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EDITORIAL TEAM

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Editorial Comments

Inaugural open-access online issue of African Journal of Pedagogy and Curriculum

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I am pleased to present the inaugural **open-access online issue of the African Journal of Open Pedagogy and Curriculum (AJOPAC)**. Previously published exclusively in print, the journal's transition to an online open-access format—conceptualised in 2024—marks a significant milestone in its development. While the vision for an open journal was clear from the outset, the work required to bring this first issue to fruition proved far more demanding than anticipated, resulting in a steep but invaluable learning journey.

Although we are affiliated with a public higher education institution, AJOPAC originated as a personal initiative aimed at creating a scholarly platform for **emerging and early-career researchers**, whose work is often underrepresented in established journals. As Editor-in-Chief, AJOPAC is truly a labour of love. I extend my sincere gratitude to the contributors and members of the Editorial Board for their dedication, collegiality, and scholarly commitment. I am equally humbled by the wide-ranging support that enabled the publication of this issue.

The establishment of AJOPAC as an open-access journal required financial investment, including funding for the Open Journal Systems (OJS) platform and Crossref membership to ensure the allocation of Digital Object Identifiers (DOIs) to all published articles. These steps were essential to ensure academic credibility, discoverability, and long-term impact. Given ongoing debates and confusion surrounding **open access (OA)** publishing, it is important to state clearly that AJOPAC is an **open-access journal**. All content is freely accessible to readers, while authors and the journal retain copyright. AJOPAC does charge **article processing charge** (APC) or in most cases waived such APC. AJOPAC receives no external financial support; rather, the journal is sustained through the personal generous funds of the Editor-in-Chief, which enable its continued operation and the publication of fully peer-reviewed, final versions of scholarly work directly on its platform.

Volume 7, Issue 1 (2025) includes eight peer-reviewed research articles. While future issues will broadly follow this structure, AJOPAC remains open to growth and innovation. The contributions in this inaugural volume address critical issues in contemporary education, including digital game-based learning in higher education; unemployment among Engineering graduates in selected TVET colleges; STEM integration for Fourth Industrial Revolution (4IR)-ready Technology Teacher preparation; simulated pedagogy in Finance education; play-based pedagogy in Early Childhood Education; 4IR as a form of digitalised neo-colonialism in Africa; the integration of Indigenous Knowledge in early childhood literacy; and school principals' instructional leadership in curriculum delivery.

We invite scholars, practitioners, and policymakers to engage critically with this work and to join AJOPAC on its journey towards advancing open, inclusive, and contextually responsive pedagogical and curriculum scholarship.

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The effect of a digital game-based learning strategy on students' self-efficacy to perform visual analytical reasoning tasks

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Abstract: Educational institutions are incorporating digital game-based learning (DGBL) as a supplementary teaching tool to improve the self-efficacy of students in mathematics and other subject areas. There is, however, a gap in the literature that addresses how to incorporate DGBL into the curriculum to improve students' self-efficacy to perform data tasks. The constructivist lens was utilized and adopted a quantitative pre-post design, rooted in self-efficacy and student-centered digital game-based learning theories. This paper presents the findings of a study that included n=174 respondents that investigated the effect that DGBL had on students' self-efficacy to perform data tasks. The research findings corroborate the hypothesis that students' self-efficacy was improved due to the use of digital game-based learning. The results revealed that using a digital game-based learning strategy impacted significantly students' self-efficacy profiles.

Keywords: self-efficacy, digital game-based learning, student-centered digital game-based learning, data visualization

Introduction

The Fourth Industrial Revolution is distinguished as being the blending of technologies that is smearing "the lines between the physical, digital, and biological spheres" (Xu, David & Kim, 2018:91). This has caused a national and international gap in data skills and individuals must upskill and reskill to become marketable in the employment sector. According to Harvard's Business Review, the most sought-after job of the 21st century is data science (Sajid, Haleem, Bahl, Javaid, Goyal, & Mittal, 2021). The U.S. Bureau of Labor Statistics noted that there will be an increase in the need for expertise in data science and by 2026, it will create 11.5 million job openings (Institute of Data, 2022). More specifically, there is a need for data visualization. Unwin (2020) simplified the definition of data visualization by noting, "of drawing graphic displays to show data (p.1)." Although it sounds simple on paper, there are individuals who struggle with the necessary confidence to learn this skill. Therefore, this intervention of a digital game to increase students' self-efficacy to learn about and perform data visualization tasks provides an alternative means of instruction for improving students' self-efficacy to perform data visualization tasks.

The aim of this research was to measure the effect of a digital game-based learning strategy to support visual analytical reasoning to improve students' self-efficacy to perform visual analytical reasoning with interactive box plots. This research sought to answer three questions:

- What were the self-efficacy levels of undergraduate respondent study respondents when asked to perform visual analytical reasoning with interactive box plots?
- What were the self-efficacy levels of undergraduate respondent study respondents when asked to learn academic topics with digital games?
- Does a digital game to support visual analytical reasoning improve the self-efficacy levels of undergraduate respondents to perform visual analytical reasoning with interactive box plots?

Literature Review

Theoretical frameworks are critical to the interpretation of empirical research on digital game-based learning. The theoretical frameworks for this research build upon the social constructivist learning theory and self-efficacy theory. Without the initial work of constructivist learning theory and the combination of student-centered learning and digital game-based learning, Student-Centered Digital Game-Based Learning (SCDGBL) would not exist. SCDGBL is the name given to the merging of student-centered learning techniques, which are practiced in primary and tertiary education (Thomas, 2021; Wright 2011), that incorporate digital video games as a learning tool instead of traditional techniques. Digital Game-Based Learning (DGBL) is the theory of how learning occurs through the use of primarily digital games (Becker, 2021). Student-centered learning focuses on the student first where the student is encouraged to participate in activities to learn information. Stewart (2021) further noted that pedagogies that arose from constructivist studies place an emphasis on "student-centered, active learning and the role of the teacher as facilitator. (p.11)". Furthermore, Murphy, Eduljee, and Croteau, (2021) also stated "the teacher is involved in the learning process and directs their learning" (p.2). An example is video games that include high activity levels, such as first-person-shooter games. They have been shown to increase a player's real-world vision. The ability to perceive changes in shades of grey improves up to 58 percent (University of Rochester, 2009). This is known as the 'Tetris effect,' which is a form of hypnagogic imagery that players experience from playing a game called Tetris. The 'Tetriminos,' which are shapes, stimulate a person's visual system to recognize low-level patterns. These patterns affect players initially while they are engaged in playing the game and continue on into their sleep (Stickgold, Malia, Maguire, Roddenbury, & O'Connor, 2000). Some even reported trying to mentally interlock real-world objects together while asleep (Earling, 1996).

Second, self-efficacy is described as a person's perceived capabilities to learn or perform behaviors at designated levels (Schunk & DiBenedetto, 2021). Sökmen, (2021:2) noted that there "is a strong relationship between self-efficacy and learner engagement," and Saeid & Eslaminejad (2017) asserted that individuals with high self-efficacy will work towards eliminating obstacles from their path while those with low self-efficacy will not even try. Hamann, Pilotti & Wilson (2021:3) further added that when preparing for an exam, students with low self-efficacy "are unlikely to believe that they have the ability to do well on the exam," whereas students with high self-efficacy may have more motivation to participate in self-regulatory actions because they hold the belief that those actions can lead them receiving what they desire. Instructors have a very important opportunity to positively impact their students' lives by teaching them the importance of not giving up and tackling tasks that seem difficult. The utilization of teaching materials that are wisely prepared can also increase self-efficacy (Tusianah, Sutarsyah, Sukirlan, Ridwan, Nurmalisa, Isnainy, Maydiantoro, Zainaro, & Puja Kesuma, 2021). Teachers play a vital role in shaping students' self-efficacy and have the ability to create and use a number of methods to create self-efficacy in their students (Toharudin, Rahmat, & Kurniawan, 2019). The Perceived Self-Efficacy Theory was developed to explain how individuals think about a situation, motivate themselves, act, and persist in conditions when they are presented with challenges and anxiety-provoking situations (Bandura & Adams, 1977). An individual's perceived self-efficacy is based on four dimensions:

- personal mastery experiences (comprised of successes and failures)
- vicarious experiences (comprised of watching others succeed so that it will strengthen the belief in the person and belief that they can succeed too),
- verbal persuasion (includes feedback and encouragement from others),
- and emotional state (includes one's level of anxiety and stress).

The theory was developed to explain how people think, motivate themselves, behave, and persist in the face of challenges and anxiety-provoking situations (Bandura & Adams, 1977). This theory advances that individuals recognize their own behaviors and compare them to others to determine if they should alter their behavior based on social norms. A study conducted by Alfaiz, Hidayat, Yandri, Sari, Sendayu, Suarja, & Arjoni, (2021:6) noted that "individuals are capable of reconstructing and modifying every experience and knowledge they get, both direct experience and experience through observation processes".

Digital Game-Based Learning supports student learning

Digital game-based learning is characterized by how individuals learn through problem-solving or task completion through the use of devices such as tablets, cell phones, or computers (Chen & Tu, 2021). Well-designed games enable the player to experience competence, autonomy, and relatedness (Ryan, Rigby, & Przybylski, 2006). In game-based learning, continuous competence or self-efficacy is defined as an individual having the opportunity to control a situation based on their position (Hense & Mandl, 2014; Salen et al., 2004). According to Sadler, Romine, Stuart, & Merle‐Johnson's (2013), findings, even with teachers doubting the

effectiveness of gaming to support learning for students at lower academic levels, curricula that are game-based could support the learning of biological content for students who have various academic levels and may provide the most benefit to students who have lower academic levels.

The Student-Centered Digital Game-Based (SCDGB) Framework underpinned this study. The SCDGBL Framework is composed of DGBL and SCL that consists of five components that comprise a system. Each component has a selection of concepts from which to choose. A system process is an ordered set of decisions and actions that users navigate to complete a task using a machine (Koubek, Benysh, Buck, Harvey, & Reynolds, 2003.) The system is iterative with each concept moving into the next and is intertwined by its shared constructs. It is meant to provide a safe environment where players can practice skills as they solve problems while receiving feedback for improvement. Learners are encouraged to try and solve problems while knowing that they learn from each interaction with the system. The feedback is intended to be helpful and to steer the learners to the correct answer. It can be determined if the system works based upon the player's interaction (Koubek, Benysh, Buck, Harvey, & Reynolds, 2003). Safe practice, experiential learning, and interaction are the pillars upon which the theory of game-based learning stands. Learning through games allows students to experiment in non-threatening scenarios and acquire knowledge through practice and social interaction both with the environment and their peers.

Context of the study

For this study, particular components were selected from each of the concepts in the creation of the game by the author, You Deserve a Seat at the Table: Data Visualization Game. The goal of the game was to immerse learners in a learning experience to improve learners' self-efficacy to learn about performing data tasks to create visualizations using box plots, or if the learners already know how to create visualizations using box plots, increase their self-efficacy to apply the skills that they have already acquired. Only undergraduate Freshmen and sophomore students (first-year and second-year) were sampled and the study consisted included n=174 respondents. Of the 174 respondents, 29% (n=51) were male and 71% (n=123) were female. Of the 174 respondents, the majority of the respondents were female who participated in the study and were first-and second-year students. Specific games were applied in the study

Digital Game-Based Learning Strategy

For this research, an intervention of a DGBL strategy was designed to enhance students' self-efficacy to equip and empower them with reasoning skills to perform tasks to create data visualizations in preparation for an ever-changing global economic market. The objectives were:

- To determine undergraduate students' reported levels of self-efficacy when exposed to elements of visual-analytical informal inferential reasoning skills using box plots. (Students' Self-Efficacy to Perform Data Visualization Tasks);
- To measure the effect of the digital games used as a DGBL strategy to enhance students' self-efficacy to learn using box plots. (Digital Escape Room Game/ How Many Tries?);
- To determine undergraduate students' impostor traits when completing learning elements of visuo-analytical informal inferential reasoning skills using box plots. (Clance Impostor Phenomenon Scale)
- To determine the impact of motivational strategies employed in a DGBL strategy by undergraduate students to learn effectively. (Motivational Strategies to Learn Questionnaire)

The digital game-based learning intervention consisted of two digital games. The first game had seven questions with branching choices. The second game had two consisted of two sections: (1) answer the six questions on the website and (2) enter the number of attempts that it took for the player to answer all the questions correctly on a Google Form.

The first game focused on building self-efficacy and overcoming self-doubt to learn about visual analytical reasoning using box plots. The second digital game focused on practicing how to solve problems using box plots for data visualizations.

The first digital game entitled You Deserve a Seat at the Table used a Google form set to quiz mode to allow respondents to move through four levels to ascend to the highest level of attainment. The four levels correspond to four dimensions of perceived self-efficacy (Bandura,1977) which are:

1. Personal mastery experiences
2. Vicarious experiences

3. Verbal persuasion

4. Emotional State

On each of these levels, respondents were asked questions about their self-beliefs regarding learning about box plots and data visualizations. Respondents were given branching choices to determine if they would ascend to the next level. Based on the choice selected, they would either move ahead if they selected the correct choice. If they selected the incorrect choice, they were sent to another section of the game that encouraged them that they could learn the material and redirected them back to the same question to try again by selecting another choice. This would occur until the respondent chose the correct answer which affirmed that they could learn about visual analytical reasoning using box plots.

Methodology

For this exploratory study, a quasi-experimental design (pre- and post-test) was used in response to the research questions. This quasi-experiment Used the dependent variable to be tested before and after an intervention. The study was conducted at a small, private historically Black university located in the southeastern part of the United States. Freshmen and sophomore students enrolled in introductory courses participating in their classroom sessions during the second portion of Phase 1. Of the number of students who were selected to participate, 174 students participated with no regard for gender or major and were selected at random to control for bias.

Data Collection (Phase 1)

The research was conducted using an online platform during the first semester of the academic school year. The study was conducted with structured questionnaires using Likert scales as well as closed-ended questionnaires. Five assessments were administered to both the control and treatment groups, four of them had pre- and post-tests and one, the motivation assessment, only had a pre-test. Only the treatment group received the intervention of two digital games.

The second part of Phase 1 included students enrolled in introductory courses which included two Mathematics classes, one Biology class, and two Freshman Seminar classes. Students in the two Mathematics classes were randomly assigned to a control and experimental group and the students in the Biology and Freshmen Seminar classes were placed in treatment groups using convenience sampling. Professors administered the assessments on the days that the classes were in session in sequential order. Students were administered a combination of three pre-assessments and one pre-test. Students were given the Motivations for Student Learning Questionnaire (MSLQ) to determine their motivations for learning and to inform which game elements to use in the two digital games based on their motivations. The first game entitled You Deserve a Seat at The Table focused on improving students' self-efficacy to learn about visual analytical tasks. The second game is entitled *How Many Tries?* focused on performing visualization tasks. Following the assessments and intervention, a questionnaire was administered to a small number of respondents in the treatment group concerning both games.

Data Analysis and Design (Phase 2 and Phase 3)

A statistical test, box plots, was computed to examine the differences in students' responses due to their demographic backgrounds (Phase 2). Based on the analysis results, a game-based learning intervention was designed (Phase 3). During Phase 1, respondents were given the first assessment to determine students' levels of perceived self-efficacy to perform visualization tasks using box plots. The second assessment was the Motivation Survey (MSLQ) which was used to determine students' motivation to learn. The third assessment was the Clance Impostor Phenomenon Scale (CIPS) to determine if students had impostor tendencies that may affect their ability to learn about and perform data visualization tasks using box plots. Finally, students were given a pre-test to measure their prior knowledge relative to performing data visualization tasks using a box plot. During Phase 2, the data from the MSLQ survey was analyzed to determine which game elements to use in the two digital games during the intervention. Data from the participants' pre- and post-tests were analyzed as well. They included the perceived self-efficacy assessments, box plot tests, and the Clance Impostor Phenomenon Scale assessments.

During Phase 3, an intervention was designed based on the results emerging from the analysis in Phase 2, which consisted of two digital games and the reading of an article. The first game entitled *You Deserve a Seat at The Table* was played during round one and focused on impacting students' self-efficacy to learn about and perform

data visualisation tasks using box plots. Respondents were then instructed to visit a website (https://bit.ly/artboxplots301je1f) to learn about box plots. They were instructed to read the information so they could apply the knowledge to the second game. The second game is entitled *How Many Tries?* Allowed respondents to practice their skills. It was played in round two and encouraged respondents to answer questions about box plots on the website until they answered each question correctly. Respondents were instructed to reread the article on box plots to assist them in answering the questions. Respondents were instructed to use the Google form entitled How Many Tries? to list the number of tries it took to answer all questions correctly.

Phase 4: Effects of Intervention of Digital Game-based Learning:

After the intervention, three post-tests were conducted to reveal students' scores on their self-efficacy, impostor phenomenon traits, and box plots knowledge. A post-test on motivation was not administered as it was only necessary to determine which game elements to use in the study. During Phase 4, each student completed a post-test about their current knowledge of box plots. The final phase also included a focus group discussion, where students were asked to answer closed-ended questions about the two digital games.

Measures for Reliability, Validity, and Data Triangulation Trustworthiness

The researcher ensured reliability, validity, and trustworthiness by using instruments that are valid and reliable based on the confidence in truth of the literature. Questionnaires and surveys were tested (Cronbach alpha coefficient, $\alpha = .7$) and retested for reliability to ensure that the questions measured what they were intended to measure (Cronbach, 1951). The overall reliability of the four instruments was 0.86 which means it was highly reliable. The constructivist lens believes in "contextualized (e.g., sensitive to place and situation) perspectives and relies on trustworthiness which refers to dependability, transferability, authenticity and credibility" (Creswell & Miller, 2000:125). Reliability refers to consistency that can be measured over a period of time using similar samples (Cohen, Manion & Morrison, 2007). Data triangulation can enhance the validity of research as it includes collecting data from various sources in an effort to attain different views of the phenomena being studied (Cohen & Manion,1997).

Ethical Considerations

The researcher aimed to conduct the research ethically taking into account the respondents' well-being and minimizing the risk of harm. The researcher obtained informed consent from the University of South Africa (UNISA) (reference number 2021/11/10/69969051/14/AM) and the university (reference number 00772). Respondents were assured of anonymity and confidentiality and were offered the right to withdraw. In this research study, the critically important ethical standards were enforced by providing clear instructions about the procedures of the research and were informed that information would be kept confidential. The respondents were also informed that the information obtained would be kept on a password-protected computer. Furthermore, the respondents were informed in writing about the objectives of the study. After potential respondents received the information, they were requested to sign the consent forms.

Findings

There were 124 respondents (n=124) who took the self-efficacy pre-test and 53 respondents (n=53) who took the self-efficacy post-test. Based on the data presented in the above table, the mean scores for self-efficacy tests (SE pre-test =28.30; SE Post-Test =29.45) show a difference of 1.15. There is an increase in the mean scores and the reliability ($\alpha < 0.91$) SE test is highly reliable completed by the respondents.

Data Collection (Phase 1)

The research was conducted using an online platform during the first semester of the academic school year. The study was conducted with structured questionnaires using Likert scales as well as closed-ended questionnaires.

Data Analysis and Design (Phase 2)

Descriptive statistics, the box plots analysis, was computed to examine the differences in students' responses due to their demographic backgrounds and games played (Phase 2). This section describes the mean differences in the self-efficacy scores for respondents who played one game, game games or no game.

No game

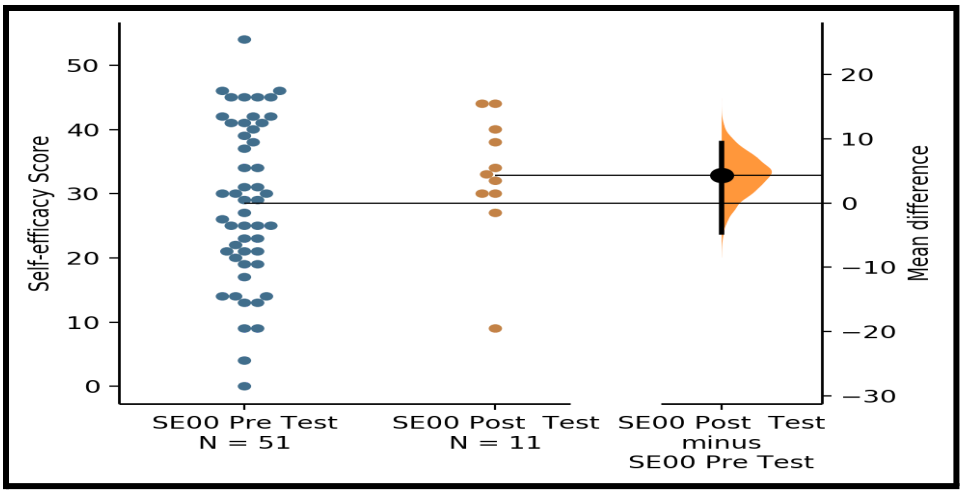

Figure 3: The estimation plot for respondents who did not play either of the games

Figure 1 shows the estimation plot for respondents who did not play either of the games. The unpaired mean difference between SE00 pre-test and SE00 post-test is 4.27. The P value of the two-sided permutation t-test is 0.295 and has a confidence interval of 95%. The effect size is 4.27. The score values ranged from -4.68 and 9.41. A total of n=51 respondents took the SE00 pre-test and n=11 respondents took the SE00 post-test. The respondents who took the SE00 pre-test had a higher mean score than the respondents who took the SE00 post-test. There is a positive effect (effect size 4.27) for respondents who did not play either of the games.

First game only

Figure 4 shows the estimation plot for respondents who played the first game only. The unpaired mean difference between SE10 pre-test and SE10 post-test is 3.55. The P value of the two-sided permutation t-test is 0.511 and has a confidence interval of 95%. The effect size is 3.55. The score values ranged from -5.62 and 12.3.

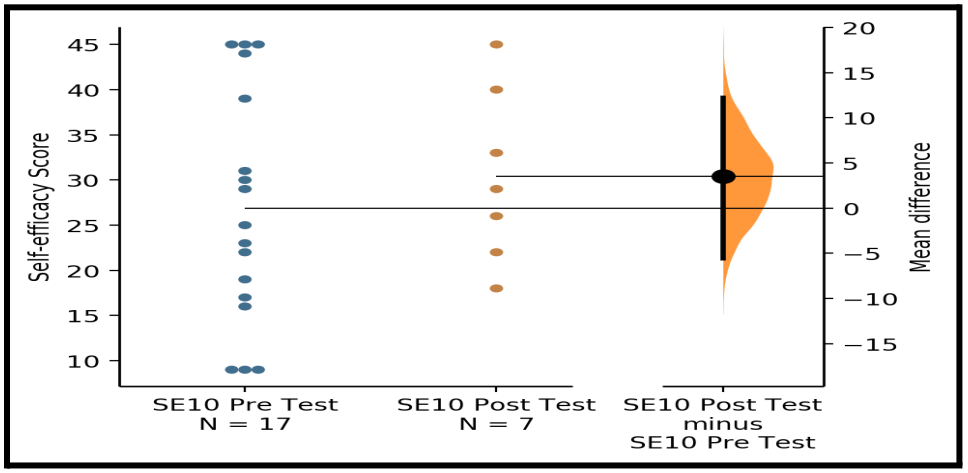

Figure 2: The estimation plot for respondents who played the first game only

A total of n=17 respondents took the SE10 pre-test and n=7 respondents took the SE10 post-test. The respondents who took the SE10 post-test had a higher mean score than the respondents who took the SE10 pre-test. There is a positive effect (effect size 3.55) for respondents who did not play either of the games.

Second game only

Figure 3 shows the estimation plot for respondents who played the second game only. The unpaired mean difference between SE01 pre-test and SE01 post-test is 1.38. The P value of the two-sided permutation t-test is 0.837 and has a confidence interval of 95%. The effect size is 1.38. The score values ranged from -9.86 and 7.81.

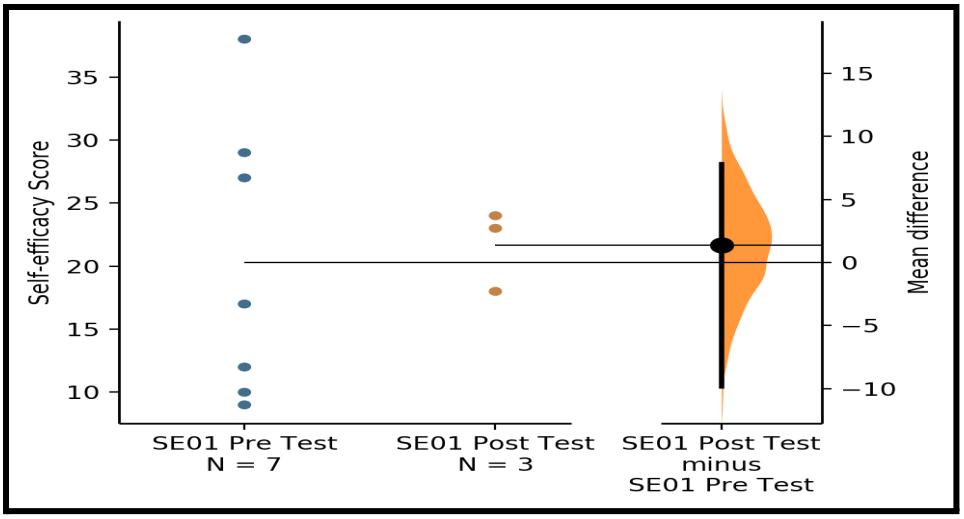

Figure 3: The estimation plot for respondents who played the second game only

A total of n=7 respondents took the SE01 pre-test and n=3 respondents took the SE01 post-test. The respondents who took the SE01 post-test had a higher mean score than the respondents who took the SE01 pre-test. There is an increase in the mean difference for the post-tests. There is a positive effect (effect size 1.38) for respondents who did not play either of the games.

Both games

Figure 4 shows the estimation plot for respondents who played both games (11). The unpaired mean difference between SE11 Pre-Test and SE 11 Post-Test is -0.735. The P value of the two-sided permutation t-test is 0.781 and has a confidence interval of 95%. The effect size is -0.735. The score values ranged from -6.09 and 4.18.

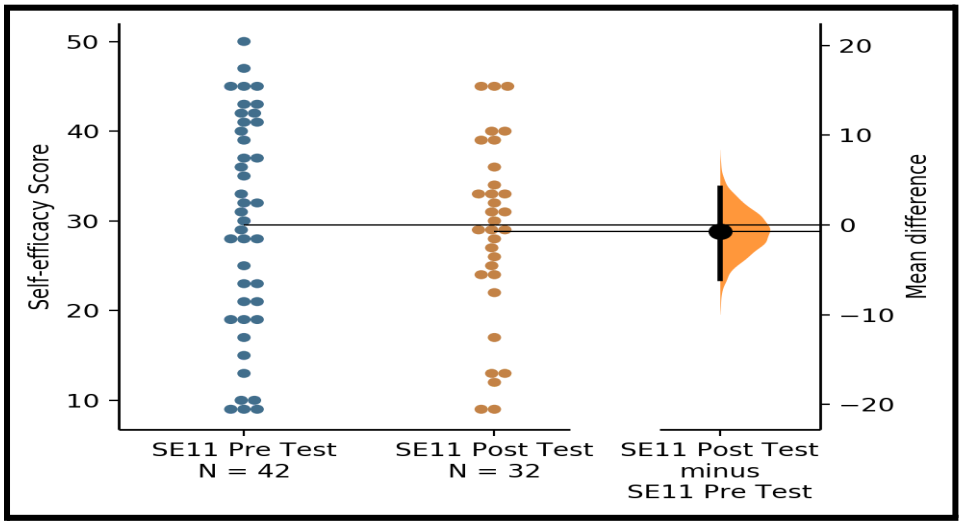

Figure 4: The estimation plot for respondents who played both games

A total of n=42 respondents took the SE11 pre-test and n=32 respondents took the SE11 post-test. The respondents who took the SE11 post-test had a lower mean score than the respondents who took the SE11 pre-test. There is a decrease in the mean difference for the SE11 post-test. There is a negative effect (effect size -0.735) for respondents who played both games.

Data Analysis and Design (Phase 3)

t-Test for three test scores

The paired-sample t-test was performed by comparing the pre-test and post-test scores of the three different tests for 174 respondents. The scores showed a statistically significant difference between the pre-test and post-test in two of the tests.

Table 1: Computed t-tests for the three instruments

Paired Differences					**t-test**	**df**	**Significance**
Mean	**Std. Deviation**	**Std Error**	**95% Confidence Interval of the Difference**				**One-Sided p**
			Lower	**Upper**			
23.54	8.31	1.58	-5.95	17.84	0.17	156	0.01*
24.87	9.01	1.53					
28.30	12.39	2.63	-7.99	16.75	0.25	175	0.01*
29.45	9.88	2.34					
56.28	13.70	2.52	-13.84	2.55	0.09	144	0.13
53.04	13.98	2.49					

Note: t-test $p > 0.05$

Based on the information in Table 1, a statistically significant test result ($P \leq 0.05$) showed that the one-sided tailed test for both Test 1 ($p < 0.01$) and Test 2 ($p < 0.01$) are accepted but Test 3 is rejected.

Three Test Scores

This table shows the pre-tests and post-tests, mean, median, and mode scores. It also shows that the standard deviation and Cronbach's Alpha for the three instruments were highly reliable.

Table 2: Respondents' results pertaining to three tests scores

	Groups	**N**	**Mean**	**Median**	**Mode**	**Std. Deviation**	**Cronbach's Alpha**
Test 1	Pre-test Box Plot Test	88	23.54	24	23	8.31	0.81
	Post-test Box Plot Test	70	24.87	27.5	34	9.01	
Test 2	Pre-test Self-efficacy Test	124	28.30	29	45	12.39	0.91
	Post-test Self-efficacy Test	53	29.45	30	33	9.88	
Test 3	Pre-test Clance Impostor Phenomenon Test	94	56.28	57	45	13.70	0.90
	Post-test Clance Impostor Phenomenon Test	52	53.04	56	58	13.98	

Note: These were applied Test 1 = Box Plots, Test 2 = Self-efficacy, and Test 3 = Impostor Phenomenon
*Cronbach's alpha coefficient, $\alpha = 0.7$

Based on the computations in Table 2 determining the reliability of the tests applied in this study, the alpha coefficient for the four items is ranging from .81; .91 and .90 respectively, suggesting that the tests have relatively high internal consistency. Note that a reliability coefficient of .70 or higher is considered "acceptable" in most social science research situations.

The Box Plot test (BP)

There were 88 respondents (n=88) who took the box plot pre-test and 70 respondents (n=70) who took the box plot post-test. The mean score for the pre-test was 23.54 and the mean score for the post-test was 24.87. Based on the data presented in the above table, the mean scores for box plots tests (BP pre-test =23.54; BP Post-Test =24.87) show a difference of 1.33. There is an increase in the mean scores and the reliability ($\alpha < 0.81$) for the BP test completed by the respondents.

Self-efficacy test (SE)

There were 124 respondents (n=124) who took the self-efficacy pre-test and 53 respondents (n=53) who took the self-efficacy post-test. Based on the data presented in the above table, the mean scores for self-efficacy tests (SE pre-test =28.30; SE Post-Test =29.45) show a difference of 1.15. There is an increase in the mean scores and the reliability ($\alpha < 0.91$) SE test is highly reliable completed by the respondents.

Discussion

First, the results of the study showed that undergraduate students, who were exposed to visual-analytical reasoning skills using box plots, performed significantly well in their self-efficacy. Therefore, the self-efficacy scores showed an increase in the mean difference post-test scores (SE pre-test =28.30; SE Post-Test =29.45) which is a difference of 1.15. There is an increase in the mean scores for the participants' self- efficacy and the reliability ($\alpha < 0.91$) of the SE test is highly reliable that was completed by the respondents. This has a positive effect and demonstrates that after respondents engaged with the DGBL intervention, their mean self-efficacy test scores increased. Based on the empirical findings for the self-efficacy test, scholarly works confirmed that using box plots increased the performance of applying self-efficacy tests in the study. A study reported by Blanco et al. (2020) on the relationship between students' self-confidence and self-efficacy while learning online during the COVID-19 pandemic, found a high correlation between self-confidence and self-efficacy and recommend that schools establish policies that will "augment students' self-confidence and self-efficacy levels to guarantee optimal learning outcomes" (Blanco et al., 2020:16). The findings of this study point to the need for an intervention to improve students' self-efficacy to perform tasks. This instrument can be used in similar studies. A further study confirmed similar results by Alfaiz et al., (2021:6) who used a self-efficacy awareness test for career readiness and noted that "individuals are capable of reconstructing and modifying every experience and knowledge they get, both direct experience and experience through observation processes." In conclusion, the findings reveal that students that were exposed to elements of visuo- analytical informal inferential reasoning skills using box plots, showed an increase in the mean difference post-tests. This has a positive effect and demonstrates that after respondents engaged with the DGBL intervention, their mean self-efficacy test scores increased.

Second, the effect of the digital games used as a DGBL strategy to enhance students' self-efficacy to learn using box plots showed significant changes in scores. The results reported demonstrate that the students who participated in the digital games using a DGBL strategy enhanced their self-efficacy scores in learning using box plots activities in the study. This was another positive effect of the DGBL teaching strategy to increase students' self-efficacy levels. Hence, the empirical results revealed that a total of 8 out of 12 respondents (67%) stated that playing the DGBL on self-efficacy helped to increase respondents' confidence to learn how or to perform data visualization tasks. A research study by Erhel and Jamet (2013) found that digital game-based learning (DGBL) can be described in two categories: it can be a learning activity where learners compete in games to acquire knowledge and meet academic goals, or it can be a simulation where learners practice their skills in a virtual setting. Additionally, an undergraduate study reported that students can experience motivational benefits from using classroom economics games (van Wyk, 2013). There is a dearth of quasi-experimental research on the added value and the effectiveness of game-based learning (Vandercruysse et al., 2012, cf. 2.6; Tahir & Wang, 2022, et al., 2021) as well as the effect that digital game-based learning can have on students' self-efficacy to perform data visualizations. Other studies have focused on game-based learning and self-efficacy, but not as it relates to performing data visualizations (Punyasettro, & Yasri, 2021 conducted a study on self-efficacy to learn evolutionary biology and Wang and Zheng (2021:77) conducted a study on the effects of game-based learning on

Chinese middle school students' learning concerning science and the students' self-efficacy, cf. 2.6). It can be concluded that the findings in this empirical study uncovered that there is a positive effect size of playing a minimum of one game for unpaired groups of pre-and post-tests as it relates to improving respondents' self-efficacy, increasing their box plot scores and decreasing their impostor traits.

