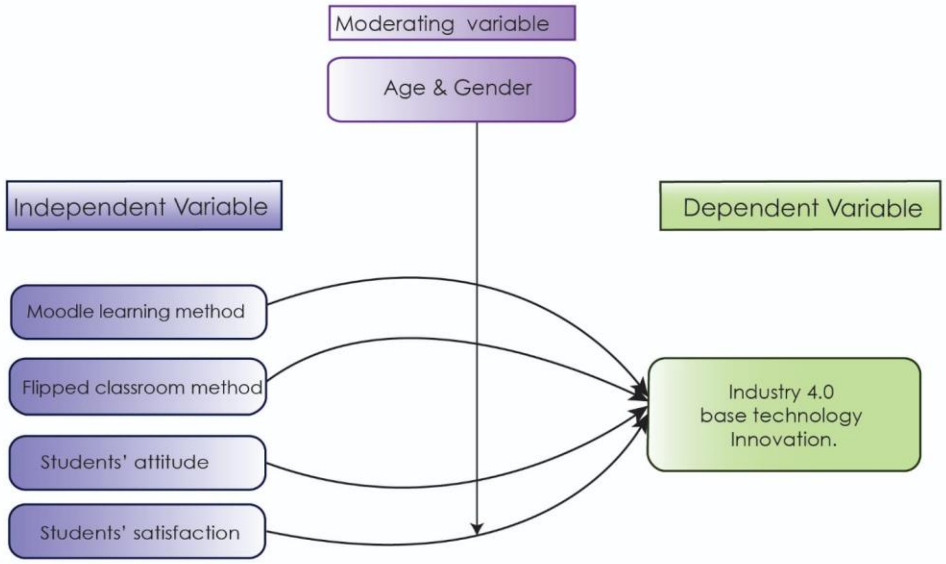


Figure 1

Figure 1 above shows the relationships between the dependent variable (Industry 4.0 base technology innovation) and the independent variable (Moodle learning method, Flipped classroom method, Students' attitude and Students' satisfaction) with the two demographic moderating variables (age, gender,) in the study.

Hypotheses

The hypotheses that will be tested are as follows:

H1: Technology innovation has a significant positive effect on learning using the flipped classroom method.

H2: Technology innovation has a significant positive effect on learning using the Moodle learning method.

H3: Technology innovation has a positive significant effect on student's attitude.

H4: Technology innovation has a significant positive effect on student's satisfaction.

H5: Demographic factors (age and gender) moderate the relationship between technology innovation and student's satisfaction.

1.9.Organisation of the Study

Chapter 2: Literature Review: This chapter highlights previous research done on fourth industrial revolution on the learning and education sector in South Africa. The strengths and limitations of previous study on fourth industrial revolution on the learning and education sector in South Africa will be discussed in detail. A parallel review and comparison of previous theories related to this research was also looked into.

Chapter 3: Research Methodology: This chapter gives a review of existing research methodology and also compares these theories. The research methodology chosen for data analysis as well as advantages and disadvantages of the chosen methodology in this case the quantitative method. Ethical considerations taken while the research was conducted was also included.

Chapter 4: Data Analysis and Test: This chapter focuses on data analysis, data presentation, and data interpretation. Charts, graphs, and tables are used to represent the data analysis and test results. The researcher focused on offering an in-depth insight by analysing the data findings with Microsoft Excel and SPSS software. The tests performed in this chapter include the normalcy test, the Cronbach alpha test for reliability, factor analysis, and correlation.

Chapter 5: Regression Analysis and Interpretation: This chapter is to analyse the data gathered for the research study in order to test the hypotheses and answer the research questions given in chapter one. This chapter summarises and interprets the research study's findings using the Statistical Package for Social Science (SPSS) software and Andrew F. Hayes' Process Analysis (version 3.2) to conduct a correlation and regression analysis in order to answer the research questions and hypothesis.

Chapter 6: Research Methodology: This chapter addresses the study's findings and conclusions based on the data that was examined, as well as whether or not those findings are compatible with those of earlier research addressed in the literature review. This section examines the findings in relation to the study's objectives, research questions, and hypothesis.

Chapter 7: Research Methodology: This chapter concluded the research study with a summary of the research, its objectives, and findings. It provides conclusions, recommendations and limitations.

Reference: All research references for the study are provided in this section

Appendix: All research instruments that will be used were displayed here (questionnaires).

1.10. Assumption

The assumptions underlying the study are outlined as follows:

a) **Technology Innovation in Tertiary Education**: It is assumed that technology innovation has a transformative impact on educational institutions, particularly in the tertiary education sector in South Africa (Maphalala et al., 2021; Mpungose, 2023; Lembani, 2020; Chisango et al., 2020). This assumption is based on the premise that technological advancements have the potential to revolutionize teaching and learning methods.

b) **Impact of Flipped Classroom Method**: The study assumes that the flipped classroom model, as a form of technology-enhanced learning, has a positive effect on student learning outcomes (Mandasari, 2021; Faith & Rahimi, 2022; Torres-Martin et al., 2022; Rathner & Schier, 2020). This assumption is supported by existing literature suggesting that the flipped classroom method promotes active learning and engagement.

c) **Effect of Moodle Learning Method**: It is assumed that the Moodle learning method, which leverages technology for online learning management, positively influences student learning outcomes (Ismail et al., 2020; Poondej & Lerdpornulrat 2020, Agustina et al., 2020; Kanetaki et al., 2021). This assumption is grounded in the belief that online platforms like Moodle provide opportunities for personalized learning experiences and collaboration.

d) **Influence on Students' Attitude**: The study assumes that technology innovation in education influences students' attitudes towards learning positively (AI-Rahmi et al., 2021; Sayaf et al., 2022; Jena, 2020; Nja et al., 2022). This assumption is based on the idea that innovative teaching methods and technological tools can enhance student motivation and engagement.

e) **Impact on Student Satisfaction**: It is assumed that technology innovation contributes to higher levels of student satisfaction with their educational experience (Susilawati et al., 2021; Gao et al., 2021; Prifti, 2022; Akter et al., 2020). This assumption is supported by the notion that innovative teaching methods and technological tools cater to diverse learning preferences and improve overall satisfaction.

f) **Moderating Effect of Demographic Factors**: The study assumes that demographic factors such as age and gender may moderate the relationship between technology innovation and student satisfaction (Sovacool et al., 2022; Ferreras-Garcia et al., 2021; Flavián, 2022). This assumption is based on the premise that individual characteristics may influence how students perceive and engage with technology-enhanced learning environments.

g) **Relevance of Findings for Sustainable Development**: It is assumed that the findings of the study will be relevant for policymakers and educators in South African tertiary institutions to develop a theoretical framework for integrating technology innovation into the curriculum. This assumption aligns with the goal of fostering sustainable development in education to prepare students for the challenges of the fourth industrial revolution.

h) These assumptions provide the foundational basis for the study's investigation into the impact of technology innovation on higher education institutions in South Africa, using both the flipped classroom and Moodle learning methods as focal points for analysis.

CHAPTER 2

LITERATURE REVIEW

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Introduction

The phrase revolution is a fascinating word that has seen significant variations in meaning and application over time. A revolution (from Latin revolutiononis = upheaval) is a stage in a nation's history that culminates in a sudden and significant (social, economic, and political) change in society, according to political science. In the past, the term "revolution" was used to describe a significant change in governance and political organisation in France and America. In the past, the word "revolution" had primarily a political sense. For example, Clark (2019) defines revolution as "the use of violence to bring about change in government, regime, and/or society." Later, in the 1960s, the word was coined to describe the world's economic ideological upheavals (Capitalism vs Communism). Rosenau (1964) defined revolution as any attempt to change state policy, rulers, and/or institutions through the use of violence in a culture where violent competition is not the norm and when well-defined institutional patterns prevail. Hegel (2017) posits, in a similar vein, that revolution is equated with irreversible change, as represented by a manifestation of the world spirit in its never-ending pursuit for its own fulfilment. In this perspective, Karl Marx claims that revolution is the product of unstoppable historical forces that culminate in a struggle between the bourgeoisie and the proletariat. The revolution, according to De Tocqueville (1955), was characterised by the overthrow of the legally formed aristocracy, ushering in a time of tremendous social, political, and economic transformation. The struggle for better economic and welfare policies for the poor in society, as well as the class war between the rich and the poor, were also reflected in these definitions.

Hopper (1950) divides the revolution into four stages of social development:

a) The first is characterised by mass dissatisfaction and unhappiness that is indiscriminate and unorganised.

b) This discontent crystallises into organised opposition with clear goals, with intellectuals swinging from incumbents to dissidents as a crucial component.

Two types of leaders arise at this stage: a) the prophet imagines a new utopia around which men's hopes can be directed, and b) the reformer works systematically toward specific goals.

(c) The revolution officially begins with the third step. Motives and objectives are formulated, an organisation is formed, and a statesman-like leader emerges. As a result, the left and right of the revolutionary movement have become increasingly split, with radicals displacing moderates.

c) The legalisation of revolution is the fourth and final stage.

Administrators seize power, a powerful central authority emerges, and society is reconstructed around a structure that integrates elements of the old system.

In a similar vein, Rahman & Iwan, (2019) stated that the term "revolution" has been used to characterise the global changes that have happened as a result of economic and technical achievements, and so the term "world revolution" can be used to describe a disruptive transition that affects all parts of human life. Kocdar, Bozkurt & Goru Dogan, (2021) posited that economic, imaginative, technical, organisational, and demographic forces can all force change, which can be managed in a variety of ways: positive or negative, voluntary or imposed, universal or partial, systematic, random, reactive, and gradual (Dean, 1993; Montana & Charnov, 2002). For the purposes of this research, we shall focus on technological innovation and the educational transformation in South Africa in the twenty-first century.

2.2.Industrial Revolution during the Ages

Stearns (2018b) argues that the industrial revolution has been the most significant transformation in human history over the last three centuries. The Industrial Revolution encompassed the utilization of machines, telephones, electricity, and various technological advancements. It had profound impacts on the social and economic aspects of society through changes in government policies and the allocation of goods and services. Vries (2008) defines the term "industrial revolution" as the shift from a pre-industrial to an industrial civilization, marked by a substantial and sustained increase in real gross domestic product per capita. Throughout history, three major industrial revolutions have occurred.

The First Industrial Revolution (1IR), as identified by Ionescu (2018), originated in the Middle Ages and extended until 1780. This period witnessed the expansion of canals, railroads, communication capabilities, and the emergence of the stock exchange, which facilitated banking, investment, and private enterprise. As seen in the work of Hague, Dickens & Hopkinson, (2006), while the United Kingdom played a central role in the 1IR, other European countries followed suit, experiencing significant transitions from low- to high-income status.

According to Allen (2009), he argued that the 1IR is credited with bringing Europe out of the Dark Ages and establishing its global dominance, marking a new era of civilization.

Taking place between the eighteenth and nineteenth centuries, the 1IR witnessed the transition from agrarian to mechanized activities. The introduction of the steam engine revolutionized manufacturing during this period (Hirschman & Mogford, 2009; Roberts, 2015). Europe and North America, in particular, experienced significant scientific advancements in steel, chemistry, electricity, and other sectors during the Second Industrial Revolution (2IR). The introduction of electricity enabled the expansion of numerous industries, facilitating mineral exploration. Kocdar, Bozkurt & Goru Dogan (2021), argued that a defining feature of the 2IR was the widespread use of machinery powered by electricity.

In the mid-nineteenth century, the Third Industrial Revolution (3IR) commenced, driven by advances in manufacturing, distribution, and energy (Roberts, 2015). This era witnessed the widespread adoption of nuclear power and electronic devices. Hirschman & Mogford, (2009) argued that the 3IR prompted global catch-up, with Europe being a focal point. Although technology progressed during the previous industrial revolutions, it did not evolve at the same rapid pace. In recent years, technology has undergone rapid development and implementation for various reasons, significantly impacting people's lives. Consequently, societies are now moving towards the Fourth Industrial Revolution (4IR). According to Miller et al. (2018), the 4IR refers to a society where individuals engage and interact digitally, utilizing technology to assist and regulate their lives. The 4IR revolves around the contemporary digital revolution.

The 4IR presents new opportunities and prospects for society, building upon the successes of previous revolutions. The twenty-first century brings forth numerous challenges that require creative solutions. The 4IR encompasses a range of emerging technologies characterized by fresh ideas, innovations, and breakthroughs, with the goal of breaking down barriers. Schwab (2016) describes the present revolution as being defined by a more pervasive and mobile internet, smaller and more powerful sensors, and the integration of artificial intelligence (AI) and machine learning. Mobile device usage skyrocketed around the turn of the century.

Schwab (2016) identifies gene sequencing, nanotechnology, renewable energy, and quantum computing as components of the 4IR. The 4IR extends beyond the mere use of smartphones or laptops, encompassing the convergence and interaction of these technologies across biological, physical, and digital realms. This ongoing progress marks the beginning of a new era of growth, development, and discovery, resulting in significant transformations worldwide.

Technology has been the driving force behind the world's four industrial revolutions, facilitating rapid expansion in both public and commercial sectors. The utilization of technology in recent years has given rise to a plethora of new concepts and ideas, taking center stage in today's era of rapid growth. These include virtual worlds, smart cities, big data, the Internet of Things (IoT), and artificial intelligence (AI). An overarching theme across these revolutions is the improvement of people's quality of life and the enhanced ease of conducting business and providing services.

In the corporate world, the term "Industry 4.0" is commonly used as another name for the 4IR. Hermann et al. (2016) define Industry 4.0 as a collective term for the technologies employed by organisations throughout the value chain. It places significant emphasis on the development of digital systems and the integration of networks through smart systems. In Industry 4.0, outdated methods that currently rely on human labour will be replaced by new technologies to perform tasks.

Overall, the industrial revolutions have played a crucial role in shaping human history and society. Each revolution brought about transformative changes driven by technological advancements, from the utilization of machinery and electricity to the emergence of digital systems and AI (Allen, 2009). As we move into the Fourth Industrial Revolution, the pace of technological development continues to accelerate, offering new possibilities, challenges, and opportunities for individuals and societies alike.

2.3.Education and the Industrial Revolution

Research have been conducted on the impact of the industrial revolution on schooling. For example, in their work titled Education 4.0 and Teachers: Challenges, Risk, and Benefits, George & Zoe (2020) investigated and captured teachers' viewpoints on the principles, benefits, and hazards of Education 4.0. They observed in their work that the role of education has shifted as a result of the Fourth Industrial Revolution, which has also impacted teacher expectations. In a similar vein, Butler-Adam (2018) observed that curricula, teaching, and learning – rather than robotic teachers – are one of the 4IR's implications for the education industry. To put it another way, education and training must be conducted across sectors. Students and educators from a wide range of backgrounds must be aware of the many factors that go into making the 4IR a success. Additionally, according to Dunwill (2016), instructors will no longer educate by themselves, but rather in partnership with other educators, education professionals, Parent and

Guardian Associations, local governments, and other groups. Teachers' changing roles in the classroom, according to Xing (2015), necessitate changes in their knowledge, skills, and attitudes. They must be able to serve as a mediator in the classroom, ensure that all students have access to a healthy, supportive and safe learning environment, and set both longer term and short-term learning objectives.

Beetham & Sharpe (2013) believe that digital technology also strengthens and develops relationships between instructors and students, as well as transforming teaching and learning. Finally, instructors agree that incorporating ICT into teaching and learning increases students' performance, motivation, and development of transversal abilities, according to a study done by the European Commission (2019).

Fisk (2017) defines Education 4.0 as having nine primary dimensions. To begin, learning can occur at any time and in any location due to the availability of e-learning resources. Additionally, it adopts a more personalised tone by allowing students to select their preferred mode of instruction (Dunwill, 2016). Additionally, students are more involved in the formulation of the curriculum, the design, and implementation of work plans, as well as in situations involving practical and experiential learning, mentoring, and teamwork. In this atmosphere, theory becomes practise, and students develop independence, the ability to reason logically, and the ability to make conclusions. Finally, the assessment is not conventional and may vary greatly depending on the situation and student.

Sary Silvhiany emphasised the importance of equipping students with critical digital literacy skills in her paper titled Critical Digital Literacies in Education 4.0: Preparing Students for the Uncertainties of the Post-Truth World. She emphasised the importance of equipping students with critical digital literacy skills so that they can effectively analyse and scrutinise digital content in order to discern fake from genuine information. While civic engagement requires critical reading, critical literacy means carefully sifting through the massive amount of content available in print and digital formats, displaying cohesive reasoning and the use of evidence. Through critical digital literacy, students are encouraged to inquire about "the sources of that information, the interests of its producers, the ways in which it represents the world, and the ways in which comprehension of these technological developments is related to broader social, political, and economic forces" (Buckingham, 2015). Additionally, Fitria et al. (2020) emphasised that traditional literacy focused on reading, writing, and mathematics must be bolstered with the development of new literacy in areas such as data literacy, technology use, and human resource management.

Students need digital literacy in order to develop the adaptive abilities needed to participate in the global digital society, benefit from the digital economy, and create new opportunities for employment and creative expression as well as social inclusion in the digital economy (Brown-Martin, 2017). Humanities and social science students must grasp artificial intelligence's underpinnings as well as how it operates, as Butler-Badat (2010) notes. Students in the basic and applied sciences must be conversant with the political and social climate in which they live and study in order to be successful. Xu, David, & Kim (2018) also found that teachers were concerned about integrating technology into the classroom due to a lack of resources, such as equipment, time, and assistance from colleagues. It was also shown that integrating technology into the classroom takes time by Legontis (2010).

The 4th Industrial Revolution is expected to bring personal and professional changes for everyone, including teachers, according to Alakrash & Razak (2018). The authors of Xing & Marwala (2017) state that teachers must strive to enhance their own performance as well as the performance of their students. For teachers to be ready for the rapid technological changes that are required, they must have the proper knowledge and abilities, as well as the exploration of their perceptions, attitudes and beliefs about the new context, according to Terrell & Lindsey (2009), educators must also be well-versed in current challenges and technologies, as well as the ability to adapt.

Additionally, Gray (2016) discusses instructors' capacity to handle globalisation, future strategies, and counselling, as well as their capacity to conduct comprehensive assessments, deliver modules tailored to students' interests, and produce new and authentic teachings (Xing & Marwala, 2017). Zinnbauer (2007) emphasised the importance of an international framework for navigating the fourth industrial revolution's educational transition. According to him, the development and dissemination of digital skills is a critical reference point for a wide range of national and international human resource education and training strategies. Workers' demands for specialised knowledge are expanding, which widens their information, communication, and interaction alternatives (OECD, 2020). Finally, they must be technologically knowledgeable and see that change is not always negative, but may also be constructive and beneficial. A critical ability for citizens in the twenty-first century is creativity, which is a framework, an approach, and a plan for resolving challenges (Kamal, Saad, Kok, & Hussain, 2018).

In a study titled "the Fourth Industrial Revolution's Challenges and Potential for Education," Kayembe & Nei (2019) used desktop research to analyse the Fourth Industrial Revolution's challenges and opportunities for the South African educational system. It is only a small portion of the issues facing South Africa's educational sector as a result of the Fourth Industrial Revolution, according to the research. Findings from the study states that the government should ensure that they invest adequately in the growth and development of the education system in other for them to take part or participate in the Fourth Industrial Revolution. The study recommended that the government should spend more time and money in infrastructure, human and financial development.

This study employed a desktop approach, which imposes limits on the ability to gather current information at the time of the investigation. Additionally, due to the fact that the research was done in 2019, certain changes in the South African educational sector may have occurred since the research was completed. Given the foregoing, this study will build on the previous study's findings and fill in some of the gaps.

Additionally, scholars have examined the fourth industrial revolution's effects on the labour market and skills. According to Hooker & Kim (2019), future technological advancements such as the AI revolution may have a more dramatic effect, replacing workers on a scale never seen before. This could result in a severe reduction in employment opportunities for a sizable segment of the population. On the other hand, numerous authors, researchers, academicians, and policymakers take a contrary position to the preceding argument. More so, it was argued that the new fourth industrial revolution will result in job growth. According to Jack Ma, each technology brings not only amazing jobs, new careers, and affluence, but also significant obstacles.

According to Panagiotopoulos & Karanikola (2017), the fourth industrial revolution has necessitated that various professional groups reassess their job profiles and equip themselves with skills that will enable them to meet the mental, physical, and emotional demands of the new labour market. To close these disparities in human capital education and training, both the public and commercial sectors will need to make significant legislative and systemic adjustments.

On a fundamental level, a citizen of the twenty-first century must possess basic talents such as numeracy, literacy, and basic computer skills. Adults, their families, and communities all benefit from these abilities, according to study, because they ensure increased socioeconomic and employment opportunities (UNESCO, 2016).

Future educational systems will be evaluated on their ability to prepare students for life in the twenty-first century, a world that will require a robust digital profile with skills in artificial intelligence, robotics, the Internet of Things, augmented reality, virtual reality, 3D printing, and smart factories, among other areas (Baruffaldi et al., 2020). The development of proper legislation, adequate learning and training, and the provision of necessary skills can all aid in the management of the fourth industrial revolution and its implications (Kemato, 2018). The modern world is sometimes portrayed as a complicated ecosystem of interconnections. Leaders require a holistic vision of changing global concerns in order to detect long-term opportunities and challenges that necessitate successful policy responses (Ghobakhloo, 2020).

2.4.Industry 4.0 for Sustainable Development

Every element of our lives is being affected by the Fourth Industrial Revolution (4IR). Four-dimensional integration (4IR) is being driven by the digital revolution and aims to design systems that benefit people while also safeguarding the environment. When it comes to 4IR and its educational applications (such as AI, robotics and the Internet of Things (IoT), big data, smart cities) some educators aren't sure whether they're hype or really useful. Examining how 4IR technologies are being used in diverse industries like business, social networking, manufacturing, and e-commerce can help establish their viability or failure. 4IR technology, including holograms and virtual interactions, is not a fantasy but a fact (Mavrikios et al., 2019; Pates, 2020). The 4IR's potential for education and fulfilling the Sustainable Development Goals has been recognised by developing countries (SDGs). The South Africa initiative of the Fourth Industrial Revolution has only recently begun in South Africa. More African countries are considering adopting the 4IR in order to become global superpowers, according to Ndung'u & Signé (2020). The following are quotes about the implementation of 4IR in society from notable individuals and organisations:

Executive Chairman of the World Economic Forum Klaus Schwab thinks that the fourth industrial revolution is a revolution. Value creation, exchange, and transfer between individuals, businesses, and countries as a whole have undergone a profound, far-reaching transformation (Schwab, 2019).

"One of our focuses will be to promote open access AI technologies that will foster local innovation," said UNESCO Director-General. Educational programmes will have to be rethought, with a heavy emphasis on technology, science, mathematics and engineering — but also on the humanities and philosophical and ethological questions (Ashworth, 2017).

The Fourth Industrial Revolution (4IR) in Africa: "The Fourth Industrial Revolution (4IR) has ushered in a new era of economic disruption and uncertainty, marked by the fusion of the digital, biological, and physical worlds, as well as the growing use of new technologies such as artificial intelligence, cloud computing, robotics, 3D printing, the Internet of Things, and advanced wireless technologies, among others."

2.5.The Fourth Industrial Revolution's (4IR) Characteristics

According to Erboz (2017), the components of Industry 4.0 are the Internet of Things, Cyber Physical Systems, Internet of Services, and Smart Factory. There are many characteristics and elements of the 4IR that are not limited to those listed above. Examples include AI, 3D printing, robotics, blockchain technology, cryptocurrencies, quantum computing, nanotechnology, and biotechnology. In the words of Skilton & Hovsepian (2018), these new technologies are reshaping the production and consumption of resources, goods, and services. The 4IR also emphasises the need of utilising modern information and communication technology (ICT). Information and communication technology (ICT) is widely employed in industry, government, and civil society. ICT activities make use of both computer software and hardware. Information and communication technology, or ICT, has become an essential aspect of all industries, including education, in the fourth industrial revolution (or 4IR) (Lee et al. 2018). Since the beginning of the twenty-first century, this has been the case.

2.5.1. Big Data

Big data is a term that refers to vast amounts of complicated data, both structured and unstructured, that cannot be processed using typical processing techniques and/or algorithms (Taylor-Sakyi, 2016). Big data is described as information assets with a high volume, a fast rate of change, and/or a high degree of diversity that require cost-effective and novel data processing methods to improve insight, decision-making, and process automation. Businesses may be able to benefit from big data platforms by analysing and making informed decisions about their data. As the globe continues to become increasingly connected, massive volumes of data are collected from a variety of devices. In order to uncover buried knowledge, these data must be analysed for future use. De Mauro, Greco, & Grimaldi (2015) claim that big data is being driven by the fact that students in South Africa and throughout the world have access to so much information at their fingertips.

2.5.2. The abbreviation AI refers to Artificial Intelligence

Artificial intelligence is a concept that dates all the way back to the 1960s. Computers' ability to perform complicated tasks is related to human intelligence; yet, AI possesses better intelligence and skills. According to Alsedrah (2017), artificial intelligence is an area of study that focuses on computers' capacity to learn and respond to certain behaviours in the same way that humans do. Machines are trained to accomplish things in the same way that people do using new computer algorithms and commands. Machines that are capable of reasoning, planning, remembering, and perceiving, all fall under the umbrella term of "artificial intelligence" (Perez, Deligianni, Ravi & Yang 2018). To put it another way, AI is a phrase used to describe computer software that exhibits characteristics associated with human intellect. Google, Siri from Apple and self-driving cars all use some sort of artificial intelligence. Computers are designed to accomplish specific tasks through the processing of vast volumes of data and the recognition of patterns in the data using cutting-edge technology. AI is crucial for educational advancement in today's ways of learning and teaching.

2.5.3. Robotics

Robotics is a branch of engineering that is based on improvements in mechatronics, electrical engineering, and computer science (Perez et al. 2018). The application of robots varies according to the environment. Robotics is deeply ingrained in businesses that rely significantly on machine-based production, such as automobile assembly plants. According to Karabegovi & Husak (2018), no industrial sector's production process is presently viable without the employment of industrial robots. Robotics contribute to increased productivity in a variety of industries. Numerous firms use robots to perform tasks judged too tough for humans to perform. According to Karabegovi & Husak (2018), the 4IR aided in the development of robotic technology by requiring leading countries to fully automate manufacturing processes or enable "intelligent automation." Businesses desire higher production, which necessitates the development of superior capabilities and intelligence in robots. As a result, new advancements and technologies are being developed in order to build robots that exceed their predecessors. Robotics can be used to train medical and engineering students in the educational sector.

2.5.4. Internet of Things (IoT)

With the advent of the Internet of Things in recent years, technology has improved (IoT). Consider a future in which numerous electrical gadgets, such as refrigerators, computers, television sets, and mobile phones, are all networked and connected to the Internet. This is made feasible via the Internet of Things (IoT). This Internet connection enables diverse devices to communicate with one another and exchange data (i.e., to share data). Gartner (2016) defines the Internet of Things as a network of physical items equipped with embedded technology that are capable of communicating, sensing, and interacting with their internal states or the external environment. The 4IR is centred on the digital interaction of machines and systems with one another (Karabegovi & Husak, 2018). To put it simply, as De Saulles (2017) argues, the Internet of Things has the ability to fundamentally alter how humans learn, work, and live.

2.5.5. Three-dimensional printing (3D)

According to Eisenberg (2013), we have entered the 3D printing era. Similar to the rise of personal computers in the late 1970s, the rise of 3D printing has parallels. Additive manufacturing, as defined by Chow-Miller (2018), is the process of creating solid three-dimensional items from digital files. This unique technology has been widely employed in a variety of industries for a variety of purposes, including medical, vehicle manufacturing for engineering students, and many more. Aeroplane components and human cell-based artificial organs are two examples of 3D printing applications. Although this technology has been around since the 1980s, it has undergone various revisions. However, the technology has only recently gained traction. 3D printing is a more efficient and cost-effective method of creating products.

2.5.6. Quantum Computing

An issue that would take billions of years on a traditional computer can be solved in a matter of days or hours using quantum computing, according to Microsoft (2019). Additional improvements in health care, energy, environmental systems and smart materials are also possible thanks to this technology. New scientific discoveries, life-saving pharmaceuticals, machine learning approaches for faster disease diagnosis, materials for more efficient gadgets and structures, and financial plans for a comfortable retirement are all possible thanks to quantum computers, IBM says. Education, according to Marshall (2016), "helps to define modern societies in part." In order to take advantage of the 4IR, governments must make substantial changes to their educational institutions in order to ensure participation in the digital society.

2.6.Education 4.0 for Sustainable Development

In the 4th Industrial Revolution, education has lagged behind technological progress. Most educational systems are still stuck in Education 2.0, rather than Education 4.0, despite the fact that cultures have advanced from the First Industrial Revolution (1IR) to our contemporary Fourth Industrial Revolution (4IR). Because of their geographical location, administrative structure, and lack of technological expertise and infrastructure, developing countries have not been able to fully profit from the preceding three industrial revolutions (Adhikari, 2020). In the 4th Industrial Revolution, small and emerging countries have the opportunity to use smart technology in a way that reduces the gap between industrialised and developing countries. In remote places, 4IR technology may be used to ensure that all children have access to an education, regardless of their socioeconomic condition. As an example, unmanned aerial vehicles (UAVs, or "drones") can be outfitted with servers that hold curriculum and learning management systems, allowing students to access learning materials via mobile devices with wireless capability. Rather than providing education to students, countries should use innovative technologies and pedagogical approaches to bring education to students (i.e., physical schools). In order to meet the SDGs, the next generation of educational systems must embrace the "benefits" of 4IR technology (Rubin & Brown, 2019). There are many global educational goals that AI can help fulfil as part of SDG4: Ensure inclusive and equitable quality education for all and promote opportunities for lifelong learning for all. (Vincent-Lancrin & van der Vlies, 2020). An educational system that incorporates 4IR technology and personalises instruction for all citizens, regardless of geography or status, is the goal of Education 4.0. (Ally & Wark, 2019; Qi, 2020; Salmon, 2019). It is possible to learn from the comfort of one's own home or office, rather than having to travel to a classroom or lecture hall. For example, students need to learn on their own through the Hole in the Wall Project (Mitra, 2014). Researcher is looking towards "hole in the cloud" solutions that leverage technology in order to allow pupils to access cloud-based learning resources. As a result of the extensive availability of free educational resources, this is becoming increasingly feasible (OER).

Kyllönen (2019) argues that the Western world, which has been characterized by an industrial era marked by mass manufacturing and highly specialized employment, requires a new educational model. In the past, when technology from the Spinning Jenny was prevalent, individuals were primarily required to exhibit obedience and possess basic manual skills. However, the current era necessitates a change from this outdated approach. Despite advancements, the architecture of school classrooms has largely remained unchanged, underscoring the need for innovation in education.

A number of industries, including e-commerce, finance, government, business, manufacturing, and health care, are making use of 4IR technology to enhance and expand their offerings to citizens. New technologies are being used by the education industry to deliver flexible and individualised learning in order to meet the Sustainable Development Goals.

Learning and teaching materials can be tailored to each student's needs, according to Vincent-Lancrin & van der Vlies (2020). For students, personalised learning means personalising lessons to their own needs and strengths. Individual students' data can be used to locate acceptable instructional resources and methodologies, and to forecast, recommend and make judgments about the next steps in the learning process (Rossi, 2019).

Schools in developing countries are turning back to an industrial-era school system that is out of date for the twenty-first century, when knowledge is readily available online and new generations of pupils are familiar with modern technology. According to Rubin & Brown (2019), a majority of stakeholders feel that our current educational system does not adequately educate students for today's difficulties and prospects, much less those of the future. They suggest that a fundamentally different strategy is needed to minimise achievement inequalities and prepare all students for jobs and future difficulties in our rapidly changing communities.

Constrained by bureaucratically organised twentieth-century institutions, Berry (2020) claims that today's educational system is constrained by these structures.

Brick-and-mortar, bureaucratically organised, factory-inspired schools are being replaced with virtual schools that can be adapted and customised for personalised virtual learning. Virtual learning is viable, but educators need to be trained to adapt to the new educational paradigm of Education 4.0. E-learning, which began in the early years of this century, is rapidly expanding into artificial intelligence (AI), wearable technology, and a race toward technological singularity (Ally & Wark, 2019). E-learning content has been democratised in a degree that has never been seen before. Free and open educational content (also referred to as OER), which includes anything from curriculum to lesson plans to a wide range of educational possibilities, such as Massive Open Online Courses (MOOCS), syllabi, and books, is becoming more and more prevalent. Rubin & Brown (2019) summarized the industrial revolution in the Table 2.1. below.

1IR 1750–1900	2IR 1901–1960	3IR 1961–2000	4IR 2001–Present
• Steam engine • Mechanical systems	• Combustion engine • Mass production	• Large computers • Micro-computers	• Artificial intelligence • Robotics • Internet of Things
1st Education Revolution	2nd Education Revolution	3rd Education Revolution	4th Education Revolution
• Small classrooms (20–30 students) • Use of blackboard	• Larger classrooms (30–40 students) • Use of blackboard and whiteboard	• Larger classrooms (30–800 students) • utilising a whiteboard, a blackboard, overhead projectors, and the Internet	• In the fourth industrial revolution, education will have to be reimagined.

Table 2.1. Industrial revolutions and education revolutions.

2.7.The History of Higher Education

Education has gone from elite to mass and then post-mass in the way that may be seen.

2.7.1. Elite

With its roots in monastic schools beginning in the sixth century, higher education has a long history that began with the mediaeval European university, which was founded at Bologna in 1088, and evolved into today's higher education systems. In the past, universities were primarily educational institutions, but they have since expanded to include research and, finally, community service (Ally & Wark, 2019). In the past, university education was only available to a small number of people. Historically, the goal of higher education was to mould the aspirations of the upper class.

2.7.2. Mass

The late twentieth century's massification' trend began as a reaction to this tension between education as a private right and a public good. This time period has seen a significant transition in everything from system size and shape to curriculum designs, organisational structures, teaching styles, delivery methods, research patterns, as well as interrelationships between institutions and outside groups (external communities). The primary objective of public higher education has always been to facilitate the transfer of knowledge and prepare students for a wide range of career opportunities in both the private and public sectors.

2.7.3. Post-Massification

Various forms of higher education have emerged, including the elite, the mass, and the post-massification kind. The tertiary participation rate in many developed and developing economies is greater than 50%. Students and teachers are becoming increasingly globalised as a result of this trend (Ally & Wark, 2019). Students from around the world are expected to travel more than 8 million miles a year by 2025 because of demographic shifts (Ally & Wark, 2019). Many students from Sub-Saharan Africa are studying in South Africa at the moment, with the bulk studying in Europe and the United States. At the time, numerous countries' primary objective is to adapt their citizens to rapid social and technical development (Ally & Wark, 2019).

2.8.Higher Education and the Fourth Industrial Revolution

Education and society are sometimes depicted as having a one-way relationship, with education expected to conform to political and economic trends rather than standing in opposition and expressing something distinct. We can project future higher education in the context of the fourth industrial revolution because we have such a broad understanding of the relationship between education and socioeconomic systems, as well as what the educational position means (Berry, 2020).

In a world where the Internet, cloud computing, and social media have transformed the landscape of formal education, there are both opportunities and challenges for institutions of higher learning (Ally & Wark, 2019). Universities are grappling with uncertainties about their own prospects, most notably employment, as students make preparations for life after graduation. Concepts like "post-work" are becoming more common as artificial intelligence-driven technologies continue to revolutionise the world. New talents are needed in this period compared to the third industrial revolution that was driven by information technology (Aoki, 2020). Examples of these skills include people management and emotional intelligence as well as judgement, negotiation, cognitive flexibility, and knowledge management and development. This section will focus on three current megatrends and how they are affecting the world today:

2.8.1. Fundamental Categories of Megatrends in a Higher Education Institution

Regardless of one's age, higher education's core goal remains the same. The purpose of higher education is to give students with access to cutting-edge information through research and service, as well as to provide high-quality learning for students.

- **Teaching**

One of the most crucial functions of every university is education. As a result, effective teaching tactics must be implemented, and work must be organised in such a way that learning is encouraged (Berry, 2020). This has implications for adaptable learning programmes, enhanced learning experiences, and a lifelong thirst for knowledge.

- **Research**

Higher education institutions must devote a significant amount of resources to research and development in order to compete on a global scale (R&D). Experts have emphasised the impact of innovative technology deployment for global cooperation and collaboration.

- **Service**

To remain competitive in the global higher education system, we must significantly improve educational services. Education must be pushed to become more inventive and competitive.

2.8.2. Teaching in the 4IR Era

Since these advancements are so rapidly changing all aspects of our lives, including education, it is critical for countries to understand the impact they have on all aspects of our lives, including education, given their pace and scope.

Wearables aid in the teaching, learning, and training of students.

Another technology is on the way, based on the large number of wearable devices on the market. In the future, wearables could revolutionise the way we teach and train our students, and how they learn. To realise this promise, educational institutions must move promptly. Engineers can utilise numerical simulations to analyse and forecast the actual state of physical systems. As cyber-physical systems become the new norm in the fourth industrial revolution, numerical simulations are becoming more and more significant in both classrooms and in the real world. Finite element analysis (FEA) is a versatile numerical simulation approach that has been used to a wide range of engineering applications, including building analysis (Marwala et al., 2017). Computers are frequently employed in modern FEA, according to Ally (2019). As a result, students will have a better grasp of fundamental ideas, and engineers will be able to undertake complicated modelling and interpret the findings more simply. However, such a design has constrained the FEA procedures in a fully virtual and offline environment (Aker & Herrera, 2020). Many physical traits are lost to human perception as a result of these limits. Some wearable technologies, such as augmented reality (AR), are advancing to the point where they can increase a user's sense and engagement with the physical environment, resulting in a virtual laboratory. Augmented reality can make it easier to explore and analyse outcomes by overlaying computer-generated information on top of a real-world scene.