Third, undergraduate students' impostor traits had shown increases when completing learning elements of visual-analytical informal inferential reasoning skills using box plots. The results demonstrated that the students who participated in the digital games using a DGBL strategy had a decrease in their impostor traits. The results revealed that respondents' impostor trait scores decreased in the mean difference for the IP11 post-test. Consequently, there was a total of n=23 respondents who took the Clance Impostor Phenomenon (IP11) pre-test and n=33 respondents who took the Clance Impostor Phenomenon (IP11) post-test. There was a mean difference and effect size of 3.58. The scores ranged between -4.52 and 12.51. A total of 8 out of 12 respondents (67%) stated that playing the DGBL on self-efficacy helped to increase respondents' confidence to learn how or to perform data visualization tasks. A total of 10 out of 12 respondents stated that seeing a person of color helped to increase respondents' confidence to learn how or to perform data visualization tasks. This is 83% of the respondents who responded to the questionnaire. Overall, the respondents enjoyed the game. Academic studies determined that approximately 40% of Blacks and 50% of Hispanics who enroll in college will earn a degree yet, a large number of "successfully matriculating students may experience a sense of intellectual phoniness known as the impostor phenomenon (IP)" (Peteet, Montgomery & Weekes, 2015:1). Another study revealed that reduced self-confidence and self-efficacy have been cited as accompanying imposter tendencies (Dahvlig, 2013). Finally, the findings concluded that due to the Clance Impostor Phenomenon scores showing a decrease in the mean difference for the IP11 post-test, it has a positive effect. Respondents experienced high traits of feeling like impostors. After the intervention, respondents experienced fewer traits of feeling like impostors.

Finally, the motivational strategies employed by undergraduate students' had enjoyed and supported learning effectively. The results indicated that the motivational strategies of control, challenge, fantasy and curiosity were used to help respondents learn effectively. The results revealed that of the 44 questions listed on the motivational strategies for learning questionnaire (MSLQ), the questions yielded a similar response rate with a minimum of 80% game mechanics. The sentences included question numbers 8,14,23 and 43. These responses were used to determine which of the 4-game mechanics to use in the digital game-based learning strategy. Question number 8 stated "I expect to do well in this class" generated an average response of 6 and was paired with challenge as the game mechanic. Question number 14 stated "Even when I do poorly on a test, I try to learn from my mistakes" yielded an average response of 6.43 and was paired with control as the game mechanic. Question number 23 stated "When I study for a test, I try to put together the information from class and from the book. It had an average response score of 5.86 and was paired with curiosity as the game mechanic. The last question was number 43 which stated "I work hard to get a good grade even when I don't like a class" and had a response score of 5.86. It was paired with challenge as the game element. Scholarly works showed that digital games have the power to attract players because of the motivational factors that are built into their design (Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012). Based on the study conducted by Asigigan and Samur (2021:47), the gamified STEM activities and contended that data acquired from the intrinsic motivation inventory and student interviews showed an increase in students' motivation and interest in the activities. Another article stated that outside of how people feel when they can classify "pursuing an activity as more like "fun" than "work," or as more like reaching (versus pursuing) a goal," one can infer that those individuals are intrinsically motivated to engage in an activity (Fishbach & Woolley, 2022:343). A student's level of motivation can be influenced by their curiosity. "Curiosity is the most direct intrinsic motivation for learning" (Ciampa, 2014:84). Lepper and Malone (1987) noted that intrinsic motivations that impact motivation are control, curiosity, challenge, and fantasy (Lepper & Malone, 1987). Furthermore, Kim & Lee (2015) included the four elements of intrinsic motivation curiosity, challenge, fantasy, and control in their dynamical model for gamification of learning (DMGL).

Based on the findings, academic works confirm that digital game-based learning elements improve students' motivation. GBL would wield a positive influence on intrinsic motivation. This stems from students being motivated by the learning activity itself because they construe it as fun and interesting (Gopalan, Bakar, Alwi, & Mat, 2017; Wouters & van der Meulen, 2020; cf. 2.5.1). Manzano-León, Camacho-Lazarraga, Guerrero, Guerrero-Puerta, Aguilar-Parra., Trigueros, & Alias, (2021:2) argued that "applying educational gamification promotes student participation in the classroom, especially if the game elements used in gamification have established objectives and rewards". In addition, several notable responses from the open-ended responses to question 11 in the online MSLQ questionnaire about motivational strategies of using game mechanics helped students to learn effectively. Many respondents wrote positively about how they had benefitted from the digital games played. They viewed the games as helpful to them to learn effectively. They echoed sentiments such as "fun learning experience with digital games". One respondent wrote: It was a great opportunity to be part of the

digital gaming sessions". This respondent said: "The Digital Escape Room Game was very insightful." Additionally, this respondent narrated that "The game helped reinforce concepts that I was already exposed to". Finally, this respondent alluded the "The game was fun, and it was informative. It also made me feel confident in my skills." Studies reported that emanating from EVT is the ARCS model of motivational design which was developed by John Keller to enhance the learning process by adding motivation (Malik, 2014). Pappas (2015) explained that the ARCS model has four dimensions: attention, relevance, confidence, and satisfaction that are utilized to design instruction. According to research by Aşıksoy and Özdamlı (2016:1591), the model is significant "in increasing the effectiveness of teaching conditions and is the only motivation model."

Furthermore, there are four conditions that must be met for individuals to become and remain motivated which include: (1) attention – it is necessary to acquire and maintain the learner's attention; (2) relevance – the instruction must be relevant to the learners present and/or future career opportunities; (3) confidence – it is important to incorporate strategies that build confidence in learners, and (4) satisfaction – it is imperative to foster experiences that cause learners to feel good about their accomplishments (Keller, 1987:3).

The results of the study showed that undergraduate students, who were exposed to visual-analytical reasoning skills using box plots, performed significantly well in their self-efficacy. Therefore, the self-efficacy scores showed an increase in the mean difference in post-test scores (SE pre-test =28.30; SE Post-Test =29.45) which is a difference of 1.15. There is an increase in the mean scores for the participants' self-efficacy and the reliability ($\alpha < 0.91$) of the SE test is highly reliable that was completed by the respondents. This has a positive effect and demonstrates that after respondents engaged with the DGBL intervention, their mean self-efficacy test scores increased. Based on the empirical findings for the self-efficacy test, scholarly works confirmed that using box plots increased the performance of applying self-efficacy tests in the study. A study reported by Blanco, Carlota, Nasibog, Rodriguez, Saldaña, Vasquez, & Gagani, 2020 on the relationship between students' self-confidence and self-efficacy while learning online during the COVID-19 pandemic, found a high correlation between self-confidence and self-efficacy and recommend that schools establish policies that will "augment students' self-confidence and self-efficacy levels to guarantee optimal learning outcomes" (Blanco et al., 2020:16). The findings of this study point to the need for an intervention to improve students' self-efficacy to perform tasks. This instrument can be used in similar studies. A further study confirmed similar results by Alfaiz, Hidayat, Yandri, Sari, Sendayu, Suarja, & Arjoni, 2021:6 who used a self-efficacy awareness test for career readiness and noted that "individuals are capable of reconstructing and modifying every experience and knowledge they get, both direct experience and experience through observation processes."

Conclusions

In conclusion, the findings reveal that students that were exposed to elements of visuo-analytical informal inferential reasoning skills using box plots, showed an increase in the mean difference post-tests. This has a positive effect and demonstrates that after respondents engaged with the DGBL intervention, their mean self-efficacy test scores increased.

Recommendations

The undergraduate students' reported levels of self-efficacy when exposed to elements of visuo-analytical informal inferential reasoning skills using box plots.

- Teachers, online facilitators, researchers, curriculum, and instructional designers should recognize the importance of self-efficacy when planning to teach elements of visuo-analytical informal inferential reasoning skills using box plots.
- It is important when planning to teach elements of visuo-analytical informal inferential reasoning skills using box plots to view self-efficacy as the first step in triggering learners' active contributions to their learning process.
- It is considered pertinent that teachers, online facilitators, researchers, curriculum and instructional designers make a willful decision to include game mechanics when teaching the elements of visual-analytical informal inferential reasoning skills using box plots to increase interaction and engagement in class thereby allowing for increased levels of participation and students' efficacy.
- Teachers, online facilitators, researchers, curriculum, and instructional designers must be cognizant of the fact that there needs to exist an adaptation phase that targets self-efficacy for learners prior to teaching the elements of visual-analytical informal inferential reasoning skills using box plots.

Limitations

This exploratory study revealed several limitations:

The sample size for the research design selected only a small number of respondents for the study and the findings can be generalized. The same self-efficacy instrument can be employed to a larger sample of final-year students which maybe yield different results. This is valuable and important issue for further research.

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Unemployed Engineering College Graduates' Views on the Curriculum Offered by the South African TVET Sector

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ABSTRACT

This paper explores how TVET College engineering graduates perceive the effectiveness of their curriculum in preparing them for employment and entrepreneurial opportunities in South Africa. Using Amartya Sen's Capability Approach, the study redefines employability as a function of a person's capabilities—real opportunities to achieve meaningful outcomes, influenced by personal, social, and environmental factors. A questionnaire was completed through purposive sampling of 210 unemployed NC (V) engineering graduates from three public TVET Colleges in Gauteng, South Africa. Descriptive statistics were used to analyze the data. The results show that the NC (V) engineering curriculum does not sufficiently prepare graduates for industry demands. Additionally, the findings suggest that the curriculum should be updated to include technological advancements and industry context. This research contributes to TVET literature by empirically identifying curriculum gaps from graduates' perspectives and framing TVET reform as an extension of free education driven by the Capability Approach. Little prior research has focused on this area. It also confirms anecdotal evidence of employer bias against TVET qualifications and highlights the significance of integrating Work-Integrated Learning (WIL), updating curricula, and soft skills training. Recommendations include revising curricula to strengthen WIL, fostering public-private partnerships to increase industry recognition, and advocating for social change to reduce prejudices and promote equitable career opportunities for TVET graduates. These insights aim to help vocational institutions and policymakers improve engineering curricula, better prepare graduates for the job market, and support broader economic growth and development.

KEYWORDS

Engineering curriculum; Engineering graduates; National Certificate (Vocational) programme; Technical and Vocational Education and Training.

INTRODUCTION

The increasing unemployment rates and continuing economic hardship in South Africa and other emerging economies have heightened research interest in Technical and Vocational Education and Training (TVET) curricula, especially their responsiveness to labour market demands (Kana & Letaba, 2024). The relevance of TVET curricula in South Africa is being questioned, where the unemployment rate for TVET engineering graduates is 33%, compared to 11% for university graduates (Statistics South Africa, 2023). Despite a 2.5% increase in TVET enrolment from 657,133 in 2018 to 673,490 in 2019 (DHET, 2021), graduates' employability continues to decline, highlighting a troubling gap between training and industry needs. The situation is worsened by a lack of research on vocational andragogy and effective learning models tailored for both local and international labour markets (Mama, 2022). Recent research emphasizes the need to address this gap. Wedekind (2021) points out how systemic obstacles hinder South Africa's vocational training system, while Allais (2022) argues that increasing competition in a shrinking job market stifles the growth and success of public TVET institutions. Anthonie (2023) questions the overall importance of TVET institutions but overlooks the quality of the curricula and their andragogy. Additionally, concerns persist about whether the curriculum incorporates practical industry experience, which is essential in the engineering field (Servant-Miklos et al., 2023). This crisis is further evidenced by media reports of TVET graduates seeking informal employment (Sibiya, 2023). Misalignment of the curriculum with sector needs undermines employer confidence and graduate employability, negatively impacting student satisfaction and economic growth (AI-Shehab, etal, 2024).

Globally, TVET institutions play an important role in promoting employment and entrepreneurial growth opportunities; however, South Africa's TVET engineering curriculum battles with developing graduates with competitive skills in a country where artisans are in considerable demand (Du Preez, 2022). This study looks into unemployed TVET engineering graduates' perceptions of the National Certificate Vocational (NCV) curriculum's efficiency in preparing them for job prospects and entrepreneurial endeavours. The curriculum's lack of responsiveness to market demands hinders graduates' capacity to find work as well as establish effective entrepreneurship entities (Mthethwa & Naidoo, 2024). Drawing on Sen's Capabilities Approach, which underscores strengthening individuals through opportunities (Sen, 2020), this study contends that an effective TVET curriculum should improve graduates' employment skills and participation in the general growth of the economy.

The role of TVETs is still crucial globally and to the South African economy, not only for helping young people find work but also for empowering them so that they can create job opportunities. Therefore, this paper explores the views of TVET engineering graduates on the extent to which engineering curricula prepare them for employment opportunities and entrepreneurial endeavours in the South African labour market. The following main research question (MRQ) is developed based on the above purpose. Does the South African NC(V) engineering curriculum in TVET colleges adequately prepare graduates with the required knowledge and skills to meet the engineering sector employment requirements after completing the programme? The following sub-research questions (SRQ) were developed to answer the main research question:

SRQ1.What are the NC(V) engineering graduates' views on the curricula's ability to accommodate authentic WIL practices in the engineering industry?

SRQ2. How do NC(V) engineering graduates perceive their recognition in the engineering industry?

SRQ3. To what extent does the NC(V) engineering programme in public TVET colleges prepare its graduates for job searching and interview management skills?

LITERATURE

CONCEPTUALISING SEN'S CAPABILITY APPROACH

Amartya Sen's Capability Approach offers a powerful lens for evaluating the efficacy of TVET curricula in advancing the employment prospects of graduates and their potential to become successful entrepreneurs. Contrary to conventional human capital theories that focus on acquiring skills for economic output (Schultz, 1961; Becker, 1964), Sen's framework emphasizes capabilities —the actual possibilities individuals have to achieve valued outcomes (functionings), such as employment and business entrepreneurship. In the South African TVET context, this type of approach shifts the concentration from simply offering theoretical knowledge and certificates to their graduates to creating opportunities to transform education into significant participation in the engineering employment sector.

BRINGING GLOBAL TVET MODELS INTO CONTEXT

The German dual TVET model, which thrives on powerful public-private partnerships, combines workplace training with classroom instruction, financially supported by commercial entities and the public sector (Schröder, 2022). Apprentices receive stipends that enhance their economic freedom and enable them to acquire skills that align with industry needs, promoting job readiness. This model's strong emphasis on practical, industry-driven competencies ensures that graduates are job-ready, addressing South Africa's 47% unemployment rate among college graduates in engineering (Kana & Letaba, 2024). Germany's framework, which prioritizes the importance of workplace experience, can also enhance South African TVET college engineering graduates' ability to engage in the economy, an essential aspect of Sen's theory.

On the other hand, Canada's e-Apprentice program makes use of computerised platforms, combining 15–20% online or classroom instruction with 80–85% practical workplace experience (Canadian Apprenticeship Forum, 2023). Sen's focus on equal opportunities is in line with this adaptable and affordable model, which improves training access, especially for the South Africans' mostly underprivileged youth who fill up spaces in the South African public TVET colleges. In the South African TVET context, where a sizeable number of TVET colleges are located in rural areas, the e-Apprentice approach might counter the geographical barriers while students benefit by acquiring skills online but adhering to industry regulatory frameworks. Canada's digital flexibility and Germany's industry collaboration could improve South African TVET's capacity to develop skills like

technical proficiency and adaptability. As suggested by Sen's framework, South Africa could empower unemployed engineering graduates, close the employability gap, and advance economic inclusion by incorporating these models.

ALIGNING THE SOUTH AFRICAN TVET CURRICULUM WITH THE MARKET NEEDS

Recent research highlights ongoing alignment issues between South African TVET curricula and labour market needs, which is inhibiting graduates' ability to find work (Mthethwa & Ndebele, 2022). As noted by Allias (2020), TVET colleges are underfunded and produce graduates who have inadequate opportunities for employment because their curricula concentrate on concepts of theory over authentic, practical, industry-relevant competencies. Sibiya et al emphasise that employer opinions frequently underrate TVET qualifications, with recruitment advertisements hardly recognising NCV qualifications as comparable to conventional higher education. qualifications, subsequently limiting graduates' social conversion factors. This lack of acknowledgement demonstrates a societal hurdle to capability realisation, as workplaces do not consider TVET graduates to be suitable candidates for engineering positions. The paucity of studies on TVET curricula's responsiveness to industry demands worsens these issues. Mthethwa and Ndebele (2022) identify an important need in empirical research on how WIL gets implemented in South African TVET colleges, especially in the Engineering programs. They conclude that inadequate exposure to the industry limits the capacity of students to gain and cultivate real-world abilities. Based on a capability approach, this implies that graduates are unable to translate education into employability when environmental conversion factors, such as workplace access, are not provided. Furthermore, Jacobs et al. (2023) contend that modern pedagogical approaches, such as workplace access digital game-based learning, remain untapped in TVET, given their established efficacy in improving engineering education.

BRIDGING THE GAP THROUGH WORK-INTEGRATED LEARNING (WIL)

WIL has widespread recognition as an important component for boosting the job readiness of TVET graduates. However, there is a paucity of studies on how to efficiently incorporate WIL into the South African TVET system (Mthethwa & Ndebele, 2022). On the same note, Oosthuizen et al. (2021) opine that there is a research gap on Work Integrated Learning for Lecturers (WILL). They conclude that a lack of exposure to the sector reduces the lecturers' capacity to present curricula that effectively link the gap between theory and application. Similarly, Mokhothu and Callaghan (2024) highlight the dearth of empirical data that demonstrates how WIL experiences for TVET lecturers can improve the implementation of the curriculum. They further contend that partnerships between lecturers and industry remain crucial for linking training with market demands. Fisher and McGhie (2023) argue that the South African TVET system is largely dependent on theoretical teaching that falls short of meeting the industry demands, resulting in a disparity between TVET qualifications and engineering industry expectations. According to Chikoko (2021), South African TVET curricula frequently overlook soft skills and entrepreneurial training, both of which are essential for managing competitive job markets or generating opportunities for self-employment. Similarly, Kanwar et al. (2020 advocate for TVET programmes that encompass technological innovations and lifelong learning to better equip students for evolving industrial contexts. However, the South African curricula lag in implementing such technological advances, as evidenced by the Umalusi (2024) report that some of the NC(V) assessments were irrelevant or fell short of meeting the expected levels.

METHODOLOGY

RESEARCH DESIGN

This study used a quantitative research design to examine how unemployed NC(V) engineering graduates perceive the effectiveness of the South African TVET curriculum in preparing them for job opportunities and entrepreneurship. A quantitative approach involves collecting and analyzing numerical data to test hypotheses or measure variables, often using statistical methods to generalize findings to a larger population (Creswell & Creswell, 2023). It is appropriate for measuring perceptions and attitudes through structured instruments. The quantitative approach was chosen for several reasons, aligning with the study's goals and the Capability Approach. This method enabled systematic data collection from a large sample, allowing an exploration of common patterns in graduates' views on the curriculum's effectiveness. This is important when examining the

lack of capabilities within a specific sample (Neuman, 2020). Additionally, quantitative methods ensure statistical accuracy, leading to reliable and objective results that can inform policy, improve the curriculum, and increase graduates' opportunities—an essential part of Sen's framework. Furthermore, the quantitative approach also supported using descriptive data to measure how much participants agreed or disagreed with statements about WIL, industry recognition, and job-searching skills, which closely relate to the article's sub-research questions and Sen's concepts of conversion factors. The quantitative design, aligned with Sen's Capability Approach, emphasizes how social and environmental barriers restrict graduates' freedoms, providing empirical evidence to advocate for curriculum changes that enhance job readiness and entrepreneurial capacity, ultimately promoting broader economic growth (Sen, 1999; Bahl & Dietzen, 2022).

RESEARCH SAMPLING

210 NC(V) engineering graduates were identified from the three colleges' former students' electronic database, and a total of 94 unemployed NC(V) engineering graduates participated in this study. A total of 40.4% (n=38) were females, and 59.6% (n=56) were males. 26.6% (n=25) were from the Electrical Infrastructure and Construction programmes, while 30.9% (n=29) had done Civil and Building Construction. A further 42.6 (n=40) specialised in the Engineering & Related Design programme.

RESEARCH INSTRUMENT

A self-designed, online Likert-type questionnaire instrument was used. Questionnaire surveys are a great and efficient research technique that utilises structured questionnaire instruments for collecting data from a large population. Questionnaire surveys are commonly used to assess attitudes and opinions among others (Babbie, 2021). The survey was selected for its capacity to effectively gather data from an expansive, geographically spread cohort of jobless NCV engineering graduates, linking with the quantitative approach's strong focus on standardised procedures and potential for generalisation (Mokhothu & Callaghan, 2024). The use of a survey can overcome this limitation. Although this strategy is particularly effective in obtaining large amounts of data, low response rates to questionnaires may reduce its impact. The self-designed questionnaire was first piloted to improve the adequacy, appropriateness, and clarity of the instruments as well as to promote their completeness, as recommended by Neuman (2020). The questionnaire consisted of 31 items, divided into five sections. Section A collected biographical data, while Section B addressed curriculum issues. Sections C and D focused on the workplace and the recognition of engineering graduates by the engineering industry, as well as job searching and interview management skills, respectively. Cronbach's alpha was used to test the internal consistency and reliability of the questionnaire, and the results showed a Cronbach's alpha of 0.776, indicating high reliability (Babbie, 2020).

DATA ANALYSIS

A purposive sampling strategy was applied to choose 210 unemployed NC(V) engineering graduates from the computerised records of three public TVET colleges in Gauteng, South Africa. There were 94 participants (40.4%). females and 59.6 males), with 26.6% in Electrical Infrastructure and Construction, 30.9% in Civil and Building Construction, and 42.6% in engineering and related design. Descriptive statistics were used to analyse the data, yielding mean scores and standard deviations for each questionnaire item (Tables 1-3). This method evaluated graduates' views, allowing for an estimation of capability challenges such as a lack of WIL (72.2% disagreement) and insufficient industry recognition (69.5% disagreement). Descriptive statistics were selected for their potential to effectively summarise huge data sets and highlight patterns, advancing the Capability Approach's emphasis on using empirical evidence for analysing freedoms and opportunities (Creswell & Creswell, 2023)

ETHICAL CONSIDERATIONS

Ethical consideration in research implies the moral principles of managing and controlling the entire research process (Govil 2013). By extension, it requires those who conduct studies to commit to the principles of the process and ensure that fair conduct is exercised at all times. In the context of this study, a research approval letter was obtained from the UNISA Research Ethics Committee, and Certificate Ref # 2018/06/13/48174947/27/MC was granted. All participants were given access to the ethics clearance certificate

and informed of their rights to withdraw at any research stage. The researchers also adhered to the confidentiality clause of the ethics clearance certificate, and no participant was required to indicate their name.

FINDINGS /RESULTS

The findings of this study are summarised in Tables 1, 2, and 3. Table 1 depicts data relating to unemployed graduates' views on whether the TVET engineering curricula accommodate authentic WIL practices in the engineering industry (SRQ1). The section focused on, among other aspects, the graduates' views on the engineering programme's structure and pacing, assessing whether students engage in real, authentic learning in the industry.

As shown in Table 1, 47.9% and 24.3 % of the unemployed NC (V) engineering graduates disagree and strongly disagree respectively, giving a total of 72.2 % of the unemployed engineering graduates who argue against the view that the NC(V) engineering curricula in South African TVET colleges does not accommodate authentic WIL practices. Only 4.4 % stated they were uncertain, whereas 22.3 percent of the graduates felt otherwise (mean 2.7; SD= 0.9). Also, 44,9 per cent disagreed with the statement that said that the NC(V) engineering programme prepared them for entrepreneurship adventures, with 1.1 % of them strongly disagreeing with the statement (Mean= 3.1; SD= 0.9).

However, 23.4 % and 7.4 % of the participants agreed and strongly agreed with the statement, respectively, implying that they felt that the engineering programme offered in South African TVET colleges prepared them adequately for entrepreneurship opportunities.

Table 1. The extent to which the engineering curriculum prepared students for the labour market

To what extent do you agree or disagree that the NC (V) engineering curriculum accommodates WIL practices?			**Five-point scale on the extent of agreement/disagreement**				
	Mean	St.Dev	SA (%)	A (%)	U (%)	D (%)	SD (%)
The programme prepared me adequately for entrepreneurship opportunities	**3.1**	**0.9**	**7.4**	**23.4**	**7.2**	**45.9**	**16.1**
Engineering subject content applies to my employment prospects	**3.8**	**0.7**	**13.8**	**58.5**	**5.5**	**12.1**	**10.0**
Learning and teaching resources for the programme are relevant	**3.3**	**1.1**	**16**	**30.9**	**7.7**	**33.3**	**12.1**
The quality of lectures received is good	**3.7**	**0.9**	**17**	**46.8**	**1.3**	**19.9**	**15.0**
The structure and pacing of the curriculum accommodate WIL practices in the workplace	**2.7**	**0.9**	**1.1**	**22.3**	**4.5**	**47.9**	**24.3**
Lecturers apply consistent & and fair assessment practices in the course	**4.0**	**0,7**	**25.5**	**45.7**	**8.0**	**9.0**	**11.8**
The practical assessments given at the college	**3.7**	**0.68**	**13.8**	**48.9**	**9.8**	**7.4**	**20.0**

are relevant to industry							
Theoretical assessments given at college are relevant to the industry	**3.5**	**0.9**	**12.8**	**40.4**	**6.0**	**13.8**	**27.0**

Notes: n=210 Likert scale: SA, strongly agree; A, agree; U, uncertain; D, disagree; SD, strongly disagree.

The recognition of the NC (V) programme from public TVET colleges by the engineering industry is analysed in Table 2. Concerning sub-research question two (SRQ2), the unemployed NC (V) engineering graduates' views were elicited on the extent to which the engineering industry recognised their NC (V) qualification regarding their employment. Furthermore, the engineering industry's attitude towards employing NC (V) engineering graduates from public TVET colleges was also determined. As indicated in Table 2, 35.5 % of the NC (V) engineering graduates strongly disagreed while 34 % disagreed, giving a combined total of 69.5 % (mean=2.4; SD=1.2) of the graduates who felt that the engineering labour market did not recognise their qualifications regarding employment. On the other hand, only 13.8 % and 6.4 % agree and strongly agree, respectively, that the engineering companies recognise NC (V) engineering graduates. This gives the study a combined total of 20.2 % of the participants who felt that the engineering labour market recognises the NC (V) engineering qualifications, in contrast to a total of 69.5 % who felt that the engineering industry market does not recognise the NC(V) engineering qualifications. Approximately 10.2 per cent of the participants indicated that they were uncertain.

Table 2. Workplace competence and recognition by the engineering industry

To what extent do you agree or disagree with the following statements regarding the recognition of the NC (V) engineering programme by the engineering industry?			**Five-point scale for the extent of agreement/disagreement**				
	Mean	**Stand Dev.**	**SA (%)**	**A (%)**	**U (%)**	**D (%)**	**SD (%)**
I am practically competent	**3.7**	**0.8**	**16**	**44.7**	**7.0**	**6.8**	**25.5**
I have adequate workplace experience	**2.6**	**1.1**	**3.2**	**24.5**	**7.5**	**45.7**	**18.6**
I am in a good state of workplace readiness	**2.4**	**1.2**	**7.4**	**39.4**	**2.9**	**22.3**	**28.0**
Industry employers' attitude towards NC (V) engineering graduates	**3.3**	**0.9**	**5.3**	**14.9**	**8.1**	**34**	**37.7**

Engineering companies recognise NC (V) qualifications from public TVET colleges	**2.4**	**1.2**	**6.4**	**13.8**	**10.2**	**34**	**35.5**

Notes: n=210 Likert scale: SA, strongly agree; A, agree; U, uncertain; D, disagree; SD, strongly disagree.

In Table 3, the views of the unemployed NC (V) graduates on the extent to which the engineering programme prepared them in job searching and interview management skills. As shown in Table 3, 38.3% and 25.3 % disagree and strongly disagree respectively, that the engineering programme prepared them in job searching skills, giving the study a combined total of 63.6 per cent (mean= 2.9; SD= 1.1) of the participants who felt that the NC(V) engineering programme did not prepare them in job searching skills. Additionally, a combined 65.8 % (mean=2.9; SD=1.2) indicated that the NC(V) engineering programme did not prepare them for job interview handling skills. However, a combined 28.8 % felt that the NC(V) engineering programme prepared them in job interview handling skills, while a further 5.4 % were uncertain about whether the programme developed them in job interview handling skills or not

Table 3 Job searching skills and further learning pathways

To what extent do you agree with the following statements related to job searching and interview skills*?*			**Five-point scale for the extent of agreement/disagreement**				
	Mean	**Stand Dev.**	**SA (%)**	**A (%)**	**U (%)**	**D (%)**	**SD (%)**
The NC (V) engineering programme prepared me for possible job markets and further learning pathways	**2.8**	**1.5**	**16**	**22**	**3.4**	**26.4**	**31.9**
NC (V) engineering graduates are accessing the job market relatively easily	**2.7**	**0.8**	**0**	**19.1**	**6.2**	**42.6**	**32.1**
After completion of the NC (V) programme, further learning pathways are available for us to pursue degree programmes at the university	**3.4**	**1.1**	**19.1**	**26.6**	**5.0**	**28.7**	**20.5**
University institutions are accessible to NC (V) engineering graduates	**3.4**	**0.8**	**2.1**	**47.9**	**3.0**	**16**	**31.0**
The programme prepared me for job-searching skills	**2.9**	**1.1**	**6.4**	**26.6**	**3.4**	**38.3**	**25.3**
The programme prepared me for job	**2.9**	**1.2**	**12.8**	**16**	**5.4**	**40.4**	**25.4**

interview handling skills							

Notes: n=210 Likert scale: SA, strongly agree; A, agree; U, uncertain; D, disagree; SD, strongly disagree

DISCUSSION

This study examined whether the South African NCV engineering curriculum in Technical and Vocational Education and Training (TVET) colleges adequately prepares graduates for employment and entrepreneurial opportunities, employing Amartya Sen's Capability Approach as a theoretical lens. According to Sen's framework, training should improve individuals' capabilities, as well as their real prospects for acquiring work or start their own businesses, while also taking into account the influences of society and the environment (Sen, 2020) A novel finding in Table 1, is there is significant capability deprivation, with 72.2% of unemployed NCV engineering graduates claiming that the curriculum does not support authentic Work-Integrated Learning processes (mean=2.7; =0.9), perceiving a lack of industry recognition for their qualifications ((Kana & Letaba, 2024).This affirms earlier works of Mitchell, et al, (2021), Fisher & McGhi, (2023), and Wedekind (2021) as well as studies of Bahl & Dietzen, (2022) which conclude that authentic workplace experience is of utmost importance for any engineering curriculum and also that vocational training linked to the workplace creates better job opportunities for its graduates and employers acknowledge and trust such models. Notwithstanding, it is interesting to note that about 23.3. per cent of the unemployed NC (V) engineering graduates felt otherwise. Admittedly, this finding is rather surprising, hence, a difference between the graduates' perceptions could be attributed to their failure to distinguish between Work-Based Education (WBE) and Work Integrated Learning (WIL). Alternatively, it may be that these graduates benefited and excelled in the theoretical knowledge offered in TVET colleges and then thought that was enough for them to be employable. On the contrary, UNESCO (2022) argues that theoretical information alone is not enough in a vocational curriculum in engineering. The findings cast a new light on what curriculum planners and other stakeholders should focus their attention on regarding the review of the NC(V) engineering curriculum in South African public TVET colleges.

Our findings in the second research question reveal that most of the unemployed NC(V) engineering graduates; about 34 % and 35.5 % (See Table 2 disagree and strongly disagree, respectively, that the engineering industry employers recognise, NC(V) qualifications from public TVET colleges in South Africa (mean=2.4; SD=1.2). Closely linked with a lack of recognition, it is interesting to note that the unemployed engineering graduates perceive that the engineering industry's attitude is not welcoming towards the NCV engineering graduates. This is evidenced by a combined percentage of 71.7 % who stated that the engineering industry has a negative attitude towards them. This demonstrates a social conversion barrier, as employer biases and social stereotypes inhibit graduates' potential to convert qualifications into employment (Sen 1999). This also confirms the conclusion from the previous works of Allais (2022), which observes a poor perception of TVET college graduates and considerable labour market and societal prejudice. The latter is further corroborated by Sibiya et al. (2021)'s assertion that job advertisements in the South African media space rarely mention a TVET qualification as an alternate qualification, giving it less value. According to Sen, the lack of recognition hinders graduates' potential to execute valued functions, thereby exacerbating unemployment and inequality in society. This is probably because, during their training, they spend less time with the employers in the industry. This is consistent with the conclusions of Wedekind (2018) and those of Wheelahan et al. (2016), which reiterate the view that engineering industry employers tend to welcome products of training that are closely linked to the workplace. Therefore, it is not surprising for NC (V) graduates to encounter such experiences, given the extent to which the NC(V) engineering curriculum in public TVET colleges is detached from the engineering industry in South Africa. Our argument also relies heavily on the relative success of the dual TVET model practised in countries such as Germany, Austria, Switzerland, Denmark, and Norway. This type of vocational training supports apprenticeship and on-the-job training while encouraging inclusivity through a public-private partnership. It generates TVET graduates with in-demand skills and leads to a high rate of graduate employment (Bahl & Dietzen, 2022).

The third research question was developed to assess the extent to which the NC(V) engineering curriculum prepares its graduates for job searching and interview management skills. In Table 3, it is found that 38.3 % and 25.3 % disagreed and strongly disagreed, respectively, with the statement that the NC(V) engineering curriculum prepared them in job searching skills (mean=2.9; SD=1.1). In addressing the extent to which TVET colleges prepared their graduates in job searching and interview management skills, a combined 65.8 % disagreed that

they were trained in interview management skills (mean=2.9; SD=1.2). The outcome is consistent with Umalusi's (2022) assessment report, which established that some of the Level 4 NC (V) assessments sampled fell short of the required standards; on the other hand, the content was not representative of the most recent advancements in those particular fields. It seems possible that these results are due to a lack of dynamism that seems to characterise the NC(V) engineering curriculum. From a Capabilities Approach, this gap in soft skills training limits graduates' agency, preventing them from actively pursuing desired outcomes. The Canadian e-apprenticeship approach, which integrates computerised strategies and workplace training (Little, 2021), provides an insightful comparison, indicating that novel strategies promote graduates' capacities. A popular narrative is that not only does a vocational curriculum require links with the workplace, but it also needs student-centred and dynamic education that can also develop holistically ideal future engineers, just as other countries like Canada do by integrating technology and introducing the concept of e-apprenticeship training (Guerra & Rodriguez, 2021).