Take advantage of huge open online courses (MOOCs)

To attend a lecture, students had to gather in a large lecture hall, or sit at a table with their classmates for a lengthy debate. On the other hand, technological advancements are breaking down these barriers and bringing about a paradigm shift in higher education. It is a type of online learning that delivers stand-alone training through Massive Open Online Courses (MOOCs) (Xing, 2015). Although more innovation is on the way, MOOCs nevertheless pose a danger to institutions in a number of ways. Physical proximity and productivity limits are two of the most important factors in determining a university's costs (Aker & Herrera, 2020). Increasing the number of students is costly, especially when facilities and teachers are added, because of the necessity for physical proximity. When classroom capacity and exam-marking rosters reach capacity, there is a limit to how many students may be accommodated. Off-campus and online courses are able to overcome these challenges since they are taught by extra students once they have been set up online.

Developing creative talent

Lack of innovative talent is a major problem in the majority of developing and disadvantaged countries. It is essential for a country's higher education system to focus not just on teaching knowledge-based competent people but also on cultivating imaginative talent, particularly high-level scientists and technologists. (Ellahi, Ali Khan, & Shah, 2019). In order to properly educate them, these scientists need to be educated in an interdisciplinary setting where humanities and social science professors teach technologists.

Learning that is a combination of traditional and non-traditional methods

Higher education students should study microeconomics because it has both social and practical ramifications (Marwala, 2013; Marwala, 2014; Marwala, 2015). The majority of its ideas, on the other hand, are highly abstract, making studying them difficult for students. Concepts are frequently isolated without a clear understanding of the links between each piece of information and the overall picture. Students are only able to recognise portions of the system as a result of this learning process, and their comprehension of how it works as a whole is blocked. If you are going to teach microeconomics, one of the most important things you can do for your students is to help them develop conceptual understanding, which can be used to a wide range of other courses as well. We believe that a generic blended learning strategy (i.e., one that integrates both online and classroom training) can be beneficial in this regard (Ellahi, Ali Khan, & Shah, 2019). Communication via real time (e.g., video conferences) or virtual settings with people who are not present at the same time has long been recognised for its educational potential (e.g., forums and chats). With this method, students can improve their analytical expressions and problem-solving abilities within the mathematical disciplines through direct instruction and evaluation in a classroom setting. Multiple-choice test questions and online graphic representations help assess and reinforce students' understanding of several fundamental conceptual topics. giving teachers the advantage of assessing their results instantly. Teachers can now receive tactile feedback on how well their information is being conveyed to students (Ellahi, Ali Khan, & Shah, 2019).

Higher education systems should embrace these new technologies and teaching methods instead of fighting against them in other to improve the educational experience for students as well as faculty members.

2.8.3. Research in the 4IR Era

a. Open Innovation

When humans and computers work together to create distributed systems, they are able to achieve new tasks that neither could accomplish on its own. Wikipedia and other early achievements show that open innovation can model and solve wicked issues including economic, environmental, and socio-political systems in a more comprehensive way than ever before. An example of an open innovation process is as follows: For more information see (Grimus, 2020):

- Micro-tasking is a type of crowdsourcing that combines the strengths of humans and technology.
- Crowd-workers are guided by pre-defined workflows in order to utilise and augment the information provided by previous phase employees.
- This combination of human and machine cognition can be used to design problem solving ecosystems that can represent the complex, linked systems that underpin the world's most challenging tasks.

b. Innovations that are both evolutionary and revolutionary

Higher education in a country's fourth industrial revolution is a major factor in its success and each country must place a premium on innovation, both evolutionary and revolutionary. By and large, evolutionary innovations are concerned with existing technologies, whereas revolutionary innovations are concerned with new technological inventions. While hybrid innovation is a solid strategy in theory, it is challenging to implement (Grimus, 2020). Academics who have established a reputation are frequently victims of their own success. For leading academics, exploring new research domains that could result in incremental research output growth has long been a success. Emerging researchers have adopted a similar method with zeal. As a field of study grows and competition increases, the proportion of research results published in patents or journals will necessarily fall. Developing new research directions entails competing with established adversaries (Xing & Marwala, 2017). In the fourth industrial revolution period, higher education must intensify its technological system changes by eliminating all barriers to innovation. Allocating resources to distinct research programmes is a substantial roadblock. Institutional and government assistance should be made accessible for technical developments that are critical for industrialization, re-industrialization, and neo-industrialization but are unable to generate revenue in the near term. On the other hand, social capital can be critical in applied technologies that are commercially viable (Xing, 2017). Additionally, a number of additional impediments must be adequately addressed: To begin, practitioners in higher education must adopt a global viewpoint in order to successfully implement its hybrid innovation strategy. Recognize the global trend in technological progress and make appropriate strategies in response. Each stream of innovation resources should be properly leveraged on an internal, local, regional, and global level. Second, because diverse departments have distinct development goals and incentive structures, their connectivity should be enhanced to avoid potential overlap. Thirdly, to accelerate economic and social progress, the rate of technology transfer must be accelerated.

c. New Technology Driven Research and Development

The primary driver of research and development is typically cited as new technology developments (Ellahi, Ali Khan, & Shah, 2019). Technology-driven research and development can take a variety of forms, including leveraging mobile capabilities to increase data acquisition accuracy, utilising advanced big-data analytics to uncover hidden statistical patterns, and retooling information search, collection, organisation, and knowledge discovery with artificial intelligence techniques, to name a few (Buckenmeyer, 2010). Finally, modern technology can be put to use to a wide variety of fields in order to continue to make an influence. It can be summarised as follows: cost and time savings, operational transformation, process improvement, and, most importantly, research direction innovation through the invention of new ideas or theories can all be facilitated by advanced technologies in higher education (Cook, 2019). Take additive manufacturing as an example (or 3D printing). For instance, this new technology can be utilised to lower the cost of prototyping, which is often inefficient and time-consuming in traditional higher education research and development. This advancement results in significant cost reductions and increased experimentation flexibility, enabling the technology to be employed in locations where it was previously prohibitively expensive in the laboratory. In the fourth industrial revolution, research and development processes employ advanced technologies to view functions such as information technology and analytics as "centres of value" rather than "centres of service or cost," to foster a collaborative mindset, and to increasingly develop an agile R&D style (Cook, 2019). Shifting higher education's research and development culture away from an antiquated "waterfall method" to idea development is a critical and tough task. Institutions of higher education that make this move will strengthen their capacity to absorb information from a range of sources.

d. Reduce Innovation Cycles

Typically, new technological advancements are cited as the primary purpose for R & D. Consider the following examples of technology-driven research and development: enhanced mobile capabilities to increase data capture accuracy, enhanced big-data analytics to uncover hidden statistical trends, and retooling information search, collection, organisation, and knowledge discovery with artificial intelligence approaches (Kyllönen, 2019). Finally, contemporary technologies can be applied in a variety of industries to maintain influence. In a nutshell, innovative technologies can benefit higher education research and development in different ways which include: cost and time savings, operational transformation, Research & Development process optimization, and, most importantly, innovation in research direction through the development of new ideas and theories. Take additive manufacturing for example (also known as 3D printing). Prototyping, which is frequently inefficient and time-consuming in traditional higher education research and development, can be decreased with this new technology (Dingli & Montalto, 2020). This innovation leads in significant cost savings and more flexibility in experimental design, enabling the technology to be used in places where it was previously prohibitively expensive in the lab. R&D procedures of the fourth industrial revolution make use of contemporary technology to view information technology and analytics as "centres of value" rather than "centres of service or expense," to foster a collaborative attitude, and to increasingly foster an agile R&D style. One of the most critical and challenging challenges is to alter the culture of higher education research and development away from the traditional "waterfall approach" to idea development (Dingli, & Montalto, 2020). Higher education institutions that successfully shift to this model will improve their capacity to absorb information from a variety of sources.

2.8.4. Service in the 4IR Era

University-as-a-Platform (UaaP)

We are all familiar with the decline of Blackberry. One of the most frequently cited causes is the Red Queen effect, which forces you to run faster in order to maintain your current position. In such a scenario, a single competitor that successfully executes a platform-based strategy can significantly reduce the innovation life cycle of an entire industry (Holmes, Bialik, & Fadel, 2019). It becomes more difficult for a challenger to overtake the dominant player as a result of the Red Queen effect. This event is referred to as escalation in systems thinking. Platform concepts are already reshaping the competitive landscape, pitting ecosystems against ecosystems. Education, ubiquitous computing, and the Internet of Things, as well as students' increasing need for personalised instruction, all contribute to the continuous shift in Service 4.0 toward platform-based competition (Mavrikios el al, 2019). In platform-based ecosystems, what works well in scientific specialties and niche markets may be a problem. It is necessary to alter one's strategy in order to run a business in higher education that is built on a platform. In the non-education sector, Facebook, Alibaba, WeChat, eBay, and Google. As a result of this platform-thinking strategy, both Amazon and Baidu are aggressively expanding their respective empires. As a result of platform-centric techniques enabling innovation in previously unimagined areas including automotive, manufacturing, fashion, healthcare, and publishing; platform thinking is not new. According to the philosophy of platform-based business models, biologically inspired thinking is prioritised over traditional organisational reasoning. For universities, this means taking a larger view and using analogies and analogical metaphors to build service architecture, rethinking their business models, redefining their competitive advantages, and restructuring their customer bases. When universities become platforms, they can outsource more of their core functions to platform companies, thereby improving the quality of their services (Holmes, Bialik, & Fadel, 2019). UaaP success hinges on many factors, including the growth of the Internet of Things, the incorporation of normal educational activities into software across a wide range of institutional systems, the use of already existing digital infrastructure, and increased connection.

Education-as-a-Service (EaaS)

A disruptive new technology emerges approximately every two decades during the fourth industrial revolution and has a profound impact on the structure of several sectors. There has been a shift in higher education due to the widespread availability of low-cost mobile devices, high-speed Internet connections, and a wealth of educational resources. A new form of education may be enabled by cloud computing, among other things, and this could represent a threat to currently established higher education systems (De Mauro, Greco, & Grimaldi, 2015). Government decision-makers and business practitioners can use the education cloud to answer a variety of critical strategic questions, including efficient, successful, and cost-effective methods for delivering education how to best help students acquire the abilities they will need in the modern workplace; how to maximise incentives for indigenous innovation while also delivering quality education (Microsoft, 2019). A lot of time and money is spent on marketing campaigns and infrastructure expenditure when colleges consider implementing EaaS in their operations. Students are more important than disruptive modalities of education delivery to EaaS, which places a higher value on them than academics do. EaaS is built around the idea of successfully serving the needs of students. It is (Morgan, 2017). Higher education institutions must therefore provide an all-encompassing educational experience capable of meeting the customer's expectations in order to recruit potential students as customers. However, this process is not as straightforward as it sounds. When it comes to EaaS, it's not about pretending to be something it isn't or making vague claims in a language that's difficult to understand. Among the many stakeholders that higher education institutions have to answer to are the government, accrediting organisations, public and private funding sources, faculty, administration, and support staff. An EaaS approach that yields a successful educational strategy will deal with these more important challenges (Mavrikios el al, 2019). Despite this, many organisations are still implementing ineffective EaaS strategies by ignoring a wide range of stakeholders and instead focusing on the bottom line. Over the past few decades, there has been a tremendous advancement in both education and technology. Teaching methods that make use of technology are becoming increasingly complex. With the increasing complexity of society, EaaS as a guideline must look for newer and more advanced solutions in Service 4.0.

Internationally connected programmes

Acquiring a wide range of academic and professional credentials has become increasingly important as the fourth industrial revolution continues to advance at an accelerating pace (Nordin & Norman, 2018). Consider the following plans, which have been deemed worthy of attention: With this in mind, there are twinning programmes that allow students to transfer credits from one school to another. A certificate from a foreign education provider is given to students who successfully complete the twining programme. As a second type of partnership, international education providers authorise a local educational institution to provide their courses or programmes, with the foreign education provider approving the programme. As a final point, a double or joint degree is an arrangement in which domestic and overseas education providers come together to deliver a combined or individual degree programme. As a final category, blended learning, wherein local and foreign education providers provide programmes in a variety of hybrid formats, such as e-learning, online learning, and classroom instruction.

2.8.5. Educational Challenges in the Age of Technological Advancement

The 4IR poses its own set of dangers as a result of the development and deployment of new technology. Prudent planning is essential to mitigate these dangers. Additionally, it will be necessary to implement new risk management systems and processes. This demonstrates the potential for emerging technologies to improve people's lives (Perez, Deligianni, Ravi, & Yang, 2018). However, the dangers and unintended repercussions of these new technological advances should not be underestimated. The first concern posed by the 4IR for education is inequality. Inequality and unequal wealth distribution are pervasive in South Africa. Social problems including high crime rates, gender violence, and unemployment are more common in unequal societies.

Equality is an issue in South Africa's education sector, and new technological breakthroughs could help. Perhaps only the wealthiest people in society will have access to new educational tools, leaving the rest of us behind (Perez, Deligianni, Ravi, & Yang, 2018). This may be seen in the past three industrial revolutions. Clean water, reliable transportation, power, and the Internet are some of the basic needs of many people today. Discrimination and distrust are exacerbated as a result of widening the gap between the "haves" and the "have nots."

2.8.6. Implications of the 4IR for Education in South Africa

It's imperative that any 4IR education plan expands on the creations of educational resources for use both in person and virtually by 3IR. It's an exciting and confusing opportunity for education in the fourth industrial revolution (HE 4.0) that has the potential to change the world. The 4IR has a wide-ranging impact on many other aspects of our lives. Both educational opportunities and obstacles are created as a result. IoT, 3D printing, quantum computing, and artificial intelligence (AI) can be combined to meet new difficulties in the education industry.

Curricula, instruction, and learning — not robot instructors – are some of the repercussions of the 4IR in education, according to Butler-Adam (2018). To put it another way, education and training must be conducted in conjunction with individuals from other fields. The 4IR emphasises an interdisciplinary approach to problem solving, in which the humanities and social sciences work together with technology to solve complex issues. Biotechnology and artificial intelligence breakthroughs are challenging long-held beliefs about humanity's interaction with the natural world. Liberal arts programmes should be developed to compensate for the social dislocations generated by the 4IR. By and large, the 4IR curriculum should address the political and societal challenges that have evolved as a result of technological innovation's rapid pace (Penprase, 2018).

As a result of the proliferation of online education and the increasing use of artificial intelligence in educational settings, it is imperative that new guidelines be developed to serve as a theoretical foundation for digital pedagogy (Penprase, 2018). Students need to be taught the skills necessary to become digitally literate in order for them to be able to take part in the global digital society, reap the benefits of the digital economy, and increase their options for careers, innovative expressions of their creativity, and social inclusion (Brown-Martin, 2017).

The educational system's impact must be considered in any digital education strategy. It's a baffling situation. It's possible that a lack of preparation and investment in resources could have an impact on the quality of graduates (Marshall, 2016). When it comes to evaluating quality, education is particularly vulnerable to stumbling blocks (Marshall, 2016). As educational change and strategy grow increasingly contested, it becomes increasingly difficult to conceptualise and operationalize quality metrics, performance indicators, and educational outcomes (Marshall, 2016).

Research and development (R&D) is generally fuelled by new technology developments (Xing & Marwala, 2017). Technology-aided research provides a wide range of advantages. Mobile capabilities, advanced big data analytics, and artificial intelligence techniques are all examples of technology-driven research and development that can be used to improve data acquisition accuracy, uncover hidden statistical patterns, and retool information search, collection, organisation, and knowledge discovery. In addition, the 4IR must be successfully applied in education if it is to succeed. Technology and the people who use it necessitate specific skills and abilities (Butler-Adam, 2018). To get the most out of modern technology, it is essential to possess the required skills. Gray (2016) estimates that about 35% of the important skills needed for today's jobs will be obsolete within the next decade. Because of this, a new set of skills will be needed for the new revolution and the application of new technologies. Consequently, People in sales and manufacturing, for example, will require a higher level of technical knowledge (Gray, 2016). Existing jobs (such as toll booth operators) will be supplanted by new technology while new jobs (such as social media professionals) are created (Nordin & Norman 2018).

There may be moral and ethical ramifications to consider as well. People's lives have been influenced by technology in a variety of ways. There are several dynamic changes taking place as a result of the widespread use of contemporary technology by businesses, governments, and other sectors of our daily lives. Hooker & Kim (2019) believe that advances in technology, such as the AI revolution, could lead to even more extreme outcomes, such as workers being replaced on an unprecedented scale. It's possible that a large portion of the population could lose their jobs as a result. In contrast, a large number of authors, researchers, academics, and politicians disagree with the aforementioned assertion. The new revolution, on the other hand, is predicted to create more jobs. It's generally agreed that widespread usage of technology will lead to job losses in the present and future.

In certain sectors, machines have clearly taken control of the power structure. It is uncertain who is to blame for the loss of labour and jobs created by new technology such as robotics, whether the government or enterprises. Concerns have been expressed about the human cost of emerging technology. Academics place a premium on ethics. As more educational materials become available and accessible, it is critical to emphasise ethical limits in order to establish ethical principles in students (Nordin & Norman 2018). The specific sociological consequences of the 4IR remain unknown. Certainty exists around the fact that education must rapidly adapt to the advent of technological innovation (Penprase 2018).

2.8.7. Opportunities for Technological Advancement in Education

Universities need to foster an environment that encourages students to think outside the box and come up with new ideas.. It's not just education that's been disrupted in the United States, but also the entire education system worldwide. The 4IR provides educational institutions in South Africa with the opportunity to create a culture of creativity and innovation. In the 4IR STEM curriculum, new methods to science, technology, engineering, and mathematics (STEM) should be reconsidered. New courses should stress 4IR collaborative abilities in addition to 4IR literacy. Furthermore, in order to build new interdisciplinary science programmes, educational solutions to 4IR demand institution change (Penprase 2018).

Technology, according to Chetty & Pather (2015), can be used to alleviate concerns of social exclusion. To put it another way, new technological advancements can help close the gap between the rich and the poor, as well as between races. Educational institutions can collaborate with other stakeholders, including as the government and commercial enterprises, in a 4IR worldview. In order to better understand the Fourth Industrial Revolution, South Africa's president has enlisted the help of specialists from several educational institutions. Private corporations like IBM, Microsoft, and others have pushed towards the 4th Industrial Revolution. These companies and stakeholders can work together on R&D projects. Furthermore, educational institutions in South Africa might collaborate with those in other countries. There has been a lack of innovation and creativity in South Africa's educational system, according to Rodny-Gumede (2019). The 4IR's educational success hinges on the development of their creative potential. R&D's success and expansion can only be achieved if innovation is encouraged and creative potential is nurtured. To maximise the benefits of new technology developments, governments must invest extensively in research and creative university curricula in partnership with higher education institutions. When it comes to enhancing education in South Africa, Meyer & Gent (2016) suggest the following measures:

- Firstly, to achieve sustainability in the long-term, the educational system's ability to integrate ICTs in support of education must be increased.
- Secondly, attention must be shifted away from grades and instead focus on building students' capacities.
- Thirdly, a tiered strategy is required, with appropriate interim goals.
- Lastly, as progress is made, it should be assessed using a variety of criteria, with a special emphasis on how well the system and teachers can utilise new technologies to enhance the teaching and learning experience.

It's important to focus on pedagogy, boost instructors' confidence, and move from pilots to integrated solutions in order to make progress. To meet the demands of the Fourth Industrial Revolution, institutions must constantly evaluate their management systems, self-awareness, procedures, and technology (Marshall, 2016).

2.8.8. Challenges of 4IR and Education in South Africa

Education and technological advancement have been highlighted in a variety of government and private sector plans, including the White Paper on e-Education from 2004 and the National Development Plan. Accurate and timely evaluation of educational achievements; Identifying which teachers need pedagogical help and;

- providing instructors and students with new 21st-century skills;
- Access to practise groups and instructional resources on the Internet;
- increasing student-centeredness, novelty, and enjoyment of learning;
- encouraging critical thinking and the discovery of new ideas;
- lowering administrative costs associated with test marking and absence reporting (Meyer & Gent 2016).

Funding is a major hurdle to successfully implementing the Fourth Industrial Revolution in South African education. However, despite recent increases in educational budget, it is still insufficient to allow educational institutions to operate fully Among other things, it has led to greater university tuition and a decrease in research funding. While increasing their investment in new technology, educational institutions must also prioritise where their funds should be spent. An educational institution's budget must be large enough to accommodate the introduction of new technology. Academics and technical infrastructure are the most expensive components of training a large number of people (Brown-Martin, 2017).

Some socioeconomic groups will be excluded from participating in the 4IR due to this issue in the education sector. According to Badat (2010), the number of African and coloured students enrolling in South African colleges has increased since 1994, yet the gross participation rate of black South Africans remains substantially lower than that of white South Africans. Universities are seen as having a responsibility in promoting social justice and fostering an equal and equitable environment in order to reverse the harmful effects of apartheid (Chetty & Pather 2015). A whole new set of abilities is needed to succeed with 4IR technology. According to PwC (2017), 4IR technologies and applications usually necessitate a combination of specialised knowledge and basic computer literacy. Universities are leading the way when it comes to increasing one's knowledge and abilities. A lack of access to these specialised skills is a result of exclusion from schools. National Education Collaboration Trust (NECT) researchers Meyer and (2016) did study on the state of education and technology in South Africa. According to their conclusions and findings, education and technical advancements were:

- Despite the fact that a plan and policy are in place, implementation is slow and capacity is limited.
- There are no clear goals, and no system-wide strategy is in place.
- Provinces and quintiles have different levels of access to technology.
- Solutions providers are driving the progress because there are no coherent provincial plans in place.
- When building solutions, resources are not taken into account.
- On various levels, there is need for reform in the educational system.
- Change management at the system level must be prioritised, and ICT-assisted assessment must be considered (Meyer & Gent 2016:1).

2.9.Theoretical Framework

The study is based on different distinct theories of technological acceptance. Numerous theories have been advanced to account for customers' adoption of new technologies and their intention to utilize them. These included, but were not limited to, the 1960-based Theory of

Diffusion of Innovations (DIT) (Rogers, 1995), the Theory of Planned Behaviour (TPB) (Ajzen, 1991a), Magout's (2020) Engagement Theory, the Technology Acceptance Model (TAM) (Davis, Bogozzi, & Warshaw, 1989), and the study's underlying Unified Theory of Acceptance and Use of Technology (UTAUT) because it is a good fit for analysing the complexity of the fourth industrial revolution (technology innovation) as experienced by educational stakeholders. Nevertheless, UTAUT theoretical model focuses on the use of technology in understanding human behavioural intention and is reliant on the influence of four important concepts which are; social influence, performance expectancy, effort expectancy, and facilitation condition which support the overall concept of this research study.

2.9.1. The Theory of Diffusion Innovation

According to Rogers (1995), study on the acceptance and adoption of new ideas can be built on the premise of 'diffusion of innovation'. Rogers developed the 'diffusion of innovation' hypothesis to explain how new ideas spread throughout an organisation and the general population. Using this idea, you may understand "the process by which an innovation gets disseminated through time among the members of a social system" (Rogers, 1995, p. 5). Diffusion, in its simplest form, is the process through which members of a social system transmit an innovation over time via certain channels. After a series of stages, including understanding, persuasion, decision, implementation, and confirmation, Rogers' (1995) S-shaped adoption curve of innovators, early adopters, early majorities, late majorities, and laggards, the diffusion of innovation theory explained how and why innovation and adoption happened. The term "technology readiness" (TR) refers to a person's willingness to adopt and make use of new technologies in order to achieve their personal and professional goals (Parasuraman and Colby, 2001). People are divided into five groups based on their level of technological preparedness, according to Parasuraman and Colby (2001). These groups are explorers, pioneers, skeptics, paranoid users, and lagging users based on their level of technological preparation. S-shaped adoption curve of innovators, early adopters, early majority, late majority and laggards is comparable to this. It is critical to the success of an organisation's application of new technology or innovation since it focuses on the market.

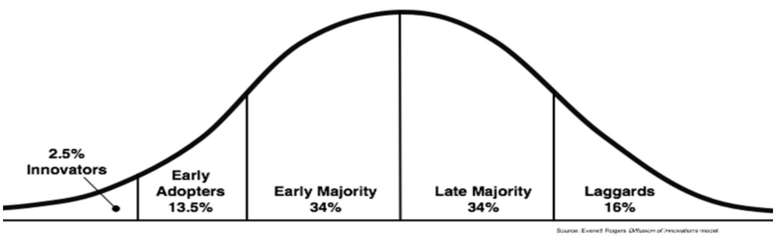


Figure 2.1. (Roger,1995).

2.9.2. The Theory of Planned Behaviour

As a result of the original model's shortcomings, the theory of planned behaviour (Fishbein & Ajzen, 1975) is an extension of the theory of reasoned action (Ajzen & Fishbein, 1980). The Theory of Planned Behaviour states that our intentions to perform a certain behaviour (such as the adoption of a new technology) arise from three major categories of influence: (1) our attitudes toward the behaviour, (2) the influences (norms) of our social circle, and (3) our perceived level of control over the behaviour. These three factors can be broken down further in the Decomposed Theory of Planned Behaviour. People's desire to engage in certain behaviours is a key component in theories of planned conduct, just as it was in the original idea of reasoned action. We assume that people's intentions capture the motivational variables that impact their behaviour; they are signs of the amount of effort they are willing to put in to carry out the behaviour. More likely someone is to act on an intention, the more probable it is that someone will actually do so. However, a behavioural intention can only be expressed in behaviour if the conduct in issue is under volitional control, i.e., if the individual can choose to perform or not perform the activity. This condition may be met by some actions, but it is dependent on non-motivational circumstances such as the availability of requisite opportunities and re-sources (e.g., time, money, skills, cooperation of others; Ajzen, 1985, for a discussion). In all, these aspects constitute people's ability to influence their own actions. If a person has the required resources and opportunity and intends to engage in the behaviour, they should be successful. No one should be surprised by the notion that behavioural success is linked to both internal drive and external control.

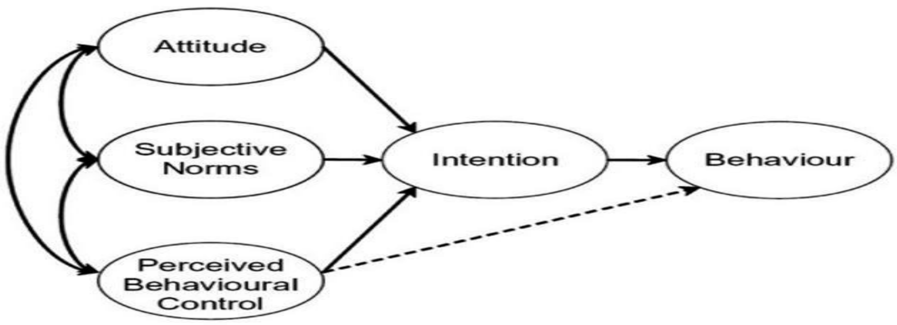


Figure 2.2. The Theory of planned behaviour (Fishbein & Ajzen, 1975).

2.9.3. Engagement Theory

As stated by Magout (2020), engagement theory states that students should be at the center of learning, where they connect with others and do valuable tasks (Allen & Lester, 2012; Clarà & Barberi, 2013; Magout, 2020). Engaged learning is defined as the importance of social interactions and collaborations in fostering learners' integration into a professional network

(Dickey, 2005). According to this approach, all students should be required to participate in activities that include active cognitive processes such as creation, problem-solving, reasoning, decision-making, and assessment (Schneiderman, 1994). In addition, students are motivated to learn because of the nature of the environment and activities they participate in (Schneiderman, 1994). Technology, according to Magout (2020), has the potential to simplify participation in ways that are difficult to achieve without it. According to some, a collaborative atmosphere can be created through the use of online tools such as online meetings, email, chat, and video conferencing. When it comes to education, engagement theory is among the emerging paradigms that emphasize the beneficial impact technology may play in human interaction and evolution (Reaves, 2019; Magout, 2020). Despite not being derived from any other theoretical framework, this idea is related to constructivism, situational learning, and experimental learning because they all place an emphasis on group work and the development of original, significant, and credible outputs (Kearsley & Shneiderman, 1998; Magout, 2020).

Figure 2.3. Engagement theory (Magout, 2020)

2.9.4. The Technology Acceptance Model (TAM)

Davis first utilized TAM to describe computer usage behavior in 1989, according to the journal Science. In Davis' (1989) Theory of Acceptance of Machines, the goal is to explain the general drivers of computer acceptance that lead to describing users' behavior across a broad range of end-user computing technologies and user groups. PU and PERE were two specific beliefs that were included in and tested as part of the basic TAM model: perceived usefulness (PU) and perceived ease of use (PERE) (PEU). When it comes to perceived usefulness, it is defined as the potential user's subjective likelihood that the use of a specific system (e.g., a single platform E-payment System) will improve his or her action, and perceived ease of use is defined as the extent to which the potential user expects the target system to be effortless (Davis, 1989). TAM recognizes that other elements, referred to as external variables, can alter a person's attitude toward a system.

2.9.5. Unified Theory of Acceptance and Use of Technology (UTAUT).

The unified theory of acceptance and use of technology (UTAUT) serves as a baseline model for answering these research concerns by defining and conceptualising 4IR and its educational utility. These findings expand our understanding of 4IR by giving us a more complete picture of its role in supporting teaching and learning by studying the viewpoints of various stakeholders. Its main objective is to find out if the education sector is ready to absorb digital technology, as well as the costs, benefits, and consequences for the sector and its stakeholder groups in those technologies. With a purposive sample technique, we investigated the viewpoints of important informants in the South African education system to meet the study's objectives by selecting participants based on the research questions (Bryman, 2015; Creswell, 2018). This research makes use of the UTAUT theory, which has been used successfully in other fields to bring creative and developmental ideas to Africa with varying degrees of success. So, the UTAUT theory, which incorporates eight different models from different philosophical worldviews and is therefore suitable for assessing the complexity of 4IR as experienced by educational stakeholders, appears to be a good fit for the assessment of 4IR as experienced by educational stakeholders. In order to examine Africa's education sector's readiness and adoption of 4IR, the model might be applied. When discussing people's perspectives of 4IR, it seems sense to include the education sector's preparation and preparedness as well.

2.10. Moodle E-learning Platform in the Fourth Industrial Revolution

According to Chimombo (2009), education is critical for achieving long-term growth. Because of its high support for characteristics that facilitate lifelong learning, e-learning has become significant to educational systems and society. As a result, demand has increased in a wide range of disciplines and institutions. According to Sulcic & Lesjak (2009), education programmes around the world are blending fourth industrial revolution technological technologies into learning and teaching procedures to meet rising demand. The technological breakthroughs of the fourth industrial revolution have changed the way we learn and teach

(Aristovnik et al, 2016). As a result of recent technology breakthroughs, teaching and learning approaches have changed. E-learning through Moodle is one example of these trends. Others include the need for immediate information transfer, the quickening rate at which training and knowledge become obsolete, and the desire to acquire more cost-effective learning and teaching methods.

Moodle instruction for dissemination and material preparation is more successful than traditional classroom training (Aristovnik et al, 2016). Because the system is well-designed for simple access by the student, one of the primary benefits of implementing Moodle e-learning is that it lowers distance, therefore minimising travel programmes and costs. Moodle e-learning is more customizable and available at any time from any location. The system, on the other hand, must be designed in such a way that it engages students and motivates them to learn.

By conducting a comprehensive literature review of Moodle-based education, as well as comparative studies and learning methodologies, one can acquire a better understanding of the current state of teaching and technology. These studies, according to Alhothli (2015), aid researchers in identifying areas that require more inquiry as well as evidence that can be included in the study. Since it has been widely utilised for both teaching and learning in recent decades, many research have been undertaken on e-learning and how it has affected student performance over time. Moodle, an important tool in the delivery of education, has been used in a variety of learning disciplines, according to Saba (2012). Moodle also generates results that are superior to or on par with traditional classroom learning systems. Nonetheless, addressing this issue was one of the primary reasons for adding Information Communication Technology (ICT) into the research process.

Despite the numerous advantages associated with this learning process, there are several disadvantages that limit the positive effects of modern ICT tools on student performance. When Moodle is used in an e-learning system, other elements that aren't linked to e-learning have a favourable or negative impact on the student's performance. Despite the fact that ICT usage during the fourth industrial revolution was a crucial platform for e-learning, Sulcic & Lesjak (2009) claims that it has no statistical relevance on the system's effectiveness. Russell (2006) came to the same conclusion, arguing that there are no statistical differences between traditional and online learning.

2.10.1. Moodle Learning System in the Fourth Industrial Revolution

According to Kasse, "Moodle was originally an acronym for Modular Object-Oriented Dynamic Learning Environment, which was intended to help educational theorists and programmers" (2013). As a consequence of this, it is important to consider how a teacher or student approaches online learning or teaching. The fundamental idea behind Moodle is to encourage students to learn through a methodology known as social constructionist pedagogy. This type of format is referred to as an interactive style. This is due to the belief that people learn best when they interact with the material that they are learning, produce new material for other people, and discuss it with other students. Moodle is used by the vast majority of higher education institutions in South Africa to facilitate the sharing of information related to the educational process. Tutors have the ability to use this interface to schedule their classes, organise their instructional materials, and provide students with the option of turning in their assignments.

2.10.2. Problem's students experience while using the Moodle system and how they affect their performance

A survey conducted in Zimbabwe found that 97.5% of teachers who facilitated open, distant, and electronic learning (ODEL) had no prior experience with distance education (Mpofu et al., 2012). Teaching staff members need extensive training in the application of remote education as a mode of delivery in order to make efficient use of the technologies that support distance learning. Few African academics have experience teaching in a virtual classroom setting. Because of this situation, expanding online educational opportunities on the continent is incredibly challenging. Welzer (2010) states that he investigated how students utilised the various communication tools provided by Moodle. When it comes to making use of Moodle's communication capabilities, in particular the more advanced web 2.0 communication tools like forums, chats, blogs, and wikis, he made the observation that the students do not appear to be as prepared or enthusiastic as their instructors. According to Welzer (2010), only 39.71 percent of students make regular use of online discussion forums and instant chats, the primary purposes of which are to keep up with current course activities or to ask questions about specific assignments and topics in general. Blogs are used by students' 11.03 percent of the time, while face-to-face conversation between students' accounts for 30.88 percent of class time. According to the findings of their investigation, the vast majority of students do not make use of the functionality provided by blogs either because they do not use blogs at all or because they are unaware that it is available to them. A similar pattern of findings was discovered for the chat functionality of Moodle. Seventy percent of students don't use it either because they prefer to communicate through e-mails or they don't require it. In addition, sixty percent of students do not use instant messaging or online forums, and of the forty percent of students who do use these technologies, only forty percent of them do so frequently. The vast majority of students report that face-to-face interaction with their teachers and teaching assistants is more beneficial to them than exchanging emails. According to Mtebe et al. (2013), the majority of educational resources available on the Moodle platform have become outdated.. The fact that learning resources are not updated after being uploaded into the system demonstrates that instructors do not do so. When asked if learning resources were updated on a regular basis and references were up to date and relevant, more than seventy percent of respondents strongly disagreed with the statement.

2.11. Flipped classroom approach on student learning experience

The flipped classroom approach is an innovative pedagogical model that has gained increasing attention for its potential to enhance student learning experiences (Faith & Rahimi, 2022). In a traditional classroom setting, students receive lectures during class time and engage in homework or assignments outside of class. The flipped classroom reverses this dynamic by providing students with access to instructional materials, such as video lectures, before class, allowing them to familiarize themselves with the content independently (Mandasari, 2021). Class time is then utilized for interactive and collaborative activities, discussions, and problem-solving exercises facilitated by the instructor. This approach aims to shift the focus from passive listening to active engagement, fostering a deeper understanding of the material and promoting critical thinking skills (Torres-Martin et al., 2022).

According to Rathner and Schier (2020) research on the flipped classroom approach consistently suggests positive outcomes for student learning experiences. Students often appreciate the flexibility and autonomy it offers, allowing them to pace their learning and revisit materials as needed. The interactive nature of in-class activities promotes peer-to-peer learning and collaboration, fostering a more dynamic and engaging educational environment. Additionally, Strelan et al. (2020) suggest that the flipped classroom has shown promise in improving student performance, with some studies reporting increased exam scores and a higher level of overall academic achievement. As technology continues to play a pivotal role in education, further exploration of the flipped classroom approach and its impact on student learning experiences is crucial for educators seeking effective strategies to enhance the quality of education in diverse academic settings.

Traditional classroom activities and environments are altered in some way in order to make them more conducive to learning. There are a number of ways to rethink the typical lecture and follow-up learning exercises, such as providing online lecture material in advance and using class time for more active group learning assignments. Flipped approaches, like any new curriculum, are motivated by the promise of more efficient resource use and the potential benefit of utilising new technology, given the economic constraints, it is probable that these rationales will be highlighted. There are studies that have been done on this topic (CavigliaHarris, 2016; Chang, 2016; Connell, Donovan, & Chambers, 2016; Bursa & Kose, 2020; Qutob, 2022) that have been able to show the importance of this topic. However, there are many studies that have been done on this topic that have been able to show the importance of this topic. With the purpose of enhancing student engagement, improving the educational experience, and ultimately, improving student outcomes, flipped techniques have traditionally been employed in university teaching and learning (Bossaer, Panus, Stewart, Hagemeier, & George, 2016; Meyliana et al., 2021)

A wide range of methods have been used to implement flipped teaching and learning methodologies, from completely in-class education to a fully online delivery mode (Bates, 2015). Active knowledge acquisition and experiential learning are the most prevalent benefits of flipped classes. Kolb (2014) four phases of experiential learning include active investigation, physiological experience, reflecting observation, and abstract conception. But these learning periods could also be completed on their own. Constructionism (or constructivism), the theoretical framework that underpins the "production of knowledge," emphasises the social aspects of learning. To paraphrase Crotty (2020), "all knowledge and consequently all meaningful reality... is based on human practises being developed in and out of interaction between human beings and their surroundings".