CONCLUSION, IMPLICATIONS, AND SUGGESTIONS

Our findings have far-reaching implications for developing TVET education in South Africa and globally. They contribute in several ways to our understanding of the NC (V) engineering curriculum offered by South African public TVET colleges as perceived by their unemployed graduates. In this study, we demonstrate that the current curriculum for NC (V) engineering programmes in South Africa does not effectively equip students for careers in the engineering sector. Consequently, this discovery confirms and extends the findings of other literature reports by Allais, (2020) and Mthethwa and Ndebele, (2022), which demonstrate systemic shortcomings in TVET, by providing empirical evidence from graduates' perspectives on a relatively understudied space In addition, NC (V) engineering graduates expressed dissatisfaction that South Africa's engineering industry does not consider them suitable for employment. The study results also indicated that NC (V) engineering graduates do not have well-developed skills in job hunting and interview management. One of the most significant findings from this study is the revelation that vocational graduates are stigmatised. Before this study, evidence of such was only anecdotal. Still, the findings of this study affirm such outcomes and their negative impact on the employment prospects of NC (V) engineering graduates from public TVET colleges. These insights from this study could enable policymakers, curriculum planners, provincial education officials, TVET college management and other related stakeholders to improve TVET curricula and the graduates' employment prospects. Above all, this could also spearhead global economic growth and development. Furthermore, policymakers may find it useful to review and effectively implement recruitment policies that may enhance inclusivity and consideration of all qualifications relevant to the employment context. The study's unique contribution is also its pragmatic shift from employing the usual conventional human capital theories when focusing on skills acquisition to the novel use of the Capability Approach to redefine TVET transformation as an expansion of freedoms. To spearhead and influence societal awareness as well as meaningful labour market recognition, the Department of Higher Education and Training could launch an advocacy campaign conscientising the employment industry on the relevance and significance of TVET programmes. These findings encourage curriculum planners, policymakers, and TVET constituents to incorporate an authentic Work Integrated Learning framework, soft skills training, and updated industry-specific content. Implementing dual TVET models, like those in Germany, and advocacy campaigns to enhance recognition within the engineering sector could enhance graduate employability, reduce industry and societal prejudice, and promote inclusive employment and economic growth.

LIMITATIONS

Although this study assisted in understanding how NC(V) engineering graduates perceive their recognition by the engineering industry, its findings cannot be generalised as the paper does not engage with TVET graduates from all programmes. Consequently, further research comprising a larger sample, including other programmes from the humanities and business studies, should be undertaken to investigate how TVET graduates perceive their recognition by the employment industry. Probably, different conclusions may be generated. Also, the research approach used was quantitative; perhaps future research may use a mixed research approach to augment the quantitative research approach.

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Integrating Pneumatics and Hydraulics in STEM for 4IR-ready Technology Teacher Preparation

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ABSTRACT

The rapid advancements associated with the Fourth Industrial Revolution (4IR) have necessitated a paradigm shift in Science, Technology, Engineering, and Mathematics (STEM) education, particularly in the training and professional development of pre-service and in-service Technology teachers. As core elements of industrial automation, pneumatics and hydraulics are essential for preparing educators to engage learners in 4IR-aligned competencies. This study explores how pneumatics and hydraulics can be effectively integrated into teacher education programs to strengthen STEM capabilities and enhance classroom readiness. Grounded in the Technological Pedagogical Content Knowledge (TPACK) framework, Constructivist Learning Theory, and the Work-Integrated Learning (WIL) approach, the study investigates current pedagogical practices, institutional gaps, and opportunities for curriculum innovation in Technology Education. A qualitative research design, informed by an interpretivist paradigm, was adopted. Data were collected through semi-structured interviews, focus group discussions, and document analysis, drawing on insights from teacher educators, curriculum developers, and industry experts. The findings reveal significant challenges in equipping teachers with the necessary technical and pedagogical skills due to limited curriculum coverage, insufficient digital simulation resources, and weak collaboration between academic institutions and industry. However, the study also identifies best practices that include competency-based and inquiry-driven instructional strategies, enhanced access to industry-standard tools, and practical exposure through structured WIL placements. The study recommends urgent curriculum reforms and policy interventions that support the infusion of 4IR technologies in teacher training. Strengthening partnerships between industry and academia, investing in teacher professional development, and modernizing teaching resources are critical steps towards producing Technology teachers who are 4IR-ready and capable of shaping future-ready learners.
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KEYWORDS

STEM education, pneumatics, hydraulics, Fourth Industrial Revolution, teacher preparation.

INTRODUCTION

The Fourth Industrial Revolution (4IR) has ushered in a new era of technological advancements, characterized by the integration of automation, artificial intelligence, robotics, and innovative technologies into various sectors, including education (Shlenova et al., 2025) . As industries increasingly rely on advanced manufacturing systems incorporating pneumatics and hydraulics, the demand for a technologically competent workforce has grown

significantly. Consequently, education systems, particularly teacher training programs, must adapt to ensure that pre-service and in-service educators have the necessary content knowledge and pedagogical strategies to teach these emerging technologies effectively (Miró-Pérez, 2020). Pneumatics and hydraulics are fundamental mechanical and industrial engineering principles that play a critical role in automation, manufacturing, and control systems (Leopold et al., 2025; Shastri, 2025). These technologies form the backbone of numerous industrial applications, including automotive systems, aerospace engineering, and advanced technology. The necessary content knowledge and pedagogical strategies to teach these emerging technologies in robotics effectively. Despite their importance, studies indicate that many technology educators lack adequate training and instructional resources to teach these concepts effectively at the secondary and tertiary levels (Blose, 2025; Muyambi & Ramorola, 2025). This skills gap poses a significant challenge to the development of a technologically literate generation capable of thriving in 4IR-driven economies (Maeko & Simon, 2024).

STEM education must undergo significant pedagogical and curricular transformations to meet the demands of modern industries (Govender et al., 2025; Pietrocola et al., 2025). Practical pedagogical approaches, including inquiry-based learning, problem-solving strategies, and work-integrated learning (WIL), are essential for equipping teachers with both theoretical and practical competencies in pneumatics and hydraulics (Mjenda & Kyaruzi, 2025; Seleke, 2021). Moreover, digital simulation tools and interactive learning environments have been identified as crucial in facilitating conceptual understanding and hands-on experience (Kefalis et al., 2025). However, integrating these approaches into teacher training programs remains limited due to curriculum constraints, resource limitations, and inadequate professional development opportunities for educators (Maringe & Prew, 2020). This study explores research-based effective content and pedagogical developments in STEM education, focusing on integrating pneumatics and hydraulics into teacher preparation programs. By examining existing literature, curriculum frameworks, and empirical research, the study aims to identify best practices for preparing educators to teach these critical concepts in alignment with 4IR demands. Furthermore, it provides recommendations for curriculum enhancement, policy interventions, and professional development initiatives that can bridge the gap between educational training and industrial needs. The following sections of this paper present the theoretical framework guiding this study, a review of relevant literature, the research methodology adopted, findings and discussions, and concluding recommendations. By addressing the challenges and opportunities associated with teaching pneumatics and hydraulics, this study contributes to the broader discourse on equipping educators with the skills and knowledge necessary to foster technological literacy in the 4IR era.

Problem statement and research objectives

Despite the increasing importance of pneumatics and hydraulics in automation and advanced manufacturing, their integration into teacher education programs remains inconsistent and underdeveloped (Khamkar & Patil; Shastri, 2025). While 4IR technologies have transformed industrial processes, many pre-service and in-service Technology educators continue to operate within outdated curricular frameworks that inadequately reflect current industry demands (Glasgow, 2025; Mahaswa & Gebbyano, 2025; Ryalat et al., 2024). This disconnect has resulted in a pronounced skills gap, where graduates from teacher training institutions often lack the practical competencies, digital literacy, and pedagogical agility required for effective instruction in fluid power systems (Teele, 2025; Maeko & Simon, 2024). Curriculum constraints, limited access to modern simulation tools, and insufficient

exposure to real-world automation environments continue to hinder the preparation of 4IR-ready educators (Maringe & Prew, 2020; Masunda, 2024; Oloba, 2025). Although research supports the use of inquiry-based learning, digital simulation, and Work-Integrated Learning (WIL) to address these challenges (Seleke, 2021; Mjenda & Kyaruzi, 2025), their implementation remains sporadic and uneven, especially in under-resourced institutions. Despite increasing interest in 4IR-aligned education, there remains a significant gap in the integration of automation-related competencies—particularly pneumatics and hydraulics—into Technology teacher training programmes in South Africa (Shastri, 2025; Glasgow, 2025; Mpofu & Chasokela, 2025). While frameworks such as TPACK and Constructivist Learning Theory are promoted in STEM education (Huang et al., 2025; Zhou & Divekar, 2025), limited empirical research explores how these are operationalised to prepare educators for industrial technologies. Furthermore, policy frameworks like the National Development Plan 2030 and MRTEQ advocate for Work-Integrated Learning (WIL), yet few studies examine its implementation in teacher education for automation (Visser, 2024; Ramrathan et al., 2024). This persistent gap, therefore, calls for an empirical investigation into the specific pedagogical, infrastructural, and institutional barriers that constrain the integration of pneumatics and hydraulics into Technology teacher training.

This study, therefore, aims to:

- Examine the pedagogical and curricular challenges experienced by teacher educators in incorporating pneumatics and hydraulics into STEM education;
- Identify best practices, instructional tools, and policy interventions that can enhance the competency of Technology teachers in 4IR-related content;
- Recommend curriculum reforms and industry-linked strategies to improve teacher readiness and student learning outcomes in the context of industrial automation.

This study, located within the South African context, investigates the pedagogical, curricular, and institutional barriers that hinder the incorporation of pneumatics and hydraulics into pre-service and in-service Technology education. By drawing on perspectives from educators, curriculum developers, and industry experts, and using an integrated theoretical lens (TPACK, Constructivism, and WIL), this research contributes practical, theoretical, and policy insights for bridging the disconnect between training and 4IR workforce demands

Theoretical Framework

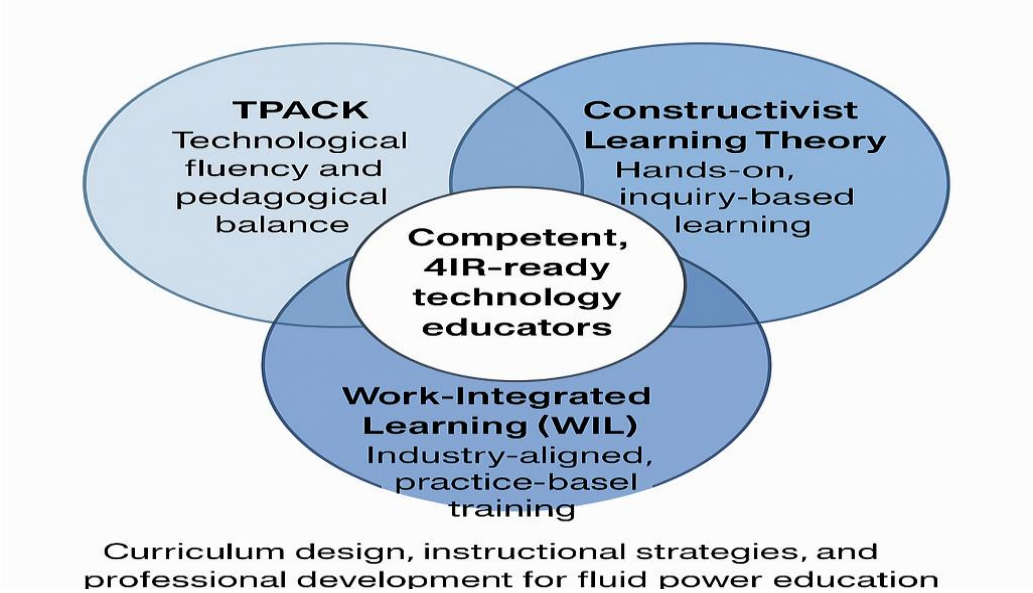
The preparation of technology teachers for the demands of the Fourth Industrial Revolution (4IR) necessitates a strong theoretical foundation that informs both content delivery and pedagogical approaches. This study is grounded in three key educational frameworks that are particularly relevant to the effective teaching of pneumatics and hydraulics: the Technological Pedagogical Content Knowledge (TPACK) framework, Constructivist Learning Theory, and the Work-Integrated Learning (WIL) approach. These theoretical perspectives collectively provide an integrative lens through which the development of teacher competencies can be analyzed concerning 4IR-aligned technology education. The Technological Pedagogical Content Knowledge (TPACK) framework emphasizes the intersection of three core components: content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK) (Aqib et al., 2025; Huang et al., 2025; Niess, 2016). In the context of pneumatics and hydraulics education, content knowledge pertains to the fundamental principles of fluid power systems, their applications in automation, and their role in modern industrial processes. Pedagogical knowledge focuses on instructional

methodologies that facilitate effective learning, including inquiry-based learning, problem-solving strategies, and active experimentation. In this context, technological knowledge integrates digital tools, simulation software, and innovative technologies into teaching practices, ensuring students engage with contemporary industry-relevant resources. The TPACK model underscores the necessity of balancing these three knowledge domains to create a learning environment that is both technologically enriched and pedagogically effective (Huang et al., 2025). Given the increasing role of intelligent automation in 4IR, integrating pneumatics and hydraulics into teacher education curricula must be framed within the TPACK model to ensure conceptual depth, technological proficiency, and pedagogical adaptability.

Complementing the TPACK framework is the Constructivist Learning Theory, which emphasizes the active role of learners in constructing knowledge through experience, inquiry, and social interaction (Piaget, 1972; Vygotsky, 1978). The constructivist paradigm is particularly relevant in teaching pneumatics and hydraulics, as these topics require learners to engage in hands-on experimentation, critical thinking, and real-world problem-solving. Through inquiry-based learning, students can explore the functionality of fluid power systems by manipulating pneumatic and hydraulic components, testing variables, and troubleshooting performance challenges (Drakatos et al., 2024). The problem-based learning (PBL) approach, a constructivist instructional strategy, further reinforces this experiential learning process by presenting learners with industry-related challenges that require the application of fluid power principles to devise solutions (Conley, 2022; Pahwa; Simonsen et al., 2021). Additionally, constructivist learning fosters collaborative engagement, wherein learners work in teams to design, simulate, and optimize fluid power systems, reflecting the interdisciplinary nature of STEM education (Zhou & Divekar, 2025). In the context of teacher preparation, embedding constructivist methodologies in technology education ensures that educators are equipped to facilitate discovery-driven learning environments that encourage innovation and adaptability, key competencies for the 4IR era.

Furthermore, the Work-Integrated Learning (WIL) approach provides a critical link between theoretical instruction and real-world application in teacher training programs (Pietersen & Langeveldt, 2024).In South Africa, the Minimum Requirements for Teacher Qualifications (MRTEQ) policy outlines precise and detailed criteria for designing learning programs, along with directives on practical training and work-integrated learning (WIL) frameworks (Ramrathan et al., 2024). However, recent studies by Visser (2024) and Doh Nubia et al. (2024) highlight that current practice is placing pre-service teachers only in schools for experiential learning with little or no attempt to place them in Industry-Based Learning. According to Both (2023), WIL promotes authentic learning experiences by integrating industry-relevant exposure, digital simulation tools, and hands-on experimentation into educational practice. Given the applied nature of pneumatics and hydraulics, WIL serves as an essential pedagogical strategy that enables pre-service and in-service teachers to develop practical competencies through structured industry partnerships, internships, and simulated training environments. In particular, the use of digital laboratories, augmented reality (AR), and computer-aided engineering (CAE) software facilitates a practice-oriented understanding of fluid power systems without the limitations of physical resource constraints (Abele et al., 2024). Additionally, by aligning curriculum content with industry standards and certification frameworks, WIL ensures that technology educators are adequately prepared to teach job-ready skills that meet the evolving demands of 4IR-driven workplaces. These theoretical perspectives provide a robust foundation for understanding the pedagogical imperatives of technology education in the 4IR era. By adopting an integrative theoretical framework,

this study offers a conceptual lens for analyzing the challenges and opportunities in technology teacher education, offering insights into best practices for curriculum development, instructional strategies, and professional development initiatives. Through this framework, the research aims to contribute to the broader discourse on technology education reform, ensuring that pre-service and in-service teachers are adequately equipped to navigate the complexities of 4IR-aligned teaching and learning. To enhance conceptual clarity, the interrelationship between the three theoretical frameworks underpinning this study, TPACK, Constructivist Learning Theory, and Work-Integrated Learning, is illustrated in Figure 1 below.



Seleke & Teis (2025). Figure 1: Integrated Theoretical Lens for 4IR-aligned Technology Teacher Preparation

LITERATURE

The transformation of STEM education in response to the Fourth Industrial Revolution (4IR) has been widely discussed in academic literature (Aboderin & Havenga, 2024; Kruger & Steyn, 2024; Van Truong & Dung, 2024). Research indicates that pneumatics and hydraulics are fundamental to automation, robotics, and smart manufacturing, yet their integration into teacher training programs remains inconsistent (Khamkar & Patil; Shastri, 2025). This section critically examines existing literature on three key areas: the impact of 4IR on education, the role of pneumatics and hydraulics in modern engineering and industry, and pedagogical approaches for teaching these technical concepts.

The 4th Industrial Revolution and Its Impact on Education

The Fourth Industrial Revolution (4IR) represents a technological paradigm shift characterized by the fusion of cyber-physical systems, artificial intelligence, the Internet of Things (IoT), and automation(Els et al., 2022; Teis et al., 2022). For Els et al. (2022), these advancements have redefined the competencies required for future workforces, necessitating a realignment of educational curricula, pedagogical strategies, and teacher training

programs. Within this evolving landscape, technology teachers must be equipped with discipline-specific knowledge, digital literacy, and pedagogical adaptability to effectively prepare students for automation-driven industries (Bhattacharjya, 2025). Recent studies highlight that many technology education curricula remain rooted in traditional mechanical and electrical engineering principles, failing to integrate modern automation technologies such as pneumatics, hydraulics, and programmable logic controllers (PLCs) (Ryalat et al., 2024). This disconnect has led to a skills gap between educational outcomes and industry expectations, where graduates lack the practical competencies required for Industry 4.0 work environments (Low et al., 2021). Tuomi et al. (2023) and Mutembei (2024) highlight that UNESCO's 2022 report on STEM education further emphasizes that technical educators must transition from knowledge transmission models to competency-based, industry-driven learning approaches.

Furthermore, the integration of 4IR technologies in education has implications for teacher professional development and curriculum design. Research suggests that adequate teacher preparation requires a multidisciplinary approach, combining STEM integration, problem-based learning, and digital simulation tools to enhance technological fluency (AlAli, 2024; Aunzo Jr, 2025; Su, 2024). However, the limited availability of specialized training programs, infrastructure constraints, and resistance to pedagogical change remain significant challenges (Bremner et al., 2023; Mhlanga et al., 2022). These issues underscore the urgent need for curriculum reforms that align pre-service and in-service teacher training programs with 4IR-aligned industrial applications.

The Role of Pneumatics and Hydraulics in Modern Engineering and Industry

Pneumatics and hydraulics are essential components of industrial automation, manufacturing, and robotics, forming the foundation of modern mechatronic systems (Channi et al., 2024; Ryalat et al., 2024). Pneumatic systems, which use compressed air to generate mechanical motion, are widely employed in assembly lines, robotic arms, and packaging systems, while hydraulic systems, which utilise pressurised fluid, are crucial for heavy machinery, aerospace applications, and automated control systems (Pawar, 2020).

Industrial reports indicate that over 80% of manufacturing processes rely on either pneumatic or hydraulic technologies, demonstrating their widespread application across engineering disciplines (Karabegović et al., 2021). The automotive, aerospace, and energy sectors have seen significant automation advancements, where innovative pneumatic systems integrated with IoT sensors are now commonplace (Ghorpade & Sidharth, 2025). Given this industry shift, engineering and technology education must prioritize fluid power systems as a core component of technical training programs. Despite the increasing importance of pneumatics and hydraulics, research highlights several educational gaps in their teaching and application. A study by Glasgow (2025) found that most engineering and technology education programs still emphasize theoretical aspects of fluid mechanics while neglecting practical applications using industrial automation tools. This lack of hands-on experience has resulted in low competency levels among technology educators, further exacerbating the skills gap between academia and industry (Teele, 2025). To bridge this gap, researchers recommend the adoption of simulation-based learning platforms, real-world case studies, and industry collaboration initiatives (Madiyala & Prajapati, 2025). The development of industry-aligned curricula, incorporating programmable pneumatic and hydraulic control systems, sensor integration, and AI-driven automation, is essential to ensure that technology teachers are equipped with relevant skills (Caratozzolo et al., 2024).

Pedagogical Approaches for Teaching Pneumatics and Hydraulics

Effective teaching of pneumatics and hydraulics requires innovative pedagogical approaches that integrate active learning, digital technologies, and competency-based instruction (Sheng & Hu, 2014). Traditional lecture-based instruction has proven insufficient in equipping students with problem-solving abilities and real-world application skills, necessitating the adoption of constructivist and inquiry-driven teaching strategies (Verawati & Nisrina, 2025). Research in STEM education suggests that inquiry-based learning (IBL) enhances student engagement by encouraging them to explore, analyze, and experiment with fluid power systems (Avsec & Kocijancic, 2014; Self et al., 2013). Students can develop a deeper understanding of pneumatic and hydraulic principles through guided experimentation, reinforcing conceptual learning through practical application. Furthermore, problem-based learning (PBL) has been identified as a highly effective strategy for developing higher-order thinking skills in engineering and technology education (Husin et al., 2025). By presenting students with real-world automation challenges, PBL fosters critical thinking, creativity, and collaborative problem-solving (Shanthi et al., 2025).
Digital simulation tools such as FluidSIM, Automation Studio, and MATLAB-Simulink have gained traction in engineering education, allowing students to visualize, design, and test pneumatic and hydraulic systems in a virtual environment (BASTOS, 2021; del-Olmo et al., 2023). These tools address resource limitations by offering a cost-effective alternative to physical laboratory experiments, providing students with interactive learning experiences that simulate real-world industrial automation processes (Subramanian et al., 2025). Research indicates that the use of virtual reality (VR) and augmented reality (AR) technologies further enhances spatial reasoning, technical comprehension, and problem-solving abilities in students, making them highly effective in competency-based training programs (Dianatfar et al., 2025). Additionally, Work-Integrated Learning (WIL) has been identified as a crucial pedagogical approach for aligning technical education with industry needs (Billing, 2025). Industry-academic collaborations, where pre-service teachers engage in industry-based apprenticeships and internships, allow educators to develop hands-on competencies in pneumatics and hydraulics (Singh, 2024). Research suggests that WIL models enhance not only technical proficiency but also instil critical workplace skills, including problem-solving, adaptability, and teamwork (Ongartsuebsakul et al., 2024; Prohimi et al., 2024).

Research Methodology

This study employed a qualitative approach within a design-based research framework, underpinned by an interpretivist paradigm, which facilitated a context-sensitive exploration of pedagogical and curricular developments required for integrating pneumatics and hydraulics into STEM education. This paradigm aligns with the views of scholars such as Creswell (2012) and William (2024), who advocate for interpretivism in studies aimed at understanding participants' perspectives within specific educational contexts. The interpretivist lens was appropriate for understanding how various stakeholders conceptualised and responded to the challenges and opportunities of automation-related instruction, particularly in relation to 4IR imperatives. Data were gathered from a diverse group of stakeholders, including pre-service and in-service Technology teachers, curriculum developers, and industry professionals involved in fluid power systems and automation. These participants were selected using a purposive sampling strategy, ensuring they possessed relevant expertise and experience in teaching, curriculum development, or industrial automation (Lim, 2024). The final sample consisted of 25

purposively selected participants, including pre-service and in-service Technology teachers, curriculum developers, and industry professionals from teacher training institutions, education departments, and private-sector organisations engaged in pneumatics and hydraulics education. Of these, 15 participants took part in one-on-one

semi-structured face-to-face interviews, while the remaining 10 were organised into two focus group discussions (FGDs), each comprising five participants with shared disciplinary or institutional affiliations. This distribution enabled the study to obtain both individual depth and collaborative insight, enriching the thematic analysis through methodical triangulation. The sampling criteria included prior involvement in STEM curriculum design or implementation, at least three years of professional experience, and practical familiarity with automation technologies. Three qualitative data collection methods were used to enable triangulation and deepen the interpretive analysis: semi-structured interviews, focus group discussions (FGDs), and document analysis (Shoozan & Mohamad, 2024; Mwilongo, 2025). Semi-structured interviews served as the primary tool for eliciting in-depth views from individual participants, exploring their perceptions of curriculum relevance, instructional strategies, and resource limitations. Focus group discussions were subsequently conducted with sub-groups of participants to probe emergent themes and encourage collaborative dialogue. This sequencing allowed initial insights from interviews to inform the framing of FGDs.

In addition, a document analysis was conducted to assess the extent to which curricular and policy frameworks addressed the needs of 4IR-aligned education. Documents analysed included:

- The Curriculum and Assessment Policy Statement (CAPS) for Technology (Grades 7–9),
- TVET College curriculum guides,
- The National Development Plan 2030,
- The Fourth Industrial Revolution Discussion Document (DTPS, 2020),
- UNESCO's ICT Competency Framework for Teachers (2018).

This approach enabled the researcher to assess the alignment (or lack thereof) between policy intentions and classroom realities.

Data were analysed using thematic analysis (Maguire, 2017), allowing for the identification, coding, and categorisation of recurrent patterns across the data sets. NVivo software was used to manage, visualise, and structure emerging themes systematically. Codes were developed inductively from the data, with analytic memos guiding the refinement of core categories. To ensure trustworthiness, a more suitable criterion than validity and reliability in qualitative inquiry, this study drew on Lincoln and Guba's (1985) four criteria:

- Credibility was ensured through prolonged engagement with participants and triangulation of data sources.
- Transferability was supported by thick descriptions of the research context and participant profiles.
- Dependability was achieved by maintaining an audit trail of coding processes and analytic decisions.
- Confirmability was enhanced through researcher reflexivity and the use of verbatim transcripts to support interpretations.

Ethical clearance was obtained from the relevant university ethics committee [FEDSECC033-11-23], and all participants provided informed consent. Confidentiality and anonymity were maintained through coding of personal data and secure digital storage of all materials, in accordance with ethical standards for human subject

research (Miller & Boulton, 2007).

FINDINGS

This section presents the analysed data obtained through semi-structured interviews, focus group discussions, and document analysis. Three main themes emerged from the data: (1) Current Gaps in Technology Teacher Preparation for 4IR, (2) Effective Pedagogical Strategies for Teaching Pneumatics and Hydraulics, and (3) Implications for Curriculum Development and Policy Reform.

Theme 1: Current Gaps in Technology Teacher Preparation for 4IR

Participants expressed deep concerns about the disconnect between current teacher training programmes and the practical demands of the Fourth Industrial Revolution. Pre-service teachers reported that their training lacked opportunities for hands-on engagement with fluid power systems, which left them feeling underprepared. One participant noted that although theoretical content was covered, there was little exposure to actual equipment or simulation tools.

> ***"We are taught the theory of how pneumatic systems work, but we've never seen or worked on an actual setup. It feels abstract."***

In-service teachers similarly reported that existing curricula did not include sufficient content on pneumatics or hydraulics. These topics were often embedded within mechanical systems but not explored in depth, leading to significant knowledge gaps. Participants indicated that inadequate training and a lack of resources made it difficult to introduce modern automation content into their classrooms.

> ***"The current curriculum is silent on pneumatics and hydraulics. Even if we wanted to teach it, we lack both the training and the resources."***

Industry stakeholders shared concerns that graduates entering the workforce lacked both theoretical understanding and practical experience. They observed that recent hires required substantial retraining before they could engage meaningfully with automated systems.

> ***"We spend the first six months teaching them what their degrees should have covered how to use simulation software, troubleshoot hydraulic faults, and interpret pneumatic schematics."***

Resource limitations, especially in rural institutions, were also highlighted, with many institutions unable to afford even basic simulation software or laboratory setups.

> ***"Budget constraints mean our students read about systems they may never operate. It's frustrating."***

Theme 2: Effective Pedagogical Strategies for Teaching Pneumatics and Hydraulics

Participants strongly advocated for inquiry-based, problem-solving approaches to teaching these technical subjects. Many described how hands-on experimentation and project-based learning improved their understanding. One pre-service teacher described a transformative experience using a basic pneumatic kit, which made abstract concepts more tangible.

> ***"I only began to understand pneumatics after we experimented with small kits during a workshop. Before that, it was just diagrams in a textbook."***

The use of simulation tools was cited as a highly effective strategy, enabling teaching and learning of hydraulic and pneumatic functions even in contexts where physical labs were unavailable. Several participants emphasized the need for project-based assignments that mirror real-world automation problems to enhance learners' problem-solving abilities and foster critical thinking.

> ***"Simulation tools allow us to teach functions, faults, and flow control without needing expensive physical labs."***

Work-integrated learning experiences were also highly valued. Participants described how site visits to industrial plants, internships, and mentoring from technicians helped bridge the gap between theory and practice.

> ***"We design real-life automation problems for our students to solve. That's when they truly start thinking like engineers."***

Such experiences were seen as vital for enabling teachers to teach 4IR-aligned content with confidence and relevance.

> ***"Until our students enter an actual plant and see these systems running, they won't fully grasp what they're learning."***

Theme 3: Implications for Curriculum Development and Policy Reform

Findings revealed a consistent call for structural reform in teacher education curricula. Participants lamented the lack of dedicated modules on pneumatics and hydraulics and called for greater integration of automation systems into existing programmes.

> ***"There is no dedicated module on pneumatics and hydraulics in our teacher education programme. If it is mentioned, it's embedded under mechanical systems and often overlooked."***

Many suggested that the content was either entirely absent or only briefly mentioned in general technology modules. The absence of a national benchmark for automation competencies in teacher education was also highlighted as a serious concern.

> ***There's no national benchmark for teacher skills in pneumatics or automation, it depends on the institution, and many don't prioritise it."***

Participants also pointed to a lack of standardisation across institutions, which led to inconsistency in graduate preparedness.

> ***"Even if we wanted to modernise our course, we simply don't have the tools."***

Further, under-resourced institutions reported difficulties implementing modernised programmes due to inadequate infrastructure and limited budgets. Participants advocated for a collaborative approach to curriculum development involving educators, government officials, and industry experts.

> ***"Without experiencing a factory environment, it's impossible to teach automation with confidence."***

There was strong support for expanding the concept of work-integrated learning beyond school placements to include structured industrial exposure as a standard part of teacher training.

DISCUSSION OF FINDINGS

This section interprets the key findings in light of the study's four objectives and relevant literature. The discussion integrates theoretical and empirical insights, offering a comprehensive explanation of how pneumatics and hydraulics can be effectively embedded in Technology teacher education within the context of the Fourth Industrial Revolution (4IR).

Objective 1: To identify current content and pedagogical gaps in the teaching of pneumatics and hydraulics

The findings reveal that teacher preparation programmes across institutions inadequately address fluid power systems, particularly pneumatics and hydraulics. This aligns with the assertions of Maeko and Simon (2024), who noted that Technology Education curricula remain heavily focused on outdated mechanical content. Mpofu and Chasokela (2025) similarly argue that fragmented curriculum designs have contributed to pre-service teachers lacking exposure to real or simulated industrial automation systems. The insufficient use of digital tools like FluidSIM or MATLAB-Simulink was further reinforced by Mhlanga et al. (2022), who found that under-resourced institutions struggle to integrate simulation technologies into their training environments. These observations underscore the systemic disconnect between educational offerings and the competencies demanded in modern 4IR industries.

Objective 2: To explore effective pedagogical strategies for teaching pneumatics and hydraulics in STEM education

Findings demonstrate that active, inquiry-based learning approaches are essential for promoting deep conceptual understanding of pneumatics and hydraulics. The emphasis on simulation-based instruction and project-based learning supports Piaget's (1972) and Vygotsky's (1978) constructivist learning theories, where experiential knowledge-building is prioritised. Seleke (2021) highlighted that learners perform better when exposed to real-world tools and problems through work-integrated and simulation-driven pedagogy. Tools such as Automation Studio, MATLAB-Simulink, and FluidSIM were found to facilitate interactive teaching, particularly where physical labs are limited. This aligns with the UNESCO (2018) ICT Competency Framework's recommendation for embedding digital pedagogy and simulation-based instruction into teacher training.

Objective 3: To assess the potential of Work-Integrated Learning (WIL) and simulation tools in preparing 4IR-ready Technology teachers

Participants emphasised the importance of integrating WIL models into pre-service and in-service training. Real-world exposure through internships, site visits, and simulation tasks was shown to build both confidence and competence in teaching complex technologies. This observation supports Syafruddin et al. (2025) and Epaphras (2025), who advocate for industry immersion in teacher education to ensure alignment with industrial practices. Visser (2024) noted that many South African teacher education programmes fall short of this ideal, particularly in

STEM and TVET fields, due to policy and funding limitations. The limited institutionalisation of WIL in the Minimum Requirements for Teacher Education Qualifications (MRTEQ) (Ramrathan et al., 2024) further constrains implementation. Nonetheless, the participants' feedback indicates that WIL, when fully embraced, contributes significantly to building 4IR teaching capacity.

Objective 4: To recommend curriculum and policy interventions for aligning Technology Education with 4IR demands

The findings affirm that Technology teacher education requires urgent reform. Respondents pointed to the absence of standardised competencies for teaching automation systems. Khoza and Mpungose (2025) have similarly called for a national curriculum audit to reflect 4IR-aligned standards in technical education. The lack of simulation laboratories and automation modules in university curricula underscores recommendations made by Teis and Els (2021; 2022) and Els et al. (2022), who advocate for expanding infrastructure and teacher professional development. Furthermore, the National Development Plan 2030's (South Africa, 2012) call for equitable access to technical education remains largely unrealised. Bremner et al. (2023) underscore the structural limitations that continue to disadvantage rural and peri-urban institutions. This study confirms the urgent need to overhaul Technology Education to include automation, simulation tools, and structured WIL. Doing so requires curriculum flexibility, enhanced industry-academia partnerships, and robust funding models that can support technology integration across the teacher education pipeline.

CONCLUSION, IMPLICATIONS AND SUGGESTIONS

This study set out to explore the integration of pneumatics and hydraulics into Technology teacher education as a critical response to the demands of the Fourth Industrial Revolution (4IR). Despite their foundational role in modern automation and manufacturing systems, these technologies remain underrepresented in teacher training programmes across South Africa. The findings revealed three major challenges: outdated curricula that marginalise automation content; inadequate access to simulation tools and physical training resources; and the absence of structured Work-Integrated Learning (WIL) experiences in industrial settings. Participants highlighted a disconnect between theoretical instruction and practical application, as well as between educational outcomes and industry expectations. These findings are significant in the broader field of STEM and Technology Education as they underscore the urgent need to realign teacher preparation with the realities of 4IR-driven industrial environments. The study contributes to the theoretical literature by demonstrating how the TPACK framework, Constructivist Learning Theory, and WIL can be jointly applied to guide curriculum innovation and professional development in Technology Education. It also adds empirical value by triangulating data from educators, curriculum experts, and industry stakeholders to offer a grounded understanding of the skills gap in fluid power education.

Based on the evidence, the study recommends the following:

- Curriculum reform to explicitly include pneumatics, hydraulics, and automation as core modules.
- Investment in simulation tools and digital laboratories, particularly in under-resourced institutions.
- Development of national competency standards for Technology educators in 4IR-related content; and
- Formal industry-academic partnerships to facilitate structured WIL placements for teacher trainees.