As an alternative, the majority of instructors differentiate between the two. According to Wanner & Palmer (2015) and Lai & Hwang (2016), one of the most common justifications for flipped classroom approaches is that they promote social learning. Social learning is included in Harasim's (2017) paradigm, which states that social learning promotes the creation and linking of ideas as well as intellectual convergence. If you're interested in the notion of "deep learning," Biggs (1996) is a good place to start. His work on the subject is recognised for its emphasis on the necessity of students' interactions with one other in order to deepen the meaning of what they are learning. "Constructing knowledge" and "experiential learning" have been defined as the ability to adapt or transfer one's knowledge and talents to different contexts, as well as obtaining deeper understandings. Two semesters of an experimental study in Boston, USA found that the experimental group (flipped approach) scored much better in their final grades than the control group (conventional lecture) in both semesters of the study. A "black box" analogy would be to simply describe what happened inside a "black box" without knowing what the box was made of.

Students' self-efficacy beliefs, intrinsic and extrinsic motivating factors, as well as self-regulation were examined in flipped classroom experiments (Chuang et al, 2018; Bhagat, Chang & Chang, 2017; Yilmaz, 2017). There was a lot of attention paid to how the flipped learning experience changed students' attitudes and satisfaction, as well as how it impacted their motivation and achievement. As a result, the writers did not go into great detail about how students' attitudes, confidence, and involvement affected their learning experience and enjoyment. Because of this, we wanted to know how the fourth industrial revolution affected students' perceptions of learning and enjoyment.

2.12. The attitudes of university students towards Fourth Industrial Revolution learning

Learning is a personal choice that exposes students to the possibility of ending up in an unfamiliar environment (Sen, 2013). According to most teachers, an exceptional student is one who is eager to learn and has a positive attitude about learning. Low learning expectations reduce motivation and, as a result, achievement (Guvenc &Acikgoz, 2007). Burke & Williams found in a study that students who are strongly motivated to learn are more successful and have a greater likelihood of developing thinking skills (Burke &Williams, 2008). Additionally, it is well acknowledged that students' positive views about technology innovation and learning assist their attempts to understand a subject (Kara, 2020). Learning is fundamentally a one-on-one interaction. As a result, positive or negative views toward the employment of technological innovation in education are critical to learning achievement. Individuals are allocated attitudes, and they build ideas, feelings, and behaviours about a psychological object in a methodical way (Maisiri, 2020). According to Oncul (2000), attitudes are "permanent and immutable thoughts, sentiments, and dispositions that cause individuals to behave in the same way toward people, objects, events, and foundations" (Kara, 2020). Positive attitudes not only assist students grasp the nature of learning, but they also make them more open to learning, enhance their expectations of the learning process, and reduce anxiety. Advance organisers aid students who have a positive attitude about reading or the Moodle learning process, for example. According to Fink, students' learning needs and expectations might change (2003). Students must comprehend what they must learn and how they will make the procedure easier in this regard. Learning to learn, attempting to learn, and having a strong desire to learn are all important focal areas for students nowadays. In this situation, one of the most important responsibilities of teachers is to help pupils establish positive attitudes toward learning. A teacher's role, according to Brookfield (2018), comprises not only conveying knowledge but also making knowledge acquisition easy for students by fostering a desire to learn. At university, students must be reminded of the necessity of learning how to learn. To encourage their receptivity to learning, bringing in a desire and ability for lifelong learning must be prioritised. Learning is involves finding facts, putting up effort in learning, and, most importantly, being able to apply facts (deep learning) (Wirth & Perkins, 2020).

2.13. Student Satisfaction, and Perceived Learning in Online Learning Environments

In the context of the fourth industrial revolution, several studies have been conducted to analyse student satisfaction in traditional and online learning contexts. It has been found that students are more likely to give positive ratings to courses and instructors if they believe their professors communicate effectively, facilitate or encourage their learning, effectively organise the course and show an interest in students' learning and progress, demonstrate respect for the student, and accurately evaluate their performance. Learning value, instructor passion, rapport, organisation, interaction, coverage, and assessment were all included in Marsh & Roche's (1997) model. Study participants who were part of cohorts with other students and had extensive feedback from and interaction with teachers were more likely to be satisfied with their educational experiences (Shea, Fredericksen, Pickett, & Pelz, 2003). Student satisfaction in online courses is influenced by four factors, according to Bangert (2006): student-faculty connection and communication, time spent on task, active and engaged learning, and peer cooperation. Another study used asynchronous audio feedback to assess students' emotions of community and teacher presence in online courses (Ice et al., 2019). Those who received textbased comments were compared to students who received auditory feedback. Students found embedded asynchronous audio feedback to be more gratifying than text-only feedback (Ice et al., 2019).

Students were three times more likely to use the content or suggested improvements of audio feedback because the nuance of communication was clearer and their professors appeared to care more about them. Students were three times more likely to use the content or suggested improvements of this type of feedback (Ice et al., 2019).

2.14. Demographic factors (age and gender) as a moderating effect on the relationship between Industry 4.0 base technology innovation and students' satisfaction.

2.14.1. Gender Moderating Effect on Education in the 4IR

Researches has shown that gender has a significant impact on individual technology use throughout the 4th Industrial Revolution. (Tarhini, Hone, & Liu, 2014; Wang, Wu & Wang, 2009). Males and females make different decisions, which is reflected in their assessments of system utility and ease of use in learning (Venkatesh & Morris, 2000; Arenas-Gaitán, Rondan-Catalua, & Ramirez-Correa, 2010). According to study, men appear to utilise computers more frequently than women (Venkatesh & Morris, 2000). He & Freeman (2010) conducted a critical study comparing male and female students' perspectives on information technology, discovering that girls are less confident with computers than boys because they have studied and practised less and are more worried about using computers. According to the UTAUT model, gender plays an important role in influencing the influence of the UTAUT independent factors on behavioural intention to use technology. (Venkatesh, Morris, Davis & Davis, 2003). According to prior gender study, males are more task-oriented than females. As a result, according to Venkatesh et al. (2003), men prioritise work, accomplishment, and prestige, whereas women prioritise social effect, being more vocal, sensitive to others' feelings, and compliant (Venkatesh & Morris, 2000). Males are more concerned with effort expectations than females when it comes to technology adoption and utilisation (Venkatesh, 2003). Females are more sensitive to others' perceptions when it comes to social impact, hence peer influence and affiliation requirements are more important to women in research on technology adoption and use (Venkatesh, 2003). When gender was introduced as a moderator, the TAM model's explanatory power increased considerably to 52%. (Venkatesh, 2003)

There are distinctions between boys and girls when it comes to technology usage. According to Alothman et al., (2017), geography and gender have an impact on the length of time undergraduate students spend using technology, with students in rural communities spending less time on technology than those in the capital city. Students use computers or laptops far less at campus than they do at home, according to the report. Students utilised computers or laptops for only four hours per week at university, and some female universities forbid students from bringing laptops or smartphones to class (Alothman et al., 2017). Male students prefer to use an e-learning system that is adaptive to fourth-generation technology innovation, according to Al-Harbi (2011). Despite this, there is no conclusive evidence that gender influences technological acceptance.

2.14.2. Age Moderating Effect on Education in the 4IR

Age has been found to play a significant role in the adoption of new technologies (Tarhini, Hone & Liu, 2014, Venkatesh, et al, 2003). Behavioral intention and technology use are less strongly influenced by age, and this trend appears to be continuing (Venkatesh, 2003). In the UTAUT model, Venkatesh et al. (2003) discovered that age had a substantial impact on the link between performance expectancy, enabling circumstances, and behavioural intention. Younger generations are more likely than older generations to embrace and make use of the system. An increase in cognitive dysfunction and inability to pay attention to important details were both found to be associated with growing older (Venkatesh, 2003). In terms of technology acceptance and use, older employees were more likely than younger employees to have a strong relationship between effort anticipation, social norms, and behavioural intention. (Venkatesh, 2003). In England, the relationship between perceived ease of use, perceived usefulness, self-efficacy, and behavioural intention was found to be influenced by age. (Tarhini, Hone & Liu, 2014). No changes were found, however, in the impact of social influence on behavioural intention to utilise an LMS (Tarhini, Hone & Liu, 2014). The effect of the moderator's gender and age on the adoption of a Webinar system in a mixed-mode and Moodle course was investigated by Khechine et al. (2014) using the unified theory of acceptance and use of technology (UTAUT). While gender was not a significant moderator of intention, age was. When it comes to online education, students under 25 have a more favourable opinion than their elders, according to Chawla & Joshi (2012). Despite this, Julie, Becker &Newton (2017) were unable to prove that age had an impact on users' intentions and pleasure of an e-learning system in an educational context. The Jusur LMS has been found in South African higher education to have a significant impact on the number of students using it. However, the majority of studies have focused on unique settings outside of South Africa. Whether or whether the age of students in South African higher education affects their use of LMS is an open question.

2.15.The Gap in the Literature

World Economic Forum (2018) defines 4IR as a technology revolution in which the lines between physical, digital, and biological realms are increasingly blurred. Human talent can be enhanced by modelling and simulation by fully developing artificial intelligence (AI), data analytics (data mining), and algorithms, which will be very useful in the education industry. More than any of the previous three revolutions, the fourth industrial revolution has had a profound impact on the way we live, work, and educate (Penprase, 2018). The past three industrial revolutions, in spite of this, have resulted in the mass production of educational services through innovative curriculum creation and the legalisation of online teaching, culminating in the establishment of countless academic institutions around the world (Chang & Wills 2013; Penprase, 2018). To reduce operational costs and eliminate logistical issues typically associated with traditional classroom training, computer-based learning, particularly e-learning, makes it possible to provide training from any location and any time. According to Chang & Wills (2013), the implementation of blended learning in the classroom increased student satisfaction and achievement by 15 percent.

Emerging technologies, such as the internet and other emerging forms of technology, allow students to learn at their own pace, regardless of where they are in the world, enabling competency-based and self-directed learning and increasing the variety of information that can be delivered to students no matter where they are in the world. Students and instructors benefit from the use of digital technology in the classroom, according to Beetham & Sharpe (2013), who argue that the use of digital technology transforms and enriches teaching and learning. Since many manufacturing and service companies are rapidly adopting new technology, educators and academics have highlighted concerns regarding the usefulness and efficacy of online instruction. (Bayne, 2019; Henderson, Selwyn & Aston, 2017).

Though digital technologies can have a good impact on teaching and learning by altering student experiences, they have not had a significant impact on teaching and learning in higher education (HE) (Bayne, 2019; Henderson, Selwyn & Aston, 2017). Although mobile (smart) gadgets and social media are widely used, teaching and learning in South Africa has remained essentially unchanged. Technology advances and tools are widely available, but academic institutions have no control over their design or use, despite the fact that digitization rather than digitalization has been used to facilitate teaching and learning. (Ng'ambi et al. 2016).

As a result of these findings, Rashid & Asghar (2016) highlighted that the engagement and self-directed learning are enhanced by the use of digital technology. Despite the fact that they found no major influence of digital technologies on students' educational attainment. The subject of whether incorporating technology into the teaching and learning process enhances teaching quality and/or improves student performance and experience continues to be contested. It has been shown that the use of interactive e-learning has a positive impact on teaching and learning experiences through five different examples of interactive learning (Chang, 2016).

According to the findings of the study, students and instructors play an essential role in providing students with well-structured and organised online learning that can boost their motivation, competence, and overall happiness with their education. There is a human-technology connection, according to Chang (2016), such as when online education and face-to-face learning are combined in a collaborative, mixed and flexible manner. Digital inventions, however, are spreading at an extraordinary rate compared to prior revolutions (Ringel, Zablit, Grassl & Manly Möller, 2018). More and more companies are struggling to keep up with the rapid pace of digital innovation in the service and education sectors. To yet, there has been no convincing proof that organisational learning in the educational sector is feasible because of a lack of consistency in the use of digital technology (Brown, 2015).

In contrast to many innovation research, including that of 4IR, which has concentrated primarily on computers and manufacturing, just a few studies have examined how 4IR is revolutionising the service industry, particularly education and healthcare (Collins, A.; Halverson, 2018; Gleason, 2018). As a result, there has been no investigation into how 4IR may enhance and enhance the sector's operations from the standpoint of its most significant stakeholders. However, students found that digital technology does not change the teaching and learning practises in higher education. According to Ng'ambi et al. (2016), Africa's technology use is fragmented, and there is no uniform policy for integrating technology into education across the continent. 4IR technology adoption and dissemination in education is not apparent as to how it can improve student learning or instructor productivity (Rashid & Asghar, 2016). For the time being we don't know enough about the education sector's methods and procedures for increasing 4IR capacities in the classroom, particularly in Africa. According to

Ng'ambi et al. 2016; Kreijns, Van Acker, Vermeulen, & Van Buuren, 2013, there are no academic institutions in the top 50 innovative enterprises in the world, and none of the organisations included are from Africa.

By examining recent studies published within the last ten years, this review will provide insights into the current state of knowledge and identify areas for future research.

The integration of artificial intelligence (AI), data analytics, and algorithms into education has the potential to enhance teaching and learning experiences. However, despite the availability of digital technologies, research indicates a lack of significant impact on higher education. While emerging technologies have enabled competency-based and self-directed learning, the adoption and effective use of these tools in educational institutions remain limited (Bayne, 2019; Henderson, Selwyn, & Aston, 2017). This finding suggests a gap in understanding how 4IR technologies can be effectively harnessed to improve teaching quality and student outcomes.

Also, research suggests that the engagement and self-directed learning of students can be enhanced through the use of digital technology. However, studies have not consistently found a significant influence on students' educational attainment (Rashid & Asghar, 2016). Exploring the role of students and instructors in providing well-structured and organized online learning experiences that motivate students and enhance their overall satisfaction is an important area for further investigation (Chang, 2016).

While the literature has examined the impact of 4IR in various industries, including education, there is a dearth of studies specifically focusing on the service industry, such as education and healthcare (Collins & Halverson, 2018; Gleason, 2018). Moreover, research on 4IR adoption and dissemination in education in Africa is limited, and there is a lack of uniform policy for integrating technology into education across the continent (Ng'ambi et al., 2016). Closing this gap is crucial to ensure that students are adequately prepared for the digital environment and to enhance teaching and learning practices in Africa.

This literature review highlights the existing gap in the understanding and implementation of 4IR technologies in the field of education. Despite the availability of digital tools, their impact on teaching quality and student outcomes in higher education remains limited. Challenges related to institutional control, rapid technological advancements, and inconsistent findings on student performance warrant further investigation. Additionally, the need to address the specific context of 4IR implementation in education, particularly in Africa, is crucial for bridging the gap and maximizing the potential benefits of 4IR technologies in the classroom. Future research should focus on understanding effective strategies for integrating and leveraging 4IR technologies to transform teaching and learning practices.

2.16. Review of the Literature

Technology advancement, innovation, and creativity are at the heart of the fourth industrial revolution (also known as the Fourth Industrial Revolution, or IVIR). Big data, robotics, AI, ICT, quantum computing and 3D printing are all included in this thesis' definition of the 4IR. In order to take advantage of the 4IR, this study determined that a new digital approach to teaching and learning, research and development, and skill development must be introduced. Some of the challenges to implementing the 4IR have been identified in the areas of pedagogical adaptation, teacher development, and higher investment in resources and infrastructure for technological innovation. As part of the 4IR, South Africa is able to engage in the digital economy more, as well as collaborate with other communities in education and learning.

2.17. Conclusion

Chapter 2 of this study provides a comprehensive exploration of the intersection between education and the Fourth Industrial Revolution (4IR), examining historical perspectives, theoretical frameworks, technological advancements, and their implications for higher education in the digital age. Through an in-depth analysis of relevant literature, this chapter aims to establish a theoretical foundation and contextual understanding of the study's research focus.

The chapter begins by tracing the evolution of industrial revolutions throughout history, highlighting their transformative impact on societies, economies, and educational systems. It elucidates the transition from traditional modes of production to the emergence of Industry 4.0, characterized by the integration of advanced technologies such as Big Data, Artificial Intelligence (AI), Robotics, Internet of Things (IoT), Three-dimensional printing (3D), and Quantum Computing.

Building upon this historical backdrop, the chapter delves into the concept of Education 4.0, which advocates for the integration of technology and innovation to foster sustainable development and prepare learners for the challenges of the digital era. It explores the evolution of higher education from elite to mass and post-massification phases, highlighting the changing dynamics of access, equity, and quality in tertiary education.

Furthermore, the chapter examines the implications of the Fourth Industrial Revolution for higher education institutions, including fundamental shifts in teaching, research, and service delivery. It discusses the challenges and opportunities posed by technological advancements in education, emphasizing the need for adaptive strategies to harness the potential of 4IR while addressing digital divides and socio-economic disparities.

Central to the discussion is the theoretical underpinning provided by the Unified Theory of Acceptance and Use of Technology (UTAUT), which offers a framework for understanding the factors influencing technology adoption and usage in educational contexts. The chapter elucidates other theoretical perspectives such as the Theory of Diffusion Innovation, Theory of Planned Behaviour, Engagement Theory, and Technology Acceptance Model, providing insights into the cognitive, social, and organizational dynamics shaping technological innovation in education.

Moreover, the chapter explores specific technologies and methodologies relevant to the study, including the Moodle e-learning platform and the flipped classroom approach. It investigates student experiences, attitudes, and satisfaction levels in online learning environments, as well as the moderating effects of demographic factors such as age and gender on technology adoption and usage.

In identifying gaps in the literature, the chapter underscores the need for further research to address key knowledge deficits and explore emerging issues in the field of educational technology and innovation. It sets the stage for the subsequent chapters by synthesizing existing knowledge and laying the groundwork for the empirical investigation conducted in this study.

Overall, Chapter 2 serves as a comprehensive overview of the theoretical, conceptual, and empirical dimensions of the study, providing a solid foundation for the subsequent analyses and discussions. By synthesizing diverse perspectives and insights, this chapter contributes to a deeper understanding of the complex interplay between technology, education, and societal change in the context of the Fourth Industrial Revolution.

CHAPTER 3

RESEARCH METHOD

CHAPTER THREE

3. RESEARCH METHODS

3.1. Introduction

This section of the research proposal explains the methodology that was used for the study which comprises of the research design, population, sample design, description of the instrument that will be used, data collection, reliability and validity, data analysis and ethical consideration.

3.2.Research Design

The research study employed a positivist paradigm as its epistemological foundation, specifically adopting a quantitative research approach (Ochieng, 2009). According to Mack, (2010), the selection of the positivist paradigm was based on its suitability for gathering data and information pertaining to social facts in an objective and detached manner. As argued by Aliyu, et al., (2014), positivism, as a research paradigm, emphasizes objectivity, empirical evidence, and the use of scientific methods to study phenomena. It assumes that there is a distinct separation between the researcher and the research subject, aiming to maintain a neutral and unbiased stance throughout the study (Hall, 2013; Aliyu, et al., 2014). The positivist paradigm seeks to uncover general laws and regularities governing social phenomena, often relying on statistical analysis and numerical data.

In the context of the mentioned research study, the positivist paradigm was deemed appropriate due to the limitations imposed by the Covid-19 pandemic. The researcher was unable to engage in in-depth interactions or extensive discussions with the study participants. Consequently, a quantitative approach allowed for the collection of data through structured surveys, questionnaires, or existing databases, minimizing the need for direct contact (Aliyu, et al., 2014). By employing a positivist paradigm, the study aimed to maintain objectivity, gather empirical evidence, and analyze data using statistical methods. This approach enabled the researchers to explore the research questions and test hypotheses in a systematic and rigorous manner. The emphasis on quantitative data also allowed for the examination of patterns, relationships, and generalizability within the study population.

It is important to note that while the positivist paradigm offers certain advantages in terms of objectivity and generalizability, it also has limitations. Its focus on measurable variables and causal relationships may overlook the complexity and nuances of social phenomena. Additionally, the positivist paradigm may not fully capture subjective experiences, emotions, and the context in which social phenomena occur.

According to Burns & Grove (2010) quantitative research concentrates on the objective and deliberate procedure of gathering, breaking down and interpreting numerical information, with respect to the relationship between factors, in this manner it involves a deductive approach (testing hypothesis) and epitomizes social reality as an outer, objective reality. Due to the nature of the study, it employed a survey research approach. A questionnaire was utilised to elicit pertinent data relevant to the study's aims. To address the research questions and test the research hypotheses, this study took a quantitative approach. Due to its structure and ability to be changed numerically, this method was used.

3.3.Sources of Data

Primary data for this study was gathered through the use of a questionnaire that is intended to capture the study's unique objectives. The researcher distributed the questionnaire at a time mutually agreed upon by the researcher and the respondents. Respondents who are unable to complete the questionnaire at the time of submission were asked to complete and return it within a specified time frame. However, the researcher collected emails from a subset of students with sufficient authorization in order to offer them a link to the online version of the questionnaire and instructions on how to complete the online survey through Google form.

3.4.Research Instrument

The study's design was based on a closed-ended questionnaire. All dependent and independent variable questions employed a five-point Likert scale ranging from strongly agree (5) to strongly disagree (1). Gender will be quantified using a nominal scale, whilst age will be quantified using an interval scale (see appendix A).

3.5. Population of the Study

The population of the study comprised business management students from a private university and a public university in Johannesburg. The private university had a total of 512 business management students as of November 2021, while the public university had a total of 3,218 business management students as of the same period. Combining these numbers, the total population sample for the study was 3,730 business management students.

The choice of this population was based on the understanding that students are likely to be more familiar with e-learning and the concept of the Fourth Industrial Revolution (4IR). As the study aimed to explore the impact of 4IR technologies on education, targeting business management students provided a relevant group of individuals who are likely to have experience with e-learning platforms and digital technologies.

Since the specific individuals within the population were unknown, the study employed a non-probability convenience sampling technique. Convenience sampling was chosen due to its practicality and the ease of access to the participants. The researchers selected a sample of 181 students from each university, resulting in a total of 362 target respondents for the study.

It is important to note that convenience sampling may introduce some bias into the study, as the participants were selected based on their availability and accessibility rather than through a random selection process. Therefore, the findings of the study may not be fully representative of the entire population of business management students in Johannesburg. However, convenience sampling was deemed appropriate given the limitations imposed by the Covid-19 pandemic and the practical considerations of the research.

3.6. Sample Size Determination

With the 362 students as the study population, the Taro Yamane formula as quoted in Etikan, Musa, & Alkassim, (2016) was used to determine the sample size. This was done at a confidence level of 95% applied. The formula is given thus:

$$n = \frac{N}{1 + N(e)^2}$$

Where

n = Sample size

N = Population (3730)

E = tolerable error (100% - 95% = 5)

Therefore,

$$n = \frac{3730}{1 + 3730(0.05)^2}$$

$$n = \frac{3730}{1 + 3730(0.0025)}$$

$$n = \frac{3730}{10.3}$$

n = 362

3.7.Validity of Research Instruments

The study used content validity to determine the instrument's validity by determining its appropriateness, adequacy, inclusivity, and relevance to the study. The purpose of research instrument validity is to guarantee that the instrument measures what it is intended or designed to measure. To ensure the validity of this study, the researcher ensured that both the dependent and independent instruments utilised were previously validated and aligned with the study's aims. The items' appropriateness for assessing the stated construct as well as their simplicity of scoring for analysis were also evaluated using a valid Cronbach's alpha of greater than 0.7. The instrument will be adjusted in accordance with the findings of the study. The researcher is convinced that content validity was reached in this manner.

3.8.Reliability of Research Instruments

According to Bryman and colleagues (2011), reliability places an emphasis on the genuineness and accuracy of a measuring method. Bryman et al. (2011) state that the concept of reliability centres on the dependability and consistency of the variables. The concept of validity, on the other hand, draws attention to the question of whether or not an indicator measures what it claims to measure, with a particular emphasis on the question of whether or not the findings of a research study can be generalised beyond the context of the research study (Bryman et al, 2011). When used in a setting that is analogous to the one being measured, a measurement is regarded as reliable if it generates results that are consistent with one another (Boynton & Greenhalgh, 2004).

The industry 4.0 based technology innovation instrument was utilised in this investigation by Stentoft et al. (2019), and the findings suggest that it is reliable and valid (it measures what it purports to measure) with a Cronbach's alpha value of (= 0.890). The Moodle learning method instrument was used in this investigation by Sumak et al. (2011), and the results indicate that it is trustworthy and valid (it measures what it promises to measure), with a Cronbach's alpha value of = 0.815. Alnuhayt (2018) used the flipped classroom method instrument in this study, and the findings suggest that it is reliable and valid (it measures what it promises to measure), with a Cronbach's alpha value of (= 0.785). In this study, Han and Conti (2020) used the student attitude instrument, and the results suggest that it is trustworthy and valid (it measures what it promises to measure), with a Cronbach's alpha value of (= 0.887). The instrument measures what it promises to measure. In conclusion, Chao (2019) used the student satisfaction instrument in this research, and the findings suggest that the instrument is reliable and valid (it measures what it claims to measure), as indicated by its Cronbach's alpha value of (= 0.9).

3.9.Data Analysis

The information gathered throughout the study were recorded and analysed. The researcher offered further insight and interpretation into the data that were analysed. This entailed using diagrams, graphs, and frequencies to interpret statistics concerning demographic data. To analyse data, the researcher utilised descriptive and inferential statistics. For data analysis, the Statistical Package for Social Science (SPSS) were utilised (correlation analysis, regression analysis etc). The programme was used to perform the required validity and reliability tests, as well as multivariate analysis. The P- values of the tested constructs were scrutinised closely in order to validate (fail to reject) or nullify (reject) any claimed hypothesis investigated. As a result, where the p-value is smaller than alpha (0.05), the null hypothesis was rejected, whereas the alternative hypothesis will not. The researcher explored the effects of the moderating variables (age and gender) on the association between industry 4.0 based technology innovation and student satisfaction using Andrew F. Hayes' process analysis (version 3.2) (Hayes, 2015).

3.10. Ethical Consideration

The researcher demonstrated a thorough commitment to ethical integrity by engaging in a comprehensive process of obtaining ethical clearance from both the University of Witwatersrand and the Eduvos Ethics Research Committee. This involved submitting detailed proposals outlining the research objectives, methodology, potential risks to participants, and measures to mitigate these risks. By securing approval from these reputable institutions, the researcher affirmed their dedication to conducting ethically sound research in accordance with established guidelines and standards.

In order to ensure the well-being and comfort of participants, the researcher exercised careful discretion in the design of the research instrument. This entailed conscientiously avoiding the inclusion of questions that could potentially elicit distress or discomfort. By prioritizing the psychological and emotional safety of participants, the researcher fostered an environment conducive to open and honest participation, free from coercion or undue influence.

Moreover, the researcher took proactive steps to obtain informed consent from all participants involved in the study. Prior to their participation, individuals were provided with comprehensive information regarding the purpose, procedures, and potential implications of the research. This information was presented in a clear and accessible manner, allowing participants to make informed decisions about their involvement without feeling pressured or coerced.

To further safeguard the confidentiality and anonymity of participants, the researcher implemented stringent data protection measures. This included the exclusion of any personally identifiable information from the data collection process, such as names, identity numbers, or other self-identifying details. Additionally, participants were assured of the confidentiality of their responses, with explicit statements outlining the intended use of the data and the measures in place to protect their privacy.

By adhering to these rigorous ethical protocols and obtaining approval from both institutional review boards, the researcher demonstrated a steadfast commitment to upholding the highest standards of ethical conduct in research. This not only serves to protect the rights and welfare of participants but also enhances the credibility and integrity of the research findings.

3.11. Limitation

In addition to meticulously adhering to ethical protocols and obtaining approval from the University of Witwatersrand and the Eduvos Ethical Research Committee, it's imperative to acknowledge certain limitations inherent in the research design and implementation.

Firstly, despite efforts to minimize risk and discomfort for participants by avoiding sensitive or challenging questions, it's important to recognize that individual interpretations of what constitutes discomfort or distress may vary. Despite the researcher's best intentions, some participants may still have found certain aspects of the research process unsettling or uncomfortable.

Furthermore, while the researcher made concerted efforts to ensure the confidentiality and anonymity of participants, there is always a degree of inherent risk associated with data collection and storage, particularly in digital formats. Despite implementing robust security measures, the possibility of inadvertent data breaches or unauthorized access cannot be entirely ruled out.

Additionally, the sample size and composition may present limitations in terms of the generalizability of the findings. The study's reliance on a specific demographic or geographic region may restrict the applicability of the results to broader populations or contexts.

Moreover, the exclusion of personally identifiable information from the data collection process, while essential for preserving participant anonymity, may limit the depth of analysis possible. Without access to individual-level demographic data, the researcher may encounter challenges in identifying potential correlations or patterns within the data.

Lastly, the research timeframe and resource constraints may have imposed limitations on the scope and depth of the study. Despite the researcher's best efforts, certain aspects of the research question may not have been fully explored or adequately addressed within the confines of the study's parameters.

Despite these limitations, the researcher remains committed to transparency and rigor in the research process, and acknowledges these constraints as important considerations for future studies in this area.

3.12. Conclusion

In conclusion, Chapter Three of this research has provided a detailed account of the research design, implementation strategy, measurement issues, and ethical considerations and limitations. The chapter has highlighted the key aspects related to conducting the study, ensuring its validity and reliability, and addressing ethical concerns. The research design was carefully crafted to align with the research objectives and the nature of the study. It involved the selection of a positivist paradigm, which facilitated the collection of quantitative data through surveys, questionnaires, or existing databases. The positivist paradigm allowed for an objective and detached approach to gathering information, ensuring that the study maintained a rigorous and systematic foundation.

Furthermore, the chapter addressed various measurement issues. It outlined the specific variables and constructs that were considered in the study, ensuring that they were clearly defined and operationalized. Measurement instruments, such as surveys or questionnaires, were selected or developed to accurately capture the intended concepts. The chapter also discussed any potential limitations or challenges associated with the measurement process, acknowledging the need for careful interpretation and understanding of the collected data.

Ethical considerations were given due importance in Chapter Three. The research design incorporated measures to protect the rights and well-being of the participants. This involved obtaining informed consent, ensuring anonymity and confidentiality, and adhering to ethical guidelines and regulations. The chapter highlighted the ethical responsibilities of the researcher and discussed potential ethical dilemmas that could arise during the data collection process.

Overall, Chapter Three presented a comprehensive overview of the research design, implementation strategy, measurement considerations, and ethical concerns. By addressing these crucial aspects, the chapter laid the foundation for conducting a valid and ethical study. It demonstrated the researcher's commitment to conducting research in a systematic and responsible manner, upholding the principles of scientific rigor and ethical conduct. The chapter sets the stage for the subsequent chapters, where the findings and analysis will be presented and discussed in light of the research design and measurement considerations outlined in this chapter.

CHAPTER 4

DATA ANALYSIS AND TEST

CHAPTER 4

4. DATA ANALYSIS AND TEST

4.1. Introduction

This chapter focuses on the data analysis, presentation and interpretation of the analysed data. The data analysis and test result are depicted by way of chart, graphs and tables. The researcher engaged on providing an in-depth understanding by using Microsoft excel and SPSS software to analyse the data findings. The tests that will be carried out in this chapter includes test for normality, Cronbach alpha test for reliability, factor analysis and correlation.

4.2. Normality Test

Numerous statistical procedures, such as correlation, regression, t tests, and analysis of variance, collectively referred to as parametric tests, make the assumption that the data follow a normal distribution. The measurement of the normality of the data is a step that is necessary for any analysis. The use of normality tests can assist in establishing whether or not a data set demonstrates a normal distribution and is adequately modelled. Graphically and numerically are the two most common methods that are utilised when normality is being measured. The Kolmogorov-Smirnov Test and the Shapiro-Wilk Test are among the most well-known of the normality tests (Ghasemi & Zahediasl, 2012). Your data are compared to a normal distribution, which is a known distribution, using the Kolmogorov-Smirnov Test. The Shapiro-Wilk Test determines whether or not a random sample was drawn from a normal distribution. The W value is provided to you by the test; when the values are low, it indicates that the distribution of your sample is not normal. The Shapiro-Wilk test works best with small sample sizes (less than fifty samples), but it is flexible enough to accommodate sample sizes of up to two thousand.

Table 4.2.1 Test for normality

Tests of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
I take pleasure in making use of various forms of information and communication technology.	.212	351	.000	.843	351	.000
I think using ICT saves time in class	.235	351	.000	.840	351	.000
I am aware that advancements in TIC can facilitate my acquisition of many new skills.	.237	351	.000	.822	351	.000
Using digital technology does not scare or threaten me in any way.	.213	351	.000	.841	351	.000
When it comes to using various forms of technology in the classroom, I have a high level of self-assurance.	.223	351	.000	.851	351	.000
I am interested in expanding my knowledge of how to make effective use of information and communication technologies in the classroom.	.182	351	.000	.874	351	.000
I am confident that incorporating new technologies into my classroom can help my students learn more.	.188	351	.000	.884	351	.000

It is possible to modify the curriculum in order to incorporate ICT.	.226	351	.000	.858	351	.000
The information and communications technology that we rely on rarely experiences failures that prevent it from being useful.	.209	351	.000	.906	351	.000
I would find Moodle useful for learning	.195	351	.000	.899	351	.000
Using Moodle enables me to accomplish tasks more quickly	.184	351	.000	.901	351	.000
Using Moodle for learning increases my productivity	.200	351	.000	.910	351	.000
If I use Moodle, I will increase my chances of getting knowledge	.209	351	.000	.905	351	.000
The flipped classroom method keeps me from getting bored in a vocabulary class	.178	351	.000	.905	351	.000
My ability to learn on my own is enhanced by the flipped classroom method,	.197	351	.000	.901	351	.000
I take pleasure in my education when it is delivered in this format.	.187	351	.000	.903	351	.000
A live lecture in the classroom can provide me with more information than watching a video at home can.	.206	351	.000	.859	351	.000
My anxiety level has increased as a result of using the flipped classroom method of instruction.	.159	351	.000	.915	351	.000

It is difficult for me to gain access to the internet and view the videos that have been assigned.	.216	351	.000	.863	351	.000
The method of instruction known as "flipping the classroom" is not one that I favour.	.168	351	.000	.897	351	.000
I was very content with mobile learning	.183	351	.000	.898	351	.000
I was very pleased with mobile learning	.168	351	.000	.904	351	.000
I was satisfied with mobile learning efficiency	.172	351	.000	.906	351	.000
I felt delighted with mobile learning	.158	351	.000	.906	351	.000
Overall, I was satisfied with mobile learning	.174	351	.000	.899	351	.000
I think it's a good idea to use technology innovation	.252	351	.000	.791	351	.000
Technology innovation will make my work more interesting	.218	351	.000	.840	351	.000
It's good to make use of the technology innovation	.252	351	.000	.783	351	.000

The results of Table 4.2.1 show that the Kolmogorov-Smirnov and Shapiro-Wilk tests are both significant; however, the data does not follow a normal distribution; as a result, non-parametric tests were utilised.

4.3. Tests for Reliability – Cronbach's alpha

Table 4.3.1. Reliability Statistics for Technology Innovation.

Technology Innovation Reliability Statistics	
Cronbach's Alpha	N of Items
.866	9

The Cronbach's alpha coefficient value for the overall items of technological innovation is shown in the table above, and it is above the threshold of 0.600, indicating that the scale can be relied upon.

Table 4.3.1.1. Technology Innovation Items.

Technology Innovation Items-Total Statistics				
	Scale Mean if Item Deleted	**Scale Variance if Item Deleted**	**Corrected Item-Total Correlation**	**Cronbach's Alpha if Item Deleted**
I enjoy using information and communication technology.	30.04	37.761	.642	.848
I believe that using ICT in class saves time.	30.03	37.242	.668	.845
I am aware that ICT can assist me in learning a variety of new skills.	29.86	38.040	.694	.844
Using ICT does not frighten or threaten me.	30.04	39.221	.490	.862

When it comes to working with technology in class, I am very confident.	30.02	37.940	.634	.849
I'd like to learn more about how to use ICT in the classroom.	30.27	38.369	.513	.861
I believe that ICT can significantly improve my teaching practise.	30.24	37.358	.673	.845
It is possible to modify the curriculum to incorporate ICT.	30.09	38.204	.606	.851
ICT does not break down frequently enough to be of much use.	30.60	39.891	.486	.862

As shown in the Cronbach's alphas presented earlier, the reliability of each of the scales used to measure technological innovation is demonstrated in Table 4.3.1.1. The table illustrates the reliability of each scale, affirming their suitability for inclusion in fulfilling the research objectives and addressing the research questions. Consequently, these scales are incorporated into the study to ensure robustness and validity in the assessment of technological innovation.

Table 4.3.2. Reliability Statistics for Moodle Learning Method.

Moodle Learning Method Reliability Statistics	
Cronbach's Alpha	N of Items
.896	4

In the table that can be found above, the value of the Cronbach's alpha coefficient for the overall items of the Moodle learning method is shown to be 0.896, which is above the scale reliability score of 0.600.

Table 4.3.2.1. Moodle Learning Method Items.

Moodle Learning Method Item-Total Statistics				
	Scale Mean if Item Deleted	**Scale Variance if Item Deleted**	**Corrected Item-Total Correlation**	**Cronbach's Alpha if Item Deleted**
I would find Moodle useful for learning	9.87	8.695	.741	.876
Using Moodle enables me to accomplish tasks more quickly	9.92	8.608	.764	.868
Using Moodle for learning increases my productivity	10.12	8.208	.811	.850
If I use Moodle, I will increase my chances of getting knowledge	10.14	8.501	.762	.869

The results presented in Table 4.3.2.1. demonstrate that all of the scales for the Moodle learning method have a high degree of reliability, as indicated by the Cronbach's alphas presented earlier. The table illustrates the reliability of each scale, affirming their suitability for inclusion in fulfilling the research objective 2 and addressing the research question 2. Consequently, these scales are incorporated into the study to ensure robustness and validity in the assessment of Moodle learning method.

Table 4.3.3. Reliability Statistics for Flipped Classroom Method.

Flipped Classroom Method Reliability Statistics	
Cronbach's Alpha	N of Items
.847	7

In the table that can be found above, the Cronbach's alpha coefficient value for the overall items of the flipped classroom method is shown to be 0.847, which is higher than the scale reliability score of 0.600.

Table 4.3.3.1. Flipped Classroom Method Items.

Flipped Classroom Method Item-Total Statistics				
	Scale Mean if Item Deleted	**Scale Variance if Item Deleted**	**Corrected Item-Total Correlation**	**Cronbach's Alpha if Item Deleted**
In my vocabulary class, using the flipped classroom method prevents me from becoming uninterested.	22.93	23.344	.652	.819

My ability to learn on my own is enhanced by the flipped classroom method, and I take pleasure in using that method to further my education.	22.92	23.154	.655	.818
A live lecture in the classroom can provide me with more information than watching a video at home can.	22.75	23.671	.696	.814
My anxiety level has increased as a result of using the flipped classroom method of instruction.	22.93	24.359	.508	.841
It is difficult for me to gain access to the internet and view the videos that have been assigned.	22.91	23.518	.640	.821
The method of instruction known as "flipping the classroom" is not one that I favour.	23.17	24.190	.481	.846

In my vocabulary class, using the flipped classroom method prevents me from becoming uninterested.	23.13	23.514	.631	.822

The results of Table 4.3.3.1 demonstrate that all of the scales for the flipped classroom method have a high degree of reliability, as indicated by the Cronbach's alphas presented earlier. The table illustrates the reliability of each scale, affirming their suitability for inclusion in fulfilling the research objective 1 and addressing the research question 1. Consequently, these scales are incorporated into the study to ensure robustness and validity in the assessment of flipped classroom model.

Table 4.3.4. Reliability Statistics for Students Satisfaction.

Students Satisfaction Reliability Statistics	
Cronbach's Alpha	N of Items
.956	5

The value of the Cronbach's alpha coefficient (= 0.956) for the overall items of student satisfaction is displayed in the table above. This value is greater than the scale reliability score of (= 0.600).

Table 4.3.4.1. Students Satisfaction Items.

Students Satisfaction Item-Total Statistics				
	Scale Mean if Item Deleted	**Scale Variance if Item Deleted**	**Corrected Item-Total Correlation**	**Cronbach's Alpha if Item Deleted**
I was very content with mobile learning	13.12	21.822	.850	.951
I was very pleased with mobile learning	13.21	21.184	.919	.939
I was satisfied with mobile learning efficiency	13.18	22.098	.860	.949
I felt delighted with mobile learning	13.34	21.379	.879	.946
Overall, I was satisfied with mobile learning	13.20	21.284	.881	.945

The results of Table 4.3.4.1 demonstrate that all of the scales used to measure students' levels of satisfaction are reliable, as indicated by the high Cronbach's alpha values. The table illustrates the reliability of each scale, affirming their suitability for inclusion in fulfilling the research objective 3 and addressing the research question 3. Consequently, these scales are incorporated into the study to ensure robustness and validity in the assessment of students' satisfaction.

Table 4.3.5. Reliability Statistics for Students Attitude.

Students Attitude Reliability Statistics	
Cronbach's Alpha	N of Items
.902	3

The Cronbach's alpha coefficient value (= 0.902) for the overall items of the student's attitude is displayed in the table located above. This value is higher than the scale reliability score (= 0.600).

Table 4.3.5.1. Students Attitude Items.

Students Attitude Item-Total Statistics				
	Scale Mean if Item Deleted	**Scale Variance if Item Deleted**	**Corrected Item-Total Correlation**	**Cronbach's Alpha if Item Deleted**
I think it's a good idea to use technology innovation	8.16	3.174	.844	**.827**
Technology innovation will make my work more interesting	8.34	3.162	.777	**.885**
It's good to make use of the technology innovation	8.16	3.253	.797	**.867**

The results of Table 4.3.5.1 show that all of the scales used to measure students' attitudes can be trusted, as shown by the high Cronbach's alpha values.

As can be seen in the Cronbach's alphas presented above, each of the scales used to measure individual factors is reliable. The table illustrates the reliability of each scale, affirming their suitability for inclusion in fulfilling the research objectives 4 and addressing the research questions 4. Consequently, these scales are incorporated into the study to ensure robustness and validity in the assessment of students' satisfaction.

Table 4.3.6. Summary Of the Total Item Reliability.

Variable	N of Items	Cronbach Alpha	Revised no. of Item	Revised Alpha
Technology Innovation	9	.866	-	-
Moodle Learning Method	4	.896	-	-
Flipped Classroom Method	7	.847	-	-
Students Satisfaction	5	.956	-	-
Students Attitude	3	.902	-	-

Table 4.3.6. displays a thorough and complete summary of the reliability for each of the five variables.

4.4. Factor Analysis

The objective of factor analysis is to categorise variables based on the degree to which they are correlated with one another. The measurement of each variable is related to the concept of factor loadings, which represent the correlation between that variable and the factor that was observed. The concept of communality describes the extent to which a factor accounts for each variable. For example, if the communality value is high, it indicates that a large portion of the variable can be attributed to a single factor in the model. This section presents the findings on retained items that have high loadings (factor scores greater than 0.5). The results showing which items were retained are presented below, organised according to each separate dimension.

Table 4.4.1. Factor analysis for Technology Innovation.

Total Variance Explained									
Component	Initial Eigenvalues[a]			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.324	48.654	48.654	5.324	48.654	48.654	3.480	31.802	31.802
2	1.274	11.642	60.296	1.274	11.642	60.296	3.118	28.493	60.296
3	.990	9.046	69.342						
4	.828	7.570	76.912						
5	.696	6.360	83.272						
6	.515	4.704	87.976						
7	.500	4.572	92.548						
8	.481	4.394	96.942						
9	.335	3.058	100.000						
Extraction Method: Principal Component Analysis.									

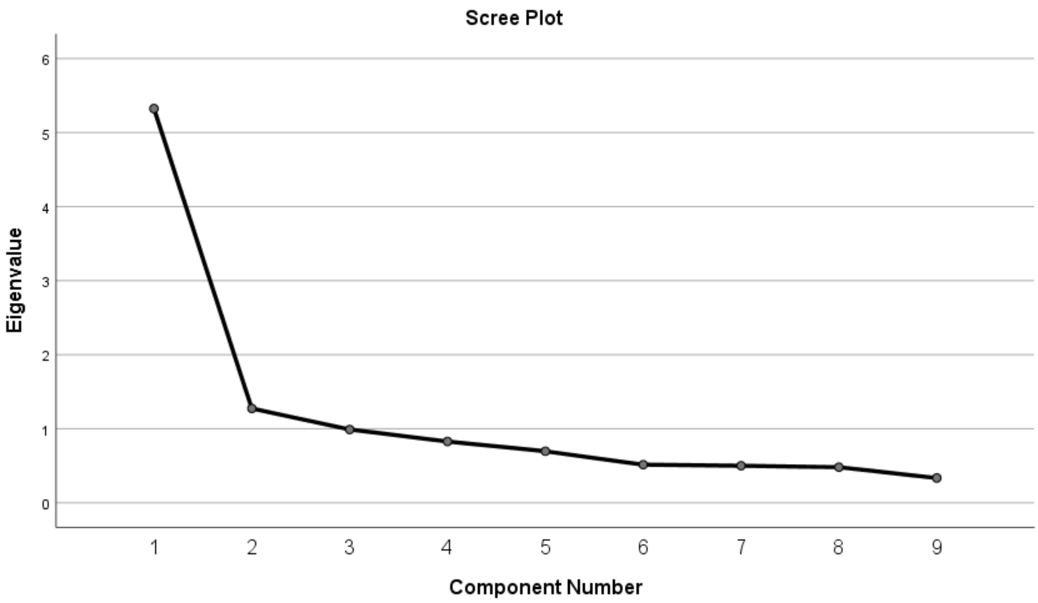
All the factors that can be extracted from an analysis of technological innovation are shown in the table above, along with their eigenvalues, the percentage of variance that can be attributed to each factor, and the cumulative variance of the factor. Based on the results shown in table 4.4.1, two initial eigenvalues were found to be greater than 1, and thus two factors were derived from the data sampled to represent the "technology innovation" dimension. The rotated sums of squared loadings suggested that two factors accounted for roughly 60% of the total variance in the dataset. The retained dataset had a total variance of 60%, with factor 1 individually accounting for 48.7% of that variance and factor 2 accounting for 11.6% of that variance. However, Kaiser's criterion is the one that is most frequently used by researchers, and because of this, factors that are greater than one is kept. There are many different criteria that can be used to determine how many principal components can be retained in a study (Yeomans and Golder, 1982). In this scenario, only two of the components have an eigenvalue that is greater than 1, and as a result, they should both be kept. Because the remaining factors each have a value that is less than 1, we are able to draw the conclusion that they do not play a significant role.

Table 4.4.2. Factor Loadings of Retained Items for Technology Innovation.

Rotated Component Matrix[a]		
	Component	
	1	2
TI: I thoroughly enjoy making use of various forms of information and communication technology.	.521	**.626**
TI2. I believe that making use of ICT helps save time in the classroom.	.584	**.623**
TI3. I am aware that information and communication technology can help me learn many new things.	.428	**.667**
TI4. The use of information and communications technology does not frighten or threaten me.	.012	**1.003**
TI5. When it comes to working with technology in class, I have a great deal of self-assurance.	.360	**.766**
TI6. I would like to acquire additional knowledge regarding the use of ICT In classroom	**.986**	.073
TI7. I am confident that incorporating new technologies into my classroom can help my students learn more.	**.804**	.362
TI8. It is possible to modify the curriculum so that ICT is incorporated.	**.757**	.312
TI9. The failure of ICT equipment does not occur frequently enough to prevent it from being useful.	**.602**	.255
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.		
a. Rotation converged in 3 iterations.		

The results of the retained items with high loadings (factor scores of at least 0.5) are displayed in the table that can be found above. These items are believed to have statistical significance when evaluating the impact of technological innovation on higher education institutions in Johannesburg. The results, which display retained items according to each separate dimension, can be seen up there. According to the data presented in the table, following the execution of the rotation method in which the Varimax with Kaiser Normalization was utilised, there were four aspects of the technological innovation that were found to have a high loading. These particular things are TI1, which has a high loading of 0.626, TI2, which has a high loading of 0.623, TI3, which has a high loading of 0.667, and TI4, which has a high loading of 1.003. During the time spent in component 1, the final three items of the technological advancement have a high loading before the rotation. TI5 has a high loading of 0.986, TI6 has a high loading of 0.804, TI7 also has a high loading of 0.804, TI8 has a high loading of 0.757, and TI9 has a high loading of 0.602. These are the ones we're talking about.

Figure 4.4.1. Scree Plot for Technology Innovation.



The scree plot is an invaluable tool that focuses on determining an appropriate number of principal components; consequently, the scree plot displays the eigenvalues against all of the factors (Mordani, 2015). It helps the researcher determine how many of the factors should be kept by directing them to look for the point where the curve begins to flatten (the point at which the remaining eigenvalues are relatively small). The diagram below demonstrates that the curve starts to flatten between factors 2 and 3, while factors 3–9 have eigenvalues that are less than one. As a result, only the first two factors are kept. Following the factor 1 with an eigenvalue of 5.324 and explaining 48.7% of the total variance is the factor 2 with an eigenvalue of 1.274 and explaining 11.6% of the total variance. The first principal component or factor has the largest eigenvalue with a value of 5.324.

Table 4.4.3. Factor analysis for Moodle Learning Method.

Total Variance Explained						
Component	Initial Eigenvalues[a]			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.656	76.316	76.316	3.656	76.316	76.316
2	.483	10.091	86.407			
3	.364	7.606	94.013			
4	.287	5.987	100.000			
Extraction Method: Principal Component Analysis.						

The above table, which explains the total variance, also provides an illustration of all the factors that can be extracted from the analysis of the Moodle learning method. The eigenvalues, the percentage of variance attributable to each factor, and the total variance attributable to these factors are all displayed. The results that were computed and displayed in table 4.4.3 indicate that there is only one initial eigenvalue that is seen to be greater than 1; consequently, one factor was extracted from the selected items in the dataset for the dimension "Moodle learning method." According to the rotated sums of squared loadings, roughly 76% of the total variance in the dataset could be attributed to just one factor. In this circumstance, only one of the components has an eigenvalue that is greater than 1, and as a result, it should be kept. Because the remaining factors each have a value that is less than 1, we are able to draw the conclusion that they do not play a significant role.

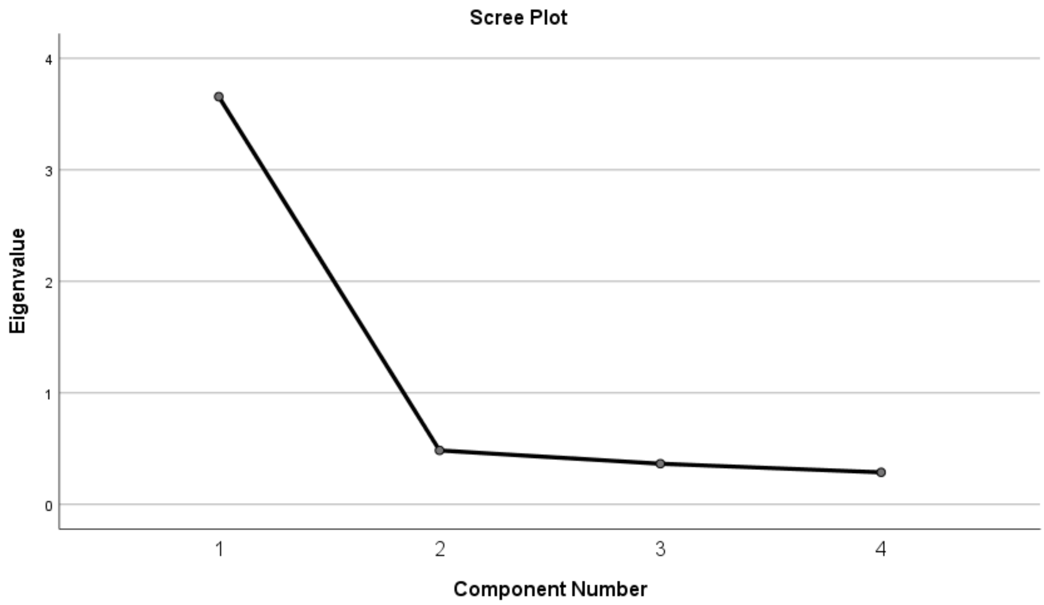
Table 4.4.4. Factor Loadings of Retained Items for Moodle Learning Method.

Component Matrix[a]	
	Component
	1
ML1. I would find Moodle useful for learning	**.924**
ML2. Using Moodle enables me to accomplish tasks more quickly	**.935**
ML3. Using Moodle for learning increases my productivity	**1.004**

ML4. If I use Moodle, I will increase my chances of getting knowledge	**.960**
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.	

This table displays the results on retained items that have high loadings (factor scores of at least 0.5), which are statistically believed to possess significance in determining the impact that the Moodle learning method has had on higher education institutions in Johannesburg. The results showing which items were retained across each of the distinct dimensions are displayed up top. According to the data presented in the table, each of the four aspects of the Moodle learning method that make up component 1 have a high loading in the area where the Varimax with Kaiser Normalization was applied. These items are designated as ML1, which has a high loading of 0.924, ML2, which has a high loading of 0.935, ML3, which has the highest loading of 1.004, and ML4, which has a high loading of 0.960. Due to the fact that there is only one component that was extracted, there is no rotation method that was used because the solution itself cannot be rotated.

Figure 4.4.2. Scree Plot for Moodle Learning Method.



As can be seen in the above scree plot from Figure 4.4.2, the curve starts to flatten between factors 2 and 4. Additionally, factors 2–4 all have eigenvalues that are less than 1, which is why only one factor was kept. The first principal component or factor has an eigenvalue of

3.656, which is the highest of any of the principal components or factors, and it accounts for 76.3% of the total variance.

Table 4.4.5. Factor analysis for Flipped Classroom Method.

Total Variance Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.717	53.097	53.097	3.717	53.097	53.097
2	.894	12.765	65.862			
3	.722	10.318	76.180			
4	.497	7.099	83.279			
5	.430	6.145	89.424			
6	.412	5.891	95.315			
7	.328	4.685	100.000			
Extraction Method: Principal Component Analysis.						

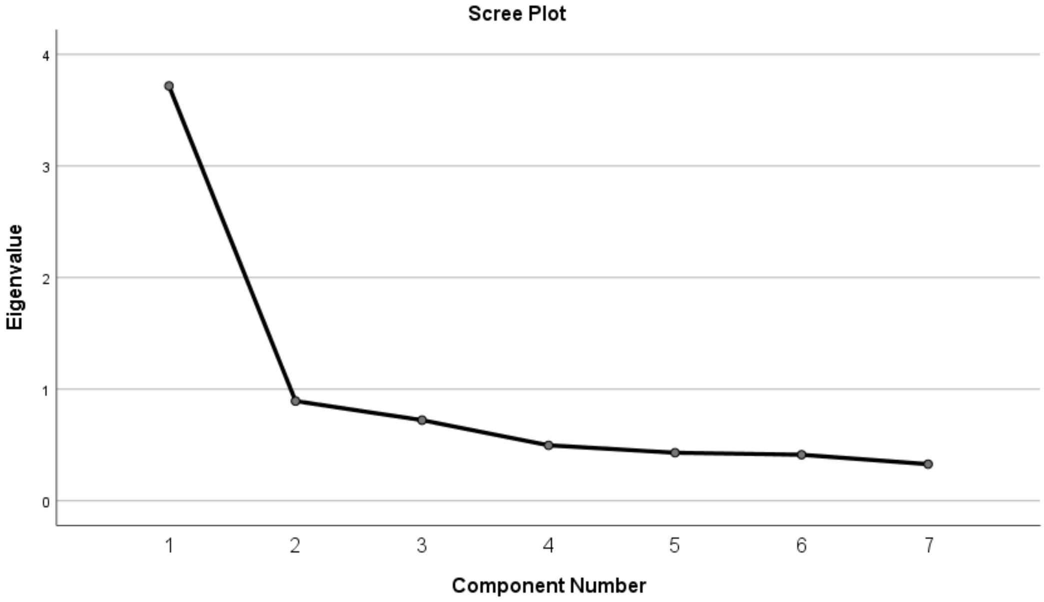
The above table, which explains the total variance, also includes an illustration of all the factors that can be extracted from the analysis of the flipped classroom method. These factors are shown along with their eigenvalues, the percentage of variance that can be attributed to each factor, and the cumulative variance of the factor. According to the results that were computed and displayed in table 4.4.5, there is only one initial eigenvalue that is observed to be greater than 1; consequently, one factor was extracted from the selected items in the dataset for the dimension "flipped classroom method." According to the rotated sums of squared loadings, approximately 53 percent of the total variance in the dataset could be attributed to a single factor. In this circumstance, only one of the components has an eigenvalue that is greater than 1, and as a result, it should be kept. Because the remaining factors each have a value that is less than 1, we are able to draw the conclusion that they do not play a significant role.

Table 4.4.6. Factor Loadings of Retained Items for Flipped Classroom Method.

Component Matrix[a]	
	Component
	1
FC1. The use of the flipped classroom method in my vocabulary class prevents me from becoming uninterested in the material.	**.766**
FC2. My ability to learn on my own is facilitated by the flipped classroom method.	**.778**
FC3. I appreciate the opportunity to learn through the flipped classroom method.	**.804**
FC4. A live lecture in the classroom can provide me with more information than watching a video at home can.	**.639**
FC5: The flipped classroom method of instruction contributes to an increase in my level of anxiety.	**.747**
FC6: It is difficult for me to gain access to the internet and watch the videos that have been assigned for	**.604**
FC7. The flipped classroom method of instruction is not one that I favour, as stated in	**.740**
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.	

The results of the retained items with high loadings (factor scores of at least 0.5) are displayed in the table that can be found above. These results are believed to have statistical significance when evaluating the impact of the flipped classroom method on higher education institutions in Johannesburg. The results, which display retained items according to each separate dimension, can be seen up there. According to the data presented in the table, all seven of the flipped classroom method's items that make up component 1 have a high loading in the areas where the Varimax with Kaiser Normalization was utilised. FC1 has a high loading of 0.766, FC2 has a high loading of 0.778, FC3 has the highest loading of 0.804, FC4 has a high loading of 0.639, FC5 has a high loading of 0.747, FC6 has a high loading of 0.604, and FC7 has a high loading of 0.740. These are the items. There was only one component that needed to be extracted, so there was no need to use a rotation method because the solution itself could not be rotated.

Figure 4.4.3. Scree Plot for Flipped Classroom Method.



The above scree plot of Figure 4.4.3 demonstrates that the curve starts to flatten between factors 2 and also shows that factors 2 through 7 have eigenvalues that are less than one. As a result, only one factor was kept in the analysis. The first principal component or factor has an eigenvalue of 3.717, making it the component with the largest eigenvalue. It also explains 53% of the total variance.

Table 4.4.7. Factor analysis for Students Satisfaction.

Total Variance Explained						
	Initial Eigenvalues[a]			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.669	85.203	85.203	6.669	85.203	85.203
2	.434	5.549	90.751			
3	.301	3.851	94.603			
4	.252	3.215	97.818			
5	.171	2.182	100.000			
Extraction Method: Principal Component Analysis.						

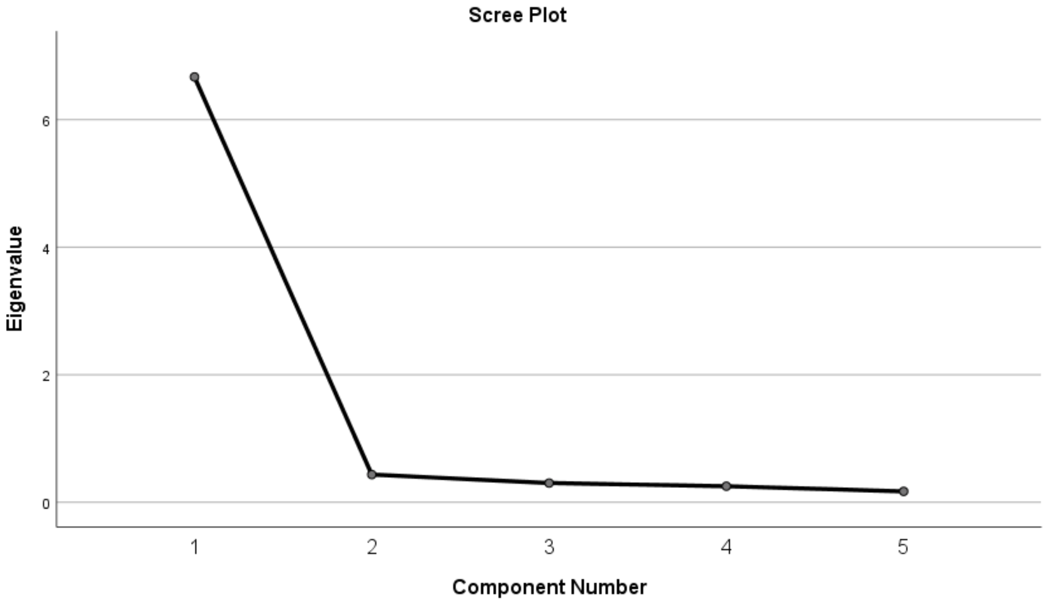
The cumulative variance of the factor is shown in the table that is located above the explanation of the total variance. The table also contains the eigenvalues of the factors, the percentage of variance that can be attributed to each factor, and the total variance that can be attributed to the analysis of the students' satisfaction. Due to the fact that the computed results from table 4.4.7 indicate the presence of only one initial eigenvalue that is seen to be greater than 1, only one factor was extracted from the selected items in the dataset for the dimension "students' satisfaction." According to the rotated sums of squared loadings, approximately 85 percent of the total variance in the dataset could be attributed to a single factor. In this circumstance, only one of the components has an eigenvalue that is greater than 1, and as a result, it should be kept. Because the remaining factors each have a value that is less than 1, we are able to draw the conclusion that they do not play a significant role.

Table 4.4.8. Factor Loadings of Retained Items for Students Satisfaction.

Component Matrix[a]	
	Component
	1
SS1. I was very content with mobile learning	**1.130**
SS2. I was very pleased with mobile learning	**1.187**
SS3. I was satisfied with mobile learning efficiency	**1.095**
SS4. I felt delighted with mobile learning	**1.175**
SS5. Overall, I was satisfied with mobile learning	**1.185**
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.	

The results of the retained items with high loadings (factor scores of at least 0.5) are displayed in the table that can be found above. These results are statistically believed to possess significance in determining the impact of student satisfaction on higher education institutions in Johannesburg. The results, which display retained items according to each separate dimension, can be seen up there. According to the data presented in the table, each of the five factors that determine the level of satisfaction felt by students in relation to component 1 receive a high loading when the Varimax method with Kaiser Normalization is applied. The items in question are as follows: SS1, which has a high loading of 1.130; SS22, which has the highest loading of 1.187; SS3, which has a high loading of 1.095; SS4, which has a high loading of 1.175; and, finally, SS5, which has a high loading of 1.185. There was only one component that needed to be extracted, so there was no need to use a rotation method because the solution itself could not be rotated.

Figure 4.4.4. Scree Plot for Students Satisfaction.



The above scree plot of Figure 4.4.4 demonstrates that the curve starts to flatten between factors 2 and also shows that factors 2 through 5 have eigenvalues that are less than one. As a result, only one factor was kept in the analysis. The first principal component or factor has an eigenvalue of 6.669, which is the highest value possible, and it is responsible for explaining 85% of the total variance.

Table 4.4.9. Factor analysis for Students Attitude.

Total Variance Explained						
	Initial Eigenvalues[a]			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.286	83.613	83.613	2.286	83.613	83.613
2	.278	10.173	93.786			
3	.170	6.214	100.000			
Extraction Method: Principal Component Analysis.						

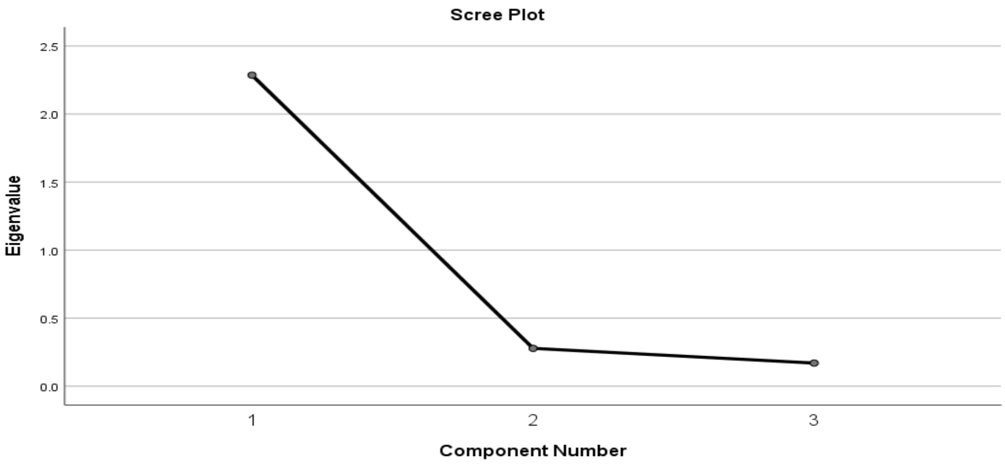
The table that can be found above contains an explanation for the overall variance, which can be found there. This table provides an illustration of all the factors that can be extracted from the study of the students' attitudes, as well as their eigenvalues, the percentage of variance that can be attributed to each factor, and the cumulative variance of the factor. The study was conducted on the attitudes of the students. According to the results that were computed and displayed in table 4.4.9, there is only one initial eigenvalue that is seen to be greater than 1; as a result, one factor was extracted from the selected items in the dataset for the dimension titled "students' attitude." The rotated sums of squared loadings indicated that only one factor was responsible for approximately 83.6% of the total variance that was found in the dataset. In this particular situation, there is only one of the components that has an eigenvalue that is greater than 1, and as a result, it is the one that should be retained. We are able to arrive at the conclusion that the remaining factors do not make a significant contribution to the overall result due to the fact that each of these factors has a value that is less than 1.

Table 4.4.10. Factor Loadings of Retained Items for Students Attitude.

Component Matrix[a]	
	Component
	1
SA1. I think it's a good idea to use technology innovation	**.869**
SA2. Technology innovation will make my work more interesting	**.893**
SA3. It's good to make use of the technology innovation	**.856**
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.	

The results of the retained items with high loadings (factor scores of at least 0.5) are displayed in the table that can be found above. These results are believed to have statistical significance when evaluating the impact of students' attitudes on higher education institutions in Johannesburg. The results, which display retained items according to each separate dimension, can be seen up there. According to the data presented in the table, each of the three aspects of the students' attitudes that make up component 1 of the analysis that used the Varimax with Kaiser Normalization have a high loading. These items are SA1 with a high loading of 0.869, SA2 with the highest loading of 0.893, and SA3 with a high loading of 0.856. Each of these has a high loading. There was only one component that needed to be extracted, so there was no need to use a rotation method because the solution itself could not be rotated.

Figure 4.4.5. Scree Plot for Students Attitude.



As can be seen in the above scree plot from Figure 4.4.5, the curve starts to flatten between factors 2 and 3. Additionally, factors 2–3 all have eigenvalues that are less than 1, which is why only one factor was kept. The first principal component or factor has an eigenvalue of 2.286, which is the highest value possible, and it is responsible for explaining 83.6% of the total variance.

4.5. Demographic Information

This research was carried out with the participation of 351 undergraduates from both private and public educational institutions. Because it was a self-administered survey, the researcher was able to clarify any questions that were unclear, which significantly contributed to the response rate. All of the participants answered all of the questions that were asked in their entirety, which can be attributed to the fact that it was a self-administered survey.

Table 4.5.1. demographic factors distribution.

Statistics				
		Gender	Age	University
N	Valid	351	351	351
	Missing	0	0	0
Mean		1.61	2.99	1.23
Median		2.00	3.00	1.00

Mode	2	4	1
Skewness	.308	-.187	1.805
Std. Error of Skewness	.130	.130	.130
Kurtosis	-.733	-.971	3.731
Std. Error of Kurtosis	.260	.260	.260
Sum	566	1048	431

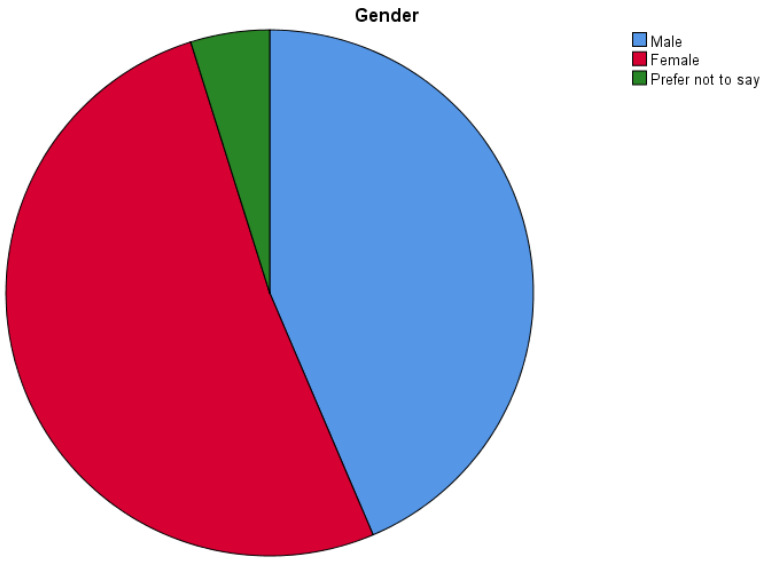
A frequency distribution of the demographic factors is presented in the following table. There was a total of 351 responses that were looked over. The following are the respective means for each factor: gender (1.61), age group (2.99), and university (1.23).

Table 4.5.2. Gender distribution.

Gender					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	153	43.6	43.6	43.6
	Female	181	51.6	51.6	95.2
	Prefer not to say	17	4.8	4.8	100.0
	Total	351	100.0	100.0	

The demographics statistics for gender are broken down as follows: 153 respondents (43.6%) were male, 181 respondents (51.6%) were female, and 17 respondents (4.8%) preferred not to say what gender they were. These results can be found in the table that follows. The gender breakdown is depicted in the pie chart that can be found below. Table 4.5.1. The example given above demonstrates that the data have a leftward bias in terms of gender distribution because the mean value (1.61), which is lower than the median value (2.00). When the kurtosis is negative, it indicates that the peak of the distribution is not very high. In Appendix B, you'll find a bar chart that breaks down the gender breakdown.

Figure 4.5.1. Gender pie chart.



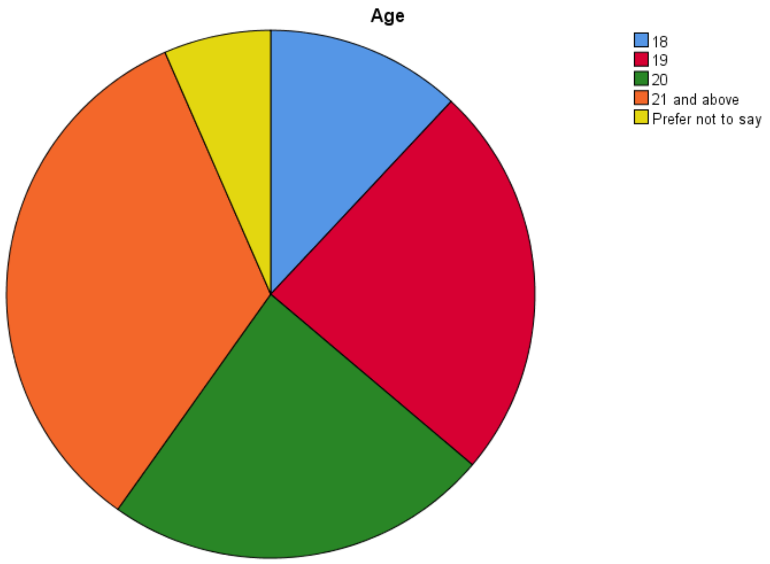
The gender profile is presented in the form of a pie chart in Figure 1, which reveals that the majority of respondents were female.

Table 4.5.3. Age distribution.

Age					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18	42	12.0	12.0	12.0
	19	85	24.2	24.2	36.2
	20	83	23.6	23.6	59.8
	21 and above	118	33.6	33.6	93.4
	Prefer not to say	23	6.6	6.6	100.0
	Total	351	100.0	100.0	

The age breakdown of all 351 respondents who took part in this research is presented in the table that can be found above. A total of 23 respondents (6.6%) chose not to disclose their age, 42 respondents (12%) are of the age of 18 years, 85 respondents (24.2%) are of the age of 19 years, 83 respondents (23.6%) are of the age of 20 years, 118 respondents (33.6%) are between the ages of 21 and above, and a total of 42 respondents (12%) are of the age of 18 years. The breakdown of ages is depicted in the pie chart that can be found below. Table 4.5.1 illustrates that the data are skewed to the left in terms of the distribution of age groups. This is due to the fact that the mean (2.99) is lower than the median value (3.00). Appendix B contains a bar chart that illustrates the distribution of ages.

Figure 4.5.2. Age pie chart



According to the pie chart representing the age groups, 33.6% of the respondents were in the age range of 21 and older. The remainder of the age distribution can be seen displayed in the pie chart.

Table 4.5.4. University distribution.

University					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Public University	273	77.8	77.8	77.8
	Private University	77	21.9	21.9	99.7
	Prefer not to say	1	.3	.3	100.0
	Total	351	100.0	100.0	

The educational levels of each of the 351 respondents who took part in this research are broken down in the table that can be found above. The public universities in Johannesburg were represented by 273 of the respondents (77.8%) of the total students. While 77 of the total students were from a private university in Johannesburg, 21.9% of the respondents came from that institution. Last but not least, out of the total number of students surveyed, only one respondent (0.3%) chose to remain anonymous regarding their educational establishment. The distribution of people's levels of education is depicted in the following pie chart. The data from the university distribution are shown to be skewed to the right in the aforementioned Table 4.5.1 due to the fact that the mean (1.23), which is greater than the median (1.00). Appendix B contains a bar chart that illustrates the distribution of educational levels.

4.6. Descriptive Statistics

This section goes over the descriptive statistics for each section, including the median, skewness, kurtosis, and frequency chats.