While the study offers valuable insights, its limitations include a relatively small purposive sample size and its geographic focus on selected institutions and stakeholders. Future research should expand the participant pool to include a broader range of provinces and institutional types and assess the longitudinal impact of simulation-based training and industry exposure on teacher effectiveness. In closing, preparing Technology teachers for 4IR requires more than policy rhetoric; it demands pedagogical innovation, curriculum transformation, and strategic collaboration. If South Africa is to build a future-ready education system, then equipping teachers with automation-related competencies must be treated not as an option, but as a national imperative.

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Simulation Pedagogy and Learner Engagement in a Finance course: A South African Higher Education Perspective

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ABSTRACT

The aim of this study was to examine the relationship between simulation-based experiential learning (SBEL) and overall student satisfaction, with deep and surface learning serving as mediating variables, at a higher education institution. The primary objective of the study was to assess the level of student satisfaction following the implementation of an SBEL project with students enrolled in finance-related courses. A quantitative cross-sectional research design was used with data collected from a sample of 288 finance and business students after the completion of a client simulation project. The sampling method was purposive. A partial least squares structural equation model was applied, with simulation-based experiential learning serving as an exogenous variable that predicts student satisfaction. The data was analysed using SmartPLS. The primary findings of the study revealed that simulation-based experiential learning had a direct, positive, and significant impact on student satisfaction and the adoption of deep learning approaches. A secondary finding included, deep learning approaches also had a direct positive impact on student satisfaction. The mediated path revealed that SBEL enhanced satisfaction through the deep learning approach, whereas the relationship with surface learning was found to be insignificant. The study contributes to the empirical evidence on SBEL in South African higher education from a finance and business students' context. In conclusion, the study highlights the importance of aligning experiential learning with educational strategies. Policy recommendations included formal integration of SBEL into curricula, faculty training in simulation design, and assessment reforms that reward deep learning.

KEYWORDS

Simulation-Based Experiential Learning; Deep Learning; Surface Learning; Finance; Structural Equation Model.

INTRODUCTION

As the world of work changes, higher education institutions are rethinking the approaches they use to prepare students for the workplace. This rethink is in response to an increasing call for academic institutions to bridge the gap between theoretical knowledge and real-world application (Adib, 2024). As a result, higher education institutions have taken the initiative to integrate practical and hands-on learning strategies into their curricula (Adib, 2024; Bakoush, 2022). Among these strategies is Simulation-Based Experiential Learning (SBEL) an approach used to improve student engagement, critical thinking and learning outcomes through simulating real-world environments (Chen et al., 2025; McHauser et al., 2020). Through simulated real-world scenarios, students are required to apply the knowledge they have acquired and problem-solving skills in an interactive format (Tiwari et al., 2014). While SBEL has been extensively examined in various disciplines, including medical education, business, and engineering, as observed by Uppor et al. (2024) and Jallad (2025), its application in South African

higher education remains relatively new. Traditional instruction approaches still dominate many university classrooms in South Africa, despite increasing calls for curriculum transformation and the adoption of student-centred learning models (Puren et al., 2022; Schreck et al., 2022). As such, there is a growing recognition of the need to introduce innovative teaching methods that align with industry skills and needs, thereby enhancing student satisfaction.

In addition to the above-mentioned disciplines, SBEL can also be useful in the context of finance education, where abstract concepts challenge students' understanding and engagement. The use of exercises that simulate client interactions, financial planning scenarios, or market fluctuations provides students with an opportunity to apply their knowledge in a practical setting. According to Sharma et al. (2018) and Carenys et al. (2017), this approach enhances learning relevance and fosters better student engagement. However, despite these perceived advantages, empirical evidence on SBEL`s effectiveness in enhancing student satisfaction in South African higher education remains limited. A study by Puren et al. (2022) on experiential learning practices in South African higher education revealed that, although experiential learning is gaining momentum, its integration remains inconsistent across institutions and disciplines. While acknowledging that experiential learning is essential for improving students' social responsiveness and critical thinking, the study also noted that its uptake across South African Universities was low due to constraints such as resource limitations, institutional inertia, and a lack of trained staff (Puren et al., 2022).

Similar observations were made by Thuketana (2020), who also noted how experiential learning could improve students' perception skills and emotional intelligence when integrated in community projects. Furthermore, McPherson-Geyser et al. (2020) suggested that experiential learning activities promote meaningful engagement and improve students' comprehension skills. Another study carried out from a South African context by Schreck et al. (2022) further argued that experiential teaching models stimulated reflective practice and enhanced learners'' connection to course content. These studies provide evidence of the positive educational value of experiential learning in a South African context. However, they fell short of addressing the impact of simulation-based experiential learning from a business perspective, especially in the finance discipline.

However, outside the South African context, Bakoush (2022) noted that students involved in financial simulations had higher levels of satisfaction compared to those receiving traditional instruction. These findings also align with those of Sharma et al. (2018), who observed that experiential learning in simulated trading environments enhanced students' perception of real-world situations and encouraged active participation. Similar results were also noted in another study by Chen et al. (2025), suggesting that simulations improved student satisfaction. However, the extent to which these findings are relevant from a South African higher education context remains uncertain. Additionally, a growing body of literature suggests that the effectiveness of SBEL may also depend on the learning approaches adopted by students. According to Adib (2024) and Kageyama et al. (2022), deep learning approaches, which focus on critical thinking and connecting new knowledge to existing ideas, are particularly well-suited for experiential learning. On the other hand, surface approaches, which focus on memorisation with minimal engagement, have been observed not to interact well with experiential approaches (Burdon & Munro, 2017; Okoro & Tembo, 2025). There is a paucity of empirical studies that have attempted to model the mediating role of these approaches in the relationship between SBEL and student satisfaction. Consequently, in a systematic review of literature on experiential learning, Gittings et al. (2020) called for an examination of how individual learning styles interact with experiential approaches to shape students' educational satisfaction and performance. As such, the key issue is the limited empirical evidence on how SBEL affects students' satisfaction with finance-related courses and how this relationship is influenced by students' deep versus surface learning approaches, especially in the context of South African higher education. Therefore, the current study makes two contributions. Firstly, it examines the impact of SBEL on the satisfaction of finance students in South Africa. Secondly, it models the mediating role of deep and surface learning approaches on the relationship between SBEL and student satisfaction. As such, the study highlights the effectiveness of experiential learning in enhancing students' learning experiences and how this, in turn, leads to satisfaction across both deep and surface learning styles.

Based on the aim of the study, the following questions.

- What is the effect of SBEL on student satisfaction?
- What is the effect of deep learning through SBEL on student satisfaction?
- What is the effect of surface learning through SBEL on student satisfaction?

LITERATURE

The foundations of experiential learning are based on the works of Kolb`s (1984) experiential cycle of learning.

According to Kolb (1984) learning is a transforming continuous cycle based on experience, reflection, conceptualisation and experimentation. Kolb (1984) argued that effective learning occurs when learners are actively engaged in an experience, reflect upon it, derive theoretical insights, and apply those insights in practice. The theory aligns with the constructivist perspective, which posits that knowledge is created through one's interaction with their environment (Alsharif, 2014; Lymperis, 2020). In this regard, the use of simulations supports Kolb's (1984) theory by providing an artificial yet realistic environment where students can experience the Kolb experiential learning cycle. From this, approaches such as the SBEL, which emphasise real-world application, critical thinking, and engagement, have been integrated into learning practices (Kageyama et al., 2022). SBEL has been widely adopted and utilised in practice-oriented fields, including medical education and engineering (Adib, 2024; Uppor et al., 2024). However, it has not been as extensively applied in the field of finance education, especially in the context of South Africa, and limited studies have investigated how different student learning approaches interact with experiential learning to influence student satisfaction.

Student Satisfaction: Theoretical Perspectives

Student satisfaction is a concept that results from the match between what students expect and their actual academic experiences (Chen et al., 2025; Sharma et al., 2018). Further, pedagogical literature suggests that student satisfaction in education is attained when pedagogical strategies align with students' needs, interests, and goals (Chen et al., 2025; Sharma et al., 2018). Accordingly, the outcome of such alignment would be increased motivation, involvement, engagement and ultimately satisfaction (Alsharif, 2014; Chen et al., 2025; Lymperis, 2020). A study by Tahir and Fatima (2023) reported that student involvement has a positive impact on student satisfaction. Additionally, student involvement often refers to physical and psychological energy expended by students on an academic project (Astin, 1984). For example, in SBEL, student satisfaction comes from being involved and seeing the simulated environment as realistic and practical (Gittings et al., 2020). However, satisfaction also depends on students' approach to learning. Some are motivated by curiosity and the desire to understand (deep learning) while others are by the desire to pass and move on (surface learning) (Gittings et al., 2020; Randall et al., 2025). Therefore, theory suggests that the different learning styles affect how students respond to experiential methods (Gittings et al., 2020; Randall et al., 2025). The manner in which students respond to experiential methods provides an indication of their impact on both deep learning and surface learning. In spite of this theoretical link, few empirical studies have gone on to model how deep and surface learning mediate the relationship between SBEL and student satisfaction as will be done under the current study.

Empirical Evidence of Simulation-Based Experiential Learning

Numerous studies have been conducted across various contexts to evaluate the educational value of simulation-based experiential learning. For instance, Adib (2024) conducted a quasi-experimental study from a European Business School context to examine how business simulations influenced student attitudes toward sustainability. Using pre- and post-surveys with a sample of 112 students, the study found statistically significant improvements in sustainability awareness and reflective engagement. However, this study did not consider student satisfaction as part of its scope, nor did it look at the mediating mechanisms of deep and surface learning in the process. Similarly, Chen et al. (2025) considered the role of instructor facilitation in shaping student satisfaction and flow during business simulation games using a sample of 305 Chinese students. The study was based on classroom experiments, and the data were analysed using structural equation modelling. Study findings indicated that active instructor engagement significantly enhanced student engagement and satisfaction. However, the study did not take into account student characteristics, which may explain variations in satisfaction. Furthermore, Burdon and Munro (2017) employed a mixed-methods approach to evaluate whether experiential methods were worthwhile from the perspective of Australian accounting students. The study's results showed that students appreciated the real-world relevance and interactivity of the simulations. However, some expressed frustration with the weak alignment between simulation content and formal assessments (Burdon & Munro, 2017). The study's findings highlight the need for aligning experiential learning with learning evaluation structures.

On the other hand, Tiwari, Nafees and Krishnan (2014) adopted a quantitative approach to measure the effectiveness of simulation on perceived learning among 207 MBA students. The study employed regression techniques to examine the relationship between simulation exposure and perceived effectiveness, revealing a significant positive correlation. However, the study focused on perceived learning and did not consider student satisfaction or deep and surface learning as mediating variables, unlike the current study.

Bakoush (2022) examined the impact of simulation-based learning on student satisfaction with a focus on the field of finance. The study employed partial least squares structural equation modelling with survey responses from 152 students at a European university. The findings revealed a positive relationship between simulation and student satisfaction. However, the current study is different in that it will be based on the South African higher education

context and will include mediating variables in the model. Additional studies by Sharma et al. (2018) and Carenys et al. (2017) investigated simulation environments in trading and accounting, respectively. Sharma et al. (2018) found that exposure to financial trading rooms improved students' perceptions of real-world preparedness. On the other hand, Carenys et al. (2017) noted that simulation and use of video games enhanced student motivation and outcomes with differences arising from gender and academic background. However, the studies did not capture the effects of deep and surface learning and how they may contribute to student satisfaction. Randall et al. (2025) and Pitic and Irimiaș (2023) examined engagement and emotional responses in simulation-based experiential learning. Randall et al. (2025) found that first-year business students exposed to simulation showed higher engagement, while Pitic and Irimiaș (2023) found that business simulation games improved students' skills development and academic experience.

From a South African context, literature indicates that experiential learning is gaining momentum; however, studies on the subject have largely focused on project-based learning, community engagement, and other fields, rather than the finance field (Council on Higher Education, 2011; Dhliwayo, 2008; Lubbe & Svensson, 2022; Botha, 2014; Malan, 2021; Wolmarans, 2005). Puren et al. (2022) evaluated the impact of experiential learning using four spatial learning modules. Study findings showed that experiential learning enabled students to develop an appreciation for the practical interventions required in urban development, while also contributing significantly to lecturer development. However, the study fell short of explicitly examining the impact of experiential learning on student satisfaction. In a study by Mayombe (2024), it was observed that applying experiential learning theory to Technical and Vocational Education and Training (TVET) programmes as a learning approach can help trainees establish job-related skills needed in the labour force. Establishing job-related skills is crucial in an economy facing high levels of unemployment (Mayombe, 2024). Another study by Schreck et al. (2022) applied experiential learning in recreation studies and used reflective journals to document student growth. Although students showed increased engagement, the study lacked a structured framework for evaluating satisfaction, and simulation was absent. Furthermore, McPherson-Geyser et al. (2020) explored experiential learning in the life sciences using a pre- and post-quantitative design. They found that interactive strategies improved concept mastery and reflective thinking. However, the study did not take into account students' satisfaction outcomes. Similar findings were obtained in another study by Thuketana (2020), which focused on community learning projects. The reviewed literature shows that only a few studies have directly modelled the relationship between simulation-based experiential learning and student satisfaction, targeting specifically the field of finance. Studies have also failed to capture how different learning approaches, such as deep and surface learning, affect satisfaction outcomes. The current study addresses these gaps by focusing on student satisfaction as a mediated outcome of deep and surface learning approaches in simulation-based experiential learning from a finance discipline and the South African context.

METHODOLOGY

Research method

The study adopted a quantitative cross-sectional research design with data collected at a single point in time following a simulation-based experiential learning intervention. This approach was appropriate given the numerical nature of the study's objective, which was to evaluate the relationship between simulation-based experiential learning and student satisfaction, while taking into account the mediating roles of deep and surface learning. The research design also allowed for the timely measurement of students' experiences following the completion of the SBEL intervention.

Research design or model

Figure 1 below depicts and discusses the empirical model that underpins the study.

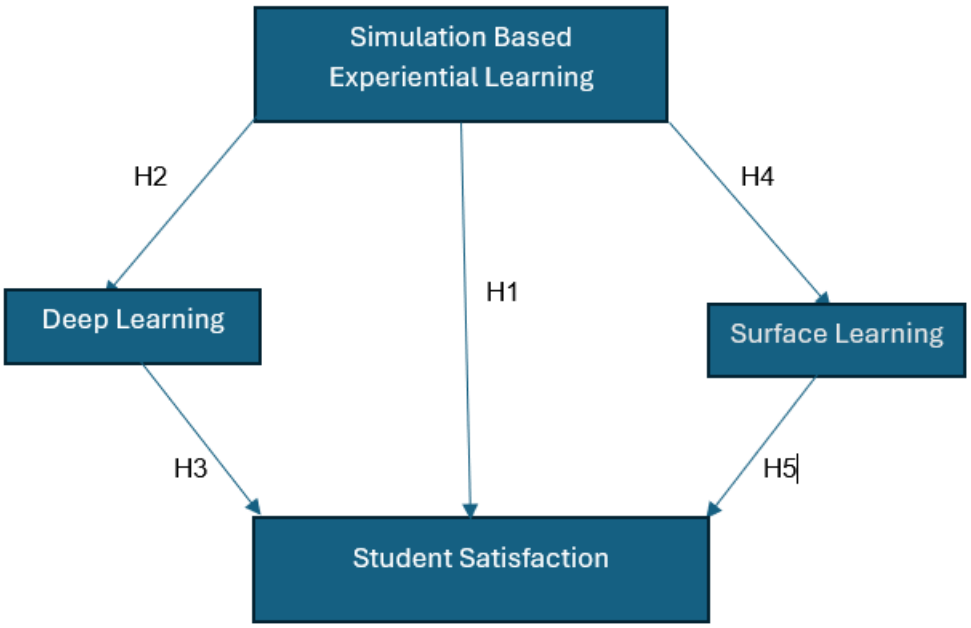


Figure 1: Conceptual Framework (Seseni et al., 2025)

Figure 1 outlines the presumed relationships among SBEL, learning approaches (deep and surface), and student satisfaction. Figure 1 shows the empirical model with the hypothesised relationship between the variables. In the functional model, simulation-based experiential learning was placed as an exogenous latent variable predicting student satisfaction, with deep and surface learning approaches specified as mediators. The latent constructs in the model were specified as reflective. In the model, simulation-based experiential learning is hypothesised to have a direct positive impact on student satisfaction (H1) as observed by Bakoush (2022). Theory also suggests that different learning styles affect how students respond to experiential methods (Gittings et al., 2020; Randall et al., 2025). Therefore, in line with this theoretical perspective, the study suggests that deep and surface learning mediate the relationship between SBEL and student satisfaction. In this regard, the second hypothesis (H2) suggests that SBEL has a direct positive impact on deep learning, and deep learning, in turn, positively influences student satisfaction (H3), indicating a mediated path through which SBEL impacts student satisfaction with deep learning as the mediator. On the other hand, SBEL is proposed to have a negative impact on surface learning (H4), and surface learning is also found to have a negative impact on student satisfaction (H5), indicating a second mediated path through which SBEL affects student satisfaction. A partial least squares structural equation model (PLS-SEM) was employed to assess the strength of the relationship between the latent constructs. The PLS-SEM was adopted due to its ability to capture multiple constructs and its robustness to non-normal data distributions (Avkiran & Ringle, 2018; Hair, Risher, et al., 2019; Sarstedt et al., 2014). In addition, PLS SEM is also ideal for small to medium-sized samples and allows for testing of direct, indirect and mediating effects at the same time, providing different path coefficients which can be useful for assessing the accuracy of findings (Hair, Risher, et al., 2019; Sarstedt et al., 2014). The PLS SEM analysis proceeded in two stages. Firstly, the measurement model was assessed to confirm the reliability and validity of latent constructs. Secondly, the structural model was evaluated to test the hypothesised relationships. Direct and indirect effects were examined using bootstrapping of 5,000 subsamples, and the computed significance of direct and indirect effects was presented in tabular form. The model fit was assessed through the standardised root mean square residual (SRMR) while the predictive relevance of endogenous constructs was captured through Q2 values.

- **Data collection tools**

Data were collected using a structured questionnaire consisting of 41 closed-ended items with a 5-point Likert scale ranging from Strongly Disagree to Strongly Agree. The questionnaire was adapted from previously validated studies on SBEL and student engagement, specifically Bakoush (2022) and Kageyama et al. (2022), with modifications tailored to the finance education context. Therefore, the questionnaire comprised items that focused on demographic data, simulation-based learning experiences, the deep learning approach, the surface learning approach, and student satisfaction. The questionnaire was hosted electronically on the University's online learning platform and remained open for students to complete from October 21, 2024, to November 20, 2024.

- **Sampling or research group**

The sampling technique was purposive, and the target population comprised undergraduate students enrolled in two finance-related modules, namely Financial Planning 3B and Entrepreneurial Growth Strategies 2B, at a higher education institution in South Africa. Purposive sampling was employed, as the researchers specifically used their own students. These modules were purposively selected due to their practical orientation and suitability for SBEL implementation. As a part of the curriculum and module outcomes, both student groups are required to complete a practical group project. A total of 288 students participated in the simulation, with valid responses obtained from 108 students. In the group, 223 students were third-year Bachelor of Commerce in Finance students, and 65 were second-year students pursuing a Diploma in Small Business Management. If the respondent didn't answer satisfactorily, for instance, if it is a constant value of only 4's (agree) with no variance, these respondents were taken out of the sample.

- **Research procedures**

The experiential learning intervention involved a group-based client simulation project. Students were grouped into teams of 6 to 8 members, drawn from the financial planning and entrepreneurial growth strategies modules. The students were tasked with developing a financial planning report and a business model canvas for a hypothetical client, based on a set of pseudo facts. This process simulated a real-world advisory scenario and was conducted over a five-week period. Feedback sessions were done to simulate real-time client interactions and repeated problem-solving. This helped students to memorise and remember what was taught in the theory classes. Moreover, it helped to make connections between the theory taught and the scenario provided as part of the simulation. This applied to both finance and business students.

- **Validity and reliability measures**

In this study, reliability and validity were tested using Cronbach's alpha. This is highlighted in the table below and the discussion that follows.

Table 1: Reliability and Validity of Higher Order Constructs

Construct	Cronbach's alpha	Average Variance Extracted
Deep approach to learning	0.738	0.792
Simulation based learning	0.793	0.706
Student Satisfaction	0.841	0.759
Surface approach to learning	0.618	0.668

Source: Primary Data

Table 1 shows the reliability and convergent validity tests of the higher-order constructs in the model. All the constructs had average variance extracted values above the recommended 0.50 threshold, indicating good convergent validity as according to Fornell and Larcker (1981). Cronbach alpha values for deep approach to learning (0.738), simulation-based learning (0.793), and student satisfaction (0.841) surpassed the acceptable 0.70 level, confirming internal consistency reliability. Surface approach to learning had a Cronbach's alpha of 0.618, which was below 0.70 but is considered acceptable given the exploratory nature of the study (Hair, et al., 2019).

- **Data Analysis**

Preliminary checks for anomalies were conducted using descriptive statistics for individual items to ensure that no anomalies or response patterns existed that could lead to bias in the results. SmartPLS was the software used for PLS-SEM. However, the descriptive summary checks were not included in the final analysis as the study focused on the structural relationships between the variables. The data were then subjected to exploratory factor analysis with promax rotation to examine the underlying factor structure. Items with loadings below 0.4 were excluded from further analysis to enhance construct validity. Data analysis also involved initial checks for the reliability and validity of the questionnaire. Internal consistency was evaluated through Cronbach's alpha, with a threshold alpha score of 0.7 deemed satisfactory (Cronbach, 1951). Convergent validity was checked through average variance extracted values with a targeted value equal to or more than 0.5 in line with Fornell and Larcker (1981), while discriminant validity was assessed through the Fornell-Larcker criterion (1981) and the heterotrait-monotrait ratio with acceptable values below 0.90 (Henseler et al., 2015).

- **Limitations**

In terms of the response rate, only 108 of the 288 students completed the questions. This is less than half of the population group. Although there were enough responses for data analysis, it is possible that more students responding would further enhance the research findings. The period during which the questionnaire was issued

coincided with exam season; in the future, it would be more beneficial to administer the questionnaire immediately after project submission and extend the period of availability. The researchers also acknowledge response bias due to self-reporting on student satisfaction.

RESULTS

Table 2 below depicts the outer loadings of lower-order constructs, followed by the analysis.

Table 2: Outer Loadings of Lower Order Constructs

Item	Concrete experience	Deep motivation	Deep strategies	Feedback support & organisation and management	Overall satisfaction	Reflective observation & abstract conceptualisation	Surface motivation	Surface strategy	Teaching and learning	active experimentation
Q100										0.827
Q11										0.812
Q14		0.843								
Q15		0.807								
Q17		0.839								
Q18		0.782								
Q19		0.796								
Q2	0.916									
Q20			0.734							
Q21			0.774							
Q22			0.832							
Q23							0.817			
Q24							0.899			
Q25							0.773			
Q29								0.90		
Q3	0.936									
Q30								0.88		
Q31				0.726						
Q32				0.893						
Q33				0.667						
Q34				0.825						
Q35				0.702						
Q36					0.89					
Q37					0.938					
Q38					0.902					
Q39									0.876	
Q4										0.699
Q41									0.913	
Q42									0.913	
Q43									0.798	
Q5						0.819				
Q6						0.776				
Q7						0.803				
Q8						0.856				
Q9										0.694

Source: Primary Data

Table 2 presents the outer loadings of the retained indicators on their respective latent constructs. A total of 42 items were initially subjected to reduction through exploratory factor analysis. Of these, 35 items exhibited loadings above 0.60 and were retained for further analysis. Seven items (Q1, Q12, Q13, Q26, Q27, Q28, and Q40) were removed as they displayed loadings below the acceptable threshold of 0.40. All retained items exceeded the 0.60 indicator reliability criteria thus supporting their inclusion in the PLS-SEM model.

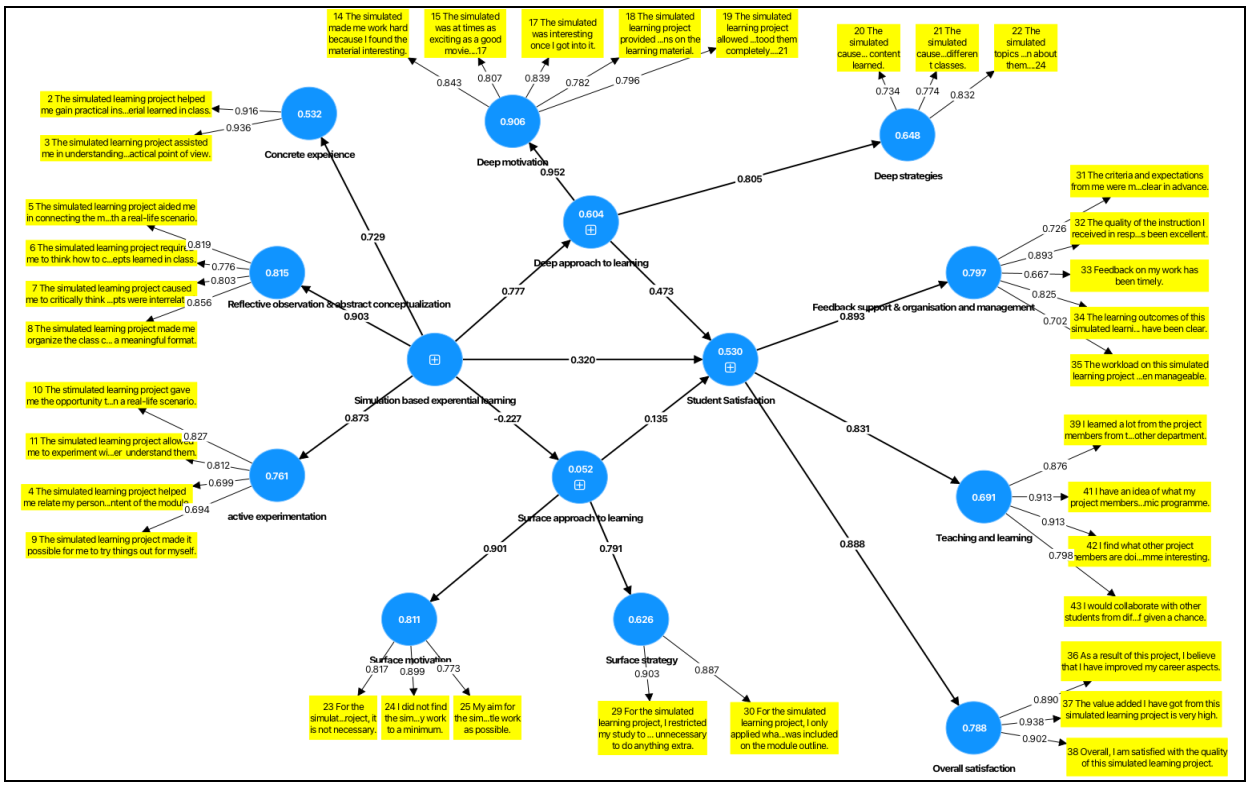
Table 3: Reliability and Convergent Validity of Lower Order Constructs

Construct	Cronbach`s Alpha	Average Variance Extracted
Overall satisfaction	0.90	0.83
Teaching and learning	0.90	0.77
Deep motivation	0.87	0.66
Concrete experience	0.83	0.86
Reflective observation & abstract conceptualisation	0.83	0.66
Feedback support, organisation and management	0.82	0.59
Surface motivation	0.78	0.69
Active experimentation	0.76	0.58
Surface strategy	0.75	0.80
Deep strategies	0.68	0.61

Source: Primary Data

Table 3 presents the results of reliability and convergent validity tests for the questionnaire constructs. All the constructs except one showed acceptable internal consistency reliability with Cronbach's alpha values exceeding the acceptable threshold level of 0.7. The teaching and learning and overall student satisfaction constructs had Cronbach's alpha values of 0.90, which, according to Cronbach (1951) is a reflection of excellent internal consistency. Similarly, deep motivation (alpha = 0.87), concrete experience (alpha = 0.83), reflective observation (alpha = 0.83), and feedback support (alpha = 0.82) had values above 0.80, which are considered good for internal consistency; the remaining constructs had acceptable levels of consistency within the 0.7 range. Deep strategies fell marginally short of the acceptable range (α = 0.68). However, Hair et al. (2019) suggest that in exploratory research, values between 0.60 and 0.70 can be deemed acceptable. For all the constructs, the average variance extracted (AVE) values were above 0.50, indicating satisfactory convergent validity (Fornell & Larcker, 1981). The high convergent validity values suggest that the items making up the constructs strongly represent the underlying latent variables. Significant discrimination was also observed between the constructs using the Fornell-Larcker matrix and HTM values, which were below 0.90, in line with Henseler et al. (2015).

Figure 2: Lower Order Factor Model with Factor Loadings



Source: Primary Data

Figure 2 illustrates the lower-order model with factor loadings. The model represents the validated structure of the individual latent constructs after item reduction and reliability and validity tests. The model confirmed that the retained indicators reliably measured their respective subdimensions, with all loadings exceeding the 0.60 mark. The validated model served as the basis for forming and testing the higher-order constructs in the structural model.

Table 4: Outer Loadings of Higher Order Constructs

	Deep approach to learning	Simulation based learning	Student Satisfaction	Surface approach to learning
Concrete experience		0.757		
Reflective observation & abstract conceptualization		0.883		
Active experimentation		0.875		
Deep motivation	0.902			
Deep strategies	0.878			
Feedback support, organisation, and management			0.893	
Overall satisfaction			0.913	
Teaching and learning			0.803	
Surface motivation				0.981
Surface strategy				0.611

Source: Primary Data

Table 4 shows the outer loadings of the lower-order constructs on their respective higher-order constructs. After confirming the validity and reliability of the lower-order constructs, related subdimensions were combined into higher-order latent constructs using the hierarchical component model approach. All the loadings had loadings above 0.70. According to Hair et al. (2017) and Sarstedt et al. (2014) outer loadings of components should exceed 0.70 for reliability. Therefore, the observed outer loadings on higher order constructs in excess of 0.70 confirmed reliability at the higher order level. In this context, Simulation-Based Learning was captured through concrete experience (0.757), reflective observation and abstract conceptualisation (0.883) and active experimentation (0.875). In addition, Student Satisfaction was represented by feedback support and organisation and management (0.893), overall satisfaction (0.913), and teaching and learning (0.803). Further, Deep Learning was explained by deep motivation (0.902) and deep strategies (0.878). while surface motivation (0.981) and surface strategy (0.611) represented the Surface Approach to Learning. The findings align with Bakoush`s (2022) observations about the multidimensional nature of simulation based experiential learning.

Table 5: Fornell-Larcker Criterion Matrix of Higher Order Constructs

	Deep approach to learning	Simulation based learning	Student Satisfaction	Surface approach to learning
Deep approach to learning	**0.89**			
Simulation based learning	0.774	**0.84**		
Student Satisfaction	0.687	0.67	**0.871**	
Surface approach to learning	-0.242	-0.249	-0.09	**0.817**

Source: Primary Data

Table 5 shows the Discriminant validity tests using the Fornell-Larcker matrix. The Fornell-Larcker criterion says that the diagonal values should be larger than all values in the same row and column (Fornell & Larcker, 1981). This was observed to be true for all the higher-order constructs in Table 5, indicating significant discrimination between the constructs. Tests were also done using the HTMT approach, which showed HTMT values below 0.90, thus confirming satisfactory discrimination between higher-order constructs.

Structural Model Results

After confirming the reliability and validity of the constructs, the next step involved evaluating the results of the structural model. Prior to the evaluation, multicollinearity checks were done to ensure stable estimates. All the variance inflation factors had values below 3, indicating the absence of multicollinearity between the higher-order construct items. Therefore, the structural model was not affected by multicollinearity, and the estimates produced were stable. The R^2 values of the dependent endogenous constructs were checked to assess the predictive power of the model. Student satisfaction had an R^2 value of 0.53, indicating that the model explained 53% of the variation in student satisfaction, which, according to Hair et al.(2019) is a moderate level of explanatory power. The model also had a slightly higher R^2 value of 0.60 for the deep approach to learning, indicating that it accounted for 60% of the variation in the construct, whereas the surface approach had an R^2 of 0.06. The model, however, exhibited a good fit with a standardised root mean square of 0.08. Hair (2019) notes that SRMR values below 0.10 are considered acceptable in terms of consistently being able to explain the covariance among the indicators. Further, through a blindfolding procedure, the predictive relevance of the model was estimated. According to Hair et al. (2017)Values between 0.02 and 0.14 indicate weak predictive relevance, while values between 0.15 and 0.34 indicate moderate predictive relevance, and values of 0.35 or greater indicate strong predictive relevance. The student satisfaction construct and the deep approach to learning had Q^2 values of 0.433 and 0.576, indicating a strong predictive relevance. On the other hand, the surface approach to learning construct had a Q^2 value of 0.007, suggesting no predictive relevance. The findings suggest that the model offers strong predictive capability for a deep approach to learning and student satisfaction, but fails to adequately predict a surface approach to learning.