Table 4.6.1. Descriptive Statistics for Technology Innovation.

Descriptive Statistics						
	Mean	Median	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
I take pleasure in making use of various forms of information and communication technology.	3.86	4.00	-.856	.130	.279	.260
I believe that making use of ICT in the classroom helps save time, and I am aware that ICT can assist me in learning many new things.	3.87	4.00	-.914	.130	.229	.260

When it comes to working with technology in the classroom, I have a very positive attitude and I do not feel threatened or intimidated by using ICT. I want to learn more about how to use ICT in the classroom because I believe that ICT has the potential to significantly improve my teaching practise.	4.04	4.00	-1.011	.130	.673	.260
It is possible to modify the curriculum in order to incorporate ICT.	3.86	4.00	-.825	.130	-.035	.260
The information and communications technology that we rely on rarely experiences failures that prevent it from being useful.	3.88	4.00	-.768	.130	-.134	.260
I take pleasure in making use of various forms of information and communication technology.	3.63	4.00	-.547	.130	-.591	.260

I believe that making use of ICT in the classroom helps save time, and I am aware that ICT can assist me in learning many new things.	3.66	4.00	-.474	.130	-.436	.260
When it comes to working with technology in the classroom, I have a very positive attitude and I do not feel threatened or intimidated by using ICT. I want to learn more about how to use ICT in the classroom because I believe that ICT has the potential to significantly improve my teaching practise.	3.81	4.00	-.785	.130	.064	.260
It is possible to modify the curriculum in order to incorporate ICT.	3.29	3.00	-.097	.130	-.490	.260

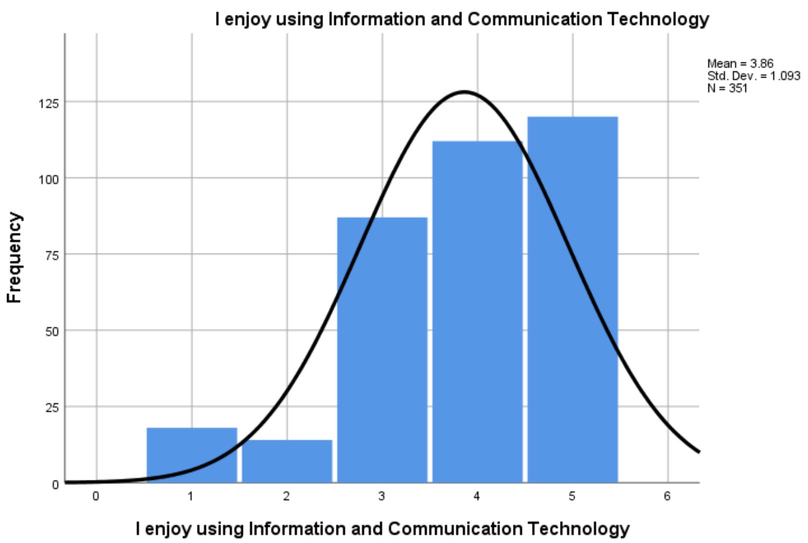
A frequency distribution of the technological innovation items utilised for this research can be seen in table 4.6.1, which can be found above. We looked into a total of 9 different questions. The following tables present a comprehensive breakdown of the frequency distribution for each component of technological advancement.

Table 4.6.2. Descriptive statistics for technology innovation frequency distributions item 1.

I enjoy using Information and Communication Technology					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	18	5.1	5.1	5.1
	Disagree	14	4.0	4.0	9.1
	Neutral	87	24.8	24.8	33.9
	Agree	112	31.9	31.9	65.8
	Strongly Agree	120	34.2	34.2	100.0
	Total	351	100.0	100.0	

The data presented in table 4.6.2 shows that out of 351 respondents, 32 respondents (9.1%) disagreed with the statement that asked if they enjoy using information and communication technology, while 232 respondents (66.1%) agreed with the statement, and 87 respondents (24.8%) were neutral to the statement. The descriptive statistics for item 1, on the other hand, reveal a skewness of -.856 and a kurtosis of.279 respectively.

Figure 4.6.1. Histogram distributions for technology innovation item 1.



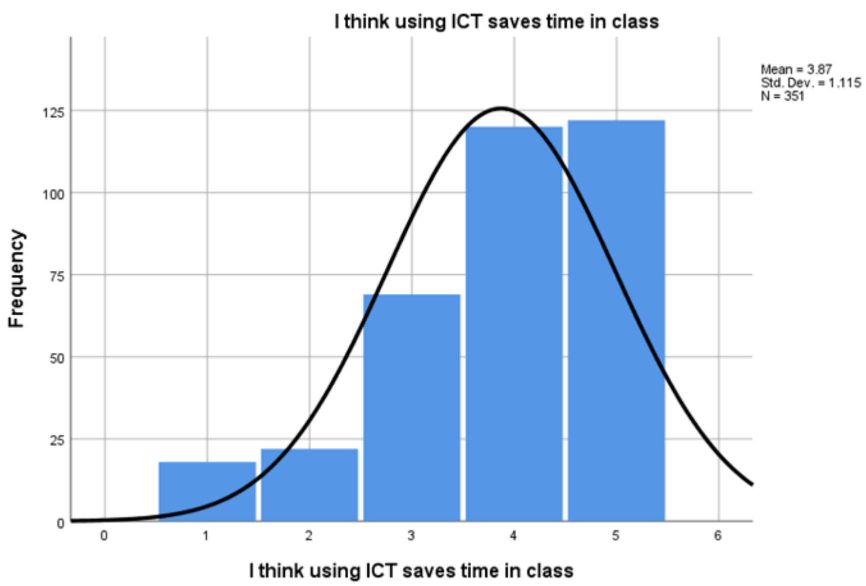
The histogram for question 1 is shown above, and it can be seen that it has a slight leftward tilt due to the fact that the mean score (3.86) is lower than the median (4.00).

Table 4.6.3. Descriptive statistics for technology innovation frequency distributions item 2.

I think using ICT saves time in class					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	18	5.1	5.1	5.1
	Disagree	22	6.3	6.3	11.4
	Neutral	69	19.7	19.7	31.1
	Agree	120	34.2	34.2	65.2
	Strongly Agree	122	34.8	34.8	100.0
	Total	351	100.0	100.0	

According to the data presented in the table 4.6.3 above, out of a total of 351 respondents, 40 respondents (11.4%) disagreed with the statement that using ICT saves time in class, 242 respondents (69%) agreed with the statement, and 69 respondents (19.7%) were neutral to the statement. The descriptive statistics for item 2, on the other hand, reveal a skewness of -.914 and a kurtosis of.229 respectively.

Figure 4.6.2. Histogram distributions for technology innovation item 2.



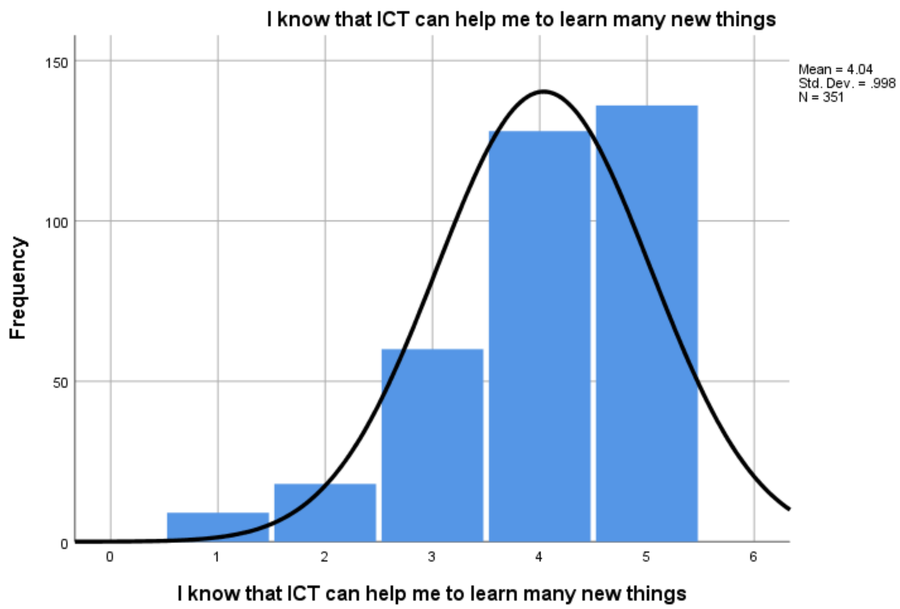
The histogram for question 2 is slightly skewed to the left, as shown above, due to the fact that the mean score (3.87) is lower than the median score (4.00).

Table 4.6.4. Descriptive statistics for technology innovation frequency distributions item 3.

I know that ICT can help me to learn many new things					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	9	2.6	2.6	2.6
	Disagree	18	5.1	5.1	7.7
	Neutral	60	17.1	17.1	24.8
	Agree	128	36.5	36.5	61.3
	Strongly Agree	136	38.7	38.7	100.0
	Total	351	100.0	100.0	

According to the data presented in the table 4.6.4 above, out of a total of 351 respondents, 27 respondents (7.7%) disagreed with the statement if they know that ICT can help them learn many new things, 264 respondents (75.2%) agreed with the statement, and 60 respondents (17.1%) were neutral to the statement. The descriptive statistics for item 3, on the other hand, reveal a skewness of -1.011 and a kurtosis of.673, respectively.

Figure 4.6.3. Histogram distributions for technology innovation item 3.



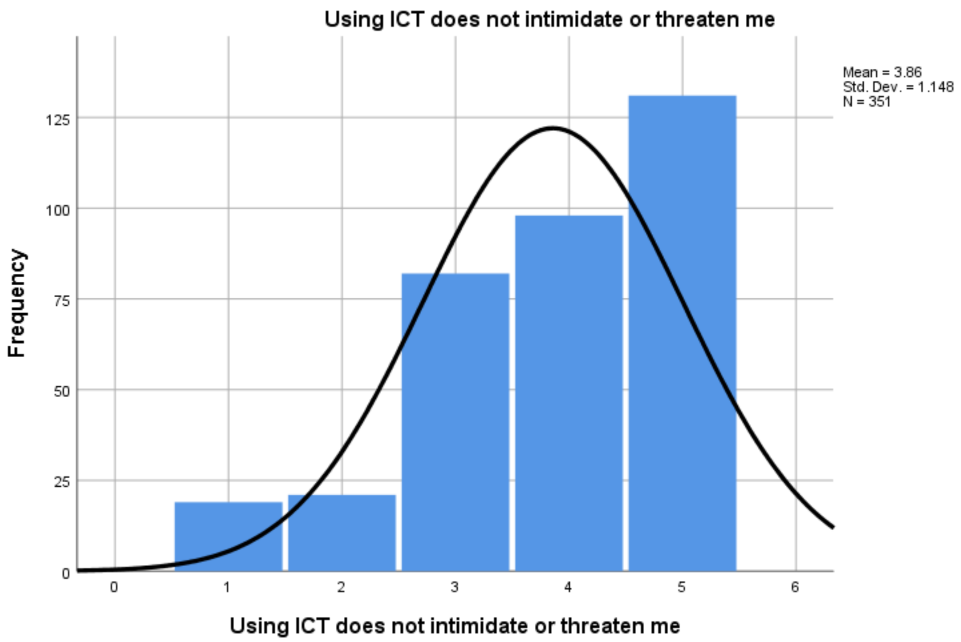
The histogram for question 3 is shown above, and it can be seen that it has a slight rightward tilt due to the fact that the mean score (4.04) is higher than the median score (4.00).

Table 4.6.5. Descriptive statistics for technology innovation frequency distributions item 4.

Using ICT does not intimidate or threaten me					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	19	5.4	5.4	5.4
	Disagree	21	6.0	6.0	11.4
	Neutral	82	23.4	23.4	34.8
	Agree	98	27.9	27.9	62.7
	Strongly Agree	131	37.3	37.3	100.0
	Total	351	100.0	100.0	

According to the data presented in the table 4.6.5 above, out of 351 respondents, 40 respondents (11.4%) disagreed with the statement, 229 respondents (65.2%) agreed with the statement, and 82 respondents (23.4%) had no opinion regarding the statement if using ICT does not intimidate or threaten them. On the other hand, the descriptive statistics for item 4 reveal that its skewness is -.825 and its kurtosis is -.035, respectively.

Figure 4.6.4. Histogram distributions for technology innovation item 4.



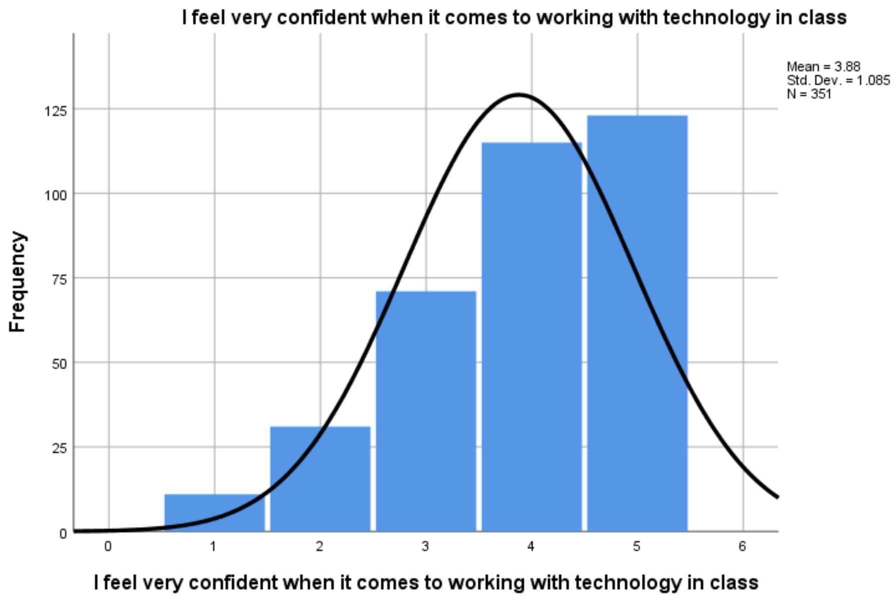
The histogram depicted above shows that question 4 has a slight leftward tilt (skewed) due to the fact that the mean score (3.86) is lower than the median score (4.00).

Table 4.6.6. Item 5 descriptive statistics for frequency distributions of technological innovation.

When it comes to using technology in class, I am very confident.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	11	3.1	3.1	3.1
	Disagree	31	8.8	8.8	12.0
	Neutral	71	20.2	20.2	32.2
	Agree	115	32.8	32.8	65.0
	Strongly Agree	123	35.0	35.0	100.0
	Total	351	100.0	100.0	

According to the data presented in the table 4.6.6. above, out of 351 respondents, 42 respondents (11.9%) disagreed with the statement, 238 respondents (67.8%) agreed with the statement, and 71 respondents (20.2%) were neutral to the statement regarding whether or not they feel very confident when it comes to working with technology in the classroom. On the other hand, the descriptive statistics for item 5 reveal that its skewness is -.768 and its kurtosis is -.134, respectively.

Figure 4.6.5. Histogram distributions for technology innovation item 5.



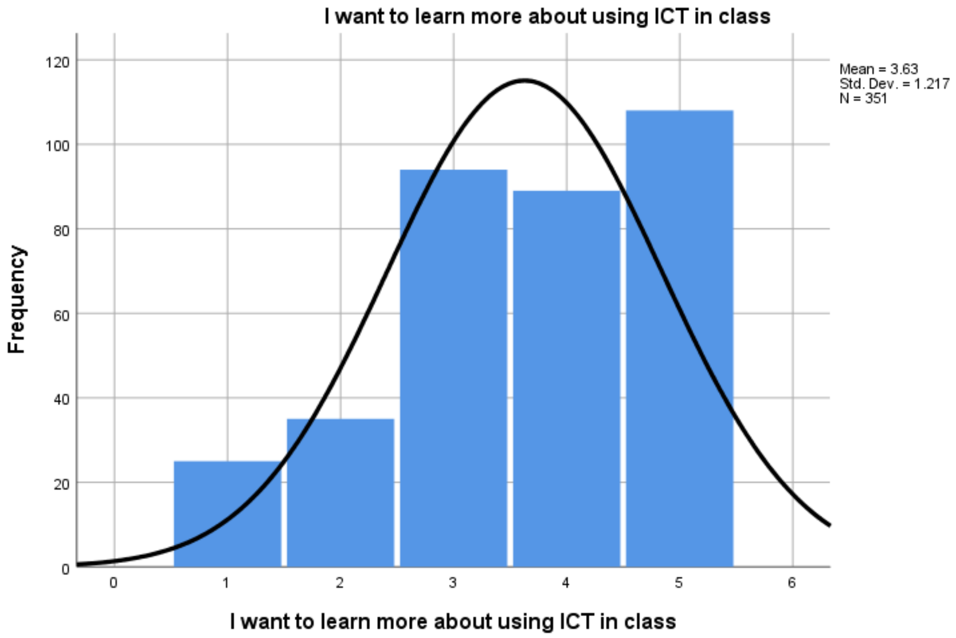
The histogram depicted above shows that question 5 has a slight leftward tilt (Skewed) due to the fact that the mean score (3.88) is lower than the median score (4.00).

Table 4.6.7. Descriptive statistics for technology innovation frequency distributions item 6.

I want to learn more about using ICT in class					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	25	7.1	7.1	7.1
	Disagree	35	10.0	10.0	17.1
	Neutral	94	26.8	26.8	43.9
	Agree	89	25.4	25.4	69.2
	Strongly Agree	108	30.8	30.8	100.0
	Total	351	100.0	100.0	

According to the data presented in the table 4.6.7 above, out of 351 respondents, 60 respondents (17.1%) disagreed with the statement if they want to learn more about utilising ICT in the classroom, 197 respondents (56.2%) agreed with the statement, and 94 respondents (26.8%) were neutral to the statement. The descriptive statistics for item 6, on the other hand, reveal a skewness of -.547 and a kurtosis of -.591 respectively.

Figure 4.6.6. Histogram distributions for technology innovation item 6.



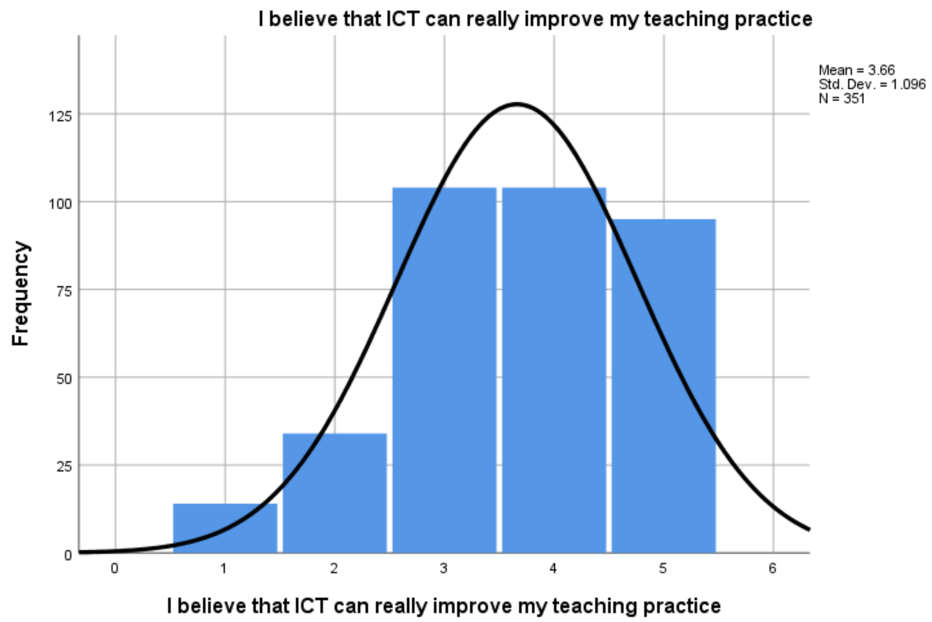
The histogram depicted above shows that question 6 has a slight leftward tilt due to the fact that the mean score (3.88) is lower than the median score (4.00).

Table 4.6.8. Descriptive statistics for technology innovation frequency distributions item 7.

I believe that ICT can really improve my teaching practice					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	14	4.0	4.0	4.0
	Disagree	34	9.7	9.7	13.7
	Neutral	104	29.6	29.6	43.3
	Agree	104	29.6	29.6	72.9
	Strongly Agree	95	27.1	27.1	100.0
	Total	351	100.0	100.0	

According to the data presented in table 4.6.8 above, out of 351 respondents, 48 respondents (13.7%) disagreed with the statement, 199 respondents (56.7%) agreed with the statement, and 104 respondents (29.6%) were neutral to the statement when asked if they believe that ICT can really improve their teaching practise. The descriptive statistics for item 7, on the other hand, reveal a skewness of -.474 and a kurtosis of -.436 respectively.

Figure 4.6.7. Histogram distributions for technology innovation item 7.



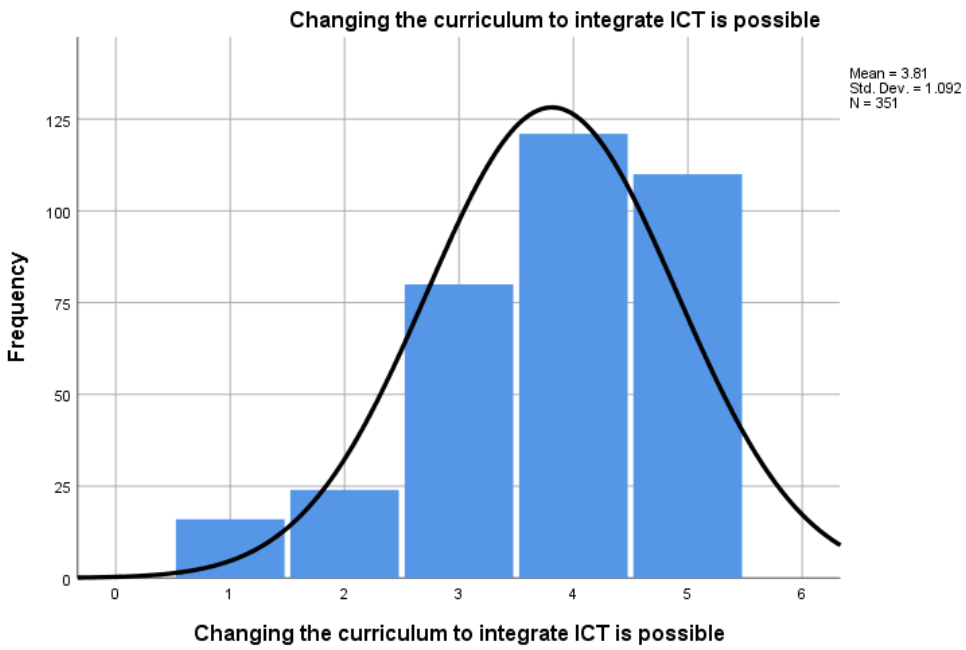
The histogram depicted above shows that question 7 has a slight leftward tilt due to the fact that the mean score (3.66) is lower than the median score (4.00).

Table 4.6.9. Descriptive statistics for technology innovation frequency distributions item 8.

Changing the curriculum to integrate ICT is possible						
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	16	4.6	4.6	4.6
	Disagree	24	6.8	6.8	11.4
	Neutral	80	22.8	22.8	34.2
	Agree	121	34.5	34.5	68.7
	Strongly Agree	110	31.3	31.3	100.0
	Total	351	100.0	100.0	

According to the data presented in table 4.6.9 above, out of a total of 351 respondents, 40 respondents (11.4%) disagreed with the statement that altering the curriculum to incorporate ICT is possible, while 231 respondents (65.8%) agreed with the statement, and 80 respondents (22.8%) were neutral regarding the statement. On the other hand, the descriptive statistics for item 8 reveal a skewness of -7.85 and a kurtosis of -0.64 respectively.

Figure 4.6.8. Histogram distributions for technology innovation item 8.



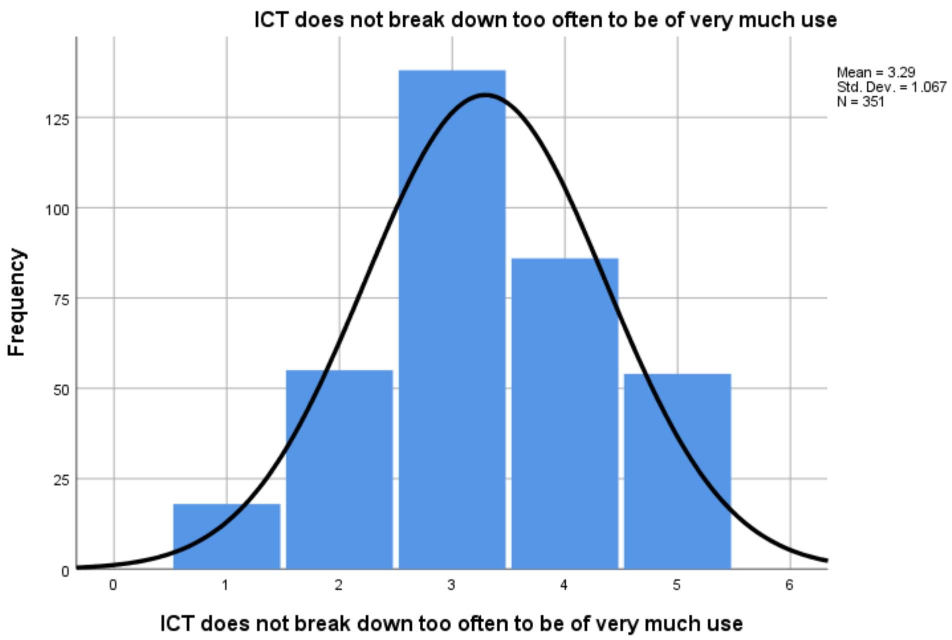
The histogram depicted above shows that question 8 has a slight leftward tilt due to the fact that the mean score (3.81) is lower than the median score (4.00).

__Table 4.6.10. Descriptive statistics for technology innovation frequency distributions item 9.__

ICT does not break down too often to be of very much use					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	18	5.1	5.1	5.1
	Disagree	55	15.7	15.7	20.8
	Neutral	138	39.3	39.3	60.1
	Agree	86	24.5	24.5	84.6
	Strongly Agree	54	15.4	15.4	100.0
	Total	351	100.0	100.0	

The data presented in table 4.6.10 demonstrates that out of 351 respondents, 73 respondents (20.8%) disagreed with the statement if ICT does not break down too often to be very much use, 140 respondents (39.9%) agreed with the statement, and 138 respondents (39.3%) were neutral regarding the statement. The descriptive statistics for item 9, on the other hand, reveal a skewness of -.097 and a kurtosis of -.490 respectively.

__Figure 4.6.9. Histogram distributions for technology innovation item 9.__



The histogram for question 9 is shown above, and it can be seen that it has a slight rightward tilt due to the fact that the mean score (3.29) is higher than the median (3.00).

Table 4.6.11. Descriptive Statistics for Moodle Learning Method.

Descriptive Statistics						
	Mean	Median	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
I would find Moodle useful for learning	3.48	4.00	-.404	.130	-.354	.260
Using Moodle enables me to accomplish tasks more quickly	3.43	3.00	-.353	.130	-.353	.260
Using Moodle for learning increases my productivity	3.23	3.00	-.089	.130	-.574	.260
If I use Moodle, I will increase my chances of getting knowledge	3.21	3.00	-.122	.130	-.446	.260

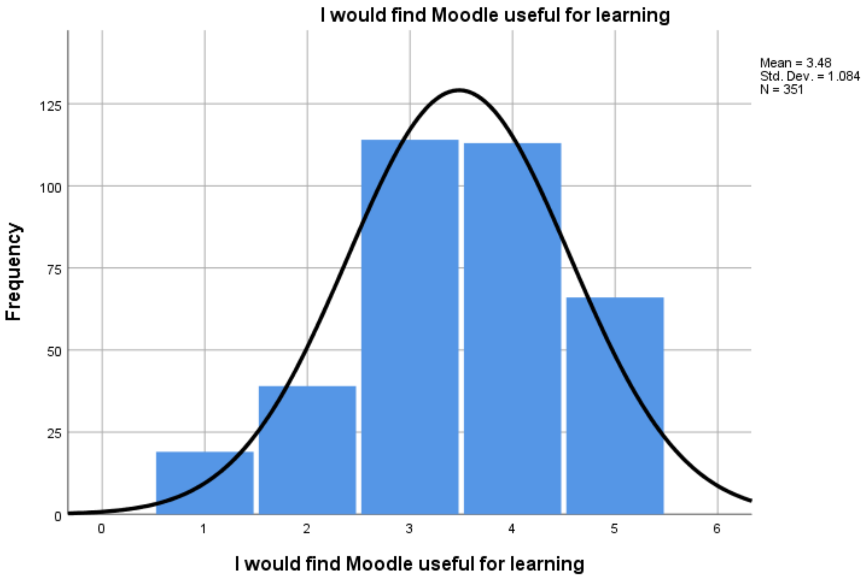
A frequency distribution of the Moodle learning method items that were utilised for this study can be seen in the table 4.6.11 above. The answers to a total of four questions were examined. The tables that follow display a comprehensive frequency distribution for each individual item that makes up the Moodle learning method.

Table 4.6.12. Descriptive statistics for Moodle learning method frequency distributions item 1.

I would find Moodle useful for learning					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	19	5.4	5.4	5.4
	Disagree	39	11.1	11.1	16.5
	Neutral	114	32.5	32.5	49.0
	Agree	113	32.2	32.2	81.2
	Strongly Agree	66	18.8	18.8	100.0
	Total	351	100.0	100.0	

According to the data presented in table 4.6.12 above, out of 351 respondents, 58 respondents (16.5%) disagreed with the statement that Moodle would be useful for learning, 179 respondents (51%) agreed with the statement, and 114 respondents (32.5%) were neutral regarding the statement. On the other hand, the descriptive statistics for item 1 reveal that its skewness is -.404 and its kurtosis is -.354 respectively.

Figure 4.6.10. Histogram distributions for Moodle learning method item 1.



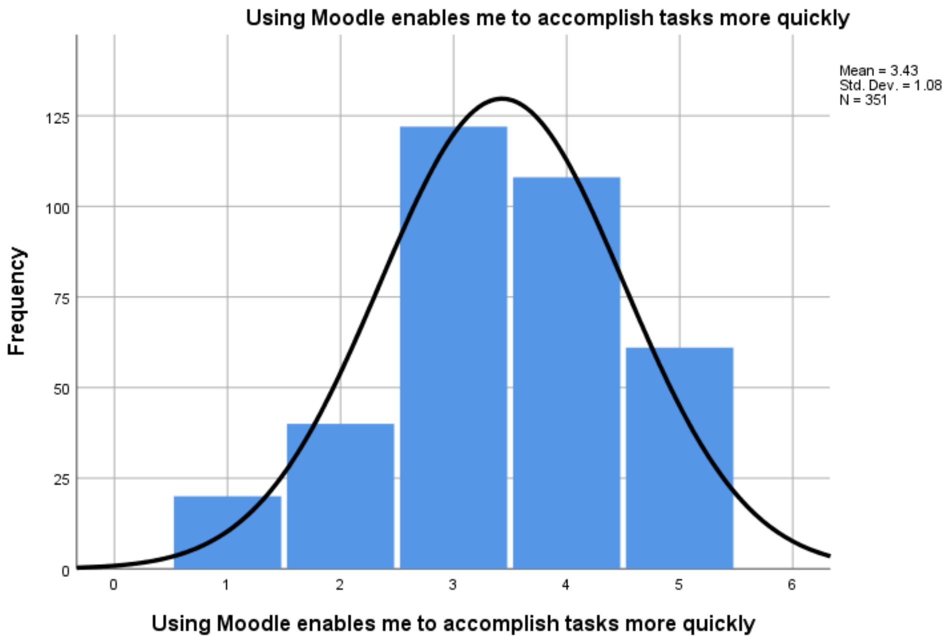
The histogram for question 1 is slightly skewed to the left, as shown above, due to the fact that the mean score (3.48) is lower than the median score (4.00).

Table 4.6.13. Descriptive statistics for Moodle learning method frequency distributions item 2.

Using Moodle enables me to accomplish tasks more quickly					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	20	5.7	5.7	5.7
	Disagree	40	11.4	11.4	17.1
	Neutral	122	34.8	34.8	51.9
	Agree	108	30.8	30.8	82.6
	Strongly Agree	61	17.4	17.4	100.0
	Total	351	100.0	100.0	

According to the data presented in table 4.6.13, which can be found above, out of 351 respondents, 122 (30.8%) were neutral, 169 (48.1%) agreed, and 60 (17.1%) disagreed with the statement that using Moodle enables them to complete tasks more quickly. The descriptive statistics for item 2, on the other hand, reveal a skewness of -.353 and a kurtosis of the same value.

Figure 4.6.11. Histogram distributions for Moodle learning method item 2.



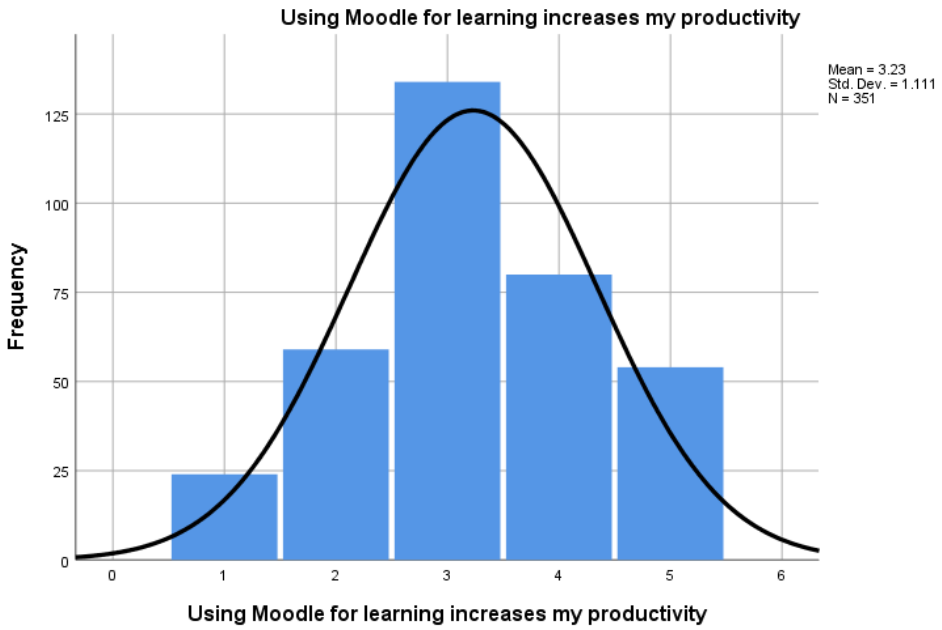
The histogram for question 2 is slightly skewed to the right, as shown in the image above, because the mean score (3.43), which is higher, is greater than the median score (3.00).

Table 4.6.14. Descriptive statistics for Moodle learning method frequency distributions item 3.

Using Moodle for learning increases my productivity					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	24	6.8	6.8	6.8
	Disagree	59	16.8	16.8	23.6
	Neutral	134	38.2	38.2	61.8
	Agree	80	22.8	22.8	84.6
	Strongly Agree	54	15.4	15.4	100.0
	Total	351	100.0	100.0	

According to the data in table 4.6.14, which can be found above, out of 351 respondents, 83 respondents (23.6%) disagreed with the statement that using Moodle for learning increases their productivity, 134 respondents (38.1%) agreed with the statement, and 134 respondents (38.1%) were neutral regarding the statement. The descriptive statistics for item 3, on the other hand, reveal a skewness of -.089 and a kurtosis of -.574 respectively.

Figure 4.6.12. Histogram distributions for Moodle learning method item 3.



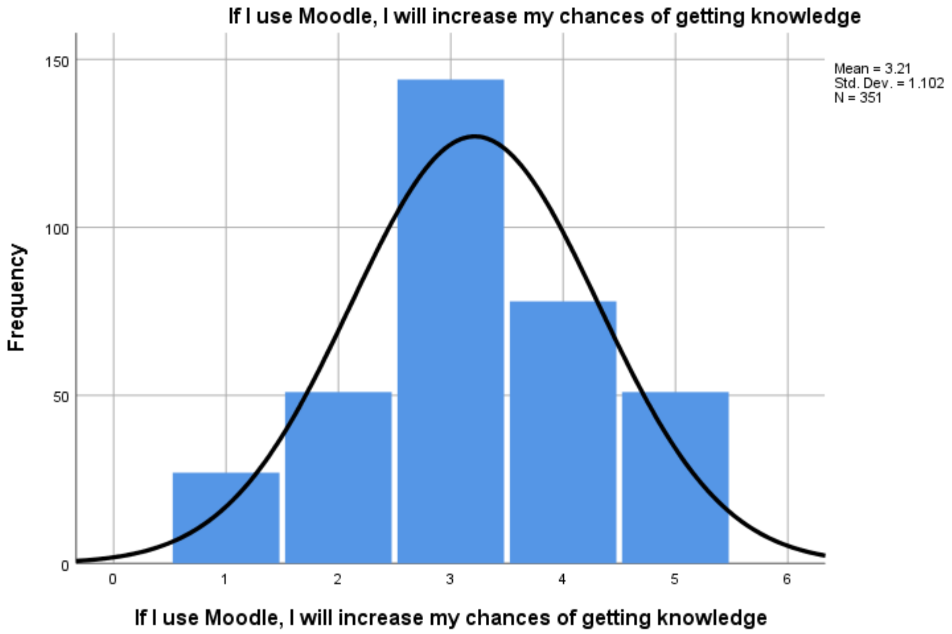
The histogram for question 3 is shown above, and it can be seen that it has a slight rightward tilt (skewed) due to the fact that the mean score (3.23) is higher than the median (3.00).