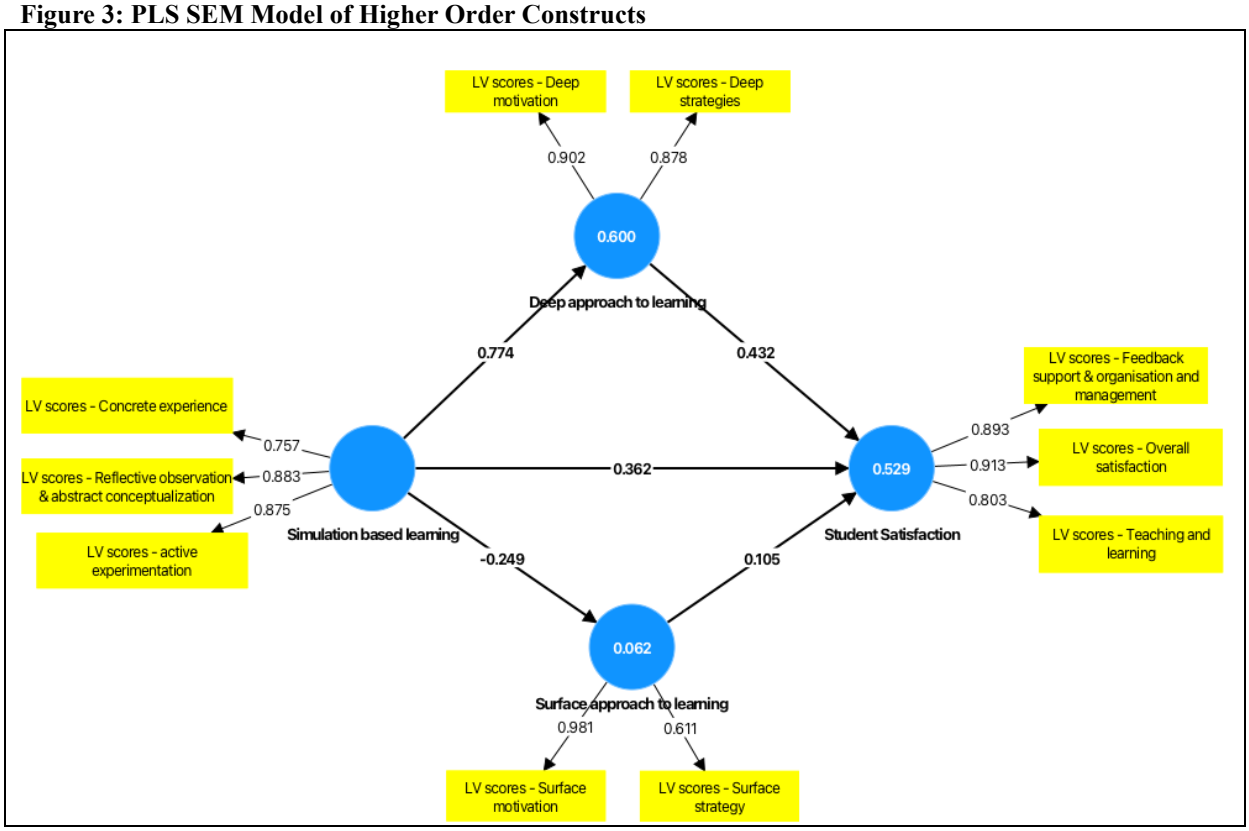
Table 6: Total and Indirect Effects

Hypothesis	Relationship	Coefficient
H1	SBEL -> Student Satisfaction	0.362***
H2	SBEL -> Deep Approach to Learning	0.774***
H3	Deep Approach to Learning -> Student Satisfaction	0.432***
H4	SBEL -> Surface Approach to Learning	-0.249
H5	Surface Approach to Learning -> Student Satisfaction	0.105
	Total Indirect Effects	
	Simulation based learning -> Student Satisfaction	0.308***
	Specific Indirect Effects	
	Simulation based learning -> Deep approach to learning -> Student Satisfaction	0.334***
	Simulation based learning-> Surface approach to learning -> Student Satisfaction	-0.026

Source: Primary Data */**/*** denotes significance at 10%, 5%,1% respectively

Table 6 presents the results of the direct and indirect relationships between simulation-based experiential learning, student satisfaction, and the use of deep and surface approaches to learning. The results of Hypothesis 1 indicate that simulation-based experiential learning (SBEL) in finance has a direct, positive, and significant impact on student satisfaction, with a coefficient of 0.362. Therefore, exposing students to experiential real-world scenarios and engaging learning environments directly promoted students' satisfaction. The moderate path coefficient size of 0.362 suggests that student satisfaction may also be dependent on other factors. However, the direct positive impact finding aligns with Bakoush (2022) who also noted that SBEL promotes satisfaction by increasing students' sense of relevance and application. The findings also confirmed Hypothesis 2, which states that SBEL has a direct and positive impact on deep approaches to learning for finance students. The path coefficient of 0.774 between SBEL and deep approaches to learning indicates the immense role SBEL played in enhancing deep learning. The findings suggest that SBEL encouraged students to go beyond surface-level engagement and stimulated motivation, critical thinking and a desire to understand conceptually.

Figure 3: PLS SEM Model of Higher Order Constructs



Source: Primary Data

Figure 3 shows the final PLS-SEM model with higher-order constructs. The model depicts the relationships between simulation-based experiential learning, deep and surface learning approaches, and student satisfaction. The SBEL structure is reflected in its subdimensions, showing the mediated pathways through both deep and surface approaches. The diagram also reveals the path coefficients with the strength of each hypothesised relationship reflected through the coefficients.

DISCUSSION

SBEL changed the way students approached learning and encouraged them to engage more in the learning process. The size of the coefficient may be an indicator of the effectiveness of the simulation design, with well-prepared simulations encouraging greater engagement. This finding confirms Kolb's (1984) experiential learning theory, which posits that meaningful experiences encourage reflection, abstract conceptualisation, and active experimentation. Findings also showed a direct positive and significant relationship between deep approaches to learning and students' satisfaction, with a coefficient of 0.432. Therefore, finance students who engaged more with learning content tended to have greater satisfaction. The findings suggest that student satisfaction may not be solely dependent on the delivery tool, such as SBEL, but also on the student's cognitive engagement in the process. This finding confirms Randall et al.`s (2025) perspective that the learning experience itself, rather than the learning tool, is the driver of student satisfaction.

In terms of hypothesis 4, findings showed no relationship between SBEL and surface learning. This suggests that SBEL, on its own, may not have been sufficient to prevent surface learning tendencies in some students. Therefore, a change in pedagogy may not have been adequate to discourage students from merely completing the minimal task and relying on rote memorisation. According to Sharma et al. (2018), external pressures on grades and time constraints may force students to focus more on surface learning. Findings also showed no significant direct link between surface approaches to learning and student satisfaction. This finding contradicts Sharma et al.'s (2018) finding that some students are satisfied with surface learning outcomes, such as passing an exam, without being concerned about the quality of their learning. The total indirect effect of SBEL on student satisfaction (coefficient = 0.308) represents the combined contribution of mediated paths from deep learning approaches (coefficient = 0.334) and surface learning approaches (coefficient = -0.026). The strong significance of the total indirect effects indicates that SBEL improved satisfaction through the learning approaches, with the deep learning approach being the primary contributor to this improvement. The mediated pathway suggests that SBEL improved finance

students' satisfaction through shifts in how students engaged in terms of reflection, critical thinking and improved conceptualisation. Randall et al. (2025) and Bakoush (2022) agree that there is a mechanism through which greater student satisfaction is attained, and this mechanism involves deeper thinking and a meaningful connection between theory and practice in learning. This finding is supported by the specific indirect effect mediated by the path from SBEL to deep learning, which in turn led to student satisfaction. This mediated indirect path had a positive and significant coefficient of 0.334. This demonstrates that student satisfaction was not only a result of simulation-based experiential learning but also a consequence of the way SBEL encouraged students to think critically, reflect, and apply their knowledge. The second mediated indirect path from SBEL to surface learning and student satisfaction had an insignificant coefficient, indicating that surface learning did not mediate the relationship between SBEL and student satisfaction. This finding supports Gittings et al,`s (2020) argument that student satisfaction is driven more by positive enablers than the negative behaviour of surface engagement.

CONCLUSION, IMPLICATIONS AND SUGGESTIONS

The study examined the impact of simulation-based experiential learning on the satisfaction of finance students in the context of a higher education institution in South Africa. Deep and surface learning approaches were employed as mediating variables, utilising a partial least squares structural equation model. Firstly, study findings showed that simulation-based experiential learning in finance had a direct positive and significant impact on student satisfaction. Therefore, exposure to experiential real-world scenarios and engaging learning environments directly improves students' satisfaction. Secondly, the study confirmed that SBEL has a direct and positive impact on deep approaches to learning for finance students. In this context, it can be concluded that SBEL encourages students to go beyond surface-level engagement and stimulates motivation, critical thinking, and a desire to understand concepts conceptually. A direct, positive, and significant relationship between deep approaches to learning and finance students' satisfaction confirmed that student satisfaction may not be dependent solely on SBEL, but also on the cognitive engagement of the student in the process. This finding was further supported by the specific indirect effect mediated by the path from SBEL to deep learning, which in turn led to student satisfaction. Therefore, student satisfaction is not only a result of simulation-based experiential learning but also a result of the way SBEL encourages students to think critically, reflect, and apply knowledge. Furthermore, the study found no direct or mediating relationship between SBEL, surface learning approaches, and student satisfaction, suggesting that SBEL on its own may not be sufficient in preventing surface learning tendencies. In light of these findings, several policy and practical recommendations can be proposed. Given the positive direct and indirect effects of SBEL on student satisfaction and deep learning, higher learning institutions should be encouraged to formalise its use across educational programmes. This can be achieved by placing simulation-based learning activities at the core of modules, ensuring that students benefit from exposure to experiential learning opportunities that stimulate critical thinking and conceptual understanding. In addition, the measured impact of SBEL in this study may reflect the quality of simulation design and delivery. Therefore, higher education institutions should invest in training their academic staff to design and implement simulation activities effectively, ensuring that simulations are relevant and aligned with learning outcomes. Further, policymakers and educational experts should ensure that assessments reward critical analysis, reflection, and application of knowledge rather than rote memorisation. This alignment between pedagogy and assessment will enhance deep learning behaviour and discourage focus on surface learning approaches. Lastly, higher education policymakers should prioritise infrastructure and resources that support the use of simulation technologies. This may include investments in simulation software, technical support, and digital platforms that can accommodate large-scale experiential activities, ensuring all students have access to these platforms.

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Experiences of teachers with the implementation of play-based pedagogy at Early Childhood Centres in Yilo-Krobo Municipality

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Abstract

This study examined early childhood teachers' experiences in implementing play-based pedagogy in early childhood centres within the Yilo-Krobo Municipality. The research adopted a qualitative, interpretivist approach, using an exploratory case study design. Thirteen early childhood educators were selected purposively, and data were collected through a structured interview guide and analysed thematically. The findings revealed that a majority of the teachers reported an acute shortage of teaching and learning materials, which significantly impeded the effective use of play-based learning. Most participants indicated that training opportunities related to play-based pedagogy were infrequent and irregular, which limited their ability to consistently apply learner-centred strategies. Over half of the teachers expressed the need for sustained professional development and external support, particularly from NGOs such as Sabre, Right to Play, and World Vision, to strengthen their competence and confidence in using play-based approaches. Participants also emphasised the importance of continuous monitoring and evaluation to ensure the relevance and impact of training on classroom practices. The study recommends that the education directorate intensify advocacy and community awareness on the value of play-based learning and prioritise the provision of adequate resources and support systems to enhance its implementation in early childhood centres.

Keywords: Play-based Pedagogy, Developmentally Appropriate Practices, Zone of Proximal Development, Early Childhood, Education Centres.

INTRODUCTION

Background

Globally, play-based learning is recognised as a developmentally appropriate pedagogy that enhances children's learning through exploration, inquiry, and hands-on engagement (NAEYC, 2006). As a child-centred approach, play-based learning promotes open-ended discovery and supports multiple domains of development, making it a critical component of effective early childhood education (Cutter-Mackenzie et al., 2014; Danniels, 2018). In Ghana, both the 2006 Kindergarten Curriculum and the 2019 Standards-Based Curriculum emphasise the facilitation of children's learning through play, underscoring the national commitment to child-centred and developmentally appropriate practices.

However, the effective implementation of this pedagogy depends heavily on teachers' knowledge, competence, and access to adequate learning resources. Although the curriculum mandates play-based teaching, many kindergarten teachers in Ghana continue to face challenges that hinder full implementation. Studies reveal that several teachers are ill-prepared due to insufficient pre-service exposure to play pedagogy, limited in-service professional development, and inadequate understanding of how to translate play-based approaches into classroom practice (Agbenyega & Klibthong, 2011; Associates for Change, 2016; Sofo et al, 2015; Tamanja, 2016). Compounding these issues are structural constraints such as shortages of teaching and learning materials and the high proportion of teachers who have not received formal early childhood training. Darkwa and Lartey (2018) further highlight poor-quality early childhood services in some districts, characterised by limited resources, low teacher qualifications, and restricted access to professional learning opportunities.

Although the Ministry of Education, Ghana Education Service, and NGOs such as Sabre Education and Right to Play have introduced interventions to strengthen play-based pedagogy, significant gaps remain at the classroom level. Interactions with early childhood teachers in the Yilo-Krobo Municipality indicate varying understandings of play, inconsistent use of play-based strategies, inadequate supervision of play activities, and limited access to instructional materials. Some teachers view play as peripheral rather than as a structured pedagogical tool, resulting in children often engaging in unguided free play instead of purposeful play-based learning. Others report that workshops and training programmes do not sufficiently address their practical challenges or build their confidence in facilitating play-based activities.

Despite these concerns, there is limited documented research that specifically examines how teachers in the Yilo-Krobo Municipality experience the implementation of play-based pedagogy. The available literature and local engagements point to notable gaps in teachers' preparedness, beliefs, resource availability, and professional support, yet these gaps have not been systematically explored within this particular context. This absence of empirical evidence presents a critical problem, as it limits the ability of stakeholders to design context-responsive interventions that address teachers' needs and strengthen the quality of early childhood education in the municipality. It is against this backdrop that this present study sought to explore teachers' experiences with the implementation of play-based pedagogy in early childhood centres

Purpose of the Study

The purpose of the study was to explore early-childhood teachers' experiences with the availability of appropriate material resources and preparedness in implementing play-based pedagogy in early childhood centres within the Yilo-Krobo Municipality.

Research Questions

The following research questions guided the study:

1. How do early-childhood teachers perceive the availability and adequacy of material resources for implementing play-based pedagogical practices in early childhood centres within Yilo-Krobo Municipality?
2. What are early childhood teachers' experiences regarding their training and preparedness for play-based pedagogical practices in early childhood centres within Yilo-Krobo Municipality?

Theoretical framework

Socio-cultural theory of Play (Lev Vygotsky, 1978)

This study is grounded in Lev Vygotsky's socio-cultural theory, which examines the central role of social, cultural, and historical contexts in children's cognitive development. Vygotsky argued that learning is socially mediated and that children construct knowledge through interactions with more knowledgeable others within their environment. Two foundational concepts underpin this theory: the Zone of Proximal Development (ZPD) and scaffolding. The ZPD refers to the gap between what a child can accomplish independently and what they can achieve with guidance, while scaffolding represents the support provided by teachers or peers to help children progress within this zone (Vygotsky, 1978).

Within the context of play, Vygotsky asserted that children often operate at levels above their everyday functioning because play naturally creates opportunities for role-taking, problem-solving, and imaginative engagement. Through pretend play and collaborative activities, children acquire language, social skills, and higher-order thinking as they interact with more experienced peers or adults guiding the learning process (Bodrova & Leong, 2019). Recent scholarship continues to support this perspective, highlighting that play provides an ideal environment for scaffolding, collaborative learning, and the co-construction of knowledge (Fleer, 2020; Weisberg, Hirsh-Pasek & Golinkoff, 2023). These studies affirm that play-based interactions enable children to demonstrate emerging competencies that are strengthened through intentional adult support.

The socio-cultural theory is therefore highly relevant to the implementation of play-based pedagogy. Contemporary research shows that when teachers create play-rich environments and engage in guided interaction, they activate children's ZPD and foster deeper cognitive and social development (Daniels, 2021; Pyle & Alaca, 2020). For teachers in early childhood centres, this means that purposeful and scaffolded play experiences provide learners with opportunities to explore, negotiate, communicate, and construct meaning within culturally situated contexts.

In relation to this study, the socio-cultural theory helps explain how teachers' practices influence children's learning during play-based activities. It highlights the importance of teacher expertise, guidance, and intentional interaction in enabling children to reach higher levels of competence. The theory aligns with the study's focus by emphasising that effective play-based pedagogy requires teachers to identify children's developmental needs, recognise their ZPD, and provide appropriate scaffolding to support their progress. Thus, the socio-cultural lens provides a strong theoretical foundation for understanding teachers' experiences, the challenges they face in guiding play, and the types of support necessary to enhance play-based learning within early childhood centres in the Yilo-Krobo Municipality.

LITERATURE REVIEW

Availability and Adequacy of Material Resources for Implementing Play-based Pedagogy

Play-based pedagogy is widely recognised as central to early childhood education, grounded in developmental theories that emphasise active, meaningful engagement. Piaget, as cited by Parker and Thomsen (2019), asserts that play facilitates cognitive development by enabling children to construct knowledge through environmental interaction, while Vygotsky highlights its socio-cultural dimension, suggesting that play fosters social learning and scaffolding within the child's zone of proximal development (Main, 2021). Material resources are thus essential, serving as the medium through which children explore, imagine, and create. Tools such as building blocks, puzzles, art supplies, outdoor equipment, and storybooks support holistic development, including creativity, problem-solving, social collaboration, and fine motor skills (Pyle & Danniels, 2017).

Research shows that adequate resources enable teachers to implement active, learner-centred pedagogy, while scarcity often constrains instruction, pushing educators towards rote, teacher-directed methods (Jay & Knaus, 2018). Improvised, locally available materials stones, sticks, and recycled containers, can supplement formal resources, enhancing play experiences when teachers innovate (Trina, 2022). Globally, resource availability varies: well-resourced classrooms in countries such as Finland, Australia, and the United States facilitate inclusion and exploration (Marks, 2020), whereas many early childhood centres in Sub-Saharan Africa operate with minimal resources, necessitating improvisation and community support (Adamu, 2024).

In Ghana, NaCCA's Kindergarten curriculum promotes play as the core medium for learning, emphasising the provision of teaching and learning materials (NaCCA, 2019; Adams et al., 2024). Despite this, empirical evidence highlights persistent shortages, particularly in rural and peri-urban schools, where teachers often improvise with locally available objects (Shah, 2018; Quaynor & Osei, 2021; Song, 2023). Yilo Krobo, like many rural districts, faces similar challenges, with dispersed settlements and limited funding affecting resource provision. Community support partially mitigates these gaps, yet disparities remain.

Overall, the literature confirms that material resources are pivotal in shaping play-based pedagogy. Adequate provision fosters inclusive, active, and creative learning, while scarcity limits teachers' capacity to realise the curriculum's play-based ambitions. This study explores the resources available to teachers in Yilo Krobo, addressing a critical gap in the empirical evidence.

Training level of teachers regarding play-based pedagogical practices

The effective implementation of play-based pedagogy relies not only on curriculum policy but also on teachers' knowledge, skills, and confidence to apply play principles in classrooms. Ghana's Kindergarten curriculum positions play as the primary medium for learning, requiring teachers to adopt creative, play-centred strategies (NaCCA, 2019; James, 2020). Translating this intent into practice necessitates targeted professional development (PD) that equips teachers with practical skills for designing, facilitating, and assessing play activities.

Empirical studies in Ghana indicate mixed levels of teacher preparedness for play-based approaches. Dzamesi and van Heerden (2020) noted that variability in teacher competence, while McChesney and Aldridge (2019) report that intensive, coaching-based PD significantly improves classroom quality and children's learning outcomes. National initiatives, including collaborations between the Ghana Education Service, NaCCA, and NGOs such as Right To

Play, aim to cascade PD through train-the-trainer models. However, uneven reach and intensity across districts limit consistent adoption of play-based practices (Onyango et al., 2023; Laney, 2025).

Persistent gaps exist, especially in rural municipalities, where teachers often have limited pre-service training and attend infrequent, theory-heavy workshops (Eshun, 2022). Teachers frequently report uncertainty about structuring sustained, purposeful play sessions, linking play to learning objectives, and conducting formative assessment within play contexts. Where PD does occur, the absence of follow-up coaching, classroom observation, and contextually appropriate teaching and learning materials undermines the durability of change.

Findings from district and municipal studies in Ghana emphasise the contextual inequalities that shape teacher preparedness. Research in districts such as Ho West District and Jomoro Municipality shows that teachers in under-resourced settings rely heavily on improvisation, and that PD efforts are more effective when they include locally relevant examples and support for using improvised materials in play activities (Tatsi et al, 2025; Eshun, 2022). This suggests that teacher training must be sensitive to resource realities and model how to design high-quality play with low-cost, locally available materials (Wolf, 2018). In Yilo Krobo, Sakyi (2022) found that teachers rely on traditional routines due to insufficient PD, irregular mentoring, and limited material support, with community and peer initiatives serving as partial mitigators.

METHODOLOGY

Research Approach

The study employed a qualitative research approach. The qualitative approach method emphasises the exploration of subjective experiences and the meanings that people attribute to them. This approach is particularly useful in exploring complex social phenomena, such as the experiences by teachers in implementing play-based pedagogy in Early Childhood Centers in the Yilo-Krobo Municipality. The Qualitative approach provides several benefits for this type of study. Since qualitative approach enables the researcher to ask questions in textual form to understand human experience, it was necessary to employ this approach in the study. In the view of Kusi (2012), qualitative researchers aim to understand 'depth' rather than 'breadth' or explore a phenomenon in detail. They are interested in understanding the meaning people have constructed, that is, how individuals make sense of their world and the experiences they have within it (Tisdell et.al., 2025).

One benefit of the Qualitative approach is its ability to provide a detailed and in-depth understanding of the experiences and perspectives of teachers. This approach enables open-ended questions and flexible data collection methods, such as interviews, focus groups, and observations, allowing researchers to gather rich and nuanced data on teachers' experiences and perspectives (Creswell, 2017). The task of qualitative research is to gain insights into constructions of reality; that is to tease out the nature of the world as it is experienced, structured and interpreted by people in the course of their everyday lives (Cropley, 2019). According to Kombo and Tromp (2006), qualitative research is a form of research that involves description to the data obtained. It seeks to describe and analyse the behaviour of groups from the point of view of those being studied.

Research Design

An exploratory single case study design was employed for this study (Yin, 2021). A case study is a qualitative research approach that involves the in-depth exploration of a specific case, such as the experiences of teachers in implementing play-based pedagogy in Early Childhood Centres in the Yilo-Krobo Municipality. The design was considered appropriate to ascertain the experiences of teachers in the implementation of play-based pedagogy at early childhood centers. Case study research design involves a detailed and intensive analysis of a particular event, situation, organisation, or social unit. Typically, a case has a defined space and time frame: "a phenomenon of some sort in a bounded context" (Saldaña, 2018).

One benefit of the Exploratory Case Study design is its ability to provide a rich and detailed understanding of the implementation process. This design enables researchers to investigate the implementation of play-based pedagogy in a specific context, providing insights into the factors that facilitate or hinder its implementation. One strength of the case study design is that it can capture and explore the complexity of a phenomenon, leading to a deeper understanding. This is what large-scale quantitative studies fail to achieve because, in most cases, they collect superficial information about a phenomenon for generalisation (Kusi, 2012). Another strength of case study design is action-centered and, therefore, the findings are useful for improving practice (Cohen, Manion, & Morrison, 2003). Notwithstanding these strengths, the case study design has been critiqued in diverse ways, including the fact that the findings are difficult to generalise. This is because such studies often concentrate on an instance or a few instances of a phenomenon and involve a relatively small sample

size. Given the fact that the advantages of using the case study design in this study outweigh the disadvantages, the case study design was considered more appropriate for the study.

Population

The target population of the study was 148 teachers teaching in Early Childhood Centers (ECCs) in the Yilo-Krobo Municipality. The teachers in the Yilo-Krobo Municipality are the key population for this study, as they have firsthand experience of the challenges and opportunities of implementing play-based pedagogy in this context. Agyedu, Donkor and Obeng (2011), defined population in research as the complete set of individuals (subjects), objects or events with common observable features for which a researcher is interested in studying. It is also regarded as the larger group from which individuals are selected to participate in a study. A population is also defined as a group of individuals or people with the same characteristics in whom the researcher is interested (Blanche et al., 2006). Kusi (2012, p. 80) defines target population as "a group of individuals that the researcher generalises his/her findings".

Sample and Sampling Technique

The study employed purposive sampling to select 13 early childhood teachers in the Yilo-Krobo Municipality. Purposive sampling was selected because it allows researchers to select participants strategically based on their experience, knowledge, and relevance to the research questions (Patton, 2002). In this study, participants were selected specifically because they had direct experience implementing play-based pedagogy following the introduction of the new Standards-Based Curriculum, and they possessed formal early childhood education qualifications from colleges of education or universities. This approach ensured that the data collected reflected informed perspectives on the practical implementation of play-based instructional practices.

To be included in the study, teachers were required to have a minimum of three to four years of teaching experience in early childhood education post-implementation of the new curriculum. This criterion was set to ensure that participants had sufficient exposure to play-based pedagogical practices and could provide rich, contextually grounded insights.

The sample size of 13 was deemed sufficient because data saturation was achieved during the interviews, where no new themes or significant information emerged from additional participants (Guest, Bunce, & Johnson, 2006; Saunders et al., 2018). Saturation was reached when responses became repetitive, and the researcher was confident that the information gathered was comprehensive enough to address the study objectives. Purposive sampling, combined with data saturation, ensured the credibility, relevance, and richness of the data collected.
According to Alvi (2016), a sample is a small, representative subset of a population, and careful selection of knowledgeable participants enhances the reliability of findings and the applicability of conclusions to the broader population.

Data Collection Instruments

The study employed a semi-structured interview guide as the primary instrument for data collection based on its objectives and research questions. Semi-structured interviews are widely recognised for their flexibility, allowing researchers to combine predetermined questions with follow-up probes to elicit detailed and context-specific insights (Lim, 2025; Minh, 2025).

The interview guide was organised into two main sections aligned with the study objectives. The first section focused on teachers' experiences with the availability, adequacy, and usability of material resources supporting play-based learning, including the types of resources, their suitability for various play activities, and how resource availability affected instructional practices. The second section explored teachers' level of training in play-based pedagogical practices, including pre-service education, in-service training, workshops, and professional development programmes. Probing questions were included to understand the relevance, frequency, and effectiveness of these training experiences and any gaps affecting teachers' competence and confidence.
The semi-structured format enabled the researcher to ask follow-up questions for clarification and deeper exploration. This approach ensured rich, nuanced, and contextually grounded data directly aligned with the study objectives (Rabionet, 2022).

Data Analysis Procedures

The field data were collated, reviewed, and cleaned to address partially answered or unanswered items. The study employed thematic analysis as the primary data analysis method. This approach involved a systematic process of coding, categorising, and interpreting data collected through the semi-structured interview guide. The analysis was guided by the research questions and objectives of the study and was aiming to identify teachers' experiences in implementing play-based pedagogy in early childhood centres within the Yilo-Krobo Municipality.

Thematic analysis followed a three-tier process of description, analysis, and interpretation. The researcher read the interview transcripts repeatedly to become familiar with the data, generated initial codes, and grouped

related codes into categories from which themes and sub-themes were developed (Perera, 2023). This process involved active reflexivity, acknowledging the researcher's influence in the meaning-making process. To ensure anonymity, letters of the English alphabet were assigned to participants, allowing for efficient identification during data presentation while maintaining confidentiality. The emerging themes and sub-themes were reviewed and discussed with the research team to ensure accuracy, coherence, and faithful representation of participants' views.

Ethical Considerations

Ethical considerations were rigorously observed throughout the study to ensure the protection, rights, and dignity of all participants. Before data collection, ethical approval was obtained from the appropriate institutional review board, and formal permission was sought from the Ghana Education Service (GES) in the Yilo-Krobo Municipality. Participants were fully informed about the purpose of the study, the procedures involved, and the expected duration of participation, as well as their right to withdraw at any stage without any negative consequences.

Informed consent was obtained from all participants, with clear explanations provided verbally and in writing, ensuring that they understood the voluntary nature of their participation and the intended use of the data. Confidentiality and anonymity were maintained at all stages: participants' identities were protected using pseudonyms, and data were securely stored on password-protected devices accessible only to the researcher.

The study also adhered to principles of research integrity, ensuring honesty, transparency, and accountability in the collection, analysis, and reporting of data. Participants were assured that the findings would be reported objectively and respectfully, without misrepresentation, and used solely for academic purposes. These measures collectively safeguarded participants' rights and strengthened the trustworthiness and ethical rigor of the study.

DISCUSSIONS

Demographic Characteristics of Participants

The study involved 13 early childhood teachers purposively selected from the Yilo-Krobo Municipality, chosen for their experience and knowledge in implementing play-based pedagogy following the introduction of the new Standards-Based Curriculum. Of the 13 participants, 11 were female, and 2 were male, reflecting the predominance of female educators in early childhood education within the municipality.

The participants' ages ranged from 25 to 42 years, providing a mix of early-career and experienced teachers. In terms of teaching experience, all participants had a minimum of three years, with some having up to ten years of experience in early childhood education. Specifically, all participants had at least three to four years of experience teaching after the implementation of the new Standards-Based Curriculum, ensuring that they had sufficient exposure to play-based pedagogical practices.

Regarding professional qualifications, all participants had formal early childhood education training, having completed programmes at colleges of education or universities. This educational background provided them with the foundational pedagogical knowledge necessary for facilitating play-based learning activities.
The participants' gender, age, teaching experience, and professional qualifications provided a diverse yet relevant sample, enabling the collection of rich, contextually grounded data.

Thematic Analysis

The interview results aimed at presenting the voice of the participants in the study, and to ensure a thorough assessment of the experiences of teachers in the implementation of play-based pedagogy at early childhood centers in the Yilo-Krobo Municipality. During the presentation, the stories of the participants are interspersed with essential quotations that expound their personal views, particularly in relation to their behaviour. It is worthy of note that only vital responses are provided for the analysis, and all names provided in the analysis are participants' pseudonyms and not their real names. The data had been analysed based on themes (thematic analysis). The analysis was based on the research questions for the study. What characterises the data is the widespread agreement of the respondents on the issues. There was absolute unanimity in the responses to several of the questions or items, and this degree of unanimity gave much power to the results.

Research Question 1: How do early-childhood teachers perceive the availability and adequacy of material resources for implementing play-based pedagogical practices in early childhood centres within Yilo-Krobo Municipality?

Data for this research question were analysed using a thematic approach, which involved multiple readings of the interview transcripts, initial coding, clustering of codes, and the development of overarching themes. The analysis generated major themes**,** which capture the constraints teachers face in accessing adequate materials for play-based pedagogy.

Theme 1: Availability and Accessibility of Material Resources

This theme highlights how limited, poor-quality, and unevenly distributed material resources affect teachers' ability to implement diverse, meaningful, and developmentally appropriate play-based learning experiences. Here are some sub-themes and excerpts from the interview;

Subtheme 1.1: Limited Resources Provided

Most of the materials we have are just a few toys and some old blocks. We rarely receive art materials or outdoor play items that can support different play activities. T4
The children always use the same set of bottle tops and building blocks because that is basically what the school provides. We hardly get new or varied resources for literacy or pretend play. T10

Subtheme 1.2: Adequacy and Quality of Resources

The available materials are not enough for the whole class. Even when I plan group activities, some children have to wait because we don't have enough items for everyone to participate. T7

Most of the materials are worn out and not suitable for active play. Some puzzles are missing pieces, and the toys are old, so the children easily lose interest. T3

Subtheme 1.3: Accessibility for All Centres

When I visited another school in town, I realised they had more learning materials than we do here. In our rural setting, we only get a few items once in a long while. T1

Schools in the urban areas seem to have better support and more supplies. Here, we mostly depend on what we can improvise because the resource distribution is not the same. T9

The quotes imply that limited, poor-quality, and unevenly distributed materials hinder diverse play opportunities, restrict full participation, reduce learner engagement, and create inequities between rural and urban centres, ultimately undermining effective implementation of play-based pedagogy.

Theme 2: Utilisation of Resources in Play-Based Pedagogy

This theme explores how teachers apply, adapt, and creatively manage available resources to support play-based learning. It highlights the strategies teachers use to integrate materials into daily lessons, improvise when supplies are limited, and ensure activities align with curriculum expectations and developmental goals. Here are the sub-themes and excerpts from the interview;

Subtheme 2.1: Teachers' Integration of Resources into Daily Activities

Every morning, I select a few materials that fit the day's lesson, but because the options are limited, I often repeat the same activities. T6

I try to include resources in literacy, numeracy, and creativity sessions, but sometimes the lack of variety makes it difficult to plan engaging activities. T2

Subtheme 2.2: Creativity and Improvisation by Teachers When Resources Are Limited

When the materials are not enough, I improvise with bottle tops, stones, or cardboard so the children can still participate in the activities. T5

We create our own teaching aids with local materials, but it takes time, and the results are not always durable for repeated play. T11

Subtheme 2.3: Alignment with Curriculum Goals and Child Development Needs

I always try to make sure the activities match the curriculum, but sometimes the lack of resources makes it hard to achieve the learning goals fully. T3

We want to meet developmental targets, but without the right materials, some skills like fine motor or pretend play, are not well supported. T8

These quotes imply that although teachers make deliberate efforts to integrate and improvise resources, limitations in variety, quality, and availability reduce their ability to deliver curriculum-aligned, developmentally appropriate, and engaging play-based learning experiences.

Theme 3: Challenges and Support Systems

This theme examines the broader constraints that affect teachers' ability to effectively implement play-based pedagogy, including financial limitations, inadequate institutional support, and gaps in professional development. It also highlights the extent to which available support systems influence teachers' confidence, preparedness, and instructional practices. Here are the sub-themes and excerpts from the interview;

Subtheme 3.1: Financial and Logistical Constraints in Resource Provision

Sometimes the school wants to buy materials, but the funds are simply not enough, so we manage with whatever is available. T2

Transporting or acquiring new resources is difficult because the school doesn't have a budget for regular purchases or replacements. T7

Subtheme 3.2: Institutional and Governmental Support

We hear about policies promoting play-based learning, but the actual support rarely gets to us in the classroom. T1

The district office promises materials or guidance, but we receive them late or sometimes not at all. T6

Subtheme 3.3: Professional Development for Teachers on Effective Resource Use

We don't get enough training on how to use the play materials effectively, so sometimes we just figure things out on our own. T4

The workshops are not frequent, and when they happen, they focus more on theory than on practical ways to use resources in class. T12

These quotes imply that financial constraints, limited institutional support, and insufficient training undermine teachers' ability to utilise resources effectively, weakening the overall implementation of play-based pedagogy and reducing learning opportunities for children.

What are early-childhood teachers' experiences regarding their training and preparedness for play-based pedagogical practices in early childhood centres within Yilo-Krobo Municipality?

Theme 1: Level of Teacher Training and Qualifications

This theme explores the teachers' formal education, specialised preparation in play-based pedagogy, and adherence to national ECE standards. The findings suggest that gaps in qualifications and targeted training influence teachers' confidence and preparedness to deliver effective play-based learning experiences.

Subtheme 1.1: Formal Qualifications in Early Childhood Education (ECE)

Some teachers hold diplomas or degrees in Early Childhood Education, while others lack formal ECE backgrounds. One participant noted,

"I completed a diploma in Early Childhood Education, but many of my colleagues come from different backgrounds without any ECE specialization. T3

Another added,

Some of us have the required qualifications, but others are teaching at the kindergarten level with no formal ECE training. T8

Subtheme 1.2: Specialized Training in Play-Based Pedagogical Approaches

Participants reported that pre-service training tended to focus on theory rather than practical application:

> *We were taught the theory of play in school, but we were not trained deeply on how to apply play-based methods in real classrooms. T4*

> *Most of my training didn't focus specifically on play-based learning, so I sometimes struggle to design activities that match the approach. T6*

Subtheme 1.3: Certification and Compliance with National Standards

Teachers also highlighted inconsistencies in certification and the application of national standards:

> *I have my teaching license, which is now a national requirement for ECE teachers. T11*

> *The curriculum expects teachers to be trained and certified, but in practice, many classrooms are handled by unqualified personnel. That is, some teachers in early childhood classrooms hold basic education qualifications rather than early childhood. T2*

These quotes imply that gaps in formal qualifications, limited practical training in play-based pedagogy, and inconsistent certification undermine teachers' preparedness and confidence, restricting their ability to deliver developmentally appropriate, engaging, and curriculum-aligned learning experiences.