Table 4.6.15. Descriptive statistics for Moodle learning method frequency distributions item 4.

If I use Moodle, I will increase my chances of getting knowledge					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	27	7.7	7.7	7.7
	Disagree	51	14.5	14.5	22.2
	Neutral	144	41.0	41.0	63.2
	Agree	78	22.2	22.2	85.5
	Strongly Agree	51	14.5	14.5	100.0
	Total	351	100.0	100.0	

According to the data presented in table 4.6.15, out of a total of 351 respondents, 78 respondents (22.2%) disagreed with the statement that using Moodle increases their chances of acquiring knowledge, 129 respondents (36.7%) agreed with the statement, and 144 respondents (41%), took no position on the statement. However, the descriptive statistics for item 4 show a skewness of -.122 and a kurtosis of -.446 respectively. This indicates that the item has a much-skewed distribution.

Figure 4.6.13. Histogram distributions for Moodle learning method item 4.



The histogram for question 4 is shown above, and it can be seen that it has a slight rightward tilt due to the fact that the mean score (3.21) is higher than the median (3.00).

Table 4.6.16. Descriptive Statistics for Flipped Classroom Method.

Descriptive Statistics						
	Mean	Median	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
The use of the flipped classroom method prevents me from becoming uninterested in my vocabulary classes.	3.86	4.00	-.856	.130	.279	.260
I am able to learn on my own with the help of the flipped classroom method, and I take pleasure in that form of education.	3.87	4.00	-.914	.130	.229	.260
I find that I retain more information from a live lecture in the classroom than I do from watching a video at home.	4.04	4.00	-1.011	.130	.673	.260
My level of anxiety has increased as a result of using the flipped classroom method.	3.86	4.00	-.825	.130	-.035	.260
Accessing the internet and watching the videos that have been assigned to me has been difficult.	3.88	4.00	-.768	.130	-.134	.260

The flipped classroom approach is not one that I favour as a method of instruction.	3.63	4.00	-.547	.130	-.591	.260
The use of the flipped classroom method prevents me from becoming uninterested in my vocabulary classes.	3.66	4.00	-.474	.130	-.436	.260

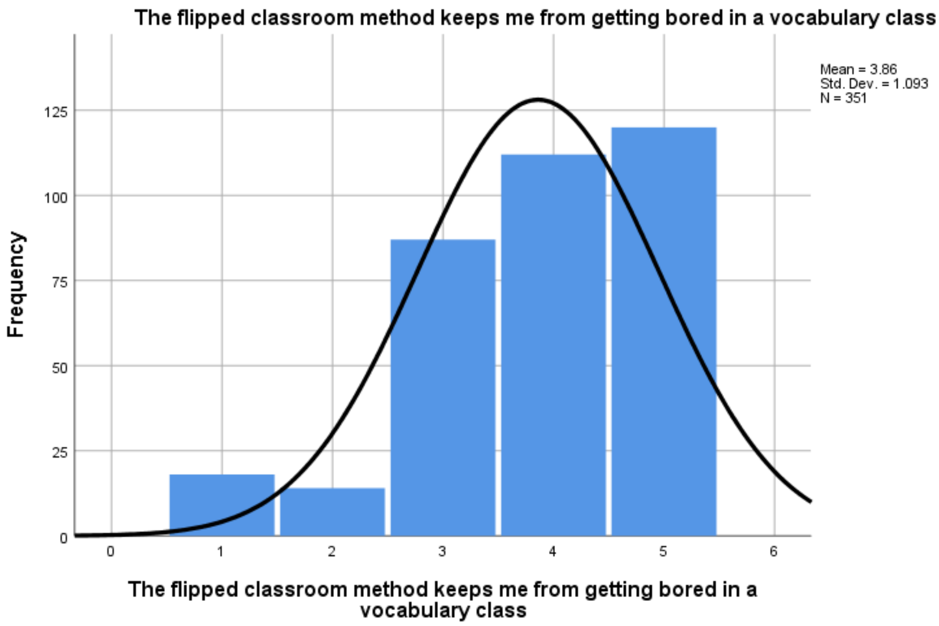
A frequency distribution of the items related to the flipped classroom method that were used for this study can be seen above in table 4.6.16. We looked into a total of 7 different questions. The tables that follow provide an in-depth look at the frequency distribution of each component of the flipped classroom method.

Table 4.6.17. Descriptive statistics for flipped classroom method frequency distributions item 1.

The flipped classroom method keeps me from getting bored in a vocabulary class					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	18	5.1	5.1	5.1
	Disagree	14	4.0	4.0	9.1
	Neutral	87	24.8	24.8	33.9
	Agree	112	31.9	31.9	65.8
	Strongly Agree	120	34.2	34.2	100.0
	Total	351	100.0	100.0	

The data presented in table 4.6.17 show that out of a total of 351 respondents, 32 respondents (9.1%) disagreed with the statement that the flipped classroom method prevents them from becoming bored in vocabulary class, while 232 respondents (66.1%) agreed with the statement, and 87 respondents (24.8%) were neutral to the statement. The descriptive statistics for item 1, on the other hand, reveal a skewness of -.856 and a kurtosis of.279 respectively.

Figure 4.6.14. Histogram distributions for flipped classroom method item 1.



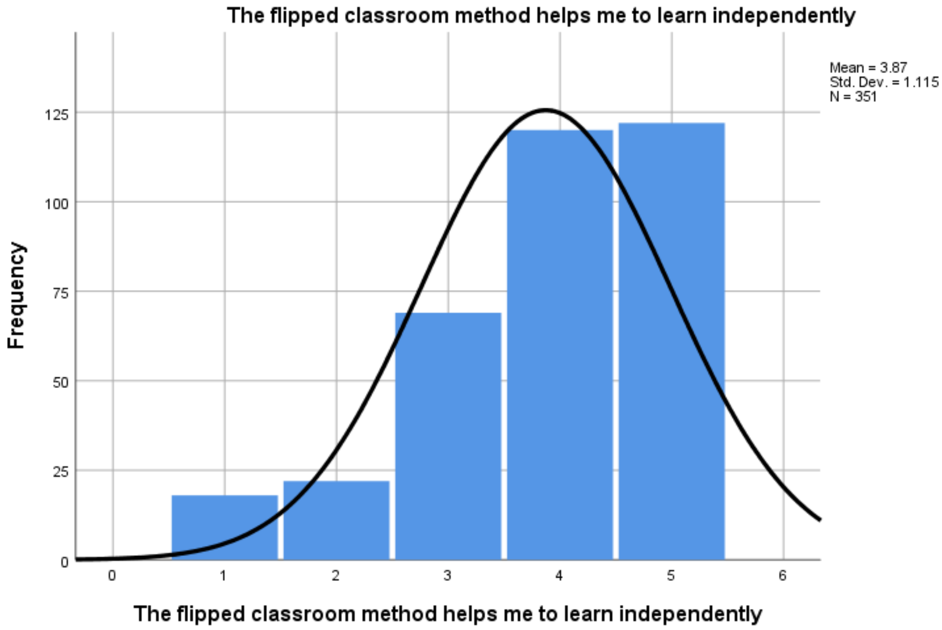
The histogram for question 1 is shown above, and it can be seen that it has a slight leftward tilt due to the fact that the mean score (3.86) is lower than the median (4.00).

Table 4.6.18. Descriptive statistics for flipped classroom method frequency distributions item 2.

The flipped classroom method helps me to learn independently					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	18	5.1	5.1	5.1
	Disagree	22	6.3	6.3	11.4
	Neutral	69	19.7	19.7	31.1
	Agree	120	34.2	34.2	65.2
	Strongly Agree	122	34.8	34.8	100.0
	Total	351	100.0	100.0	

According to the data presented in table 4.6.18, which can be found above, out of a total of 351 respondents, 40 respondents (11.4%) disagreed with the statement that the flipped classroom method helps them learn independently, while 242 respondents (69%) agreed with the statement, and 69 respondents (19.7%) were neutral to the statement. On the other hand, the descriptive statistics for item 2 reveal a skewness of -9.114 and a kurtosis of 0.229.

Figure 4.6.15. Histogram distributions for flipped classroom method item 2.



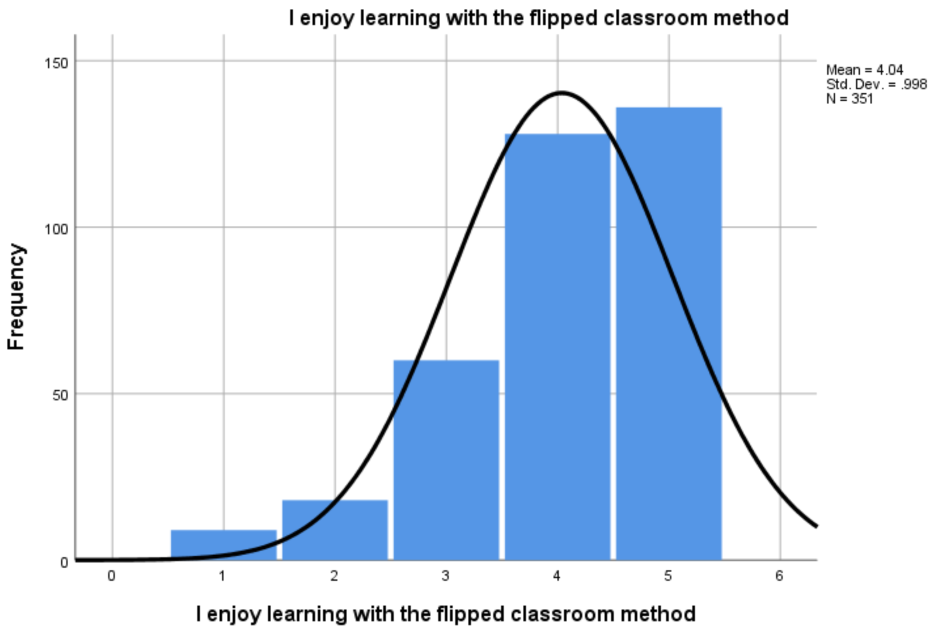
The histogram for question 2 is slightly skewed to the left, as shown above, due to the fact that the mean score (3.87) is lower than the median score (4.00).

Table 4.6.19. Descriptive statistics for flipped classroom method frequency distributions item 3.

I enjoy learning with the flipped classroom method					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	9	2.6	2.6	2.6
	Disagree	18	5.1	5.1	7.7
	Neutral	60	17.1	17.1	24.8
	Agree	128	36.5	36.5	61.3
	Strongly Agree	136	38.7	38.7	100.0
	Total	351	100.0	100.0	

Among the 351 respondents, the table 4.6.19 shows that 27 respondents (7.7%) disagreed with the statement, 264 respondents (75.2%) agreed with the statement, and 60 respondents (17.1%) were neutral in response to the question of whether or not they enjoy learning with the flipped classroom method. The descriptive statistics for item 3, on the other hand, reveal a skewness of -1.011 and a kurtosis of.673, respectively.

Figure 4.6.16. Histogram distributions for flipped classroom method item 3.



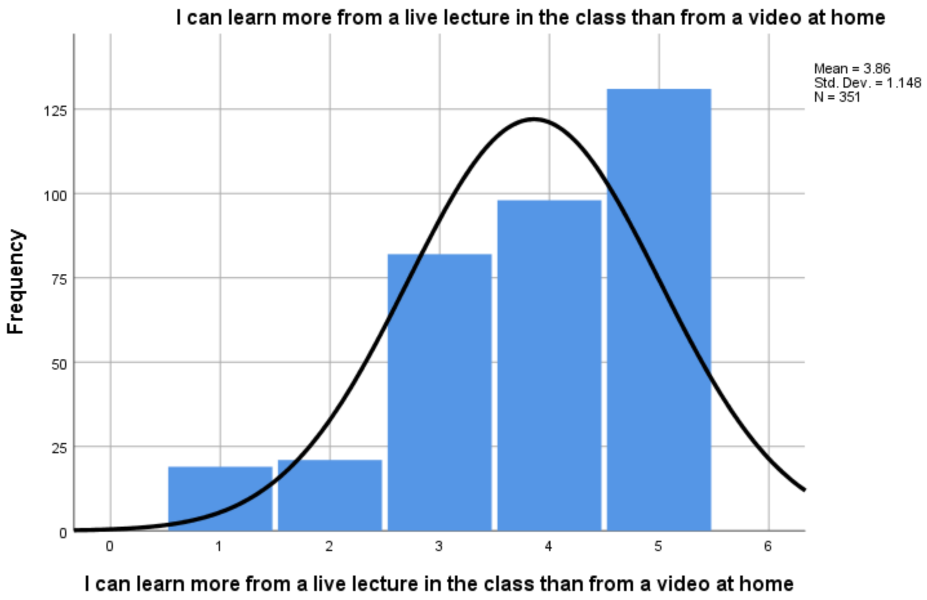
The histogram for question 3 is shown above, and it can be seen that it has a slight rightward tilt due to the fact that the mean score (4.04) is higher than the median score (4.00).

Table 4.6.20. Descriptive statistics for flipped classroom method frequency distributions item 4.

I can learn more from a live lecture in the class than from a video at home					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	19	5.4	5.4	5.4
	Disagree	21	6.0	6.0	11.4
	Neutral	82	23.4	23.4	34.8
	Agree	98	27.9	27.9	62.7
	Strongly Agree	131	37.3	37.3	100.0
	Total	351	100.0	100.0	

According to the data in table 4.6.20, which can be found above, out of 351 respondents, 40 respondents (11.4%) disagreed with the statement, 229 respondents (65.2%) agreed with the statement, and 82 respondents (23.4%) were neutral in response to the question of whether or not they can learn more from a live lecture in the classroom than from a video at home, while the remaining 82 respondents (23.4%) were unsure. The descriptive statistics for item 4, on the other hand, reveal a skewness of -.825 and a kurtosis of -.035 respectively.

Figure 4.6.17. Histogram distributions for flipped classroom method item 4.



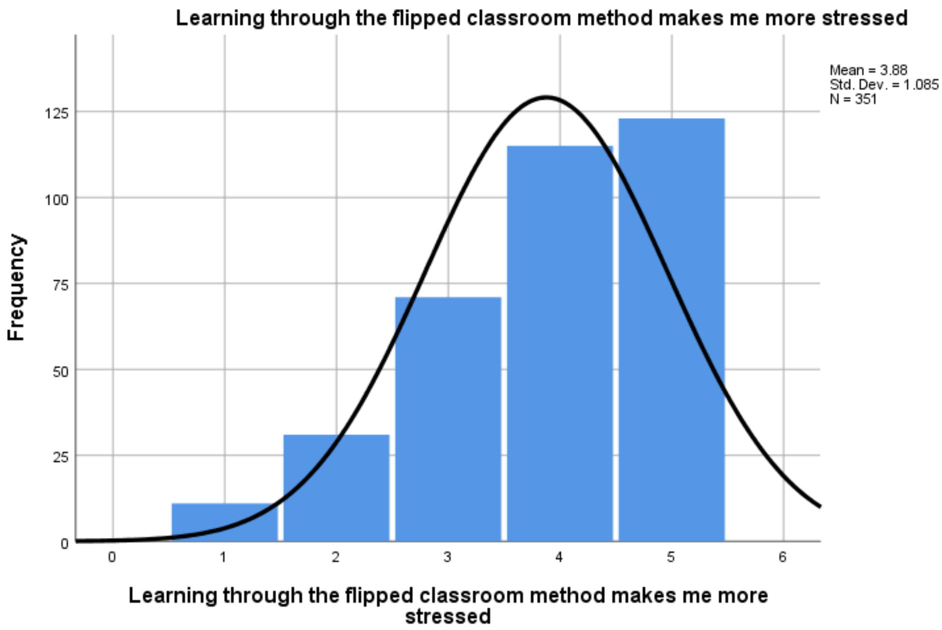
The histogram depicted above shows that question 4 has a slight leftward tilt due to the fact that the mean score (3.86) is lower than the median score (4.00).

Table 4.6.21. Descriptive statistics for flipped classroom method frequency distributions item 5.

Learning through the flipped classroom method makes me more stressed					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	11	3.1	3.1	3.1
	Disagree	31	8.8	8.8	12.0
	Neutral	71	20.2	20.2	32.2
	Agree	115	32.8	32.8	65.0
	Strongly Agree	123	35.0	35.0	100.0
	Total	351	100.0	100.0	

According to the data in table 4.6.21, which can be found above, out of a total of 351, respondents, 42 respondents (11.9%) disagreed with the statement that learning through the flipped classroom method makes them more stressed, while 238 respondents (67.8%) agreed with the statement, and 71 respondents (20.2%) were neutral to the statement. On the other hand, the descriptive statistics for item 5 reveal that its skewness is -.768 and its kurtosis is -.134, respectively.

Figure 4.6.18. Histogram distributions for flipped classroom method item 5.



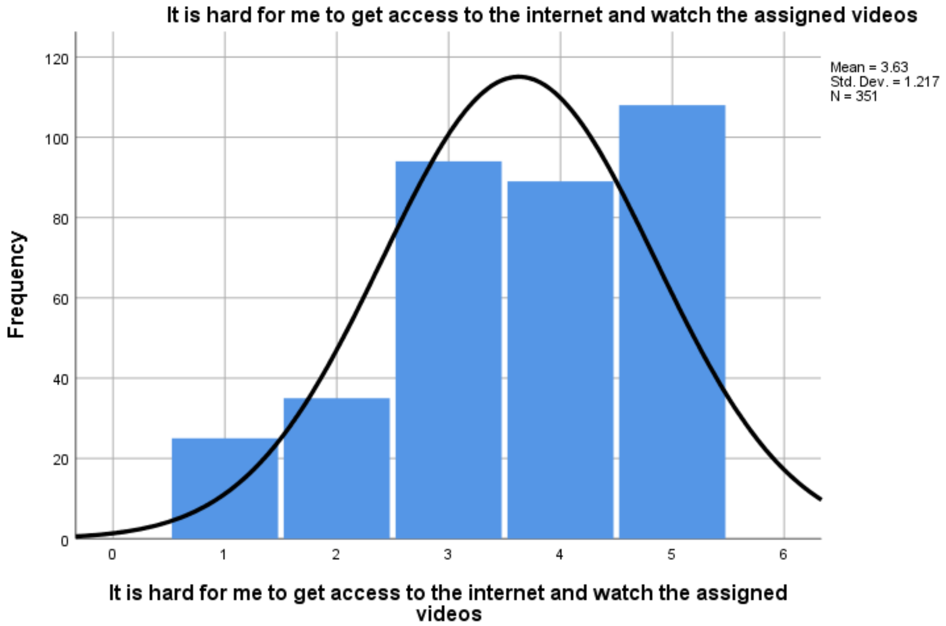
The histogram depicted above shows that question 5 has a slight leftward tilt due to the fact that the mean score (3.88) is lower than the median score (4.00).

Table 4.6.22. Descriptive statistics for flipped classroom method frequency distributions item 6.

It is hard for me to get access to the internet and watch the assigned videos					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	25	7.1	7.1	7.1
	Disagree	35	10.0	10.0	17.1
	Neutral	94	26.8	26.8	43.9
	Agree	89	25.4	25.4	69.2
	Strongly Agree	108	30.8	30.8	100.0
	Total	351	100.0	100.0	

According to the data in table 4.6.22, which can be found above, out of 351 respondents, 60 respondents (17.1%) disagreed with the statement that it is difficult for them to get access to the internet and watch the assigned videos, 197 respondents (56.2%) agreed with the statement, and 94 respondents (26.8%) were neutral to the statement. The descriptive statistics for item 6, on the other hand, reveal a skewness of -.547 and a kurtosis of -.591 respectively.

Figure 4.6.19. Histogram distributions for flipped classroom method item 6.



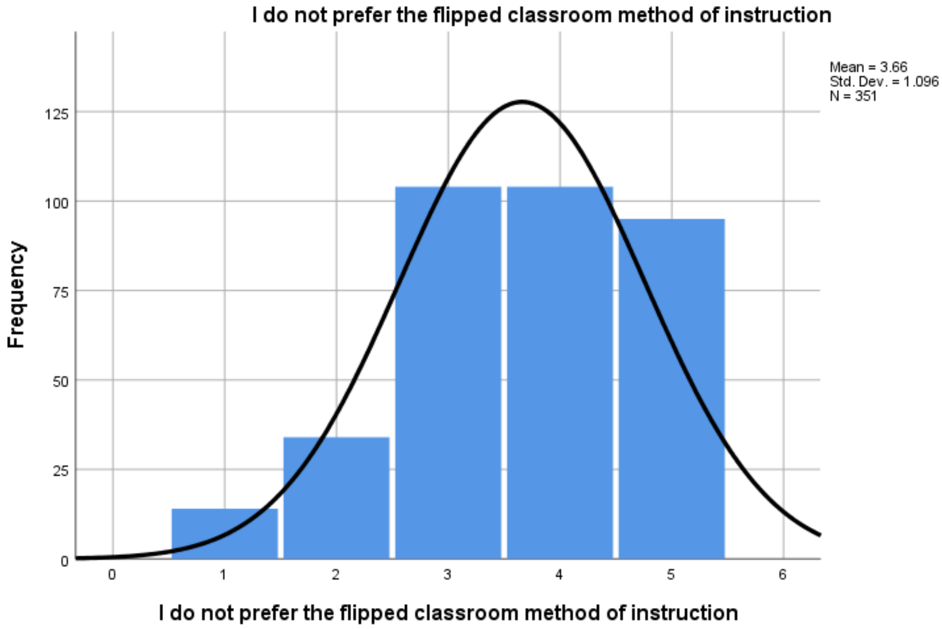
The histogram for question 6 is slightly skewed to the left, as shown above, due to the fact that the mean score (3.63) is lower than the median score (4.00).

Table 4.6.23. Descriptive statistics for flipped classroom method frequency distributions item 7.

I do not prefer the flipped classroom method of instruction					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	14	4.0	4.0	4.0
	Disagree	34	9.7	9.7	13.7
	Neutral	104	29.6	29.6	43.3
	Agree	104	29.6	29.6	72.9
	Strongly Agree	95	27.1	27.1	100.0
	Total	351	100.0	100.0	

According to the data in table 4.6.23, which can be found above, out of 351 respondents, 48 respondents (13.7%) disagreed with the statement, 199 respondents (53.7%) agreed with the statement, and 104 respondents (29.6%) were neutral to the statement regarding whether or not they prefer the method of instruction known as the flipped classroom. The descriptive statistics for item 7, on the other hand, reveal a skewness of -.474 and a kurtosis of -.436 respectively.

Figure 4.6.20. Histogram distributions for flipped classroom method item 7.



The histogram depicted above shows that question 7 has a slight leftward tilt (skewed) due to the fact that the mean score (3.66) is lower than the median score (4.00).

Table 4.6.24. Descriptive Statistics for Students Satisfaction.

Descriptive Statistics						
	Mean	Median	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
I was very content with mobile learning	3.39	3.00	-.322	.130	-.900	.260
I was very pleased with mobile learning	3.30	3.00	-.233	.130	-.920	.260
I was satisfied with mobile learning efficiency	3.33	3.00	-.265	.130	-.800	.260
I felt delighted with mobile learning	3.17	3.00	-.094	.130	-.970	.260
Overall, I was satisfied with mobile learning	3.32	3.00	-.304	.130	-.910	.260

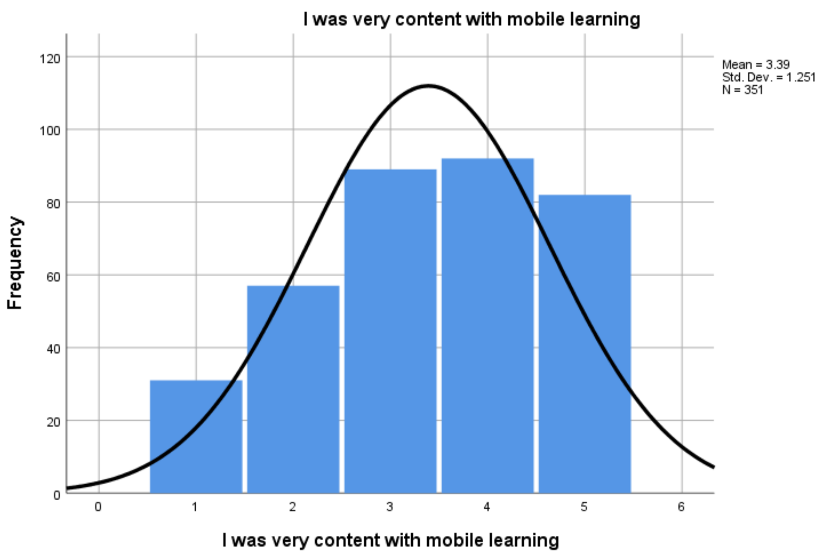
A frequency distribution of the students' satisfaction items used for this study is shown up above in table 4.6.24. There was a total of 5 questions that were looked into. The following tables display, in exhaustive detail, the frequency distribution of each component of the students' overall satisfaction.

Table 4.6.25. Descriptive statistics for students' satisfaction frequency distributions item 1.

I was very content with mobile learning					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	31	8.8	8.8	8.8
	Disagree	57	16.2	16.2	25.1
	Neutral	89	25.4	25.4	50.4
	Agree	92	26.2	26.2	76.6
	Strongly Agree	82	23.4	23.4	100.0
	Total	351	100.0	100.0	

According to the data presented in table 4.6.25. above, out of 351 respondents, 88 respondents (or 25%) disagreed with the statement if they are very content with mobile learning, 174 respondents (or 49.6%) agreed with the statement, and 89 respondents (or 25.4%) were neutral regarding the statement. On the other hand, the descriptive statistics for item 1 reveal a skewness of -0.322 and a kurtosis of -0.900 respectively. These values are presented in the table below.

Figure 4.6.21. Histogram distributions for students' satisfaction item 1.



The histogram for question 1 is slightly skewed to the right, as shown above, due to the fact that the mean score (3.39) is greater than the median score (3.00).

Table 4.6.26. Descriptive statistics for students' satisfaction frequency distributions item 2.

I was very pleased with mobile learning					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	34	9.7	9.7	9.7
	Disagree	60	17.1	17.1	26.8
	Neutral	97	27.6	27.6	54.4
	Agree	86	24.5	24.5	78.9
	Strongly Agree	74	21.1	21.1	100.0
	Total	351	100.0	100.0	

The data presented in table 4.6.26 shows that out of 351 respondents, 94 respondents (26.8%) disagreed with the statement that they are pleased with mobile learning, 160 respondents (45.6%) agreed with the statement, and 97 respondents (27.6%) were neutral regarding the statement. The descriptive statistics for item 2, on the other hand, reveal a skewness of -.233 and a kurtosis of -.920 respectively.

Figure 4.6.22. Histogram distributions for students' satisfaction item 2.

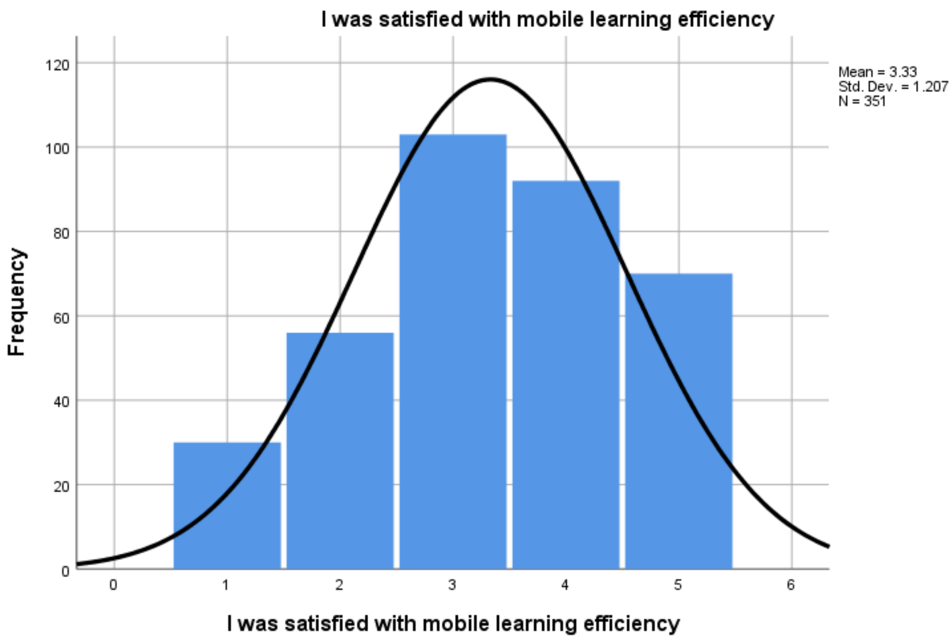
The histogram shown above indicates that the distribution for question 2 is slightly skewed to the right because the mean score of 3.30 is greater than the median score of (3.00).

Table 4.6.27. Descriptive statistics for students' satisfaction frequency distributions item 3.

I was satisfied with mobile learning efficiency					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	30	8.5	8.5	8.5
	Disagree	56	16.0	16.0	24.5
	Neutral	103	29.3	29.3	53.8
	Agree	92	26.2	26.2	80.1
	Strongly Agree	70	19.9	19.9	100.0
	Total	351	100.0	100.0	

According to the data in table 4.6.27, which can be found above, out of the total of 351 respondents, 86 respondents (24.5%) disagreed with the statement if they are pleased with mobile learning, 162 respondents (46.1%) agreed with the statement, and 103 respondents (9.3%) were neutral. The descriptive statistics for item 3, on the other hand, reveal a skewness of -.265 and a kurtosis of -.800 respectively.

Figure 4.6.23. Histogram distributions for students' satisfaction item 3.



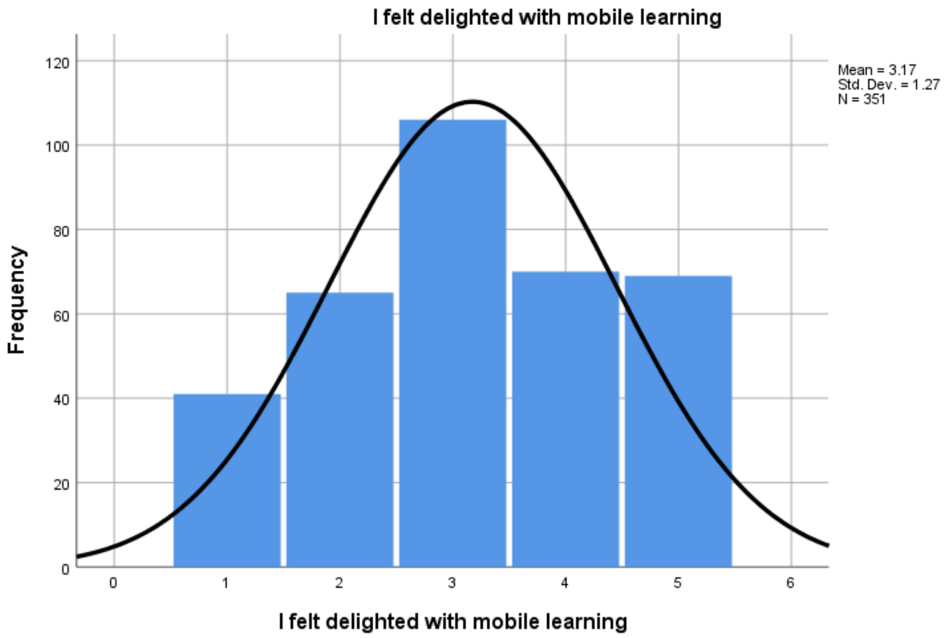
The histogram for question 3 is slightly skewed to the right, as shown above, due to the fact that the mean score (3.33) is greater than the median score (3.00).

Table 4.6.28. Descriptive statistics for students' satisfaction frequency distributions item 4.

I felt delighted with mobile learning					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	41	11.7	11.7	11.7
	Disagree	65	18.5	18.5	30.2
	Neutral	106	30.2	30.2	60.4
	Agree	70	19.9	19.9	80.3
	Strongly Agree	69	19.7	19.7	100.0
	Total	351	100.0	100.0	

According to table 4.6.28, among 351 respondents, 106 (30.2%) disagreed, 139 (39.6%) agreed, and 106 (30.2%) were neutral to the statement if they were delighted with mobile learning. However, the descriptive statistics for item 4 show that the skewness is -.094 and the kurtosis is -.970.

Figure 4.6.24. Histogram distributions for students' satisfaction item 4.



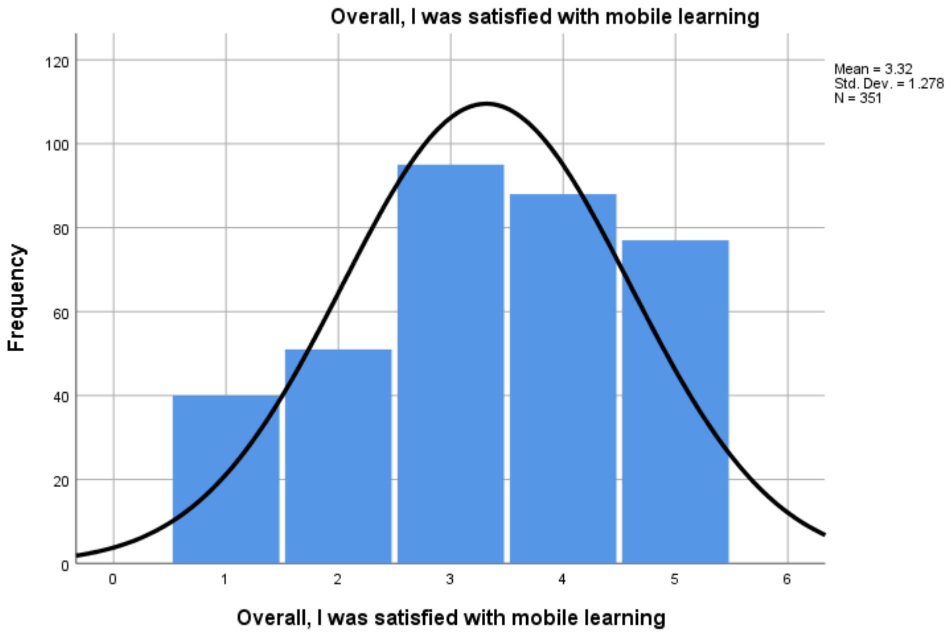
The histogram depicted above shows that question 4 has a slight rightward skewed due to the fact that the mean score (3.17) is greater than the median score (3.00).

Table 4.6.29. Descriptive statistics for students' satisfaction frequency distributions item 5.

Overall, I was satisfied with mobile learning					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	40	11.4	11.4	11.4
	Disagree	51	14.5	14.5	25.9
	Neutral	95	27.1	27.1	53.0
	Agree	88	25.1	25.1	78.1
	Strongly Agree	77	21.9	21.9	100.0
	Total	351	100.0	100.0	

According to the data in table 4.6.29, which can be found above, out of 351 respondents, 91 respondents (25.9%) disagreed with the statement that asks if they are satisfied with mobile learning overall, 165 respondents (47%) agreed with the statement, and 95 respondents (27.1%) were neutral. The descriptive statistics for item 5, on the other hand, reveal a skewness of -.304 and a kurtosis of -.910 respectively.

Figure 4.6.25. Histogram distributions for students' satisfaction item 5.



The histogram for question 5 is shown above, and it can be seen that it has a slight rightward skewed due to the fact that the mean score (3.32) is higher than the median (3.00).

Table 4.6.30. Descriptive Statistics for Students Attitude.

Descriptive Statistics						
	Mean	Median	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
I think it's a good idea to use technology innovation	4.17	4.00	-1.188	.130	1.325	.260
Technology innovation will make my work more interesting	3.99	4.00	-.788	.130	.165	.260
It's good to make use of the technology innovation	4.17	4.00	-1.270	.130	1.653	.260

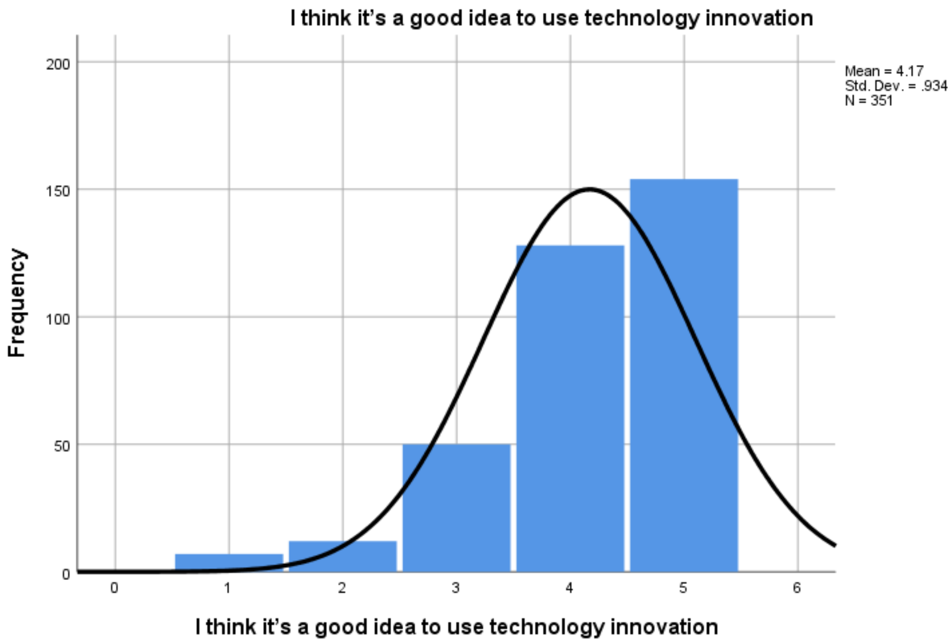
A frequency distribution of the students' attitude items that were used for this study is displayed above in table 4.6.30. We looked into a total of three different questions. The following tables present a comprehensive frequency distribution for each aspect of the students' attitudes.