Theme 2: Professional Development and Continuous Learning

This theme focuses on teachers' opportunities for professional growth, the level of institutional support they receive, and their attitudes toward continuous learning. The data suggest that professional development is limited, inconsistently supported, and sometimes undervalued.

Subtheme 2.1: Access to Workshops, Seminars, and Refresher Courses

> *We only attend workshops once in a long while, and sometimes the information does not cover practical classroom needs. T7*

> *I wish we had more refresher courses because the last one I attended was almost two years ago. T5*

Subtheme 2.2: Institutional Support for Ongoing Training

> *Our school doesn't always sponsor us for training, so many teachers skip workshops because they have to pay out of their own pockets. T1*

> *The district office encourages training, but the support is inconsistent, and not everyone gets the chance to attend. T9*

Subtheme 2.3: varied Teacher Behaviour Toward Continuous Professional Development

> *"I am always eager to learn new strategies, but the opportunities are limited, which makes improvement difficult. T10*

> *"Some teachers don't really show interest in training because they feel it won't change much in their classroom situation. T4*

These quotes imply that limited access to workshops, inconsistent institutional support, and mixed teacher behaviour hinder continuous professional growth, reducing teachers' capacity to update skills and effectively implement play-based pedagogy in their classrooms.

Theme 3: Pedagogical Competence and Classroom Practice

This theme examines teachers' understanding of play-based learning principles, their ability to design and implement activities, and the challenges they face in translating training into practice.

Subtheme 3.1: Teachers' Understanding of Play-Based Learning Principles

> *I know play helps children learn, but sometimes I am not sure how to connect the play activities directly to the learning outcomes. T5*

> *We understand the importance of play, but we need more guidance on how to structure it effectively. T8*

Subtheme 3.2: Ability to Design and Implement Play-Based Activities

> *I try to design activities based on the curriculum, but without enough materials, it becomes difficult to implement them well. T4*
>
> *I enjoy planning play lessons, but managing the activities with large class sizes is a big challenge. T5*

Subtheme 3.3: Challenges in Applying Training to Real Classroom Contexts

> *What we learn from workshops doesn't always fit the realities here because our classes are overcrowded and under-resourced. T3*
>
> *Even when we understand the methods, applying them becomes hard due to the lack of space, materials, and time. T7*

These quotes suggest that gaps in teacher training, limited access to professional development, and challenging classroom conditions undermine teachers' confidence and competence, restricting their ability to implement play-based pedagogy effectively and limiting children's opportunities for meaningful, engaging learning experiences.

DISCUSSIONS

Material resources available to teachers for play-based pedagogical practices at early childhood centers in Yilo-Krobo Municipality

The findings from this study reaffirm the central role of material resources in enabling meaningful play-based pedagogical practices, consistent with established literature. Play-based learning, as emphasised by Piaget's constructivist view and Vygotsky's sociocultural theory, requires access to varied, high-quality materials through which children engage, explore, and construct knowledge (Parker & Thomsen, 2019; Main, 2021). However, teachers in Yilo-Krobo reported persistent shortages, limited variety, and deteriorating materials, which impeded their ability to provide developmentally appropriate and diverse play experiences. This aligns with studies showing that inadequate resources restrict active, child-centred learning and often force teachers to rely on repetitive or teacher-directed activities (Jay & Knaus, 2018). The uneven distribution of materials across rural and urban schools in the municipality also reflects broader regional disparities documented across Sub-Saharan Africa, where resource scarcity disproportionately affects rural centres (Adamu, 2024; Quaynor & Osei, 2021). Although teachers demonstrated creativity by improvising with bottle tops, stones, and recycled objects mirroring Trina's (2022) assertion that local materials can enrich play these efforts were insufficient to compensate for the lack of durable, curriculum-aligned resources, particularly for supporting fine motor development, pretend play, and outdoor exploration. Furthermore, challenges such as limited funding, delayed institutional support, and infrequent practical training further undermined teachers' ability to maximise the use of available materials, echoing global findings that systemic support structures significantly influence the implementation of play-based pedagogy (Marks, 2020). The inconsistencies between the curriculum's expectations and the realities of resource provision in Yilo-Krobo reflect ongoing concerns identified by NaCCA (2019) and Ghanaian empirical studies, which note that despite the curriculum's emphasis on play, most schools still struggle to access the necessary materials (Shah, 2018; Song, 2023). Overall, the study's findings contribute to the growing evidence that material resource availability is foundational to effective play-based pedagogy, and that without sufficient, high-quality, and equitably distributed resources, teachers' ability to actualise the curriculum's play-based vision remains significantly constrained.

Teachers' Experiences Regarding Their Training and Preparedness for Play-based Pedagogical Practices

The findings reveal that early-childhood teachers in Yilo-Krobo experience significant gaps in their training and preparedness for implementing play-based pedagogy, reflecting challenges widely discussed in the literature. Although Ghana's Kindergarten curriculum emphasises play as the primary medium for learning (NaCCA, 2019; James, 2020), many teachers lack specialised Early Childhood Education qualifications, while others have received largely theoretical pre-service preparation. This mirrors national studies showing inconsistent teacher competence and limited practical exposure to play-based instructional methods (Dzamesi & van Heerden, 2020). Teachers' accounts of struggling to link play activities to learning outcomes and uncertainty about structuring meaningful play reflect the broader issue of insufficient hands-on training.

Furthermore, the data show that professional development opportunities are infrequent, inconsistently supported, and often disconnected from classroom realities. This aligns with research indicating that PD in many Ghanaian districts, especially rural ones, is irregular, theory-heavy, and lacking follow-up coaching or modelling, which limits its impact on classroom practice (Eshun, 2022; McChesney & Aldridge, 2019). Teachers' complaints

about paying for workshops, limited district sponsorship, and the absence of practical guidance reinforce literature highlighting uneven PD reach across districts, despite national initiatives such as those championed by Right To Play and the Ghana Education Service (Onyango et al., 2023; Laney, 2025).

Teachers also described practical constraints large class sizes, inadequate materials, and overcrowding, that hinder the application of training. Similarly, PD becomes effective only when it incorporates contextually relevant strategies and models the use of low-cost, local materials (Wolf, 2018; Tatsi et al., 2025; Sakyi, 2022). Overall, the findings demonstrate that insufficient qualifications, limited PD, and contextual barriers collectively weaken teachers' preparedness to implement play-based pedagogy effectively.

Conclusions

The study found that early childhood centres in Yilo-Krobo Municipality are constrained by limited, unevenly distributed, and often deteriorated play materials, which restrict teachers' ability to facilitate diverse, engaging, and developmentally appropriate play-based activities. The findings highlight the critical role of adequate, high-quality, and well-maintained resources in supporting teachers to deliver meaningful learning experiences.

In addition, teachers reported experiencing inconsistent and fragmented training in play-based pedagogy, with minimal follow-up, practical demonstrations, or ongoing coaching. These gaps in professional development weaken teachers' confidence and pedagogical competence, limiting their ability to translate curriculum intentions into classroom practice and increasing dependence on informal peer support.

Recommendations

The Yilo-Krobo Municipal Education Directorate should ensure that all early childhood centres receive adequate, diverse, and safe play materials within the next 12 months. Centres should conduct quarterly inventories and maintenance checks to guarantee materials are functional, equitable, and sufficient to support play-based learning for all children.

The Municipal Education Directorate, in partnership with NGOs such as Right To Play, should implement at least two practical, context-specific workshops per year, coupled with monthly in-class coaching and mentoring. Teacher progress in designing and implementing play-based activities should be monitored through termly classroom observations and self-assessment checklists to measure improvement in pedagogical competence.

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The Fourth Industrial Revolution (4IR) and new Colonialism: An Afrikan feminist-decolonialist perspective

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Abstract

This paper examines the Fourth Industrial Revolution (4IR) positing that it is a new form digital colonialism in Afrika, placing emphasis on South Africa as a case study. The paper utilises qualitative critical discourse analysis (CDA) primarily 2010–2024 texts (academic articles, policy documents, grey writing, NGO opinions). It further uses feminist and decolonial theories to assess how centralised ownership of hardware, software, and network connectivity bolster deeply asymmetric power relations. The research asks: (1) How do current 4IR debates enable centralised digital control across Afrikan countries? (2) What open-model alternatives have been explored by academics and progressive tech experts ? The paper makes a contribution to a conceptual framework to create more digital domination in the Global South. It further debates the repercussions for digital policy & governance, and technology governance , including practical recommendations for expansive decentralised ICT strategies to govern and shift power in the Afrikan and global tech spaces . The article recommends great caution as Afrikan states trumpet this new era without adequate consideration for the existing structural deficits in the skills and labour market, and social, gendered, racial and class prejudices that already dispossess large portions of society, rendering them 'surplus people'. Furthermore, this is a continent with a demographic bulge of young people. The prospects for creating an enabling, vibrant economy for them to thrive and sustain themselves and the broader community are further compromised by 4IR, a spectre of further dislocation and digital colonisation.

Key Words: 4IR, digital colonisation, corporate colonisation, digital surveillance, the future of work

INTRODUCTION

Coined by Klaus Schwab, Founder and Executive Chairman of the World Economic Forum (WEF), the Fourth Industrial Revolution (4IR) is the amalgamation of innovations in the fields of Artificial Intelligence (AI), the 'Internet of Things' (IoT), genetic engineering, quantum computing, automation, and 3D printing among many other emerging knowledge systems. The arrival of 4IR has been termed 'the advent of "cyber-physical systems" by the Inclusive Growth Forum (2018) and an epoch of human development. It has significantly impacted human interactions and altered society's make-up and structure. This suggests entirely new capabilities for people and machines and that:

[w]hile these capabilities are reliant on the technologies and infrastructure of the Third Industrial Revolution, the [4IR] represents entirely new ways in which technology becomes embedded within societies and even our human bodies (Mhlanga & Moloi, 2020: 353 – 354).

The view of this article is that 4IR presents hyperbolic assertions rooted in Western neoliberal knowledge of 'extractivism'. This article argues that digital colonialism is a structural form of domination exercised through

the centralised ownership and control of the three core pillars of the digital ecosystem: software, hardware, and network connectivity. Control of these pillars vests the United States (US) with immense political, economic, and social power. As such, Google/Alphabet, Amazon, Facebook, Apple, and Microsoft (GAFAM) and other corporate giants, including state intelligence agencies like the National Security Agency (NSA), are the New Imperialists in the international community. Assimilation into the tech products, models, and ideologies of foreign powers led by the United States constitutes a 21st-century form of colonisation (Kwet, 2019a; Benyera, 2021). Added to US technological power, China is a strong and aggressive contender for global technological leadership. Already, they are the largest producer of microchips and are rapidly moving from disposable, flimsy goods to formidable technological alternatives like Huawei. For its part, Afrika, which already occupies a marginalised position due to globalisation, is pushed further to the fringes of the global knowledge economy.

However, the present structure of the tech ecosystem is not written, embedded, or immovable. Alternative technologies, models, and ideologies exist for constructing a digital society aligned with human rights, feminist access, race equity, social democracy, and socioeconomic justice. Decentralised ownership and control of software, hardware, and the internet are necessary prerequisites. Activists, technologists, and intellectuals in the global Free Software community have been at the forefront of this movement, and they have developed some of the alternative technologies that can be used today. The concerns of digital information empires have been raised in works like *The Googlisation of Everything (And Why We Should Worry* in which Siva Vaidhyanathan (2011) raises a valid concern about the lack of an overarching authority monitoring and ensuring the validity and trustworthiness of dominant search engines on the internet, such as Google.

Where there is already humanity and exclusion, the incursion of non-human beings and further displacement of Afrikan knowledge systems through US and China technology will only reproduce existing colonialities, including racial, gender, class and regional chauvinisms. This paper proposes a theoretical and conceptual framework for assessing digital or technological colonialism, drawing on South Africa (SA) as a case example. As Edmund Terem Uger (2023: 33) cautions:

While the transfer of technology from one locale, especially economically advanced countries, to developing countries, comes with economic benefits for both regions, it is crucial to understand that technologies are not value-neutral; they come with the values, cultures, and worldviews of their designers.

In doing so, it makes three contributions to scholarship: Firstly, it theorises digital colonialism as rooted in control over the digital ecosystem. Secondly, it provides a conceptual framework for digital domination in the Global South. Lastly, it recommends practical alternatives that societies can pursue.

Problem Statement and research approach

Digital colonialism is reinforced by the over concentration of a control and ownership by a small cohort of global actors. This encompasses the core pillars of the digital ecosystem including software, hardware, and network connectivity and further peripheralises Afrikan digital developmental trajectories maintaining reliance on these

centralised infrastructures. This risk of this skewed architecture is the entrenchment of racialised and gendered inequities in the access to and design of the digital world.

Objectives of Critical Discourse Analysis

1. To analyse how current 4IR discourses reproduce power asymmetries in the digital realms and their impact on political, social and economic outcomes across Afrikan countries.

2. To subject these discourses to decolonial and feminist critiques.

3. To develop and articulate a conceptual framework for digital domination and viable, decentralised alternatives.

Research questions

- Research Question 1: How are concentrated digital infrastructures utilised to enlarge digital reach and power in Afrikan countries?
- Research Question 2: How can feminist and decolonial approaches examine potential alternatives to digital colonialism?
- Research Question 3: Which technological and policy conduits (e.g. open-source, decentralised networks) could support more equitable digital development in Africa?
- Research Question 4: What are the alternative, decentralised digital models that can potentially entrench human dignity, inclusion, and socioeconomic redistribution?

Theoretical/framing: The analysis draws on decolonial and feminist critiques of technology and on debates about digital sovereignty and global digital democracy.

Method/Scope: A secondary-data synthesis (2010–2024) drawing on policy reports, academic literature, and activist scholarship to map power dynamics in Afrika, with South Africa as a focal context. The paper utilises qualitative critical discourse analysis (CDA) as the primary method. Unit of analysis: scholarly articles, NGO reports, policy documents, and activist writings (2010–2024) addressing 4IR and digital colonialism in

Africa, with emphasis on South Africa. Data collection used purposive sampling from databases publishers, and primarily Afrika-focused outlets and writings, yielding a corpus of over a hundred documents.

Analytical steps

1) Text familiarisation and coding schema development (inductive and deductive codes related to governance, labour, power and control).

2) Identification of discursive strategies (technocratic language, depoliticisation, normalisation, securitisation).

3) Mapping actor-structure connections (Big Tech, communities and states) across texts.

4) Cross-textual comparison with open-technology /decentralised narratives.

5) Reflexivity and audit trails: continuous documentation of analytic decisions.

Implications: The paper discusses practical avenues for decentralised technologies, autonomous, majority world led digital governance, and policy reform to disrupt digital colonisation.

This study adopts a decolonial, feminist, and anti-capitalist framework to interrogate the political economy of 4IR. These lenses are the most apposite particularly because they centre structural power, epistemic violence, and social reproduction-dimensions often ignored in techno-determinist analysis.

- Decolonial Theory (Quijano 2000; Nhemachena et al. 2018) centres the continuity between coloniality and modernity. This theory illustrates how 4IR extends historical patterns of dispossession by embedding Western epistemologies and capitalist logics into digital infrastructures.

- Feminist Critique (Tamale 1996; Randriamaro 2006) underscores how digital capitalism exacerbates gendered exclusion and reinforces male-centric hierarchies in digital access and labour markets.

- Anti-Capitalist Political Economy (Amin 1997; Shivji 2009) situates 4IR within global capitalism's latest phase, revealing how technological advancement is used to perpetuate extraction, precarity, and accumulation by dispossession.

Collectively, these frameworks enable an analysis that is both diagnostic (unpacking the structures of domination) and propositional (imagining alternative, decolonial futures of technology).

Methodology.

While 4IR promises transformative potential, its current articulation risks deepening the Afrika continent's enduring inequalities by embedding control in a few global actors. The central question is how digital colonialism operates through control of the digital ecosystem (software, hardware, connectivity) to reproduce racialised, gendered, and spatial disparities, and what decentralised, equity-oriented options exist.

Objectives

(1) Map how core pillars of the digital ecosystem are controlled and how this relates to the Afrikan region's development challenges; (2) analyse the implications for work, skills, and inclusion in the South African context; (3) outline concrete, decentralised alternatives and policy pathways to advance digital sovereignty and transformative digital justice.

Literature Review and Theoretical/Conceptual Framework What to adjust (structure, depth, clarity).

Literature Review

This review draws on secondary and grey literature - including academic journals, policy papers, activist publications, and critical essays - to map five intersecting areas: (i) 4IR debates, (ii) digital colonialism, (iii)

Afrikan philosophies of technology, (iv) feminist and anti-capitalist perspectives, and (v) critiques of techno-optimism.

(i) Fourth Industrial Revolution (4IR) Debates:

Conventional 4IR narratives, popularised by Schwab (2016) and the World Economic Forum, describe technological advancement as an inevitable and universally beneficial process. Counter-narratives from the Majority World (Mahlatsi 2020; Benyera 2021; Kwet 2019) reject this universalism, exposing how 4IR reproduces colonial hierarchies and embeds digital dependency within the Global South.

(ii) Digital Colonialism:

Kwet (2019) and Benyera (2021) describe digital colonialism as the hyper concentration of control over the digital ecosystem-software, hardware, and network infrastructure-by Western and Chinese corporations. These patterns repeat the extractive logic of colonialism, now conveyed through surveillance capitalism, algorithmic bias, and data extraction.

(iii) Afrikan Philosophy of Technology:

Afrikan scholars such as Nhemachena, Warikandwa, and Amoo (2018) contend that technologies are not value-neutral and embody the ontological assumptions of their creators. From an Afrikan philosophical standpoint, technological adoption must be evaluated against Afrikan ethics of harmony, community, and mutual responsibility (Ramose 1999; Shivji 2019).

(iv) Feminist and Anti-Capitalist Perspectives:

Feminist scholars (Tamale 1996; Randriamaro 2006) have long warned that techno-capitalism reproduces patriarchal and racial hierarchies. The feminisation of precarious labour and exclusion of women from digital ownership constitute a gendered colonisation of digital space. Anti-capitalist thinkers such as Amin (1972; 1997) and Negri (1989) locate these dynamics within a longer continuum of imperial accumulation, underscoring that the 4IR is not post-capitalist but hyper-capitalist.

(v) Critiques of Techno-Optimism:

Techno-optimistic theories-including transhumanist paradigms and neoliberal globalisation-presume that technology autonomously advances human progress. Critical theorists (Couldry & Mejias 2019; Speck 2017) refute this assumption, arguing that 4IR is an ideological project that supports capitalist concentration and techno elite control , rather than redistributive social progress.

The reviewed literature collectively supports the article's premise that digital colonialism is both a technological and ideological project.

Comparative Discussion of Alternative Theories

The paper acknowledges various frameworks such as modernisation theory, techno-optimism and neoliberal globalisation and ultimately rejects them. These theories centre Eurocentric assumptions and equate technological adoption with progress while ignoring the asymmetries of global power. Neoliberal models emphasise "market efficiency" while concurrently ignoring the social and racial costs of digital dependency. In contrast, the chosen

framework foregrounds power, justice, and epistemic sovereignty-criteria essential to analysing digital colonialism from the Global South.

Source Selection Criteria

Given the paucity of time and the scope of inquiry, this paper deliberately privileges relevance and recency over quantity. The sources were selected using the following criteria:

- Time frame: Primarily 2018–2024, drawing from the most contemporary and relevant scholarship on 4IR and digital colonialism.
- Type of source: A mix of peer-reviewed scholarship, policy reports, and grey literature (media articles and independent research) to depict diverse epistemic perspectives.
- Relevance: Precedence was given to literature that engages with Afrikan, feminist, or decolonial standpoints.
- Language: Due to accessibility and publication predominance the study utilised English-language sources.
- Diversity: The review spans academic, policy, and activist domains, acknowledging that knowledge production on technology and justice transcends the academy.

Preference for sources with explicit methodological or empirical grounding

Population and sample - Textual corpus

Approximately 120 documents (e.g., 40 policy reports, 40 peer-reviewed articles, 20 books/chapters, 20 activist/NGO pieces), drawn from SA- and Afrika-wide sources (2010–2024).

Rationale: ensures representation across policy, academic, and activist discourses; focuses on the Afrika region's 4IR narratives.

Ethics - No human subjects; archival/textual analysis only obtained or citations provided per publisher guidelines.

While it is never possible to draw from infinite sources, this curated selection represents the most relevant and recent contributions to debates on 4IR and digital colonialism, appropriate for the article's scope and purpose as a conceptual and theoretical study, not an empirical one.

Critical Discourse Analysis Critical Discourse Analysis (CDA) would read this article as a discursive map of power and inequality around 4IR in Afrika. The text repeatedly casts dominant global actors—particularly US tech giants and China—as "New Imperialists" whose centralised control of software, hardware, and connectivity legitimates a digital colonial order that marginalises Africa and South Africa. Key terms such as "digital colonialism," "extractivism," and "surplus people" function as evaluative frames that attribute agency to imperial actors while constituting the Afrika region as 'vulnerable' and in need of paternalistic protection or reform. The rhetorical framing naturalizes centralized governance as both a problem and a rationale for decentralized, open technologies, thereby shifting legitimacy toward local, rights-based alternatives. By tracing metaphors of invasion, extraction, and fringe positioning, a CDA reading shows how language normalizes unequal power relations,

justifies external intervention, and simultaneously offers a counter-narrative that foregrounds inclusion, sovereignty, and gendered justice as criteria for evaluating 4IR trajectories.

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• van der Meulen, J. (2020). Sourcing and documenting secondary data for decolonial research. Journal of Decolonial Studies, 4(2), 88-105.

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South Africa, Apartheid and Economics

More than three decades into formal democracy, South Africa is struggling to overcome its settler apartheid past. Economic inequality has increased since 1994, and the country ranks among the most unequal across indices. The problematic Gini coefficient places inequality at 0.63 per cent, where 0.1 per cent represents complete inequality, and anything between 0.3 and 0.4 percent is deemed acceptable (Roberts, 2022). Again, these are problematic World Bank indices that do not always accurately represent South Africa's reality. However, the Palma Ratio [2], created to address the shortcomings of the Gini coefficient, places South Africa at 6.89, Mexico at 2.04, and Norway at 0.9 (World Bank, 2022). South Africa has substantial socio-economic discrepancies among its citizens, so introducing robotics and non-human economic activity would complicate and exacerbate the already unequal socio-economic outcomes dynamic among the Afrikan people. Racial disparities are high concerning income, wealth, employment, and education, while residential segregation has persisted with wealth and economic opportunities continuing to be concentrated among the White minority (Nagar, 2021).

The African National Congress (ANC) has delivered some modest services to the indigenous Afrikan majority – including millions of low cost Rural Development Programme (RDP) houses, access to electricity, and social welfare grants – yet poverty remains a visceral and embedded reality. About 55 per cent of the population falls under the upper-bound poverty line (UBPL) of less than $3 per day. Figures from 2020 show that approximately 49 per cent of Afrikan people fall below the UPBL compared to 0.4 per cent of White South Africans (Nagar, 2021). This means that there is already a racialised structural deficit of access to information, opportunity and technology. Khanyi Mlaba (2021, para 3) states these concerns, saying:

> 7.5 million low-income South Africans are paying 80 times more than middle- and upper-income citizens for access to the internet, exacerbating inequality in the country. South Africa's digital

> divide can be broken down into three factors: access to hardware, understanding digital means of communication, and internet affordability.

Given the outcomes of the neoliberal development path favoured by the ANC and the leading opposition party, the Democratic Alliance (DA), some scholars are beginning to label South Africa a "neo-apartheid" rather than a "post-apartheid" society (Madlingozi, 2017; Dube, 2021; Chiodelli, 2022) in which these racialised outcomes are enabled by global capitalism, including burgeoning societal capitalism. The additional complexity of constructing a post-human society, where people are reduced to sites of data extraction, is more than a dystopian nightmare but a progressively realised state of being global. Like the earlier waves of colonisation, this extraction primarily emanates from the West (and now the East) and, yet again, is steeped in Western phenomenology, biases, interests and prejudices (Mudimbe, 1988; Benyera, 2021). Just like the previous colonial iterations, there are no prospects for redeeming Afrikan people from anything that is not peripheral to Minority World interests. Digital colonisation is rooted in profit and plunder of the non-White world by the minority world, just as in the previous colonial epochs.

Amid this, digital technology is rapidly being diffused worldwide, resulting in massive disruption in the places it has been deployed. This includes displacing intellectual property rights that would enable local digital or technological innovations to compete with Big Tech. As much as Microsoft and Apple cannibalised the information technology (IT) sector globally twenty years ago, Facebook and Twitter have captured local media to the extent of an 'existential threat'. In South Africa and Kenya, Uber has displaced local cab services to the extent of violent encounters between companies.

Michael Kwet (2019b, para 3) has noted:

> In India, Facebook was forced to cancel its "Free Basics" programme, which gave the social media giant control over the Internet experience on mobile phones. Indians protested that the service deepened Facebook's monopoly power and subjected them to censorship and surveillance.

While there are myriad online meeting platforms, including some from the Majority World, many of which are free to use, platforms such as Zoom and Teams, and have essentially become the default access points into virtual highways, particularly during and since the Coronavirus Disease 2019 (Covid-19) pandemic.

Because technological integration is imminent, many countries of the Global South are naturally hastening to construct policies for 21st-century life. Still, these are hampered by prohibitively expensive and exclusive intellectual property regimes. These are often governed by large multinational corporations (MNCs) who monitor, use, and encrypt software so that these cannot be replicated. Once more, western MNCs across technology, entertainment, publishing, and telecommunication are monopolising patents and registering products in anticipation of future innovations. A particularly egregious instance of this concerns the patenting of the Swahili phrase 'Hakuna Matata' by the Disney company after the popular movie Lion King was released. This encapsulates the many ethical and imperial underpinnings of societal and technological colonialisms.

For cultures that utilise oral storytelling to convey histories and herstories, cultural practises and mythologies, questions of ownership, physical reproduction, digitisation and archiving are mediated by communal versus individual and commercial versus community interests. South Africa is no exception, and in anticipation of a digital transformation, the ANC recently proposed a new framework for the digital era, Including the National Integrated ICT Policy (Republic of South Africa, 2016). Despite recent attention to new technologies, members of government, non-governmental organisations (NGOs), business classes, and intellectuals have provided little critique of what paths are available at the fundamental level. The exception includes platforms like the Right2Know Campaign and People's Technologies for African contexts, which provide necessary and consistent advocacy on big tech, surveillance technology, and the deep class and racial divides regarding access. Many local tech and 4IR policy champions have instead been trying to "catch up" with the Western world by attempting to

mainstream digital technology across all societal platforms while training South Africans in "digital literacy" for uncritical assimilation into US products like Apple, Uber, Zoom and Amazon (Kwet, 2019a).

Most of the literature on digital tech in South Africa has not critiqued the Big Tech MNCs (e.g. GAFAM, Uber, and Netflix) and their models for the digital society, including Big Data, AI, and machine learning; centralised cloud services; the gig economy; the rise of invasive close-circuit television (CCTV) surveillance; the prolific corporate data trafficking that routinely violates our private lives; as well as industry-specific trends, such as predictive analytics in private security, policing, education, finance, employment and elections. Cambridge Analytica mined data from 50 million Americans and 1 million British through Facebook (now Meta), which was found to have significantly influenced the 2016 US elections (Coleman, 2019). The pervasive and intrusive presence of Big Tech was resisted by tech democracy activists both virtually and physically when plans for Amazon to build headquarters in Cape Town were announced in 2021 at a time when Amazon had retrenched 15,000 employees globally. The objections ranged from disrespect for Khoisan heritage, a violation of the Paris Agreement on environmental preservation and concerns about the building of the premises on the site of one of the first anti-colonial wars in South Africa (Damon, 2022). Sadly the Amazon headquarters were opened in January 2025 despite the objections raised by Khoisan , information and environmental movements and allegations of bribery and fraud by the developer Liesbeek Leisure Property Trust (LLPT).

However, very little of the resistance to and analysis of 4IR and the technology of 'everyday things', like the influence of data mining on local consumer tastes through expansive product distribution, has been targeted through Western corporate data extraction. Earlier iterations of globalisation criminalised market protectionism for Afrikan countries and prevented them from protecting and promoting local producers and creators under arm-twisting World Trade Organisation (WTO) prescripts. This structural violence is repeated in the digital economy, where national governments are struggling to frame the legal and consumer protection mechanisms to protect their economies, industries, producers and consumers from the egregious incursions of Western corporations, deindustrialisation and deskilling (Kwet, 2019a; Benyera, 2021). Benyera (2021) also warns of the weaponisation of citizenship and even of personhood, arguing that a fast-performing robot could make besieged Afrikan identities and bodies more disposable and unwelcome in economies that crown efficiency over human compassion and dignity.

4IR is not a neutral or spontaneous industrial process. It is laden with the same colonial, racialised and exclusionary logic of previous industrial epochs. Mahlatsi (2020: 25) warns:

> Like all preceding industrial revolutions, the 4IR transcends industry, science, technology and economics. While prevailing discourse presents them as isolated, these fields are interdependent structures that evolved historically. This necessitates that we engage the 4IR as both an industrial and an ideological revolution. Fundamental to understanding the importance of grounding discourse on the 4IR in ideological analysis is an appreciation of the historical developments that have led us to this revolution.

South Africa can address this task and develop a grassroots movement against digital colonisation. During the 1970s and 1980s, anti-apartheid activists protested against International Business Machines Corporation (IBM) and other corporations supplying computers for apartheid (Feder, 1986). In the 1980s, they launched the People's Education for People's Power movement to support direct democracy in education (Axium Education, 2021). During the 2000s, activists in South Africa fought and won a battle to access generic HIV/AIDS medication. Led by the Treatment Action Campaign (TAC), they waged a successful war against Big Pharma's intellectual property rights (Molelekwa, 2022). Similar vigour and consistency are required to effectively push back against imperial technology.

Tech Hegemony: A New Form of Colonialism?

Colonial conquest typically entails the dispossession of valuable resources from the indigenous people and the ownership and control of critical infrastructure by colonial powers. In South Africa, shortly after the discovery of diamonds and gold in Kimberley in 1867 and the Witwatersrand in 1886, a handful of mining magnates — known

as the Rand Lords — seized the most valuable land. The Oppenheimer family dynasty controlled almost all the country's diamonds, half the gold and platinum, and a quarter of the coal (Sharife & Bond, 2011). With their accumulated riches, they obtained critical stakes in many other industries, including banking, steel, auto, electronics, and agriculture. This was a deeply enmeshed monopoly economy, an early colonial conglomerate (Goldschein, 2011). In many parts of the Global South, critical infrastructure such as railways was designed by colonial powers not to benefit the indigenous population but to service the 'mother country' (Kwet, 2020). The Dutch East India and Dutch West India companies were instructive in creating a symbiotic flow of resources from the imperial adventures back to Europe. These included:

> Land, bonds, and the equities of these companies are essential for their role in European imperialism and for their role in facilitating the separation of ownership from control in the joint-stock company. The rise of these two firms created a permanent and anonymous capital that could be traded on exchanges, and it connected the firms closely to imperial growth and control of overseas territories (Lavelle, 2004: 34).

In the arrangement that emerged through European colonialism, raw materials were extracted by exploited local labour and shipped back to the empire (Shivji, 2009; Michalopoulos & Papaioannou, 2021).

For the most part, colonial administrations imported cheap, machine-made industrial products to local villages, deliberately undermining local artisans and the capacity to build competitor industries. This is still the modus approach of neo-colonial capitalism. In Afrika and elsewhere, railroads were built straight to the ports and military stations from the country's interior, with no attempt at a "spread effect" connecting indigenous people throughout the continent. The architectural design of the production system was not engineered to benefit the local inhabitants but to serve European settler needs (Kerby, Moradi & Jedwab, 2017).

Similarly, under digital colonialism, exogenous powers, including the US, are imposing Amazon HQ-like infrastructure across most of the world, primarily engineered for their extractive priorities. They have, for example, prevented several Afrikan governments from using GNU/Linux FOSS instead of Microsoft as the default operating system in public institutions like schools and government departments (Kwet, 2021; Rikap & Lundvall, 2021). Kwet (2021) notes that Apple charges rent for branding its smartphones, while the minerals that are cheaply and exploitatively extracted from the Congo do not translate into any leverage for Congolese national industrial interests. This facilitates economic, commercial and socio-cultural hegemony while imposing privatised forms of governance (Ogunsola, 2005; Deedat, 2020). To maintain this domination, major corporations like BMW, Apple and Facebook design digital technology to entrench their pre-eminence over multiple critical functions in the tech ecosystem instead of outsourcing them and enabling greater distribution of reach, influence and markets (Quach et al., 2022).

This enables them to accumulate profits from revenues derived from rent (in the form of intellectual property or access to infrastructure) and surveillance (in the form of Big Data). This also entrenches their control over the flow of information (such as the distribution of news and streaming services), social activities (like social networking and cultural exchange), and a plethora of other political, social, economic, and military functions mediated by their technologies to entrench digital dominance. It has also enabled a creatively unhealthy pipeline from the producers of digital goods to distributors through streaming platforms and complex conglomerate webs like the Disney Platform (Li & Peng, 2021).

The monopoly power of MNCs is used for resource extraction through rent and surveillance – economic domination. By controlling the digital ecosystem, Big Tech corporations like Apple, Amazon, Google and Facebook (now Meta) control computer-mediated experiences, giving them direct power over political, economic and cultural domains of life, essentially granting far-reaching imperial control. The dominant pillar of surveillance capitalism, Big Data, constantly violates the sanctity of privacy and has embedded economic power in the hands of US corporations – a system of global surveillance capitalism. One of the bulwarks of surveillance capitalism is the unhealthily symbiotic relationship between intelligence agencies and their corporations for the purposes of conducting targeted mass surveillance across the Majority World. This deeply intensifies imperial state surveillance. These agencies include the National Security Agency (NSA), General Communications Headquarters (GCHQ) and the Central Intelligence Agency (CIA), among others, and the concerns about their unfettered data power are borne out by the then CIA's bosses remarks reported in the Council of Europe's hearings on public surveillance, which noted his unrepenting admission that "we kill people on the basis of metadata"

(Cole, 2014). The hearings were in the wake of Edward Snowden's 2013 whistle-blowing mass data leak, which catalysed ongoing global debates on data privacy, state surveillance and the centralisation of information by states like the US.

US corporate and political powers have convinced the broader population that society must be framed around its overbearing class conceptions of the digital world, setting the foundation for tech hegemony (Nhemachena, Hlabangana, and Matowanyika, 2020).