Table 4.6.31. Descriptive statistics for students' attitude frequency distributions item 1.

I think it's a good idea to use technology innovation					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	7	2.0	2.0	2.0
	Disagree	12	3.4	3.4	5.4
	Neutral	50	14.2	14.2	19.7
	Agree	128	36.5	36.5	56.1
	Strongly Agree	154	43.9	43.9	100.0
	Total	351	100.0	100.0	

The data presented in table 4.6.31 shows that out of 351 respondents, 19 respondents (5.4%) disagreed with the statement, 282 respondents (80.4%) agreed with the statement, and 50 respondents (14.2%) were neutral to the statement regarding whether or not they believe it is a good idea to use technological innovation. However, the descriptive statistics for item 1 show a skewness of -1.188 and a kurtosis of 1.325 respectively. This indicates that the item is skewed negatively.

Figure 4.6.26. Histogram distributions for students' attitude item 1.



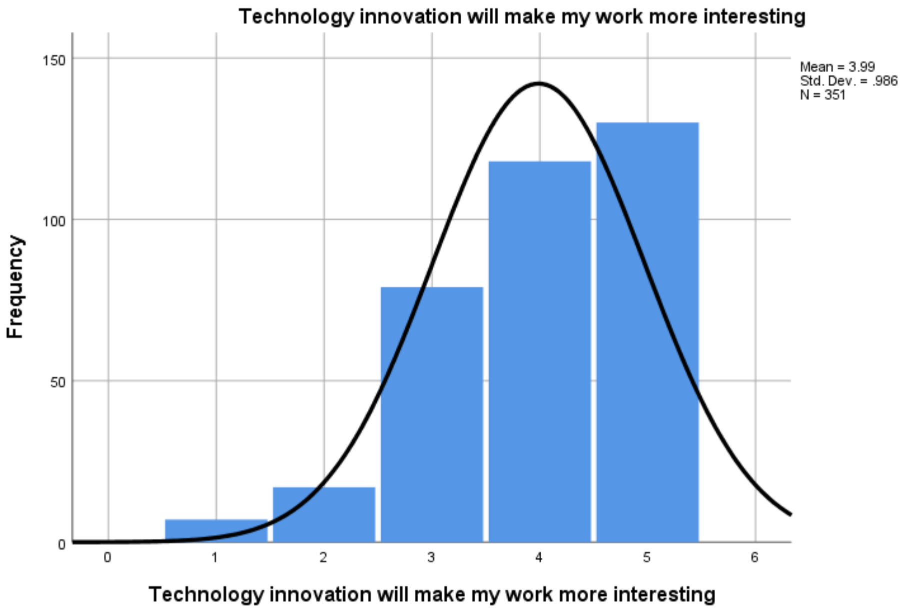
The histogram for question 1 is shown above, and it can be seen that it has a slight rightward tilt (skewed) due to the fact that the mean score (4.17) is higher than the median (4.00).

Table 4.6.32. Descriptive statistics for students' attitude frequency distributions item 2.

Technology innovation will make my work more interesting					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	7	2.0	2.0	2.0
	Disagree	17	4.8	4.8	6.8
	Neutral	79	22.5	22.5	29.3
	Agree	118	33.6	33.6	63.0
	Strongly Agree	130	37.0	37.0	100.0
	Total	351	100.0	100.0	

According to the data in table 4.6.32, which can be found above, out of 351 respondents, 24 respondents (6.8%) disagreed with the statement that technological innovation will make their work more interesting, while 248 respondents (70.6%) agreed with the statement, and 79 respondents (22.5%) were neutral regarding the statement. The descriptive statistics for item 2, on the other hand, reveal a skewness of -7.88 and a kurtosis of 1.165.

Figure 4.6.27. Histogram distributions for students' attitude item 2.



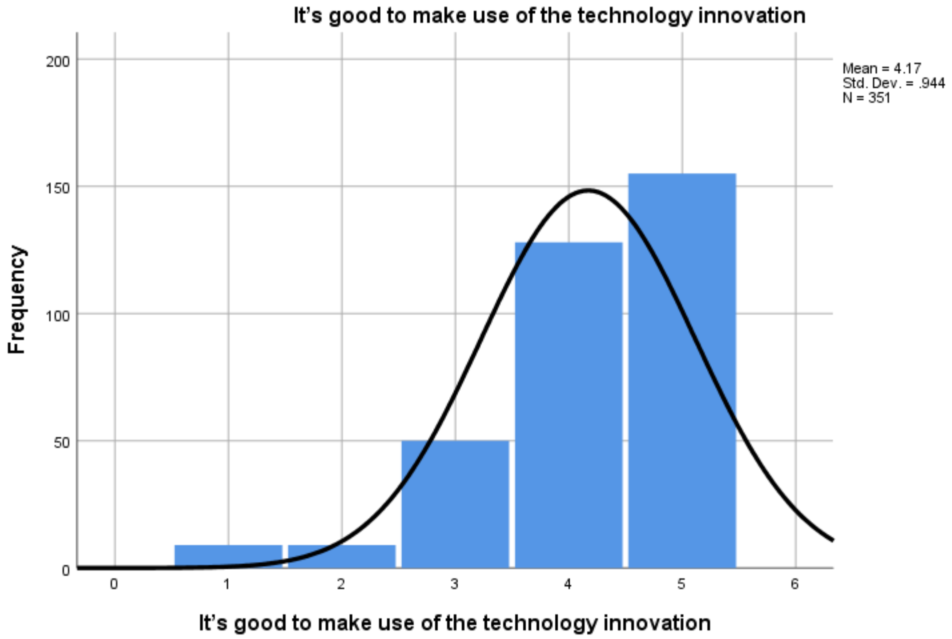
The histogram depicted above shows that the distribution for question 2 is slightly skewed to the left. This is due to the fact that the mean value (3.99) is lower than the median value (4.00).

Table 4.6.33. Descriptive statistics for students' attitude frequency distributions item 3.

It's good to make use of the technology innovation					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	9	2.6	2.6	2.6
	Disagree	9	2.6	2.6	5.1
	Neutral	50	14.2	14.2	19.4
	Agree	128	36.5	36.5	55.8
	Strongly Agree	155	44.2	44.2	100.0
	Total	351	100.0	100.0	

The data presented in table 4.6.33 demonstrates that out of 351 respondents, 18 respondents (5.1%) disagreed with the statement that it is good to make use of technological innovation, while 283 respondents (80.7%) agreed with the statement, and 50 respondents (14.2%) were neutral regarding the statement. The descriptive statistics for item 3, on the other hand, reveal a skewness of -1.270 and a kurtosis of 1.653 respectively.

Figure 4.6.28. Histogram distributions for students' attitude item 3.



According to the histogram that can be found above, the distribution of responses to question 3 has a slight rightward tilt because the mean (4.17), which is shown above, is greater than the median (4.00).

4.7. Conclusion

In this concluded chapter four we conducted a normality test and the results show that the Kolmogorov-Smirnov and Shapiro-Wilk tests for all the instrument used were significant, nevertheless, all the data used in the study does not follow a normal distribution, as a result, a non-parametric test was used in the course of the study and the result were adequately modelled as shown graphically and numerically. This chapter also conducted a reliability test to check if all the instruments that was used in the study were genuine and accurate to measure what it claims to measure. The results from the reliability test shows that all the instruments used were above 0.6, which made all the instruments valid for measurement. The chapter also contains the findings of the factor analysis as its categories the degree to which variables are correlated with each other. The results were displayed in tables and Scree plot as seen in this chapter. The chapter also conducted a demographic factor distribution which shows the results for the statistical analysis of the demographics used in the study. The results were displayed on tables and pie charts. Lastly, this chapter went further to look at the descriptive statistics and its frequency distribution for each instrument used. The results were displayed in tables and histogram.

CHAPTER 5

REGRESSION ANALYSIS AND INTERPRETATION

CHAPTER 5

5. REGRESSION ANALYSIS AND INTERPRETATION

5.1. Introduction

The purpose of this chapter five is to analysis the data collected for the research study in order to test the hypotheses with the aim of answering the research questions as stated in chapter one. This chapter summarises and interpret the result findings of the research study using a Statistical Package for Social Science (SPSS) software and Andrew F. Hayes' Process Analysis (version 3.2) to conduct a correlation and regression analysis with the aims of answering the research questions and hypothesis.

5.2. Correlation Analysis

A correlation analysis was carried out in order to determine whether or not there was a possibility of encountering multicollinearity. The findings are summarised in the table that can be found below.

Table 5.2.1. Kendall's Correlation Result.

Correlations						
		TechnologyInnovation	MoodleLearning	FlippedClassroom	StudentsSatisfaction	Students Attitude
TechnologyInnovation	Pearson Correlation	1	.371**	.052	.453**	.609**
	Sig. (2-tailed)		**.000**	.329	**.000**	**.000**
	N	351	351	351	351	351
MoodleLearning	Pearson Correlation	.371**	1	-.037	.449**	.395**
	Sig. (2-tailed)	**.000**		.488	**.000**	**.000**
	N	351	351	351	351	351
FlippedClassroom	Pearson Correlation	.052	-.037	1	-.148**	-.012
	Sig. (2-tailed)	.329	.488		**.005**	.826
	N	351	351	351	351	351
StudentsSatisfaction	Pearson Correlation	.453**	.449**	-.148**	1	.482**
	Sig. (2-tailed)	**.000**	**.000**	**.005**		**.000**
	N	351	351	351	351	351
StudentsAttitude	Pearson Correlation	.609**	.395**	-.012	.482**	1
	Sig. (2-tailed)	**.000**	**.000**	.826	**.000**	

The Pearson r value for the correlation between technological innovation and the Moodle learning method is 0.000, indicating a very strong positive linear relationship between the two variables. With a Pearson r value of 0.000, the correlation between technological innovation and student satisfaction is highly significant. With a Pearson r value of 0.000, the correlation between technological innovation and student attitude is also highly significant. According to the table, however, there is no correlation between technological innovation and the flipped classroom method of instruction. In the table 5.2.1, the highlighted numbers indicate the level of significance.

This research utilised Kendall's coefficient of correlation. Kendall correlation is a non-parametric test for determining the degree of dependence between two variables. According to the data in table 5.2.1, technology innovation and the Moodle learning method are significant at both the 1% and 5% levels of significance when considering Kendall's. Thus, we cannot reject the null hypothesis stating that technological innovation has a significant positive effect on learning using the Moodle method. The relationship between technological innovation and student satisfaction is significant at both the 1% and 5% levels of significance; therefore, the null hypothesis that technological innovation has a significant positive effect on student satisfaction cannot be rejected. Also, technology innovation and student's attitude are significant at both the 1% and 5% levels of significance; thus, the null hypothesis that technology innovation has a positive significant effect on student's attitude cannot be rejected. However, technology innovation and the flipped classroom method are deemed insignificant at both the 1% and 5% levels of significance. Therefore, we conclude in favour of the alternative hypothesis, which states that technological progress has no appreciable beneficial effect on learning when employing the flipped classroom method, and thus reject the null hypothesis. The findings from the Kendall’s correlation analysis fulfil all predetermined research objectives and effectively address each of the research questions posited in this study. A comprehensive discussion and interpretation of these results will be provided in Chapter 6, offering detailed insights into the relationships uncovered through the analysis.

5.3. Regression Analysis

Regression analysis is a tried-and-true method for figuring out which variables have an impact on an issue. Regression analysis allows researchers to determine the relative importance of variables, the variables that can be safely ignored, and the interactions between the variables

(Lani, 2018).

Table 5.3.1. Model Summary Result for Multiple Regression – Technology Innovation (Dependent Variable).

Model Summary									
					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.648[a]	.420	.413	.587	.420	62.523	4	346	.000
a. Predictors: (Constant), StudentsAttitude, FlippedClassroom, MoodleLearning, StudentsSatisfaction									

The R square, the adjusted R square, and the standard error of the estimate are presented in the model summary table, which can be used to determine how well the regression model fits the data. This table can be found above in section 5.3.1. Because the R square in the table is 0.420 and the adjusted R square is 0.413, we can deduce that the predictor's students' attitude, the flipped classroom method, the Moodle learning method, and students' satisfaction account for 41.3% of the variance in technological innovation when taken as a set.

Table 5.3.2. ANOVA analysis on predictors and dependent variable.

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	86.264	4	21.566	62.523	.000[b]
	Residual	119.345	346	.345		
	Total	205.609	350			
a. Dependent Variable: TechnologyInnovation						
b. Predictors: (Constant), StudentsAttitude, FlippedClassroom, MoodleLearning, StudentsSatisfaction						

The analysis of variance (ANOVA) displayed in the preceding table 5.3.2 shows that independent variables (students' attitudes, flipped classroom method, Moodle learning method, and students' satisfaction) statistically and significantly predict the dependant variable (students' overall satisfaction) (technology innovation).

Table 5.3.3. Coefficients.

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.978	.240		4.079	.000
	MoodleLearning	.080	.038	.099	2.111	.035
	FlippedClassroom	.118	.054	.090	2.167	.031
	StudentsSatisfaction	.127	.033	.192	3.837	.000
	StudentsAttitude	.420	.042	.478	9.940	.000
a. Dependent Variable: Technology Innovation						

The unstandardized coefficients shown in table 5.3.3 above indicate the degree to which technological innovation varies with an independent variable such as students' attitudes, the flipped classroom method, the Moodle learning method, and students' satisfaction when all other factors remain the same. Therefore, for every unit increase in students' attitude, flipped classroom method, Moodle learning method, and students' satisfaction, there is a 0.080, 1.118, 0.127, and 0.420 percentage point increase in technological innovation. The parameter estimates are shown in relation to the dependant variable in the multiple linear regression equation that is presented below (technology innovation).

Y (technological innovation) equals 0.978 plus (0.080 times Moodle learning method) plus (0.118 times flipped classroom method) plus (0.127 times students' satisfaction) plus (0.420 times students' attitude).

5.4. Linear regression – Flipped Classroom Method

The following hypothesis was formulated with regards to technology innovation and flipped classroom method:

H_0: Technology innovation has no significant positive effect on learning using the flipped classroom method.

H_1: Technology innovation has a significant positive effect on learning using the flipped classroom method.

Table 5.4.1. Model Summary for Flipped Classroom Method.

Model Summary									
					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.052[a]	.003	.000	.767	.003	.954	1	349	.329
a. Predictors: (Constant), Flipped Classroom									

The model summary for the flipped classroom method can be found in table 5.4.1 above. This table shows that the R square value for this method is 0.003, and the adjusted R square value is 0.000. This indicates that the regression line explains less than 1% of the variance.

Table 5.4.2. ANOVA Test Result for Flipped Classroom Method.

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.560	1	.560	.954	.329[b]
	Residual	205.048	349	.588		
	Total	205.609	350			
a. Dependent Variable: Technology Innovation						
b. Predictors: (Constant), Flipped Classroom						

The effect of technological innovation on the flipped classroom method of learning is demonstrated by the ANOVA, which can be found above in table 5.4.2. According to the findings, there is no positive or significant contribution made by the innovation of technology to the learning that is accomplished through the use of the flipped classroom method. As a result, we are unable to conclude that the null hypothesis is false.

5.5. Linear regression – Moodle Learning Method

The following hypothesis was formulated with regards to technology innovation and Moodle learning method:

H_0: Technology innovation has no significant positive effect on learning using the Moodle learning method.

H_1: Technology innovation has a significant positive effect on learning using the Moodle learning method.

Table 5.5.1. Model Summary for Moodle Learning Method.

Model Summary									
					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.371[a]	.138	.135	.713	.138	55.695	1	349	.000
a. Predictors: (Constant), Moodle Learning									

The model summary shown in table 5.5.1. above for the Moodle learning method displays a R square value of 0.138 and an adjusted R square value of 0.135. This indicates that the regression line explains 13.8% of the variance in the data.

Table 5.5.2. ANOVA Test Result for Moodle Learning Method.

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	28.297	1	28.297	55.695	.000[b]
	Residual	177.312	349	.508		
	Total	205.609	350			
a. Dependent Variable: Technology Innovation						
b. Predictors: (Constant), Moodle Learning						

The results of the analysis of variance (ANOVA) can be seen in the preceding table, which is titled "Moodle Learning Method of Learning." According to the findings, there is a significantly positive relationship between the use of the Moodle learning method and technological innovation in the classroom. As a result, we can conclude that the alternative hypothesis is more plausible than the null hypothesis.

5.6. Linear regression – Students Attitude

Regarding technological innovation and student attitudes, the following hypothesis was developed:

H_0: Technology innovation has no positive significant effect on students' attitude.

H_1: Technology innovation has a positive significant effect on students' attitude.

Table 5.6.1. Model Summary for Students Attitude.

Model Summary									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.609[a]	.371	.369	.609	.371	205.424	1	349	.000
a. Predictors: (Constant), StudentsAttitude									

The model summary for the students' attitude can be found in table 5.6.1. above. This table shows that the R square value for the model is 0.371, and the adjusted R square value is 0.369. This indicates that the regression line explains 39.9% of the variance in the data.

Table 5.6.2. ANOVA Test Result for Students Attitude.

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	76.182	1	76.182	205.424	.000[b]
	Residual	129.427	349	.371		
	Total	205.609	350			
a. Dependent Variable: TechnologyInnovation						
b. Predictors: (Constant), StudentsAttitude						

The effect of technological innovation on students' attitudes is illustrated by the ANOVA in table 5.6.2., which can be found above. According to the findings, there is a significantly positive relationship between students' attitudes and the introduction of new technological concepts. As a result, the alternative hypothesis is selected to explain the data rather than the null hypothesis.

5.7. Linear regression – Students Satisfaction

The following hypothesis was formulated with regards to technology innovation and students' satisfaction:

H_0: Technology innovation has no positive significant effect on students' satisfaction.

H_1: Technology innovation has a positive significant effect on students' satisfaction.

Table 5.7.1. Model Summary for Students Satisfaction.

Model Summary									
					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.453[a]	.205	.203	.684	.205	90.250	1	349	.000
a. Predictors: (Constant), StudentsSatisfaction									

The model summary for student satisfaction can be found in table 5.7.1. above. This table shows that the R square value for the model is 0.205, and the adjusted R square value is 0.203. As a result, the regression line explains 20.3% of the variance in the data.

Table 5.7.2. ANOVA Test Result for Students Satisfaction.

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	42.245	1	42.245	90.250	.000[b]
	Residual	163.364	349	.468		
	Total	205.609	350			
a. Dependent Variable: Technology Innovation						
b. Predictors: (Constant), Students Satisfaction						

The results of the analysis of variance (ANOVA) can be seen in table 5.7.2. above. It shows the effect of technological innovation on the level of satisfaction felt by students. According to the findings, there is a significantly positive relationship between the introduction of new technologies and the level of satisfaction experienced by the students. As a result, the alternative hypothesis is selected to explain the data rather than the null hypothesis.

5.8. Moderation Regression Analysis

An intervening variable describes a factor that moderates the effect of another predictor on an outcome. In order to determine if the independent variable is related to the dependent variable, a moderation analysis can be performed. Interaction effect occurs when the presence of a moderating variable alters the direction and consequences of the relationship between an independent and a dependent variable (Hayes, 2015). The "Process analysis version 3.2" statistical model for resolving moderation issues was developed by Andrew F. Hayes. Analysis of the study's moderating effect used this model.

5.8.1. Technology Innovation and Students Satisfaction moderated by age

With respect to the relationship between employees' ages and the external factors influencing their ethical perspectives, the following hypothesis was formulated:

H_0: Age do not moderate the relationship between technology innovation and student's satisfaction.

H_1: Age moderate the relationship between technology innovation and student's satisfaction.

Model: 1

Y: Technology Innovation (Dependent Variable)

X: Students Satisfaction (Independent variable)

W: Age (Moderator variable)

Table 5.8.1.1. Model Summary of Demographic factor (Age) moderating the relationship between technology innovation and students' satisfaction.

R	**R-sq**	**MSE**	**F**	**df1**	**df2**	**P**
0.46	0.21	0.47	30.75	3.00	347.00	0.00

The model summary can be found in table 5.8.1.1. above, which displays an R square value of 0.46 and an adjusted R square value of 0.21. This indicates that the regression line explains 21% of the variance in the data.

Table 5.8.1.2. Interaction effect of Demographic factor (Age) moderating the relationship between technology innovation and students' satisfaction.

Model	**coeff**	**se**	**t**	**p**	**LLCI**	**ULCI**
Constant	3.15	0.31	10.01	**0.00**	2.53	3.76
Students Satisfaction	0.21	0.09	2.30	**0.02**	0.03	0.40
Age	-0.13	0.10	-1.29	**0.20**	-0.33	0.07
Int_1	0.03	0.03	1.04	**0.30**	-0.03	0.09
Product terms key: Int_1: Student Satisfaction x Age Dependent variable: Technology Innovation						

The data presented in the previous table, titled "Table 5.8.1.2. Interaction Effect between Technological Innovation and Students' Satisfaction," can be found above. According to the result, the regression model is significant when it's constant at the 5% level of significance (p value 0.00 0.05), but there is no positively significant impact at the 5% level of significance (p value 0.30 > 0.05) in the interaction variable. This is indicated by the fact that the p value was 0.00 rather than 0.30. (Student satisfaction x Age). As a result, we are unable to conclude that the null hypothesis is false. In conclusion, when age is used as a moderator, there is no positive relationship to be found between technological innovation and the level of satisfaction experienced by students.

5.8.2. Technology Innovation and Students Satisfaction moderated by Gender

With respect to the relationship between employees' ages and the external factors influencing their ethical perspectives, the following hypothesis was formulated:

H_0: Gender do not moderate the relationship between technology innovation and student's satisfaction.

H_1: Gender moderate the relationship between technology innovation and student's satisfaction.

Model: 1

Y: Technology Innovation (Dependent Variable)

X: Students Satisfaction (Independent variable)

W: Age (Moderator variable)

Table 5.8.2.1. Model Summary of Demographic factor (Gender) moderating the relationship between technology innovation and students' satisfaction.

R	**R-sq**	**MSE**	**F**	**df1**	**df2**	**P**
0.46	0.21	0.47	30.57	3.00	347.00	0.00

The model summary table .2.1 reveals that the regression line accounts for 21% of the total variance. The value of R square is 0.46, and the value of R square after adjustment is 0.21.

Table 5.8.2.2. Interaction effect of Demographic factor (Gender) moderating the relationship between technology innovation and students' satisfaction.

Model	**coeff**	**se**	**t**	**p**	**LLCI**	**ULCI**
Constant	2.65	0.32	8.18	**0.00**	2.01	3.28
Students Satisfaction	0.37	0.09	3.99	**0.00**	0.19	0.55
Age	0.08	0.19	0.43	**0.67**	-0.29	0.44
Int_1	-0.04	0.05	-0.80	**0.43**	-0.15	0.06
Product terms key: Int_1: Student Satisfaction x Gender Dependent variable: Technology Innovation						

The above table 5.8.2.2 shows how gender plays a moderating role in the interaction effect between technological innovation and students' levels of satisfaction. According to the result, the regression model is significant when it's constant at the 5% level of significance (p value 0.00 0.05), but there is no positively significant impact at the 5% level of significance (p value 0.43 > 0.05) in the interaction variable. This is indicated by the fact that the p value was 0.00 rather than 0.43. (Student satisfaction x Gender). As a result, we are unable to conclude that the null hypothesis is false. In conclusion, when gender is used as a moderator variable, there is no positive relationship between technological innovation and the level of satisfaction experienced by students.

5.9. Conclusion

In this concluded chapter five the researcher conducted a correlation analysis test to check the likelihood of encountering multicollinearity. The results were displayed in a table format and it shows the relationship between the dependent variable and the independent variables used in the study. This chapter also conducted an in-depth regression analysis, and the results were also displayed in table format. The researcher went further to interpret the results for all the hypothesis test for the study, which answered the core questions for the study.

CHAPTER 6

DISCUSSION OF THE FINDINGS

CHAPTER 6

6. DISCUSSION OF THE FINDINGS

6.1. Introduction

This chapter discusses the study's findings and conclusion based on the analysed data, and it sheds light on whether or not those findings are consistent with those of previous studies discussed in the literature review. This section analyses the findings in light of the study's aims, research questions, and hypothesis.

6.2. Discussion of the results.

The results of all hypothesis tested for this study are summarised in Table 6.2 below.

Table 6.2. Hypothesis results for the study.

NO	HYPOTHESIS	RESULT
1.	H_0: Technology innovation has no significant positive effect on learning using the flipped classroom method. H_1: Technology innovation has a significant positive effect on learning using the flipped classroom method.	non-significant
2.	H_0: Technology innovation has no significant positive effect on learning using the Moodle learning method. H_1: Technology innovation has a significant positive effect on learning using the Moodle learning method.	significant
3.	H_0: Technology innovation has no positive significant effect on students' attitude. H_1: Technology innovation has a positive significant effect on students' attitude.	significant

4.	H_0: Technology innovation has no positive significant effect on students' satisfaction. H_1: Technology innovation has a positive significant effect on students' satisfaction.	significant
Age and gender as moderating demographic variables		
NO	HYPOTHESIS	RESULT
5.	H_0: Age do not moderate the relationship between technology innovation and student's satisfaction. H_1: Age moderate the relationship between technology innovation and student's satisfaction.	non-significant
6.	H_0: Gender do not moderate the relationship between technology innovation and student's satisfaction. H_1: Gender moderates the relationship between technology innovation and student's satisfaction.	non-significant

6.2.1. Hypothesis 1 (Technology innovation and flipped classroom method)

The findings of this research resonate with the existing body of literature, which has extensively explored the relationship between technological innovation and pedagogical methodologies, particularly within the context of the flipped classroom approach. The findings reveal that the integration of technology within educational contexts, specifically within the framework of the flipped classroom method, does not yield a statistically significant and favourable impact on learning outcomes. At the established significance level of 5%, the analysis fails to provide sufficient evidence to reject the null hypothesis, which posits that technological innovation does not exert a significantly positive effect on learning when employed in conjunction with the flipped classroom approach. Furthermore, the study concludes that there exists no discernible positive correlation between technological innovation and the learning outcomes facilitated by the flipped classroom method.

These conclusions align with the findings of previous research conducted by scholars such as Liu & Stephen (2019), Saini & Abraham (2019), Xu, David, & Kim (2018), Legontis (2010), Rashid & Asghar (2016), Bayne (2019), and Henderson, Selwyn, & Aston (2017). The collective body of evidence presented in these studies reinforces the notion that technological innovation does not significantly influence the efficacy of the flipped classroom model in enhancing learning outcomes.

This research report delves into a comprehensive discussion of these findings, synthesizing insights from various scholarly contributions to elucidate the absence of a substantial relationship between technological innovation and the flipped classroom learning paradigm.

It is worth noting, however, that contrasting findings have been reported in other studies, including those by CavigliaHarris (2016), Chang (2016), Connell, Donovan, & Chambers (2016), Wanner & Palmer (2015), Lai & Hwang (2016), Chuang et al. (2018), Bhagat, Chang & Chang (2017), Yilmaz (2017), and Beetham & Sharpe. These studies have demonstrated a significant positive association between technological innovation and the effectiveness of the flipped classroom approach in fostering learning outcomes.

The respondents, comprising individuals engaged in educational practices, served as key participants in this study. Their perspectives and experiences provided valuable insights into the effectiveness of the flipped classroom model in conjunction with technological innovations. By incorporating the viewpoints of university students, the research endeavours to capture a comprehensive understanding of the dynamics at play within the educational landscape.

As the researcher, I played a pivotal role in shaping the research design, methodology, and interpretation of findings. Leveraging my expertise in educational research and technology integration, I guided the study process, ensuring rigor and adherence to ethical standards. By synthesizing insights from diverse sources and engaging in critical analysis, I aimed to elucidate the nuanced complexities inherent in the relationship between technological innovation and pedagogical practices.

Nevertheless, after critically engaging with these contrasting viewpoints and synthesizing evidence from diverse sources, this research contributes to a nuanced understanding of the complex interplay between technology, pedagogy, and learning outcomes. Furthermore, by centring the perspectives of respondents and integrating insights from existing literature, the study aims to inform evidence-based educational practices and guide future research endeavours in this evolving field.

6.2.2. Hypothesis 2 (Technology innovation and Moodle learning method)

The findings of this study not only underscore the transformative impact of technological innovation within educational contexts but also resonate with the existing body of literature that has extensively explored the intersection of technology and pedagogy, particularly within the framework of the Moodle learning method. The findings derived from this comprehensive study unequivocally demonstrate the profound impact of technological innovation on learning outcomes within the context of the Moodle learning method. Through rigorous analysis conducted at a 5% significance level, the study establishes a statistically significant positive effect, compelling the acceptance of the alternative hypothesis while simultaneously rejecting the null hypothesis. This pivotal result underscores the transformative potential of technology in enhancing the educational experience and underscores its role as a catalyst for positive change within the realm of pedagogy.

Central to this impact is the observed increase in interaction between students and learning materials facilitated by technological innovation within the Moodle learning environment. By leveraging innovative technological tools and platforms, students are afforded greater opportunities for engagement, collaboration, and active participation in the learning process. This heightened level of interactivity not only enriches the learning experience but also fosters deeper understanding and retention of course content, ultimately leading to improved academic outcomes.

Moreover, the study identifies the Moodle learning method as a facilitator of enhanced interaction between students and learning materials. By providing a versatile and dynamic platform for content delivery, communication, and collaboration, Moodle empowers educators and learners alike to engage with course materials in meaningful and impactful ways. This finding underscores the instrumental role played by the Moodle platform in promoting student-centered learning environments that prioritize active engagement and knowledge construction.

The alignment of these findings with those of esteemed scholars such as Beetham & Sharpe (2019), Chang (2016), Aristovnik et al. (2016), Kasse (2013), Brown (2015), Chang & Wills (2019), and Buckenmeyer (2017) further solidifies the conclusion drawn in this study. Collectively, these scholars' research findings corroborate the significant positive relationship between technological innovation and the effectiveness of the Moodle learning method, providing robust empirical evidence in support of the study's conclusions.

However, it is essential to acknowledge the contrasting perspective presented by Dar es Salaam, Mtebe et al. (2013), whose work suggests a preference among students for in-person communication with professors and assistants over the utilization of the Moodle learning method. While this perspective offers valuable insight into student preferences, it does not detract from the overarching trend observed in the current study and supported by a substantial body of literature, emphasizing the transformative potential of technology within educational settings.

The respondents, comprising individuals actively engaged in educational practices, played a pivotal role in this study. Their perspectives and experiences provided invaluable insights into the efficacy of the Moodle learning method in conjunction with technological innovations. By incorporating the viewpoints of university students, the research aimed to capture a comprehensive understanding of the dynamics at play within the educational landscape and to ensure that the findings accurately reflected the experiences and perspectives of those directly involved in the learning process.

As the researcher, I assumed a central role in shaping the research design, methodology, and interpretation of findings. Leveraging my expertise in educational research and technology integration, I guided the study process, ensuring rigor and adherence to ethical standards. By synthesizing insights from diverse sources and engaging in critical analysis, I aimed to elucidate the nuanced complexities inherent in the relationship between technological innovation and pedagogical practices within the Moodle learning environment.

The literature review conducted as part of this study not only contextualizes the research findings within the broader scholarly discourse but also highlights the divergent perspectives and findings reported in previous studies.

In conclusion, the findings of this study contribute to a nuanced understanding of the intricate relationship between technological innovation and pedagogical practices, particularly within the context of the Moodle learning method. By highlighting the significant positive impact of technology on learning outcomes and interaction dynamics, this research informs evidence-based educational practices and underscores the importance of continued exploration and integration of technological advancements in educational settings.

6.2.3. Hypothesis 3 (Technology innovation and students' attitude)

The findings of this study not only shed light on the transformative influence of technological innovation on students' attitudes towards learning but also align closely with the existing body of literature that has explored the intersection of technology and education. The results derived from this study offer compelling evidence that technological innovation exerts a significant positive effect on students' attitudes towards learning. Through rigorous statistical analysis conducted at the 5% significance level, the null hypothesis is decisively rejected in favour of the alternative hypothesis, affirming the presence of a robust and meaningful relationship between technological innovation and student attitude.

This pivotal finding underscores the transformative potential of technology in education, particularly in shaping students' perceptions and attitudes towards the learning process. By leveraging innovative technological tools and approaches, educators can cultivate an environment that fosters greater enthusiasm, engagement, and enjoyment in learning activities. This, in turn, enhances students' motivation to learn and makes the learning experience more dynamic, interactive, and enjoyable.

The positive impact of technological innovation on student attitude aligns closely with the insights provided by Burke & Williams (2008), who emphasize the importance of student motivation in driving academic success and cognitive development. Their research underscores the notion that students who exhibit strong motivation towards learning are more likely to develop critical thinking skills and achieve higher levels of academic proficiency.

Furthermore, the findings of this study are consistent with the perspectives highlighted by Kara (2020), who acknowledges the pivotal role played by students' positive views towards technology innovation in facilitating their understanding of subjects. Kara emphasizes that students' attitudes towards technological innovation and learning play a crucial role in shaping their learning outcomes and overall learning experiences.

Additionally, the study findings resonate with the research conducted by Oncul (2000), who asserts that positive attitudes towards learning not only enhance students' comprehension and retention of course material but also foster a more open and receptive mindset towards the learning process. This, in turn, reduces anxiety and creates a conducive environment for effective learning and knowledge acquisition.

The consensus among scholars, including Beetham & Sharpe (2019), Rashid & Asghar (2016), Chang (2016), Beetham & Sharpe (2013), Bangert (2006), and Ice et al. (2019), further reinforces the significance of the relationship between technological innovation and student attitude. Their collective research findings provide robust empirical evidence in support of the study's conclusions, underscoring the transformative potential of technology in shaping students' attitudes towards learning and enhancing their overall educational experiences.

The respondents, comprising students actively engaged in the learning process, played a central role in this study. Their perspectives and experiences provided invaluable insights into the relationship between technological innovation and student attitudes towards learning. By incorporating the viewpoints of students, the research aimed to capture a comprehensive understanding of the dynamics at play within the educational landscape and ensure that the findings accurately reflected the experiences and perceptions of those directly involved in the learning process.

As the researcher, I assumed a critical role in shaping the research design, methodology, and interpretation of findings. Leveraging expertise in educational research and technology integration, I guided the study process, ensuring rigor and adherence to ethical standards. By synthesizing insights from diverse sources and engaging in critical analysis, I aimed to elucidate the nuanced complexities inherent in the relationship between technological innovation and student attitudes towards learning.

The literature review conducted as part of this study not only contextualizes the research findings within the broader scholarly discourse but also highlights the diverse perspectives and findings reported in previous studies.

In summary, the findings of this study contribute to a deeper understanding of the complex interplay between technology, pedagogy, and student attitudes towards learning. By highlighting the significant positive impact of technological innovation on student attitude, the research informs evidence-based educational practices and underscores the importance of continued exploration and integration of technology in educational settings.

6.2.4. Hypothesis 4 (Technology innovation and students' satisfaction)

The findings of this study not only illuminate the significant positive impact of technological innovation on students' satisfaction with their learning experiences but also resonate with the existing body of literature that has explored the intersection of technology and education. The findings show the significant positive impact of technological innovation on students' satisfaction with their learning experiences. Through rigorous statistical analysis conducted at a 5% significance level, the alternative hypothesis emerges as more plausible than the null hypothesis, indicating a robust and meaningful correlation between technological progress and students' sense of fulfilment in their educational endeavours.

This pivotal result underscores the transformative potential of technology in enhancing students' overall satisfaction with their learning journey. By leveraging various forms of technological innovations, such as Flipped and Moodle learning platforms, educators can create dynamic and engaging learning environments that cater to diverse learning styles and preferences. The integration of these innovative tools and approaches not only enhances the quality of instruction but also fosters a sense of satisfaction and fulfilment among students as they navigate their educational experiences.

The study's findings also align closely with the insights provided by Bangert (2006), who identified four key factors influencing student satisfaction in online courses: student-faculty connection and communication, time spent on task, active and engaged learning, and peer cooperation. By addressing these factors through the strategic implementation of technological innovations, educators can effectively enhance students' satisfaction with their learning experiences and promote positive outcomes.

Moreover, the research findings are consistent with the perspectives highlighted by scholars such as Rashid & Asghar (2016), Beetham & Sharpe (2019), Chang (2016), and Chang & Wills (2013), whose research demonstrates a significant relationship between technological advancement and the level of satisfaction experienced by students. Their collective findings provide robust empirical evidence in support of the study's conclusions, underscoring the transformative impact of technology on students' educational experiences.

However, it is essential to acknowledge the divergent perspectives presented by studies such as those conducted by Bayne (2019) and Henderson, Selwyn, & Aston (2017), which suggest a lack of significant impact in the relationship between technology innovation and students' satisfaction. While these studies offer valuable insights into the complexities of technology integration in educational settings, they do not detract from the overarching trend observed in the current study and supported by a substantial body of literature, emphasizing the positive correlation between technological innovation and student satisfaction.

The respondents, comprising students actively engaged in the learning process, played a central role in this study. Their perspectives and experiences provided invaluable insights into the impact of technological innovation on their satisfaction levels with educational experiences. By incorporating the viewpoints of students, the research aimed to capture a comprehensive understanding of the dynamics at play within the educational landscape and ensure that the findings accurately reflected the experiences and perceptions of those directly involved in the learning process.

As the researcher, I assumed a critical role in shaping the research design, methodology, and interpretation of findings. Leveraging expertise in educational research and technology integration, I guided the study process, ensuring rigor and adherence to ethical standards. By synthesizing insights from diverse sources and engaging in critical analysis, I aimed to elucidate the nuanced complexities inherent in the relationship between technological innovation and student satisfaction.

The literature review conducted as part of this study not only contextualizes the research findings within the broader scholarly discourse but also highlights the diverse perspectives and findings reported in previous studies.

In conclusion, the findings of this study contribute to a deeper understanding of the complex interplay between technology, pedagogy, and student satisfaction in educational contexts. By highlighting the significant positive impact of technological innovation on students' satisfaction with their learning experiences, the research informs evidence-based educational practices and underscores the importance of continued exploration and integration of technology in educational settings.

6.2.5. Hypothesis 5 (Technology innovation / students' satisfaction and age)

The findings of this study regarding the moderating effect of age on the relationship between technological innovation and student satisfaction resonate with existing literature in the field of educational technology The findings of this study reveal that age does not exert a moderating effect on the relationship between technological innovation and the level of satisfaction experienced by students. Through rigorous analysis conducted at a 5% significance level, it becomes apparent that the null hypothesis cannot be rejected, suggesting that age does not significantly influence the correlation between technological advancement and student satisfaction.

When considering the impact of students' ages on this relationship, it becomes evident that there is no discernible positive correlation between technological innovation and the level of satisfaction experienced by students across different age groups. This suggests that regardless of age, students' satisfaction with educational experiences remains unaffected by technological advancements.

This finding aligns with the insights provided by Venkatesh (2003), who posits that behavioral intention and technology use are less strongly influenced by age. Similarly, Julie, Becker & Newton (2017) failed to establish a significant impact of age on users' intentions and enjoyment of an e-learning system within an educational context. These studies underscore the notion that age is not a significant determinant of students' attitudes towards technology use and their overall satisfaction with educational experiences.

However, it is essential to acknowledge the contrasting perspectives presented by studies such as those conducted by Tarhini, Hone & Liu (2014) and Chawla & Joshi (2012), which suggest a significant positive relationship between technology innovation and students' satisfaction when age is considered as a moderator variable. While these studies provide valuable insights into the potential influence of age on the relationship between technology and satisfaction, the current study's findings suggest that age may not play a significant moderating role in this context.

The respondents, comprising students from various age groups, played a central role in this study. Their perspectives and experiences provided invaluable insights into the impact of technological innovation on their satisfaction levels with educational experiences across different age cohorts. By incorporating the viewpoints of students of diverse ages, the research aimed to capture a comprehensive understanding of the dynamics at play within the educational landscape and ensure that the findings accurately reflected the experiences and perceptions of those directly involved in the learning process.

As the researcher, I assumed a critical role in shaping the research design, methodology, and interpretation of findings. Leveraging expertise in educational research and technology integration, I guided the study process, ensuring rigor and adherence to ethical standards. By synthesizing insights from diverse sources and engaging in critical analysis, I aimed to elucidate the nuanced complexities inherent in the relationship between age, technological innovation, and student satisfaction.

The literature review conducted as part of this study not only contextualizes the research findings within the broader scholarly discourse but also highlights the diverse perspectives and findings reported in previous studies. While some scholars, as referenced above, have echoed the current study's findings regarding the lack of a moderating effect of age on the relationship between technological innovation and student satisfaction, others have presented contrasting viewpoints.

6.2.6. Hypothesis 6 (Technology innovation / students' satisfaction and gender)

The findings of this study regarding the moderating effect of gender in the relationship between technological innovation and students' satisfaction resonate with existing literature in the field of educational technology. The results of this study provide insight into the relationship between gender, technological innovation, and students' satisfaction with their educational experiences. The findings reveal that gender does not act as a moderator in influencing the relationship between technology innovation and student satisfaction. Through rigorous analysis conducted at a 5% significance level, the null hypothesis is retained, indicating that gender does not significantly affect the association between technological advancement and student satisfaction.

Furthermore, when considering gender as a moderator variable, the study concludes that there is no positive association between technological innovation and student satisfaction across different gender groups. This suggests that irrespective of gender, students' satisfaction levels with their educational experiences remain unaffected by technological advancements.

This study's findings align with the research conducted by Al-Harbi (2011) and Chawla & Joshi (2017), which found no solid evidence supporting the notion that gender influences technological acceptance or moderates the relationship between technology innovation and student satisfaction. These studies underscore the notion that gender does not play a significant role in shaping students' attitudes towards technology use or their satisfaction with educational experiences.

However, it is important to acknowledge the contrasting perspectives presented by studies such as those conducted by Tarhini, Hone, & Liu (2014), Wang, Wu & Wang (2009), Venkatesh & Morris (2000), Arenas-Gaitán, Rondan-Catalua, & Ramirez-Correa (2010), He & Freeman (2010), Davis & Davis (2003), Venkatesh (2003), and Alothman et al. (2017). These studies demonstrated a significant positive relationship between technology innovation and students' satisfaction when gender is considered as a moderating variable. They suggest that males and females may make different decisions, which is reflected in their assessments of system utility and ease of use in learning environments.

The respondents, comprising students from diverse gender backgrounds, played a central role in this study. Their perspectives and experiences provided invaluable insights into the impact of gender on their satisfaction levels with educational experiences and the role of technological innovation in shaping these perceptions. By incorporating the viewpoints of students of diverse genders, the research aimed to capture a comprehensive understanding of the dynamics at play within the educational landscape and ensure that the findings accurately reflected the experiences and perceptions of those directly involved in the learning process.

As the researcher, I assumed a critical role in shaping the research design, methodology, and interpretation of findings. Leveraging expertise in educational research and technology integration, I guided the study process, ensuring rigor and adherence to ethical standards. By synthesizing insights from diverse sources and engaging in critical analysis, I aimed to elucidate the nuanced complexities inherent in the relationship between gender, technological innovation, and student satisfaction.

The literature review conducted as part of this study not only contextualizes the research findings within the broader scholarly discourse but also highlights the diverse perspectives and findings reported in previous studies. While some scholars, as referenced above, have echoed the current study's findings regarding the lack of moderation by gender in the relationship between technological innovation and student satisfaction, others have presented contrasting viewpoints.

In conclusion, the findings of this study contribute to a nuanced understanding of the role of gender in shaping students' attitudes towards technology use and their satisfaction with educational experiences. By highlighting the absence of a moderating effect of gender on the relationship between technological innovation and student satisfaction, the research informs evidence-based educational practices and underscores the importance of considering individual differences in technology integration initiatives.

6.3. Conclusion

In this chapter, we have delved into a comprehensive discussion of the findings obtained through rigorous analysis, aligning them with the research framework established in Chapter

One, which was meticulously designed to address the research objectives and hypotheses. The culmination of this analysis not only provides insightful answers to the research questions posed in Chapter One but also elucidates the implications of the research framework, including the moderating hypotheses outlined in Appendix C.

The results of the study underscore a nuanced understanding of the relationship between technology innovation and various aspects of learning and student experiences. Firstly, while no significant positive relationship was found between technology innovation and learning when utilizing the flipped classroom method, a contrasting result emerged regarding the Moodle learning method, where a positive significant relationship was observed. This highlights the differential impact of technology innovation across different educational methodologies.

Moreover, the findings reveal positive significant relationships between technology innovation and students' attitudes, as well as their satisfaction with the learning process. These results underscore the transformative potential of technology in shaping students' perceptions and experiences within educational settings, enhancing their overall engagement and satisfaction.

However, despite these positive associations, it is noteworthy that no significant positive relationship was established between technology innovation and the flipped classroom method of learning. This suggests that while technology may enhance certain educational approaches, its impact may not be uniformly beneficial across all methodologies.

Furthermore, the study elucidates that demographic factors such as age and gender do not moderate the relationship between technology innovation and students' satisfaction. These findings challenge prior assumptions about the influence of demographic variables on the effectiveness of technology integration in education.

In the forthcoming chapter, the researcher will expound upon the theoretical, empirical, and methodological contributions of this study, shedding light on its broader implications for educational practice and research. Additionally, the researcher will discuss the limitations of the study and provide recommendations for future research endeavours, aiming to further advance our understanding of the intricate interplay between technology innovation and educational outcomes.

CHAPTER 7
CONCLUSION

CHAPTER 7

7. CONCLUSION

7.1. Introduction

The previous chapter deliberated on the findings of this study as depicted in Chapter 4 and 5. In this chapter, the research is concluded with a summary of the research, its objectives, and findings. It provides conclusions, recommendations and limitations with regards to the results as discussed in Chapter 5. This research should be able to offer new assessments and guide policy and future studies. This chapter also discussed the significant contribution of this research study to tertiary institutions in South Africa.

7.2. Contribution of Study

7.2.1. Theoretical Contribution

This study contributes by investigating the factors that influence technology innovation in higher education institutions in Johannesburg, both private and public. The current study also incorporates five theoretical approaches (the Theory of Diffusion of Innovations (DIT) (Rogers, 1995), the Theory of Planned Behavior (TPB) (Ajzen, 1991), Magout's (2020) Engagement Theory, the Technology Acceptance Model (TAM) (Davis, Bogozzi, and Warshaw, 1989), and the study's underlying Unified Theory of Acceptance and Use of Technology (UTAUT). The study's underlying theory, the Unified Theory of Acceptance and Use of Technology (UTAUT), provides as a baseline model for responding to these research issues by defining and conceptualizing 4IR and its educational utility. These findings contribute to our understanding of 4IR by providing a fuller picture of its role in assisting teaching and learning by examining the perspectives of diverse stakeholders. Its primary goal is to determine if the education sector is prepared to absorb digital technology, as well as the costs, advantages, and implications of those technologies for the sector and its stakeholder groups. This study employs the UTAUT theory, which has been applied with different degrees of success in other domains to bring creative and developmental concepts to Africa. As a result, the UTAUT theory looks to be a good fit for analysing the complexity of 4IR as experienced by educational stakeholders, as it integrates eight diverse models from different theoretical perspective. Finally, a theoretical contribution concerns the applicability of theoretical notions and theories created in different domains. Because of variations in social and cultural circumstances, the applicability of various research theories and models produced in other developed countries to studies in the context of a developing country has been called into doubt. The successful application of these theories, particularly the UTAUT theory, in this work contributes to presenting examples of case study interpretation from developing country such as Nigeria.

7.2.2. Empirical Findings

The empirical findings contribute to our understanding of the interplay between the impact of technological innovation on private and public higher education institutions in Johannesburg. This study also contributes to our understanding of the effect of technology innovation on learning utilising the flipped classroom model, the effect of technology innovation on learning utilising the Moodle learning method, and the effect of technology innovation on students' attitudes. The study also contributed empirically to measuring the effect of technological innovation on student satisfaction and determining whether demographic variables (such as age and gender) moderate the association between technological innovation and student satisfaction. Although some research has been conducted on how organisations and people in developing nations adopt and utilise 4IR (Ferreras-Garcia et al., 2021; Flavián et al., 2022), several universities in South Africa are actively embracing the challenge presented by the Fourth Industrial Revolution (4IR). For instance, the University of Johannesburg (UJ) is committed to proactively shaping the future, viewing the 4IR as a pivotal opportunity in this endeavour (Du Preez & Sinha, 2020). The university's engagement with the 4IR is aimed at cultivating graduates who possess the ability to think innovatively and stand out in their respective fields. Central to this initiative is a focus on learning, which now encompasses a fusion of teaching, research, and innovation. In an era characterized by rapid change, even the foundational principles of learning are evolving (Du Preez & Sinha, 2020). Nevertheless, very little research has been conducted on Higher Education Institutions in Johannesburg (Macome, 2004). In contrast to the majority of innovation research, including that of 4IR, which has mostly focused on computers and manufacturing, just a handful of studies have studied how 4IR is revolutionising the service sector, particularly education and healthcare (Collins, A.; Halverson, 2018; Gleason, 2018). Consequently, there has been no examination into how 4IR could strengthen and improve the sector's operations from the perspective of its most influential stakeholders. Students discovered, however, that digital technology does not alter teaching and learning practises in higher education. According to Ng'ambi et al. (2016), Africa's usage of technology is fragmented, and there is no continent-wide policy for integrating technology into education. It is unclear how adoption and diffusion of 4IR technology in education will enhance student learning or instructor efficiency (Rashid & Asghar, 2016). Currently, we lack sufficient knowledge on the education sector's strategies and procedures for enhancing 4IR capabilities in the classroom, especially in Africa. According to Ng'ambi et al. (2016; Kreijns, Van Acker, Vermeulen, & Van Buuren, 2013), none of the top 50 creative firms in the world are academic institutions, and none are based in Africa. This study contributes to the knowledge of the impact of technological innovation on Private and Public Universities in Johannesburg, South Africa.

7.2.3. Methodological Findings

This research was conducted in South Africa. The contribution to the methodology is the expertise that was obtained through the implementation of a case study strategy, as well as an interpretative method and methodologies used for data collecting. This experience may be helpful for subsequent research on the acceptance and usage of initiatives linked to information and communication technology in organisations and communities within the setting of developing countries.

7.3. Implications of the Study

This research case study suggest that 4IR-related learning activities should be linked to practically all South African higher education institutions. This suggests that understanding the social settings of labour, job, and organisation should be prioritised for effective implementation. This will contribute to the ICT initiative's societal integration and, eventually, its institutionalisation. According to the case study, 4IR experts and stakeholders must develop new negotiation and communication skills in order to persuade other actors to join the network of adoption and use of 4IR-related initiatives such as learning utilising the Moodle learning method.

Another practical contribution is a framework for analysing the process of ICT initiative adoption and use in order to acquire a better understanding of the interaction between 4IR and development in a specific setting. This study's contribution is to understand, using theoretical assumptions, how the 4IR project may be institutionalised and how it contributes to sustainable development. To that purpose, the due process concept can be employed as a practical instrument in South Africa's educational system.

7.4. Limitations of the study and future research

In addition to acknowledging the limitations of this study, it is essential to outline avenues for future research that can build upon the findings and address emerging challenges in the field of educational technology and innovation.

One promising direction for future research is to explore the scalability and transferability of technology innovation initiatives across diverse contexts. While this study focused on higher education institutions in Johannesburg, future research could extend its scope to include a broader range of organizations, communities, and sectors within South Africa, as well as other developing nations. By conducting comparative analyses and cross-cultural studies, researchers can elucidate the factors influencing the adoption and implementation of technology innovation strategies in different socio-economic and cultural contexts.

Moreover, future research endeavours could delve into the longitudinal impact of technology innovation on learning outcomes, student experiences, and organizational practices. Longitudinal studies would allow researchers to track the evolution of technology adoption over time and assess its sustained effects on educational practices and outcomes. By employing mixed-methods approaches and longitudinal data collection techniques, researchers can capture the dynamic nature of technology innovation and its implications for educational development.

Furthermore, there is a need for research that examines the role of emerging technologies, such as artificial intelligence, virtual reality, and blockchain, in transforming teaching and learning processes. Exploring the potential applications of these technologies in educational contexts can provide valuable insights into their efficacy, feasibility, and ethical considerations. Future research could investigate innovative pedagogical approaches that integrate emerging technologies to enhance student engagement, collaboration, and critical thinking skills.

Additionally, future research endeavours should explore the impact of external factors, such as policy interventions, funding mechanisms, and socio-economic disparities, on the adoption and diffusion of technology innovation in education. By examining the macro-level influences shaping technology adoption within educational systems, researchers can inform evidence-based policy recommendations and institutional strategies for promoting digital inclusion and equitable access to educational opportunities.

Overall, future research in the field of educational technology and innovation should embrace interdisciplinary approaches, collaborative partnerships, and methodological innovations to address complex challenges and opportunities in the digital age. By fostering a culture of innovation and knowledge exchange, researchers can contribute to the advancement of educational practices, social development, and economic prosperity on a global scale.

7.5. Recommendations

Based on the findings and conclusion from this study the following are the recommendation**s**

i. In recognition of the greater ecosystem, tertiary institutions should strengthen inter-institutional collaboration to share resources and/or work toward shared objectives.

ii. The study recommended that higher education institutions completely support the development of "blended learning which incorporates (Moodle learning technique)," in which they offer a combination of both online and classroom approaches.

iii. It's important to assess the quality of content production for technologically based educational materials. For this reason, training should be provided to professionals who make educational content, including instructional designers, scriptwriters, audio and video producers, programmers, and web developers.

iv. The study suggested that in order to increase students' learning satisfaction, higher education institutions should use cutting-edge technological teaching strategies like "Moodle", and make it user friendly so that students can easily access learning at ease.

v. Finally, when establishing a teaching technique, higher education institutions should consider diverse innovative aspects that tends to build students attitude and satisfaction towards learning experience and/or monitoring success.

7.6. Conclusion

In conclusion, this study has provided valuable insights into the complex dynamics surrounding technology innovation in higher education institutions in Johannesburg, South Africa. The study has successfully addressed its research objectives and research questions, thereby making significant contributions to the understanding of technology innovation in higher education institutions in Johannesburg, South Africa.

Firstly, the study aimed to investigate the factors influencing technology innovation in higher education institutions in Johannesburg, both private and public. Through a comprehensive examination of theoretical frameworks such as the Theory of Diffusion of Innovations, the Theory of Planned Behaviour, and the Unified Theory of Acceptance and Use of Technology, among others, the research has provided insights into the complex interplay of factors shaping technology adoption and implementation within educational contexts.

Secondly, the research sought to explore the impact of technology innovation on various aspects of learning and student experiences, including attitudes and satisfaction levels. Empirical findings from the study have revealed significant relationships between technology innovation and learning outcomes, students' attitudes, and satisfaction levels, highlighting the transformative potential of technology in reshaping educational practices.

Furthermore, the study aimed to assess whether demographic variables, such as age and gender, moderate the association between technology innovation and student satisfaction. While the findings indicated no significant moderation effect, the research contributes valuable insights into the nuanced dynamics of technology adoption and its implications for diverse student populations.

In addition to addressing its research objectives and questions, this study has made notable theoretical, empirical, and methodological contributions to the field of educational technology.

The theoretical contributions of this study lie in its exploration of the factors influencing technology innovation within higher education, drawing upon established theoretical models such as the Theory of Diffusion of Innovations, the Theory of Planned Behaviour, Magout's Engagement Theory, the Technology Acceptance Model, and the Unified Theory of Acceptance and Use of Technology. By synthesizing these frameworks, this study offers a holistic perspective on the role of technology in enhancing teaching and learning practices, particularly within the context of the Fourth Industrial Revolution (4IR).

Empirically, this research has shed light on the impact of technology innovation on learning outcomes, students' attitudes, and satisfaction levels within both private and public higher education institutions in Johannesburg. The findings underscore the transformative potential of technology in reshaping educational experiences, while also highlighting the need for tailored approaches to address the diverse needs and preferences of stakeholders.

Methodologically, this study has contributed insights into the implementation of case study strategies and interpretative methods within the context of developing countries, providing valuable lessons for future research endeavours in similar settings. By navigating challenges such as data collection during the COVID-19 pandemic, this study demonstrates resilience and adaptability in research methodology.

Moving forward, the implications of this research extend to both policy and practice within tertiary institutions. Recommendations include fostering inter-institutional collaboration, promoting blended learning approaches, enhancing the quality of educational content production, and leveraging innovative teaching strategies such as Moodle to enhance student learning satisfaction.

However, it is essential to acknowledge the limitations of this study, including its contextual specificity and challenges encountered during data collection. Future research should aim to address these limitations by expanding the scope of investigation to encompass a broader range of contexts and sectors within South Africa, while also considering strategies to mitigate challenges related to data collection in adverse circumstances.

In summary, this study provides a comprehensive understanding of the role of technology innovation in higher education within the South African context. By bridging theoretical insights with empirical evidence and methodological considerations, this research serves as a foundation for informed decision-making and future research endeavours in the field of educational technology and innovation.

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APPENDIX A

IMPACT OF FOURTH INDUSTRIAL REVOLUTION ON TERTIARY INSTITUTION IN SOUTH AFRICA QUESTIONNAIRE

I would be grateful if you could take part in this research project that is aimed at determining the effects that the Fourth Industrial Revolution will have on tertiary institutions within the South African University located in Johannesburg, South Africa. My doctoral studies in management are being conducted at the Wits Business School in Johannesburg, and this research is a component of those studies.

We will not inquire about your identity by requesting your name, ID number, contact number, or any other private information. You are under no obligation to respond to any of the questions. Your responses will be reviewed in complete confidence and will only be used for the scholarly aspects of this investigation. After you have finished filling out this questionnaire, no one will get in touch with you again for any reason regarding this study.

If there is anything about this questionnaire that you need clarified, please don't hesitate to ask me. George Iroha (Stud: no: 1760493), who works in the School of Economic and Business Sciences at the University of the Witwatersrand, is the person who can answer your questions directly. Cell: 072 364 7274.

SECTION A: DEMOGRAPHIC INFORMATION

In regard to the items that follow, please respond by selecting the option that best describes your response using the checkboxes.

1. **Gender** ________________________________ **or** Prefer not to say ☐

2. **Age (*in years*) at your last birthday** ☐☐ Prefer not to say ☐
(Please kindly withdrawl from the survey if blow 18years)

3. **University attending**

Wits ☐ Pearson Institute ☐ *Prefer not to say* ☐

SECTION B: FIVE-POINT LIKERT SCALE QUESTIONS

Please tick (/) for the most appropriate responses/answer in respect of the following item

Strongly Disagree	***Disagree***	***Neutral***	***Agree***	***Strongly Agree***
1	***2***	***3***	***4***	***5***

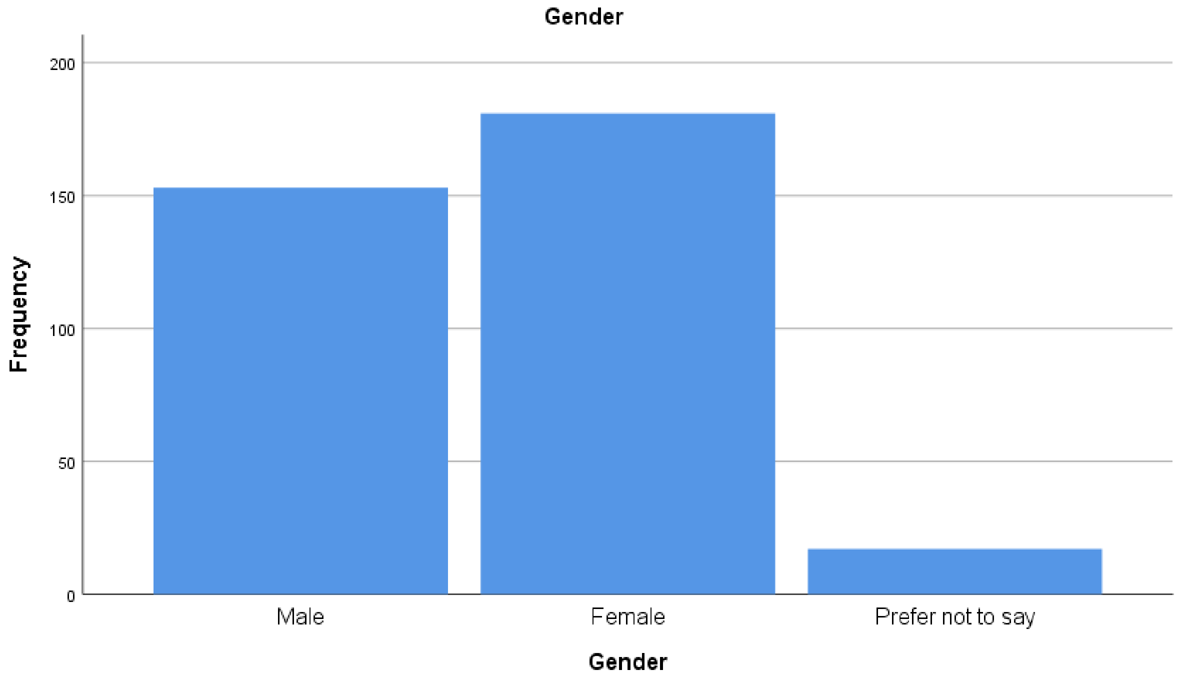
Industry 4.0 Technology Innovation Statements	***Please Tick (/)***				
I take pleasure in making use of various forms of information and communication technology.	1	2	3	4	5
In my opinion, the efficient use of ICT in the classroom saves time.	1	2	3	4	5
I'm aware that my access to digital tools and resources can help me learn many new things.	1	2	3	4	5
Using digital technologies does not scare or threaten me in any way.	1	2	3	4	5

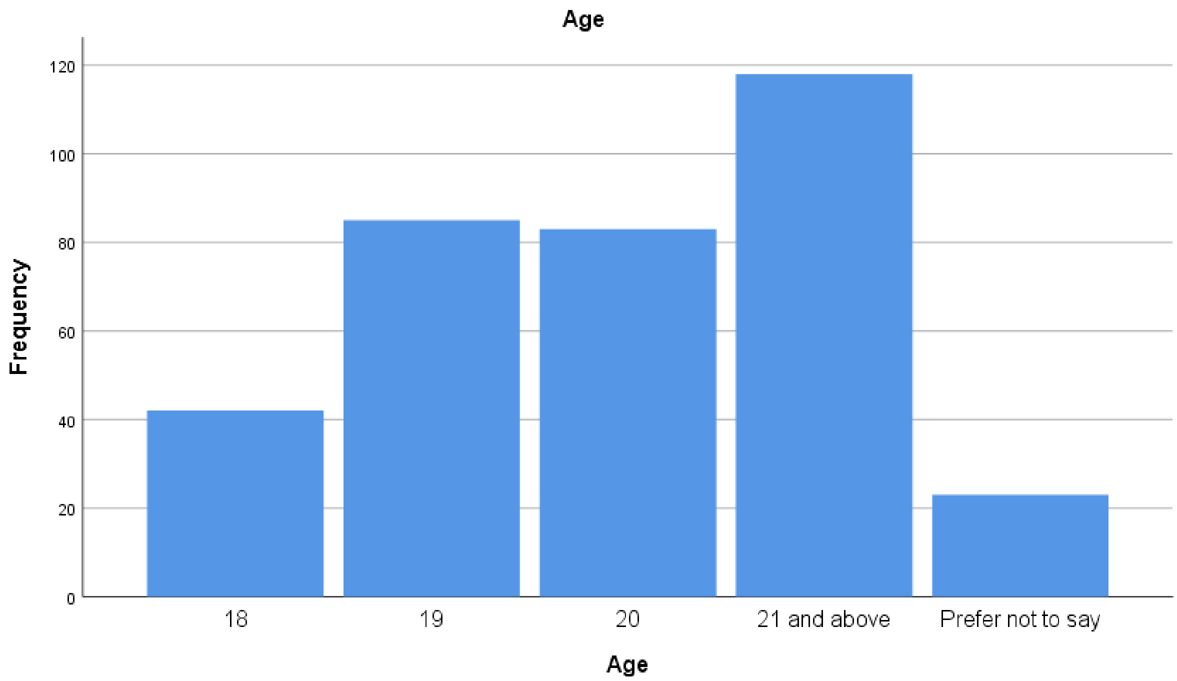
When it comes to using various forms of technology in the classroom, I have a high level of self-assurance.	1	2	3	4	5
I'm interested in expanding my knowledge of how to apply ICT in the classroom.	1	2	3	4	5
My experience has shown me that incorporating ICT into my classroom can yield significant results.	1	2	3	4	5
It is possible to modify the curriculum in order to incorporate ICT.	1	2	3	4	5
The information and communications technology that we rely on rarely fails, which enables it to fulfil its intended purpose.	1	2	3	4	5
Moodle Learning Method	***Please Tick (/)***				
Learning would be easier with Moodle, in my opinion.	1	2	3	4	5
By utilising Moodle, I am able to complete tasks in a timelier manner.	1	2	3	4	5
My productivity has increased since I started using Moodle for educational purposes.	1	2	3	4	5
If I make use of Moodle, I will improve the likelihood that I will gain knowledge.	1	2	3	4	5
Flipped Classroom Method	***Please Tick (/)***				
The use of the flipped classroom method prevents me from becoming uninterested in my vocabulary classes.	1	2	3	4	5
I am able to learn on my own with the help of the flipped classroom method, and I find that this mode of instruction is very enjoyable.	1	2	3	4	5
I find that I retain more information from a live lecture in the classroom than I do from watching a video at home.	1	2	3	4	5
My level of anxiety has increased as a result of using the flipped classroom method.	1	2	3	4	5
Accessing the internet and watching the videos that have been assigned to me has been difficult.	1	2	3	4	5
The flipped classroom approach is not one that I favour as a method of instruction.	1	2	3	4	5
The use of the flipped classroom method prevents me from becoming uninterested in my vocabulary classes.	1	2	3	4	5
Students Satisfaction	***Please Tick (/)***				
I was very content with mobile learning.	1	2	3	4	5

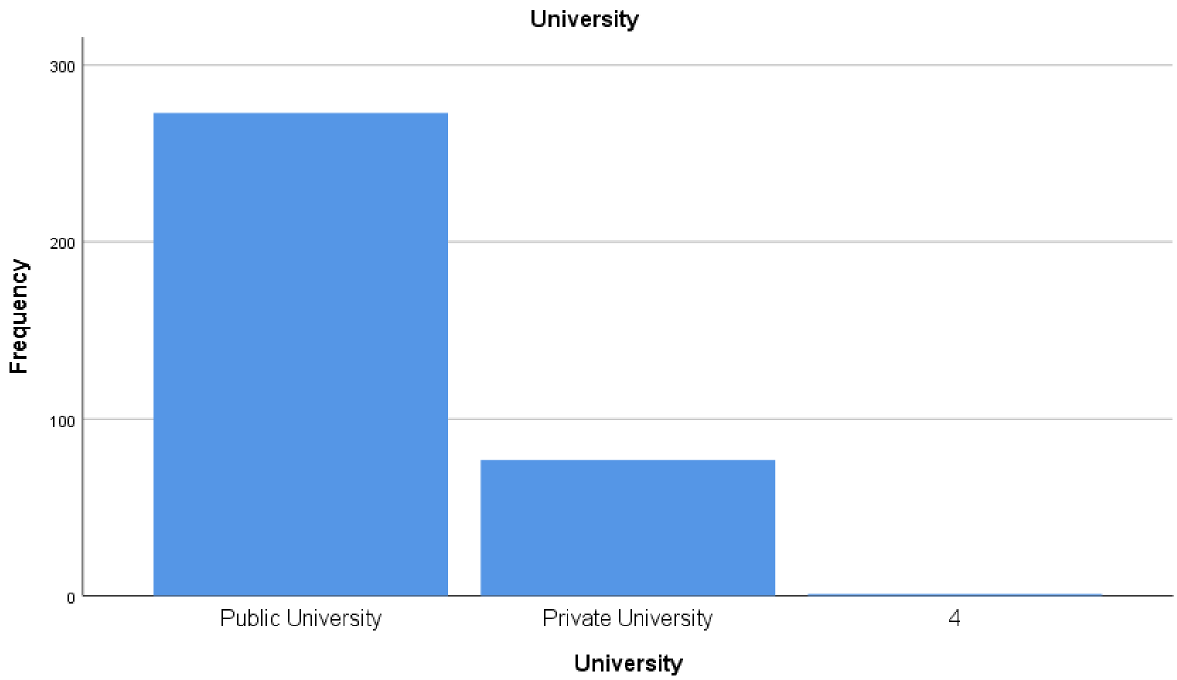
I was very pleased with mobile learning	1	2	3	4	5
I was satisfied with mobile learning efficiency	1	2	3	4	5
I felt delighted with mobile learning	1	2	3	4	5
Overall, I was satisfied with mobile learning	1	2	3	4	5
Students Attitude	***Please Tick (/)***				
I think it's a good idea to use technology innovation	1	2	3	4	5
Technology innovation will make my work more interesting	1	2	3	4	5
It's good to make use of the technology innovation	1	2	3	4	5

APPENDIX B

Graph of demographic data



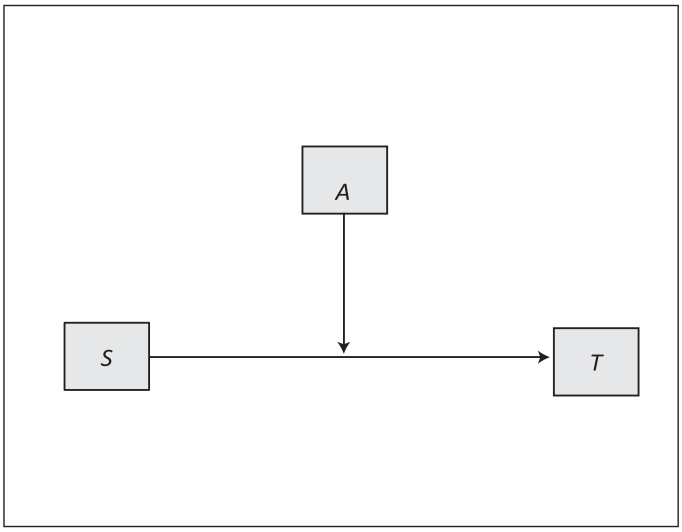



University
Frequency
300
200
100
0
Public University
Private University
4
University

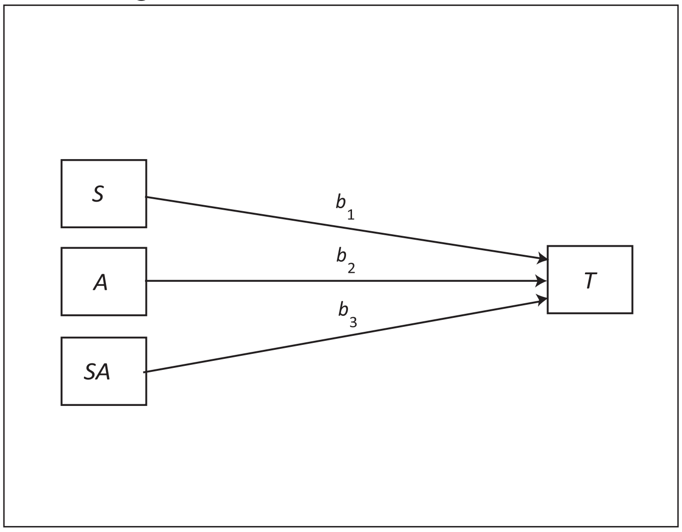
APPENDIX C

The following are the research framework specifications of the two resulting moderating hypotheses that are tested:

1. Age has a moderating effect on technological innovation and student satisfaction.



Statistical Diagram



Conditional effect of S on T= $b_1 + b_3A$

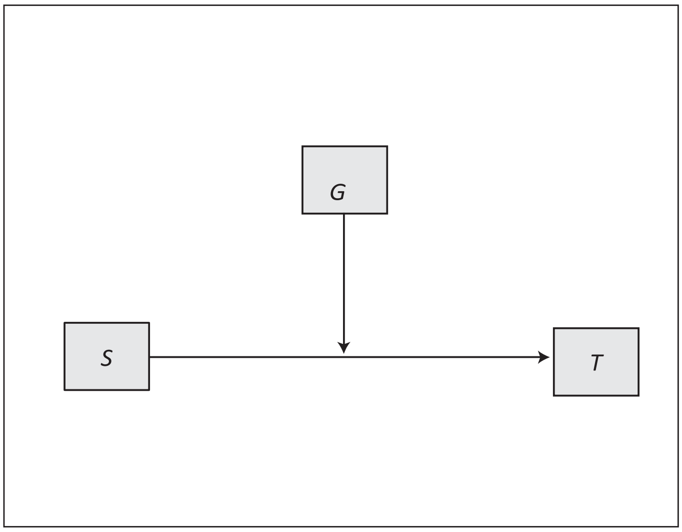
Where,

T = Technology innovation with scale as the dependent variable

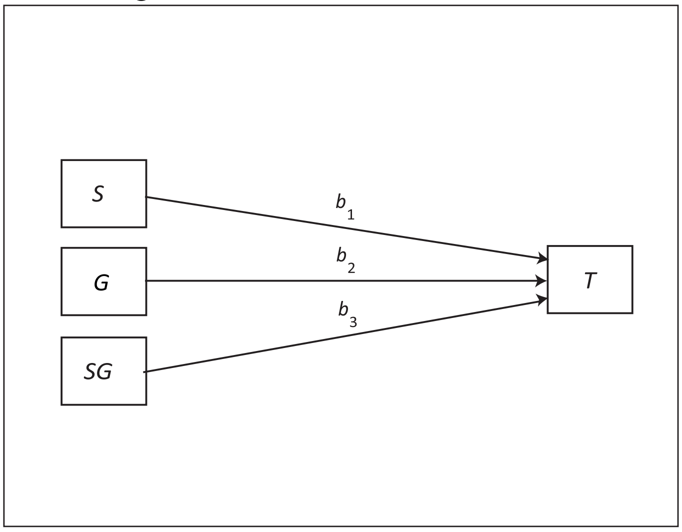
S = stands for student satisfaction, and scale is the independent/predictor variable.

A=Age: categorical moderator factor

4. How gender moderate both employees' ethical perspectives and individual factors



Statistical Diagram



Conditional effect of S on T= $b_1 + b_3G$

Where,

T = Technology innovation with scale as the dependent variable

S = stands for student satisfaction, and scale is the independent/predictor variable.

G= Gender: categorical moderator factor