4IR and the New Digital Voyagers

Whilst it is a contested construct, 4IR is transforming the world of work and how workspaces and processes are imagined at an extraordinary pace. This is propelled by burgeoning advances in artificial intelligence, which have clouded the lines between the physical, digital, virtual and biological spheres and, significantly, are blurring the lines between human and non-human functions (Schwabb, 2016). The social impacts of information and communication technologies are often discussed using familiar colonial and post-colonial frames. 'Founding fathers' such as Bill Gates, Steve Jobs, and now Mark Zuckerberg have created brave new 'virtual worlds' populated by 'digital immigrants' – a few decades later, the logic of historical development has created the new 'digital natives' (Prensky, 2001; Bayne and Ross, 2011). They continue in the imperial trajectory of their pillaging forebearers Christopher Columbus, Cecil B. Rhodes and Vasco da Gama, conquering digital spaces in the way Columbus et al invaded and occupied physical spaces with no regard for occupants of that land. Indeed, information and communication technologies (ICT) consumers are blockaded from the rest of humanity by an opaque conglomerate of technical, material, financial, access and usage barriers broadly clustered as the 'digital divide' (Van Dijk and Hacker, 2003). According to Haywood (1998: 19), “with introducing all new technologies, we enter an initial period when the missionaries declare the new scriptures."

Against the backdrop of digital postcolonialism, traditional (neo)colonial policies have been influenced by military and economic power. The greasy handshakes of multinational merchants of computers, routers, software and other paraphernalia also complement them. Therefore, the fourth pillar of 4IR refers to the new mechanisms of (re)producing neo-colonial relationships directly and indirectly related to ICTs.

The extent of the 4IR fever has convinced its adherents that every industry and all components of our existence will be disrupted by artificial intelligence. It even suggests that by 2050 the world will be unrecognisable (Abdulzaher, 2019). Benyera (2021: 151) posits a cautionary perspective on disruption, saying:

> Civilisations transition from one mode to another. These transitions could be endogenously or exogenously driven. Countries in Euro-North America that were the initiators and beneficiaries of the past three industrial revolutions usually transitioned from within and occurred on their own terms (Benyero, 2020).

In contrast, when it comes to Afrikan countries, societal transitions are generally a reaction to outside forces and historically very negative phenomena such as the slave trade and colonialism.

Throughout history, there have been many definitive epochs where exponential changes have occurred. The first industrial revolution utilised water and steam to mechanise mass production between 1760 and 1840. The second industrial revolution used electric power to increase production, while the third used information and communications technology to automate production and occurred from 1870 to 1914 (Jerath, 2021). Over the 20th century, the third epoch was characterised by much more profound systemic and seismic changes than any other in history due to technological advances and unfettered Western capitalist power.

While nation-states and their multilateral institutions are central players in determining the trajectory of change, diverse multinational actors are engaged in this contestation. These include the MNCs that create and participate in international production networks that manufacture, assemble, and trade a wide range of commodities like Toyota, Amazon, McDonalds, Ford and Walmart (Gamboa, 1988). Other MNCs have singular objectives around mining and raw material extraction. These include Rio Tinto, Glencore, BHP, Fortescue Metals and Anglo-American (FitchSolutions, 2022). Rio Tinto, for example, conducts the mining, exploration, and processing of various mineral resources and is involved with every facet of mineral and metal production (FitchSolutions, 2022). Rio Tinto supplies a gamut of diamonds, aluminium, gold, uranium, copper, iron ore, and industrial minerals like borax, titanium dioxide, and salt. Significantly, Rio Tinto began piloting driverless trains in 2016 due to much

controversy and concern over employment protection. This level of reach, market domination and enormous product and process range is very much like the Vereenigde Oostindische Compagnie (VOC) of 400 years ago.

The expansion of these networks in the production of electronics and other high-technology commodities, as well as in the expansion of the number of services that can be outsourced, has not been a purely private sector-led initiative. Instead, national governments played an intermediation role in linking domestic firms with global markets, especially in the case of the relationship between East Asian conglomerates and their developmental states. Workers on these grinding global labour pipelines are cynically presented by free-market proponents as the new hope of economic growth and deliverance from bitter poverty (Meagher, 2019; Tejani & Fukuda-Parr, 2021). At various points between the end of what is characterised as the Second World War and the neo-liberal consolidation of the 1990s, East Asian economies like Taiwan, Singapore and South Korea adopted statist approaches to enable local producers and industries to penetrate global markets (Yeung, 2014). In the context of the pervasive and digital industrial complex, these states carefully selected key industries in sectors which showed the potential for rapid technological advancement and labour productivity growth.

The changes in the world of work are a reaction to the realities of technological production and advancement, articulated clearly in the work of Sanjaya Lall (2001, 2003). One, technological capabilities behind high-technology production result from learning accumulated over time. In other words, there is a first-mover advantage. Two, there are agglomeration economies in building technological capabilities.

Afrikan Women and 4IR

For many labouring women across Afrika, the modes of struggle and social organising that have historically defined their world have characteristically emanated from below and with their lived contexts and realities. Such struggles have articulated social and economic questions that also critically articulate political questions of autonomy, freedom, labour, equality and liberation. In precolonial Afrikan kinship systems, gender flexibility in the political and cultural system was often amenable to women at the highest echelons of society, whether in the status acquired through titles, marriage or social and kinship position. Power and authority often emerged out of the reproductive and productive roles that women played in society, and women's political power emerged out of those roles articulated to daily struggles for survival (Lebeuf, 1963; Amadiume, 1987; Santoru, 1996; Oyewumi, 1997; Ossome, 2018). This power was later complicated by structural relationships to settler colonial labour, globalisation, neo-liberal capital and invidious global 'value' chains. As Sylvia Tamale (1996: 5) states:

The advent of colonialism, however, pushed the African woman to the limits of subordination. Colonialism eroded most of the power and autonomy that women had previously enjoyed, relegating them to second-class citizenry. The various ways in which the domination of women was manifested — gender, economic or political — was not achieved without a fight.

Many women workers found themselves in assembly lines on factory floors, and even more were in home-based work manufacturing goods on a piece-rate basis. Other women were quickly absorbed in call centres, working anonymously in help centres, in data encoding, and in the digitisation of business processes. In reality, the employment benefits have been limited. Where such benefits exist, these are concentrated among a small share of the skilled workforce. These networks have contributed to increased skills inequality among workers that eventually becomes expressed as wage and income inequality in the labour market (Randriamaro, 2006).

As shown above, the social and political subordination of labouring women today is rooted in a more extended history of resistance to colonial domination. The gendered division of labour and control of women's labour, especially by colonial authorities, often provoked women into social and political mobilisation. Anticolonial and nationalist movements gradually became masculinised and subordinated women's agency to patriarchal, individualised, elite and state power (Adesina, 2020). Some of these movements included the tax revolts by market traders in Nigeria from the 1920s; practises like sweeping by Igbo women signifying sweeping out colonial and missionary pollution; Somali nationalist movements that centred women's protest poetry as part of struggle practise; and the Cameroonian Anlu women's uprising of 1959, which was centred on women withdrawing their domestic and agricultural labour to protest against the British administration. Women were also a part of the armed struggle in Zimbabwe, South Africa, Eritrea, and Kenya, including Mau Mau women warriors like the recently departed Field Marshall Muthuni. In all these anti-colonial battles was a contention for Afrikan

women's personhood. Similarly, digital economics are highly masculinised, and the concentration of power can fairly be described as a new colonial structure. Then they can process the data into intelligence, which can be packaged and sold to third parties for large profits, akin to monopoly rents. Tinuade A. Ojo and Kamogelo Segone (2022, para 4) note:

> 4IR has revealed considerable inequality in South Africa, especially among unskilled and low-income citizens, among whom women and girls represent the majority. Factors such as gender stereotyping, digital illiteracy, inaccessibility to data and discrimination have confirmed digital gender exclusion in the countries.

The data is also the raw material for AI, which is based on the massive accumulation of data in order to 'train' algorithms to make decisions. In the economy of the future, whoever owns the data will dominate the market. These companies are already being widely criticised by local producers, Afrikan tech innovators, educators, data activists for their monopolistic and oligopolistic behaviours, which would be consolidated under these proposals (Carrim, 2022; Benyera, 2021; Moll, 2021).

The emergence of companies based on sharing economies, such as Uber and Lyft, is affecting traditional businesses, such as the taxi industry, while Airbnb is increasingly becoming more successful than many global hotel groups. Jobs in these sectors are, thus, shifting and becoming fragmented. This is mainly because the 4IR is characterised by the development of disruptive technologies causing shifts in business and work models. Such changes in job patterns can lead to precariousness, especially for women. For instance, “there is the risk that if work becomes more fragmented with competition for each new task, much of the progress made by women in retaining access to employment through paid maternity leave may disappear” and the spectre of women being replaced by non-sentient workers is more than a dystopian nightmare (Owasanoye, 2020). The International Labour Organisation (ILO) has recently reported that AI could replace up to 4 per cent of women's jobs globally as compared to only 1 per cent of jobs held by men (ILO, 2023). Even market orthodox, 'trickle down' exponents like Goldman Sachs recently reported that up to 300 million jobs could eventually be lost to AI globally (Briggs & Kodnani, 2023). This includes administrative work where women are highly represented.

In addition, across much of Afrika, women do not own assets, such as houses and cars, which would allow them to participate in these shared economies. In South Africa, basic digital citizenship is still mediated by class, race, gender and a skewed urban-rural divide (Nagar, 2021). In 2021, The then Minister of Communications and Digital Technologies, Mondli Gungubele, indicated that by 2024, 80 per cent of the population would have internet access, an increase from 56.3 per cent as of 2023 (Republic of South Africa, 2023). This was proposed in the context of high data costs, load shedding and a historical resource divide, including water, electricity, education, health care, affordable, reliable public transport and decent housing. On the hierarchy of basic service provision, digital technology needs to address the contexts and challenges of a society. These include more accessible teaching and learning materials to enable girls in remote areas to continue their education uninterrupted when transportation is not available, mechanisms for women to get medical attention online if clinics are far, or rapid online response mechanisms for domestic violence and violence against women. Internet access and digital technologies need to partner with and speak to immediate social and economic contexts rather than exacerbating existing class fissures and further dispossessing the working poor and social precariat (Zastow, 2016; Davis, 2016; Ojo & Segone, 2022; Mahlatsi, 2020).

Does Work Have A Future?

The world of work is changing with the rapid increase in industrial internet connectivity and automation. Increased internet connectivity promises 'the here and now'; the capacity to experience entertainment, education, work, social and professional spaces without leaving the house, was made visceral during COVID-19 for the socioeconomic groups who have the financial and structural capacity to participate in the digital economy in this manner (Mahlatsi, 2020). The greater use of robots in industrial production places many jobs at risk, especially in the manufacturing sector. A report by McKinsey (2022) states that 3.3 million existing jobs could be lost in South Africa by 2030. Most of these are in the retail sector, primarily absorbing Black women. The African Development Bank (AfDB) predicts that 100 million Afrikan youth will not be able to access the labour market by 2030 due to automation (AfDB, 2019).

Even in emerging Afrikan economies, such as Angola and Ethiopia, current jobs, around 50 per cent and 44 per cent respectively, are susceptible to automation (World Economic Forum, 2017). It concludes that developing Afrikan countries will lose their cost advantage and potentially their ability to achieve rapid economic growth by shifting workers to factory jobs (Kuroya et al;2023. Despite this, the 4IR congregants keep utilising the same logic that 'Africa must catch up and upskill', even though this is another iteration of neo-liberal globalisation, constructed by Western expansionist interests, straight from the World Economic Forum, hardly a force for Black and Brown people's interests (Benyera, 2021; Mahlatsi, 2022).

Small Micro Medium Enterprises (SMMEs) can participate in e-commerce now. Still, they are less likely to reap the benefits of scale, historic subsidies, strong state-sponsored infrastructure, tax avoidance strategies, and a system of trade rules written for them and by their lawyers if e-commerce rules in the World Trade Organisation (WTO) were to be adopted. These include their ability to access industry data which Big Tech increasingly monopolises; the capacity to move information, goods and services across borders at lower tariffs than larger multinationals; sector protections at national level and anti-dumping provisions (Rennie et al., 2023). What SMMEs need are policies along the lines of a digital industrialisation strategy. Still, the policies envisioned by proponents are more likely to result in the new digital colonialism by US monopoly of digital architecture, domination of the digital ecosystem across cultural, entertainment and even political spheres of life, and the ongoing violation of data privacy laws resulting in US surveillance across the Global South (Kwet, 2019a).

US multinationals exercise imperial control at the architecture level of the digital ecosystem: software, hardware, and network connectivity, which then gives rise to related forms of domination. The monopoly of power of MNCs is used for resource extraction through rent and surveillance – economic domination (Kwet, 2020).

There is a significant growing group of workers who are also tapping into the virtual economy in an attempt to escape precarity. A proportion of these workers work in areas such as online tutoring, transcription, research, consultancy, hot forex trading, and many other online jobs. Friedman (2007) has argued that the labour market is increasingly becoming globalised due to online outsourcing and off-shoring of work, creating a 'flat world'. In this argument, there is an emphasis on the positives of technology and how it will create new opportunities, yet it obfuscates the significance of structural and institutional changes happening in labour markets. For example, emerging evidence from research in the developed world, where the phenomenon has become widespread, points to the de-standardisation of work and the emergence of non-standard work in the form of self-employed or own-account workers who do not hire other individuals, or in the form of temporary or fixed-term contracts, and part-time work (Codagnone et al., 2016; De Stefano & Aloisi, 2018). Most importantly, from a labour perspective, on online/digital labour markets, work is performed under even less standard forms than 'traditional' non-standard work, thus, raising questions of inequality, precarisation and erosion of labour rights.

Mahlatsi (2020: 28) insists that local industries have an obligation to protect existing sectors and markets:

> While we cannot halt the march of time and technological developments, it is difficult to accept that some jobs will be rendered obsolete by the advanced technologies of the 4IR. Governments need to concretise regulatory choices to protect worker's rights. Companies must be compelled, legislatively, to contribute to social protection, so that workers are not reduced to a state of vulnerability. In addition, companies must be encouraged to equip their workers with skills that can be marketable and useful in the 4IR economy.

Much of the readiness to uncritically embrace the notion of 4IR is based on a shoddy understanding of human history and a conflation of three very different things: technological innovation, scientific change, and social change. Whereas technological innovations occur all the time, not all are "high tech" or outcomes of new scientific paradigms, nor are they necessarily associated with the kind of social changes to earn the title "revolution". In the ongoing tension between social rights and human dignity on one hand and unfettered business expansion, privileges by race, capital and White supremist logic on the other, 4IR cannot be uncritically accepted as a force for positive progress when it has not been constructed on the continent.

Situating 4IR Against the First Industrial Revolution

The original Industrial Revolution of the late 18th century England – the conversion of water and human energy to steam and pedal power – did not occur because of significant scientific changes. The physical sciences of mechanics and dynamics developments at the time were still variations of Newton's classic Philosophiae Naturalis Principia Mathematica, a work of some 100 years preceding their application to steam, mechanics and the textile industry (Ó'Gráda, 2016).

The link between the First Industrial Revolution and colonialism is pronounced. The increasing application of science and technology to industry enabled the mass production of manufactured goods. But manufacturing goods at this scale needed a huge supply of raw materials and natural resources. The acquisition of these was facilitated by conquering countries rich with minerals and natural resources – a significant amount of which are located on the Afrikan , Asian and South American continents (Mahlatsi, 2020: 25). However, the social changes were far-reaching in England and later North-Western Europe – literally the change from feudalism to capitalism – which is why historians, in retrospect, dubbed the applications of the spinning jenny and the steam engine as an Industrial Revolution.

What became better known as the Second Industrial Revolution did not have the same qualitative social change as the original Industrial Revolution, but it is so-called because the technological changes were profound – in electricity, communications, railroads, and steamships – which laid the basis for global human movement on a scale never seen before. These technological innovations were associated with new scientific paradigms; new understandings of the nature of light and energy and opening the door to the revolutions in physics from Newtonian absolutism of space and time to Relativity and then the Quantum Theory (Kincheloe, Steinberg & Tippins, 1999).

Technological innovation, scientific change and qualitative social change are not necessarily a continuum. It would be well worth noting that inventions such as the spinning jenny, the steam engine and water to coal and steam as the source of energy in production occurred in the 1770s England, but no one used the term "Industrial Revolution" until almost 100 years later. It was first used in France, which had known a revolution, and then in England by economic historian Arnold Toynbee, who found connections between the technological changes applied to production and the much broader social changes which ensued, no less than the rise of towns, the enclosure of the rural commons, new gendered divisions of labour and the consequent rise of capitalism itself (Toynbee, 1956).

Nevertheless, the promoters of the 4IR also assume that its implementation could bring with it risks and threats, the principal one being the increase of inequalities and processes of exclusion, both within countries and between countries. The new industry 4.0 would be very automatised and robotised, and it can be anticipated that many jobs linked to traditional industries would be lost or become flexible up to never-before-seen levels. At the same time, as men with high qualifications would be most under demand, persons with less qualifications and/or of other genders would continue to be less competitive. In addition, they claim that only those countries that are able to transform themselves with boldness will be able to enjoy growth, which would not be available for the entire population (Datta, 2023). A fundamental concern arises around who will manage these risks and threats and how these would be apportioned to societies and their governments. It is difficult to assess how states would continue to strengthen the use of technology for social control without addressing the precarisation of our societies. Can societies that call themselves democratic adopt an innovation of this calibre without even discussing whether this is a direction they want to take (Lye, 2017)? The tale of the 4IR responds to the necessity of this global oligarchy to entrench itself, given the decline of its old industrial power (Speck, 2017).

Going further, in line with a critique of transhumanism and hyper-individualisation, would such a hypothetical "posthuman" species live as a member of an inferior and useless species, that is, those who could not or did not want to incorporate themselves into this revolution? It seems that the 4IR can only be presented as an opportunity if one hides the ecological unsustainability of economic growth, in the context of exhaustion and degradation of material and energy resources. Furthermore, it is essential to consider the social undesirability that gives rise to the processes of inequality, social expulsion and exclusion accompanying it.

Even if it would be possible from the point of view of energy and material resources, we can suspect that the 4IR would be in the service, yet again, of an oligarchic minority formed by the industrial, technological, financial,

media and political elites that are pushing for it. However, this does not negate this epoch of industrialisation. Certainly, they pointed in the direction of a general intensification of social life's orientation towards capitalism. Still, they were somewhat vague about the mechanisms, except when they relied on the idea that the structure and norms of work somehow expanded into social life (Couldry and Mejias, 2019). As Gill and Pratt (2008: 10) put it,

> From this perspective labour is deterritorialised, dispersed and decentralised so that "the whole society is placed at the disposal of profit".

Linking Digital Colonialism with Current Globalisation

The current phase of global economic expansion has imposed upon the peripheral societies (such as South Africa) the privatisation, deregulation, and denationalisation of their economies (Harris and Lauderdale, 2002). This project is being carried out to more effectively "integrate" these economies into the global economic system, for instance, to facilitate the more effective accumulation of capital and the transfer of wealth from these societies to the centres of the global economic system. Terms such as "free market" and "free trade" have attempted to obfuscate the ideological underpinnings for this new form of economic imperialism. Some research indicates that the neoliberal restructuring and integration or globalisation of non-Western economies involves the transfer of much of the income created and earned by the popular classes in these societies to the transnational corporations and, furthermore, to the financial institutions of the major centres of the global economy (Harris and Seid, 2000).

This process also involves the transfer of a portion of their income to the small upper and middle classes in these peripheral societies, who are willing or unwilling local collaborators in the current stage of global expansion (Harris & Seid, 2000). The consequences for the popular classes in the peripheral societies via this new expansion stage include declining real incomes, precarious employment and unemployment, inadequate social services, and increased poverty. Some studies provide evidence of these effects (United Nations, 2000; Hongoro et al., 2022; Erixon, 2011; Rudra & Tobin, 2017).

If Amin's analysis is correct, then the position of the South African economy in the global system, which he refers to as "globalised apartheid," does not give it much hope of becoming "competitive" in the global economy in the near future, mainly if it follows the neoliberal prescription to open up its economy to foreign "competition." He also argues that it is not a question of applying the correct "rational" economic policies and deregulating the economy so that it obeys the "objective laws of the market" as advocated by the neoliberal experts in the International Monetary Fund (IMF), the World Bank, the WTO, and the states of the Group of 7. According to Amin (2001: 7), the position of a country in the world pyramid is defined by the level of competitiveness of its products on the world market. Amin's analysis is thus that globalisation is a colonial expansionist project determined by Western imperial economic interests that peripheralise Afrikan states and workers. Foreign competition is not based on peers and equals; it is a race for extracting human, tangible and intangible resources. The 4IR is an evolving facet of this global project of White economic subjugation (Pheko, 2020). Amin's earlier work is aligned with Walter Rodney's hypothesis that Western foreign competition in Afrikan economies is an incursion that removes sovereignty, displaces government power and reduces the continent to amass cheap labour force and consumer class (Amin, 1972; Rodney, 1973).

Amin is partially answered by Mahlatsi (2020: 25):

> Like all preceding industrial revolutions, the 4IR transcends industry, science, technology and economics. While prevailing discourse presents them as isolated, these fields are interdependent structures that evolved historically. This necessitates that we engage the 4IR as both an industrial and an ideological revolution. Fundamental to understanding the importance of grounding discourse on the 4IR in ideological analysis is an appreciation of the historical developments that have led us to this revolution.

Colonising Space, Data and Digital Worlds

Firstly, the colonisation of Outer Space, as well as the colonisation of the Internet, have been constantly referred to as "the masculine adventure of earthly colonialism" (Flanagan & Jakobsson, 2023), which has

effectively provincialised the existing worlds – the first by opening the skies, and the latter by opening the cyberspace. Jeff Bezos' current space adventures, echoed by Elon Musk and Richard Branson, have been critiqued by Chanda Prescod-Weinstein (2021, para 4), the Black feminist astrophysicist, as follows:

> From my point of view, the ability to see and study the sky isn't a luxury but a fundamental part of what liberation looks like. As a species, we evolved under the night sky. Every community has studied the stars and developed cosmologies: origin stories that explain not just our universe but ourselves. In turn, the stars help us find our way here on the ground; heroes such as Harriet Tubman are believed to have used constellations to navigate their journeys to freedom. Looking at the sky and wondering is fundamentally human activity. It is part of who we are.

Secondly, digital worlds can be linked with the empire through the representation of place: Just like the Space Shuttle, the computer ('smart' phone, tablet, or any other networked gadget) represents both "an immediate presence and a conduit beyond the horizon" (Prescod-Weinstein, 2021). In a sense, the digital worlds provide one more dimension beyond the existing dimensions in standard space-time four-vectors. The champions of 4IR argue that this experience can be accessed in the privacy of our rooms and armchairs to explore the digital territories created by the Internet. However, there are class, gender and deeply racialised mediators to this, including algorithm biases and the deep racism and sexism that are embodied in the digital realm.

Data colonialism merges the exploitative extraction of past colonialism with abstract computing approaches. To comprehend Big Data from the Global South entails an appreciation of the present reliance of capitalism on this novel kind of acquisition that operates at every juncture, where individuals or objects are connected to contemporary communication infrastructures. The magnitude of this shift suggests that it is premature to anticipate the forms and scope of capitalism that will arise from it globally. Similar to how historical colonialism laid the necessary foundations for the rise of industrial capitalism, we can anticipate that data colonialism will establish the prerequisites for a future stage of capitalism beyond our imagination. In this new stage, the central aspect will be the control and exploitation of human life through data.

Currently, it is crucial to refrain from engaging in speculation regarding the future stage of capitalism. Instead, our focus should be on actively opposing the ongoing phenomenon of data colonialism. This is key to our comprehension of and engagement with Big Data from a southern perspective. A practical approach is to maintain data localisation, where data is not universally dispersed but controlled by individual countries and regulated at both local and regional levels through Regional Economic Communities (RECs). This involves decentralising central data servers in the United States and Northern Europe. Although India has the highest number of Facebook users globally, it is essential to note that none of this data is housed on Indian servers or clouds (Benyera, 2021: 159).

Technology is embedded in power relations, and whoever controls technology matters to elites and the popular classes. Discussions around tech should be holistic and address structural inequality, identity, culture, and politics. Yet most critical digital studies scholarship fails to link these concerns to the core authoritarian (often surveillance-based) technologies designed for domination. Moreover, it is not enough to focus on US and European experiences when thinking about the digital world, as most discussions do in the North. Many countries in the Global South are rapidly digitising their societies, and the ecosystem must be viewed from a global perspective. A paradigm shift is required to change focus from outcomes on the surface for Westerners (in domains like privacy and discrimination) to structural power at the technical architectural level within a global context.

Conclusion

This paper proposes a theoretical and conceptual framework for assessing digital colonialism, drawing on South Africa as a case example. This study argues that 4IR in Africa constitutes digital colonialism when framed through centralised control of core digital pillars. A decolonial-feminist lens reveals mechanisms by which power circulates and shapes labour, access, and governance. The proposed conceptual framework identifies paths toward democratic, decentralized digital futures, including open technologies, community networks, and inclusive governance.

Current conversations omit that the domination of the ecosystem by Big Tech is directly linked to architectural design, which constitutes structural inequality. US elites exercise hegemony by convincing everyone that their technologies and ways of building a digital society are the only possible ways to do so. New technologies are often viewed as something that "comes out" on the market rather than designed with particular values and power relations embedded into them. From an engineering perspective, it does not have to be this way. The present way of "doing digital technology", especially Big Data, cloud computing, and proprietary software, is rooted in authoritarianism, but it could be otherwise.

Ojo and Segone (2022) offer a practical conceptual framework that this article drew on:

- Actively implement policy to bring women and girls into the digital space, especially those in poor and marginalised communities.
- Address gendered discrimination, the exploitation of women, and gender-based violence to enable the development of a sustainable digitalised society.
- Revisit established ICT-specific regulations for relevant institutions to address gender-equal access to ICTs and the STEM economy, including financial institutions, to develop strategies that make more women comfortable to engage online.
- Include feminist stakeholders in all decisions made regarding ICT regulations.
- Ensure that gendered policies on e-governance are open, inclusive, accountable, transparent and collaborative.

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Spearheading sustainable youth entrepreneurship through financial literacy training - A case of one TVET institution in Zimbabwe

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Abstract

Financial literacy is essential for sustainable entrepreneurship of youths. The main objective of the study was to examine the effects of financial literacy on sustainable youth entrepreneurship at one TVET institution, establish socio-economic factors that influence sustainable youth entrepreneurship, to ascertain the relationship between financial literacy and sustainable youth entrepreneurship, and suggest strategies to enhance the levels of financial literacy of youths towards sustainable youth entrepreneurship. The study adopted a case study research design. The population consisted of 500 youths in the division, and a sample of 218 was used. Factor analysis was used for data analysis, and it was concluded that financial literacy had an effect on sustainable youth entrepreneurship at the TVET institution implying that as levels of financial literacy increased, so does the chances of increased sustainable youth entrepreneurship. It was also found out that economic variables do affect sustainable youth entrepreneurship, whilst some social factors also affect sustainable youth entrepreneurship. It was recommended that the institution should improve the financial literacy levels of their youths through training, short courses or seminars, and infusing financial literacy aspects in entrepreneurship skills development to ensure that their youths are equipped for sustainable youth entrepreneurship. Youths were advised to partake in financial literacy seminars which would be organized by the institution so as to broaden the need for youths to personally invest in training programs and also attend courses to improve their financial literacy.

Keywords: Financial literacy, sustainable youth entrepreneurship, financial skills, financial capability

Introduction

The lower levels of financial literacy are now a universal issue (Jaffar et al., 2024). Puelz & Puelz, (2022) established that lower levels of financial literacy exist in every society. The importance of financial literacy was

exacerbated by the global crisis of 2008 (Chaity et al., 2024). It was noted from the studies conducted that most youths lack financial literacy and also lack the requisite skills to make financial decisions expeditiously (Letamendia & Silva, 2017). High levels of financial illiteracy threatens the financial system and the economy at large, hence triggered much attention from researchers, financial institutions and governments (Song et al., 2022). The ability to manage personal finances has become a key issue in today's world (Lilian et al., 2024). Individuals ought to pursue both long-term and short-term investment decisions for sustainable youth entrepreneurship and for their children's future and education (Khawar & Sarwar, 2021). Several studies that have been conducted pointed to financial literacy as a key ingredient which contributes to good financial attitudes and timely sustainable youth entrepreneurship (Mulasi & Mathew, 2021).

Background

Financial literacy is the capability to make sound financial decisions on issues of financial management (Kadoya et al., 2020). Demertzis, (2018) views financial literacy as a gauge of the knowledge on key financial notions whilst Fanta & Mutsonziwa, (2021); and Njoka, (2021) defines it as the capacity to use economic information and develop sound financial decisions on wealth accumulation, pensions, and debt management. The researchers of financial literacy came to an agreement that a financial literate individual has the capacity to make sound financial decisions and take necessary actions in financially related issues (Hauff et al., 2020; Ketkaew et al., 2022; Mitchell & Lusardi, 2011). Financial literacy can be explained as the capacity to make sound financial decisions and proper financial management (Sajuyigbe et al., 2024). Financial knowledge ensures that individuals develop financial skills and understanding to undertake good financial decisions (Das & Mahapatra, 2023;).The knowledge of savings is useful for effective financial decisions which is pertinent to sustainable youth entrepreneurship (Mustafa et al., 2023). The concept of financial literacy has recently received much attention from researchers, financial intermediaries and government as the ability to use personal finances has increasingly become vital in today's world as individuals are advised to plan for sustainable entrepreneurship (Dare et al., 2023). Lusardi & Streeter, (2023) defines financial literacy as the usage of information, abilities, and services related to financial management and the capacity to make strategic decisions. Financial literacy increases the participation in financial markets hence enhance asset accumulation, consumption smoothing and easy access to several sources of financing (Aulia et al., 2023; Ratnawati et al., 2023). Financial literacy covers debt management and investment literacy and its impact on the use of financial services (Ghaffar & Sharif, 2016) In summary, financial literacy enables youths to use economic information in making effective financial decisions which becomes vital to youths in managing the ever-increasing complexity of financial services in the market (Roshan Singh, 2021). Financial literacy is key in this modern world where youths are accountable for good financial decisions (Sudakova, 2018). Similarly, Abyad, (2021); and Kamakia et al., 2017) reveals that it is a process where financial education learnt from formal and informal sources are used in youths' financial decision-making for the good financial results. Additionally, Dhlembeu et al., (2022) expresses that financial literacy contributes to increased savings and financial planning, realistic exhibition of financial knowledge, skills and bargaining power.

Problem statement

Youth entrepreneurship is increasingly recognized as a critical factor in fostering economic growth, especially in developing economies. Many young individuals are encouraged to venture into entrepreneurship as a means of addressing unemployment and contributing to national economic development. However, despite the potential for entrepreneurship to be a vehicle for economic empowerment, a significant number of youth-led businesses fail within the first few years of operation. One of the primary reasons for this high failure rate is poor financial decision-making and inadequate financial management skills (Kuratko, 2016). Research has shown that financial literacy plays a pivotal role in the ability of entrepreneurs to manage business operations effectively, make informed decisions, and sustain their ventures (Lusardi & Mitchell, 2014).

In many cases, young entrepreneurs lack the essential financial knowledge needed to manage their business finances, such as budgeting, cash flow management, financial forecasting, and understanding basic accounting principles. This lack of financial literacy hinders their ability to make sound financial decisions, leading to poor investment choices, inadequate capital allocation, and ultimately business failure (Dabija, 2018). Furthermore, without the capacity to manage risks or plan for long-term financial stability, many youth entrepreneurs face challenges that jeopardize the sustainability of their enterprises (Mankiw, 2015).

Given the critical role that financial literacy plays in the success of entrepreneurship, it is essential to assess how financial literacy influences the sustainability of youth entrepreneurship, particularly within the context of Technical and Vocational Education and Training (TVET) institutions. TVET institutions are in a unique position to equip young entrepreneurs with the necessary skills and knowledge to thrive in business. Therefore, this research seeks to examine the impact of financial literacy on sustainable youth entrepreneurship and identify strategies to enhance financial literacy among students at TVET institutions, ultimately fostering more resilient and successful youth businesses.

Research questions

The research questions that underpinned the study were as follows:

i. To what extent does financial literacy influence the sustainability of youth entrepreneurship at the TVET institution?

ii. Which socio-economic factors influence the sustainability of youth entrepreneurship at the TVET institution?

iii. What is the nature of the relationship between financial literacy and sustainable youth entrepreneurship at the TVET institution?

iv. What strategies can be implemented to enhance financial literacy levels among youth in order to promote sustainable entrepreneurship at the TVET institution?

Scope of the study

The study focused on financial literacy and sustainable youth entrepreneurship at the TVET institution, in Zimbabwe. The elements of the financial literacy factors such as financial education, financial capability, financial skills and investment decisions were looked at as they were deemed as the key elements of measuring the financial literacy levels of the youths together with other socio-economic factors. The study only focused on youths at the

TVET institution from January 2024 to December 2024 so as to gather relevant information for the study. The research was meant to help the top management at the institution to ensure effective sustainable youth entrepreneurship as it was influenced by financial literacy. The findings, conclusions and recommendations from the study would be useful to other institutions and the youths as well in enhancing their financial literacy levels towards effective sustainable youth entrepreneurship.

Literature review

Financial literacy

Financial literacy is the ability to use information and abilities in managing financial resources efficiently for a given period (Kamakia et al., 2017).Moreover, Ghaffar & Sharif, 2016)asserts that financial literacy covers the aptitude to use information and transform the financial behaviour and experiences of an individual. Sustainable entrepreneurship enhances youth to effectively plan and make good business decisions and effectively contribute to accelerated economic growth of economies (Ghaffar & Sharif, 2016). Financial literacy impacts the saving attitude and involvement of youth in sustainable entrepreneurship and further ads to economic growth of nations (Yahiaoui, 2023).

Financial education

Financial education is when financial consumers have an appreciation of financial services and be able to make sound financial decisions (Aulia et al., 2023). Financial education is important in youths` appreciation of financial opportunities, decisions and payoffs (Vieira, Matheis, & Rosenblum, 2023). It can change into wealth gathering and ensure appropriate managing of obligations as customers master the importance of funds and the demand and supply issues (Lusardi & Streeter, 2023).

Financial capability

Financial capability is explained as the opportunity to achieve valuable results from youths by exhibiting what an individual can do (Mathew et al., 2024). It may also refer to the process in which individuals use knowledge of financial concepts to access financial products and services (Das & Mahapatra, 2023).This perspective shows that capability entails both the individuals' internal capabilities and the exterior settings and other prospects existing for example access to products, services and institutions (Vieira, Matheis, & Maciel, 2023).

Financial Skills

Financial skills refer to the capability to utilise knowledge of financial services in financial decision making (Lone & Bhat, 2024)Financial skills enhance individuals to make good financial decisions and eliminate their chances of being misguided on financially related issues (Das & Mahapatra, 2023). An individual should exhibit knowledge to make good financial decisions in life (Mustafa et al., 2023). Hence, increasing the financial literacy skills is critically important for sound financial and investment decisions and youths should have skills to evaluate the complex financial instruments so as to make sound decisions and enhance the benefits derived from sound financial decisions and sustainable entrepreneurship (Vieira, Matheis, & Maciel, 2023).

Sustainable youth entrepreneurship

Sustainable youth entrepreneurship entails the process by which youths actively embark on effective saving behaviour, investments and management of funds predestined to help an entrepreneur run a business without jeopardizing the future generations` right to access financial resources (Mousavi & Rasaeimanesh, 2023; Sun & Curnutt, 2023). It helps to determine business proceeds and the activities and choices essential to attain business goals. It contains identification of the sources of revenue, compiling overheads, instigating a savings platform and dealing with assets and risk (Mathew et al., 2024).

Socio-economic factors that influence sustainable youth entrepreneurship

The socio-economic factors affect the ability of youths to engage in sustainable youth entrepreneurship. They interact in a complex way in shaping the business landscape in Zimbabwe, highlighting the need for targeted interventions, policy reforms, and sustainable development initiatives to enhance accelerated economic growth (RBZ, 2020; and Report on the 2021 Global Money Week Celebrations, 2021).

Inflation rates

Inflation is the general increase in prices of commodities at a given period and Zimbabwe's inflation rate soared to 676.39% in 2023, and the hyperinflation has been a recurrent issue in Zimbabwe, severely eroding the value of the local currency and diminishing purchasing power (Ncube, 2024).High levels of inflation negatively affects the sustenance of an entrepreneurial venture or start up as a hyper inflationary environment reduces the purchasing power of money which these youths would have mobilised thereby negatively affecting their businesses.

Income level

Income levels entails the diverse range of personal or household income within a population (Sorgente et al., 2024). Income levels are useful in analysing economic inequality, purchasing power, and the distribution of wealth in a society.Income level of the youths negatively affect sustaainability of start ups and entrepreneurial ventures as low income level means low level of capital and high income level means high level of capital. The World Health Organisation defined income level on the basis of GNI per capita and posits that low income is any amount equivalent to $1 045 or less, while middle income is any amount ranging from $1 046 to $12 745, and high income is any amount ranging from $12 745 or more. Income levels have a profound impact on sustainable youth entrepreneurship as it influences various aspects of economic security and stability (Basics et al., 2024). According to a 2021 report by the World Bank, over 70% of Zimbabwe's population lives below the national poverty line, with extreme income inequality persisting (Zhongming et al., 2020).

Interest rates

Interest rate is the cost of borrowing from a financial institution (Jakit et al., 2023). The higher the cost of borrowing, the less capable youths can borrow as high interest rates discourages youths from borrowing (Sudakova, 2018). High-interest rates make borrowing costly, restricting individuals and businesses from obtaining loans, and this hinders investments in education, business expansion, and asset acquisition, ultimately affecting

the well-being of citizens (The Zimbabwe National Budget, 2024). Interest rates impact returns on savings and investments. High-interest rates promote saving but may discourage spending, slowing economic growth (Mulasi & Mathew, 2021). Conversely, low-interest rates encourage investment and consumption, fostering growth and sustainable youth entrepreneurship (African Development Bank Group, 2024). Interest rates influence inflation and currency value, since high-interest rates can control inflation, maintain currency value and citizens' purchasing power. However, excessively high-interest rates can lead to deflation, negatively affecting employment, wages, and economic growth (Vosloo et al., 2024).

Family size and family expenditure

The family size also impacts sustainable youth entrepreneurship in Zimbabwe as larger families often face higher expenses, including those related to healthcare, education, and daily living, thereby constraining the financial resources available for saving and investment, and ultimately affect the overall business operations (Karakara et al., 2022). The household financial constraint is predominantly significant in Zimbabwe; due to economic hardships that amplify the influence of family size on family expenditure and sustainable youth entrepreneurship (Stability, 2024). Family expenditure patterns also impact sustainable youth entrepreneurship as most Zimbabweans spend a significant portion of their income on basic necessities like food, transportation, and utilities (RBZ, 2020).

The knowledge gap

Few studies were conducted on sustainable youth entrepreneurship at TVET institutions. This research aims to address this gap by establishing the effects of financial literacy on sustainable youth entrepreneurship at one TVET institution in Harare, and provide relevant literature for future studies. Despite growing policy attention to youth entrepreneurship, empirical research on sustainable youth entrepreneurship within Zimbabwean TVET institutions remains limited, particularly in the African context. Existing studies tend to focus broadly on youth entrepreneurship or small business development, with insufficient attention to the role of financial literacy as a determinant of sustainability among TVET graduates. Moreover, much of the available literature overlooks institution-specific dynamics, such as curriculum design, access to financial training, and contextual economic constraints faced by TVET students. In Zimbabwe, and specifically in Harare, there is a notable absence of evidence-based studies examining how financial literacy competencies influence entrepreneurial sustainability outcomes. This study addresses this knowledge gap by generating context-specific empirical evidence from a TVET institution in Harare, thereby enriching the literature and informing future research and policy interventions.

Research methodology

The study was quantitative in nature and a positivism research paradigm was employed. A case study research design was used for the study. The population for the study was made up of all the youths at one TVET institution in Harare totalling five hundred first year students enrolled in one division. The population of study statistics was obtained from the official enrolment statistics at the institution. The Principal Component Analysis, factor analysis and the cross-tabulation analysis was used for data analysis. The case study was deemed appropriate as it helped in collecting in-depth data about financial literacy levels of youths in the division through the use of

questionnaires and interviews. The sample size for the research was two hundred and eighteen (218) which was determined by using the sample size calculator as illustrated in Figure 3.1 below

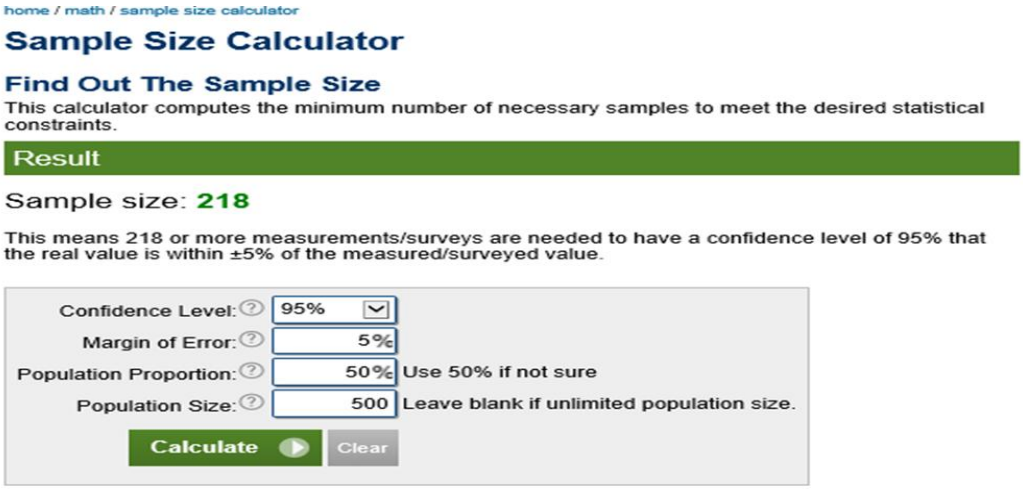


Figure 3.1: Sample size, Source: Researcher`s calculations basing on www.calculator.net

The study used primary and secondary data sources to gather information relevant in exploring the effects of financial literacy on sustainable youth entrepreneurship. The study employed interview guides and questionnaires to gather primary data from the respondents as supported by Toyon, (2021) who asserts that primary sources of information directly involve the researcher to experience and interact with the real world. The researcher made use of published research papers, textbooks, journals and other sources to collect data about the impact of financial literacy on sustainable youth entrepreneurship from other previous. The research was anchored on primary data collected by the researcher from the field. The primary data was collected using structured self-administered questionnaires and interviews guides. 218 questionnaires were administered. The researcher relied on information collected from 198 respondents giving a questionnaire response rate of 90.8%. Data collected for the study was analysed using SPSS statistical package. The Principal Component Analysis, factor analysis and the cross-tabulation analysis was used for the analysis of data as discussed below.

Data analysis, presentation and discussion of results

The questionnaire response rate and reliability score: Questionnaires were administered in gathering data from the youths. A total number of 218 questionnaires were used and only 198 questionnaires were returned by the respondents giving an overall questionnaire response rate of 90.8% as illustrated in Table 4.1 below.

Table 4.1: The Questionnaire Response Rate

	Youths	**Rate**
Questionnaires sent	218	100%
Responses returned	198	90.8%
Responses not returned	20	9.2%

Source: Author computation using Primary Data (2025)

It was established from Table 4.1 that the overall questionnaire response rate was 90.8% out of the total

questionnaires sent and this was deemed a good response rate to enable analysis of the data in support Xu et al., (2023) who indicated that a favourable response rate in research should be above 75%, so the response rate of this study was favourable since it was 90.8%. The reliability score of the questionnaire determined by the cronbach alpha coefficient was 0.80 indicating that the questionnaires were sufficiently consistent and reliable.

The effects of financial literacy on sustainable youth entrepreneurship

The communalities as shown in Table 4.2 under the extraction column had values which were more than 0.3 implying that they were all significant in explaining the relationship between financial literacy and sustainable youth entrepreneurship at the TVET institution. The study found that factors such as age, gender, income levels, marital status, and field of study influenced sustainable youth entrepreneurship. This aligns with prior research showing that demographic factors like age, gender, income levels, and education level affect financial behaviour, particularly sustainable youth entrepreneurship (Aulia et al., 2023). The study found that financial literacy has an effect on sustainable youth entrepreneurship at the TVET institution, corroborating prior research on the relationship between financial literacy, sustainable youth entrepreneurship, and investment decision-making (Kangogo Jonathan & Ayuo, 2022; Lusardi & Streeter, 2023; Mathew et al., 2024; Noralhuda et al., 2023; Xu et al., 2023).

Table 4.2: Extraction Method: Principal Component Analysis

Communalities

	Initial	Extraction
What is your respondent number?	1.000	.547
What is your field of study?	1.000	.455
What is your age?	1.000	.636
What is your gender?	1.000	.375
What is your marital status?	1.000	.677
What is your financial literacy score?	1.000	.494
What social factors affect sustainable youth entrepreneurship?	1.000	.537
What economic factors affect sustainable youth entrepreneurship?	1.000	.691
Does financial behaviour affect sustainable youth entrepreneurship?	1.000	.916
Does financial capability affect sustainable youth entrepreneurship?	1.000	.650
Does financial skills affect sustainable youth entrepreneurship?	1.000	.916
Does financial literacy affect sustainable youth entrepreneurship?	1.000	.669
Financial behaviour affect sustainable youth entrepreneurship?	1.000	.673
Financial capability affect sustainable youth entrepreneurship?	1.000	.926
Financial skills affect sustainable youth entrepreneurship?	1.000	.923
Does interest rate affect sustainable youth entrepreneurship?	1.000	.889
Does exchange rate affect sustainable youth entrepreneurship?	1.000	.879
Does inflation rate affect sustainable youth entrepreneurship?	1.000	.892
Does income level affect sustainable youth entrepreneurship?	1.000	.811
Does level of education affect sustainable youth entrepreneurship?	1.000	.564
Does age affect sustainable youth entrepreneurship?	1.000	.884
Does type of gender affect sustainable youth entrepreneurship?	1.000	.894
Does marital status affect sustainable youth entrepreneurship?	1.000	.783

Source: Primary data (2025)

The socio-economic factors that affect sustainable youth entrepreneurship at the TVET institution.

According to Table 4.3 below, factors such as age, gender and level of education where found to be very important in explaining sustainable youth entrepreneurship for the cohort of respondents at the TVET institution as illustrated where the total variance explained indicated a total Eigen value of 5.192 for the first component and this explained 22.574% of variance whilst the second component had an Eigen value of 3.730 and explained 16.217% of variance and the last component number 7 had an Eigen value of 1.125 and explained 4.890% of the variance of the effects of financial literacy on sustainable youth entrepreneurship where the dependent variable is the sustainable youth entrepreneurship.

Table 4.3: Extraction Method: Principal Component Analysis

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.192	22.574	22.574	5.192	22.574	22.574
2	3.730	16.217	38.791	3.730	16.217	38.791
3	2.270	9.871	48.663	2.270	9.871	48.663
4	1.722	7.488	56.150	1.722	7.488	56.150
5	1.426	6.199	62.349	1.426	6.199	62.349
6	1.215	5.284	67.633	1.215	5.284	67.633
7	1.125	4.890	72.523	1.125	4.890	72.523
8	.971	4.223	76.746			
9	.932	4.052	80.799			
10	.817	3.553	84.352			
11	.663	2.880	87.232			
12	.634	2.757	89.989			
13	.520	2.260	92.250			
14	.475	2.067	94.317			
15	.395	1.718	96.035			
16	.324	1.410	97.445			
17	.230	1.002	98.447			
18	.223	.968	99.415			
19	.046	.199	99.614			
20	.041	.179	99.793			
21	.040	.174	99.967			
22	.008	.033	100.000			
23	-3.182E-018	-1.383E-017	100.000			

Source: Primary data (2025)

The relationship of financial literacy to sustainable youth entrepreneurship at the TVET institution.

A component matrix should have relationships of less than 0.3 or 0.4 and such were considered as being insignificant. These associations were normally referred to as loadings; the associations could also be negative and in such cases, associations of between -0.4 or -0.3 and 0.0 were regarded as being insignificantly minor. Basing on the component matrix in table 4.4 below, all correlations which were above 0.3 were essential whilst all with a negative sign were trivially small in as far as establishing the relationship between financial literacy and sustainable youth entrepreneurship were concerned.

Table 4.4: Component matrix on the relationship between financial literacy and sustainable youth entrepreneurship

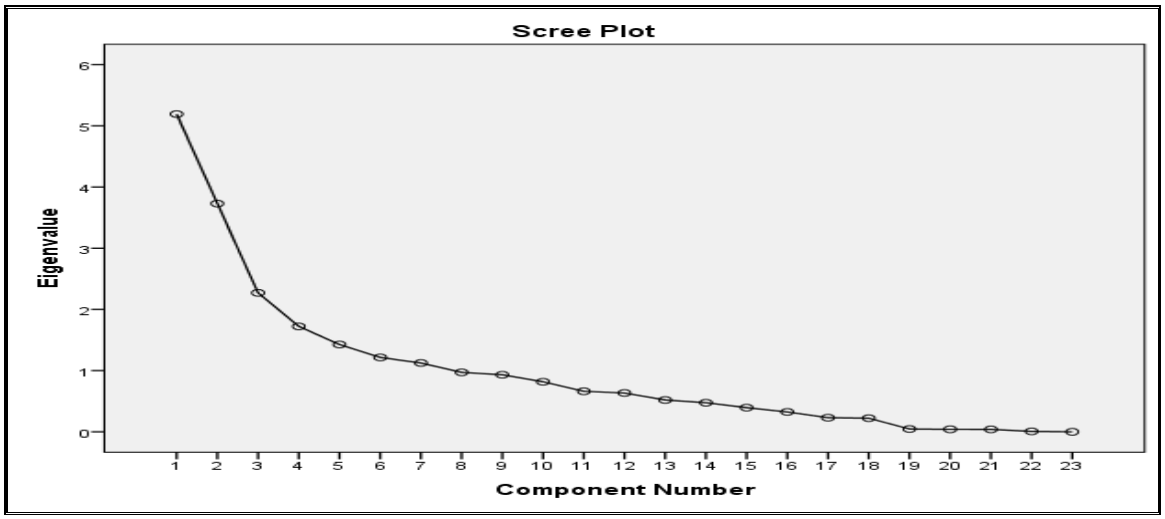
Component Matrix[a]

	Component						
	1	2	3	4	5	6	7
What is your respondent number?	-.087	-.074	-.125	.687	.080	-.178	.092
What is your field of study?	.232	-.052	.112	.193	.303	.506	.001
What is your age?	-.072	-.207	.125	-.232	.674	.223	.123
What is your gender?	-.143	.188	.362	-.056	.318	-.250	-.145
What is your marital status?	.185	.366	.007	-.045	-.376	.435	-.420
What is your financial literacy score?	-.285	.000	.094	.041	-.484	-.044	.408
What social factors affect sustainable youth entrepreneurship?	.071	-.241	-.040	-.479	.308	.385	-.004
What economic factors affect sustainable youth entrepreneurship?	.035	.406	.025	-.045	.361	-.306	.546
Does financial behaviour affect sustainable youth entrepreneurship?	-.019	-.587	.718	.079	.003	-.153	-.161
Does financial capability affect sustainable youth entrepreneurship?	-.014	-.433	.640	.059	-.134	.115	.135
Does financial skills affect sustainable youth entrepreneurship?	-.019	-.587	.718	.079	.003	-.153	-.161
Does financial literacy affect sustainable youth entrepreneurship?	-.021	-.069	.258	-.058	-.273	.423	.584
Financial behaviour affect sustainable youth entrepreneurship?	.776	-.047	.009	.254	.011	.055	.026
Financial capability affect sustainable youth entrepreneurship?	.901	-.128	-.021	.295	.053	.064	.055
Financial skills affect sustainable youth entrepreneurship?	.902	-.135	-.009	.289	.045	.062	.040
Does interest rate affect sustainable youth entrepreneurship?	.884	-.131	-.051	.283	.024	.058	.057
Does exchange rate affect sustainable youth entrepreneurship?	.811	.042	.057	-.420	-.095	-.168	.051
Does inflation rate affect sustainable youth entrepreneurship?	.809	.031	.075	-.431	-.119	-.164	.057
Does income level affect sustainable youth entrepreneurship?	.759	.030	.027	-.404	-.105	-.240	-.043
Does level of education affect sustainable youth entrepreneurship?	.282	.612	.000	.237	.195	-.060	-.109
Does age affect sustainable youth entrepreneurship?	.042	.828	.435	.057	.028	.056	-.015

Does type of gender affect sustainable youth entrepreneurship?	.038	.825	.457	.043	-.001	.034	-.017
Does marital status affect sustainable youth entrepreneurship?	-.009	.779	.409	-.001	-.029	.092	.015

Source: Primary data (2025)

Furthermore, in explaining the relationship between financial literacy and sustainable youth entrepreneurship**,** the first seven factors in the scree plot in **figure 4.1** below had variances (eigenvalues) that were greater than 1. The eigenvalues changed less markedly when more factors were used. Therefore, 8–23 factors seemed to clarify much of the variabilities of the data. The scree plot indicated that the first six variables accounted for much of the total variabilities in data. The remaining variables accounted for a very small amount of the variability and were likely to be insignificant.



Source: Primary data (2025)

Discussion of Results

The effects of financial literacy on sustainable youth entrepreneurship

The key research finding was that financial literacy had a positive impact on sustainable youth entrepreneurship at the TVET institution. This means that as the level of financial literacy among youths increased, so did the quality and extent of their sustainable youth entrepreneurship.

The socio-economic factors that affect sustainable youth entrepreneurship at the TVET institution

The study found that demographic factors such as age, gender, marital status, field of study, and level of education impacted sustainable youth entrepreneurship at the TVET institution. This aligns with prior research showing that demographic factors like age, gender, income, and education level affect financial behavior and sustainable youth entrepreneurship (Kangogo Jonathan & Ayuo, 2022; Lusardi & Streeter, 2023; Mathew et al., 2024; Noralhuda et al., 2023; Xu et al., 2023).

The relationship of financial literacy to sustainable youth entrepreneurship at the TVET institution

The key research findings established a positive relationship between financial literacy and sustainable

youth entrepreneurship at the TVET institution. This means that as financial literacy levels increased, so did the youths' engagement in sustainable youth entrepreneurship decisions. The relationship was characterized as positive, meaning that an increment in levels of financial literacy corresponded with an increment in sustainable youth entrepreneurship. Conversely, a decrease in financial literacy was associated with a decrease in sustainable youth entrepreneurship. A value of zero would have indicated no linear correlation between the variables. The survey responses also directly confirmed that a relationship exists between financial literacy and sustainable youth entrepreneurship, corroborating prior research that has found a substantive association between these factors (Mousavi & Rasaeimanesh, 2023; Sun & Curnutt, 2023).

Conclusion

Basing on the research questions of the study, it can be concluded that financial literacy plays a significant and positive role in promoting sustainable youth entrepreneurship at the TVET institution. The findings indicate that youth who possess higher levels of financial knowledge, skills, and competencies are better equipped to start, manage, and sustain entrepreneurial ventures. Financial literacy enhanced participants' ability to budget, manage cash flows, make informed investment decisions, access financial services, and mitigate business risks, all of which are critical for long-term business sustainability. Consequently, financially literate youth demonstrated greater confidence, resilience, and adaptability in their entrepreneurial activities. In addition, the study established that demographic factors such as age, gender, marital status, field of study, and level of education had a positive influence on sustainable youth entrepreneurship at the TVET institution. These factors shaped entrepreneurial attitudes, access to resources, and decision-making capacities. For instance, higher levels of education and training were associated with improved business planning and innovation skills, while age and field of study influenced experience, technical competence, and opportunity recognition. Gender and marital status also played important roles in shaping entrepreneurial motivation, responsibility, and commitment to business sustainability. Furthermore, the study confirmed a strong positive relationship between financial literacy and sustainable youth entrepreneurship, implying that as financial literacy levels increase, the likelihood of establishing and sustaining successful youth-owned enterprises also increases. This relationship highlights financial literacy as a critical enabler of sustainable entrepreneurship within TVET contexts. Overall, the findings underscore the importance of integrating comprehensive financial literacy programmes into TVET curricula and support structures to enhance sustainable youth entrepreneurship outcomes and contribute to youth employment creation and economic development.

Recommendations

The recommendations cover the strategies to enhance the levels of financial literacy of youths towards effective and sustainable youth entrepreneurship on three stakeholders namely the TVET institution management, youths, and the policy makers as follows;

The TVET institution:

The study found that the TVET institution`s youths had low levels of financial literacy. This highlights the need for the institution's authorities to improve youths' financial literacy through training, short courses, or seminars. This would help ensure youths are well-prepared for sustainable youth entrepreneurship. The study noted that ESD as a module had low financial literacy aspects hence limiting youths` financial literacy levels. The

researcher advises that the TVET institution should not just focus on theoretical competencies in financial literacy trainings, but rather engage youths in practical through college youths' start-ups and entrepreneurial ventures.

Youths:

The study recommended that youths should actively participate in financial literacy workshops organized by the TVET institution, as seminars were found to be an effective mode of educating the youths to have a better mastery of financial issues. Findings showed that financially literate youths have better chances of engaging in sustainable youth entrepreneurship than those who were financially illiterate. This highlights the need for youths to take advantage of financial literacy training to improve their financial planning and decision making. While youths expect the TVET institution to provide financial literacy education, the study also advised the TVET institution to invite successful business role models and financial institutions to address real business financial management issues that affect the operations of a business and proffer practical experience on how to ensure success despite the difficult economic environment. This would help bridge the gap in youths' financial literacy and sustainable youth entrepreneurship.

Policymakers:

The study recommended that policymakers should integrate financial literacy training into the education system at all levels from elementary up to the tertiary level, regardless of program or subject area. This would empower youths to independently plan for start-ups and entrepreneurial ventures, rather than relying solely on theory. The conclusions also highlighted the importance of financial service providers and higher education institutions to educate youths on the time value of money concepts like compounding and discounting, as they are critical for effective financial decision-making. Additionally, the gender gap observed in financial literacy levels suggested the need for women's advocacy groups to incorporate financial literacy topics into their workshops in order to improve the levels of financial literacy of the female youths.

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Instructional Leadership Styles and Curriculum Delivery: Principals' Perceptions in selective Limpopo Secondary Schools

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ABSTRACT

This article presents a qualitative case study that examined secondary school principals' perceptions of how instructional leadership styles support curriculum delivery in public secondary schools in Limpopo Province, South Africa. Guided by Role Perception Theory and Transformational Leadership Theory, the study focused on principals' understandings and applications of transactional and transformational instructional leadership. A purposive sample of seven secondary school principals participated in face-to-face, semi-structured interviews. Thematic analysis was employed to interpret the data in relation to existing scholarship on instructional leadership and curriculum implementation. The findings show that principals perceive transactional instructional leadership as a structure-driven and compliance-oriented approach that emphasises rewards, sanctions, monitoring, and the achievement of short-term performance goals. In contrast, transformational instructional leadership was described as a relational, empowering, and developmental approach that motivates teachers, fosters collaboration, and cultivates a positive teaching and learning environment. Principals reported drawing flexibly on both leadership styles to supervise instruction, monitor curriculum coverage, support teacher professional development, and manage school performance, although their practices were shaped by policy demands and contextual constraints such as resource limitations and administrative workload. The study concludes that a balanced and contextually responsive integration of transactional and transformational instructional leadership is essential for strengthening curriculum delivery and improving learner outcomes. It is recommended that targeted professional development initiatives be implemented to enhance principals' capacity to apply these leadership styles strategically and effectively within diverse school contexts.

Keywords: instructional leadership styles; transactional leadership; transformational leadership; curriculum delivery; role perception; school principalship; Limpopo Province

INTRODUCTION

The increasing complexity of curriculum changes in South African schools, particularly under ongoing policy reforms and accountability demands, has heightened the importance of instructional leadership in mediating curriculum delivery (Ralebese, Jita & Badmus, 2025). In Limpopo Province, persistent educational challenges—including uneven curriculum implementation and unequal learner performance—underscore the need to understand how school principals enact instructional leadership to support teaching and learning.

Instructional leadership as a formal construct emerged in the early 1980s (Steward, 2006). Hallinger (2003) conceptualises instructional leadership around three core dimensions: defining the school's mission, managing the instructional programme, and promoting a positive school learning climate. Dimmock (1995), however, cautions that if leadership is perceived only as prescriptive and top-down, it may marginalise teacher agency. He argues that instructional leadership is more effective when it becomes a collaborative, bottom-up process involving multiple stakeholders in shaping teaching and learning.

Steward (2006) further argues that instructional leadership in curriculum delivery is pivotal because it integrates learners, teachers, instruction and teaching strategies. It provides opportunities for stakeholders to collaboratively promote a positive learning environment, supports teachers and learners to meet curriculum standards, and ensures continuous professional development of teachers as key agents of curriculum delivery. Effective instructional leadership thus provides direction for curriculum implementation, supports teachers, and nurtures an environment conducive to improved learning outcomes (Kilag & Sasan, 2023).

Leadership style is a critical element of instructional leadership. Emma (2024) contends that instructional leadership styles shape school culture and positively influence learner performance by establishing a climate of engagement and high expectations. Transactional instructional leadership is associated with clear structures, rewards and penalties, contributing to order, accountability and short-term performance (Emma, 2025). In contrast, transformational instructional leadership focuses on vision, inspiration, collaboration and continuous improvement, fostering deeper professional commitment and organisational learning (Aniebonam, Chukwuba & Taylor, 2023; Emma, 2024).

Within the South African policy context, the *Policy on the South African Standard for Principalship* (DBE, 2015) positions principals as instructional leaders responsible for leading teaching and learning, managing the quality of teaching and learning, and developing and empowering self and others. Yet evidence suggests that many principals are not adequately prepared for these roles, particularly in contexts characterised by socio-economic disadvantage and ongoing curriculum reform (Chabalala & Naidoo, 2021; Hallinger, 2019; Ralebese et al., 2025).

Against this background, the purpose of this study is to explore how secondary school principals in Limpopo Province understand and use instructional leadership styles especially transactional and transformational styles to promote curriculum delivery. The study is guided by this research question *"What are the perceptions of secondary school principals on how instructional leadership styles promote curriculum delivery in Limpopo Province schools?*"

Problem Statement

South African school principals are expected to lead curriculum delivery amidst continual policy shifts, accountability pressures and resource constraints (Ralebese et al., 2025). Scholars such as Hallinger (2011), Shava

and Heystek (2018), and DeMathews (2024) agree that principals, as instructional leaders, are mandated to foster and direct effective teaching and learning by supervising, supporting and developing teachers and learners.

However, there is a persistent concern regarding the depth of principals' understanding of instructional leadership as a concept and practice. It remains unclear whether principals fully recognise their roles and obligations as instructional leaders and whether they possess the knowledge, skills and dispositions necessary to enact these roles effectively (Chabalala & Naidoo, 2021; Mestry, 2017). If principals are unsure about how to use instructional leadership styles to guide teaching and learning, they may be unable to motivate teachers, cultivate positive learning environments or secure desired learner performance outcomes.

Given these concerns, this study seeks to investigate principals' perceptions of instructional leadership styles—focusing on transactional and transformational styles—and how these are used to promote curriculum delivery in secondary schools in Limpopo Province.

LITERATURE REVIEW

The concept of instructional leadership gained prominence from the 1960s through to the 1980s as researchers sought to identify factors contributing to effective schools (Chabalala & Naidoo, 2021). In many developing countries, including South Africa and Lesotho, principals often assume instructional leadership roles without sufficient training or a robust knowledge base on how to interpret and enact these responsibilities (Ralebese et al., 2025).

Instructional leadership denotes the actions and processes undertaken by school principals to motivate and guide teachers, thereby enhancing curriculum implementation and learner achievement (Chabalala & Naidoo, 2021; Gading, 2024). Emma (2024) outlines four broad leadership styles relevant to educational contexts: Transfor*mational leadership,* which focuses on articulating a shared vision, inspiring stakeholders and reshaping the learning environment for quality education; *Transactional leadership*, which emphasises structures, clear expectations, rewards and penalties; *Servant leadership*, which prioritises serving others and meeting the needs of learners and staff; and *Instructional leadership*, which specifically focuses on improving teaching practices and learner performance. In this study, the emphasis is on transactional and transformational instructional leadership styles, as they most directly relate to principals' roles in curriculum delivery.

Transactional leadership is characterised by structured policies, clear expectations and contingent reward systems. Leaders using this style focus on task completion, performance monitoring and compliance with rules and regulations (Emma, 2024; Qaradaghi & Ahmed, 2024). Rewards are used to reinforce desired behaviours, while sanctions are applied when expectations are not met. Although transactional leadership can enhance order and short-term productivity, it may limit creativity and self-development if over-emphasised (Qaradaghi & Ahmed, 2024).

Transformational leadership, in contrast, is concerned with inspiring followers to exceed expectations, fostering creativity and aligning personal and organisational goals (Aniebonam et al., 2023; Korejan & Shahbazi, 2016). Transformational leaders cultivate positive, collaborative school cultures, promote professional growth and encourage innovation in teaching and learning. They aim to transform both individuals and institutions, thereby contributing to sustainable school improvement and academic excellence (Emma, 2024).

In practice, principals often draw on both transactional and transformational elements, combining structure and

accountability with inspiration and professional development (Agyeman & Aphane, 2024; Mestry, 2017). Understanding how principals perceive and balance these styles is therefore crucial to understanding curriculum delivery in context.

The Role of Instructional Leadership Styles in Curriculum Delivery

Instructional leadership plays a central role in shaping school culture and influencing learner performance (Emma, 2025; Shava & Heystek, 2021). The *Policy on the South African Standard for Principalship* (DBE, 2015) identifies eight key areas of principalship, several of which directly relate to instructional leadership: leading teaching and learning, managing the quality of teaching and learning and securing accountability, and developing and empowering self and others.

Research indicates that when principals effectively enact these roles by supervising instruction, providing feedback, supporting professional development, and promoting an orderly yet collaborative school climate—curriculum delivery is strengthened and learner outcomes improve (Chabalala & Naidoo, 2021; Gading, 2024; Kilag & Sasan, 2023; Shava & Heystek, 2021). Transactional instructional leadership contributes to curriculum delivery by ensuring policy compliance and curriculum coverage; Setting clear performance expectations and monitoring progress; Maintaining order and discipline; and Clarifying accountability among staff (Emma, 2024; Qaradaghi & Ahmed, 2024).

Whereas transformational instructional leadership enhances curriculum delivery by Inspiring teachers to work beyond minimum expectations; Creating positive and supportive learning environments; Encouraging innovation in teaching methods; Promoting collaboration and shared decision-making; and supporting continuous teacher professional development (Aniebonam et al., 2023; Emma, 2024; Ralebese et al., 2025).

In South African schools, where principals are expected to function as both managers and instructional leaders, the challenge lies in balancing these leadership styles in ways that are responsive to contextual realities such as resource limitations, socio-economic disadvantage and ongoing curriculum reform (Hallinger, 2019; Mestry, 2017).

Aim and Research Question

The aim of this study is to investigate the perceptions of secondary school principals on how instructional leadership styles specifically transactional and transformational instructional leadership promote curriculum delivery in schools in Limpopo Province.

The study is guided by the following research question “What are the perceptions of secondary school principals on how instructional leadership styles promote curriculum delivery in Limpopo Province schools?”

Theoretical Framework

This study is underpinned by Role Perception Theory (RPT) and Transformational Leadership Theory (TLT). Role Perception Theory, developed by Merton in 1957, is based on the premise that the social roles individuals occupy, and the expectations attached to those roles, shape their behaviour and interactions (Parker, 2007, cited in Ralebese & Naidoo, 2021). In school settings, the role of the principal is guided by formal policies, normative expectations and organisational culture.

RPT is relevant to this study because school principals, as instructional leaders, operate within a social and policy framework that prescribes expectations regarding curriculum delivery (DBE, 2015). As principals assume leadership positions, they adjust their behaviour to meet the mandates and expectations of the education system (Ralebese et al., 2021). Their perceptions of instructional leadership styles are therefore filtered through their understanding of their role and the demands associated with it.

Transformational Leadership Theory, initially conceptualised by Burns (1978) and later elaborated by Bass (1985) and Bass and Avolio (1997), focuses on leaders who inspire followers to transcend self-interest, embrace shared goals and pursue higher levels of performance and moral purpose (Korejan & Shahbazi, 2016; Aniebonam et al., 2023). Transformational leaders motivate staff through idealised influence, inspirational motivation, intellectual stimulation and individualised consideration.

In school contexts, transformational leaders seek to improve conditions for teaching and learning by fostering collaboration, enhancing teachers' professional capacity and promoting a shared vision of academic excellence (Shava & Heystek, 2021; Mestry, 2017). Transactional leadership, in this framework, is recognised as a complementary style focused on exchange relationships, rewards and sanctions. In this study, TLT is used to interpret how principals understand and enact transformational and transactional instructional leadership, and how these styles influence curriculum delivery.

Together, Role Perception Theory and Transformational Leadership Theory provide a lens for analysing principals' perceptions: RPT foregrounds the expectations tied to the principalship, while TLT illuminates the nature and impact of their chosen leadership styles on curriculum delivery.

METHODOLOGY

Research Design

A qualitative single case study design was employed to explore in depth the perceptions and experiences of secondary school principals regarding instructional leadership styles and curriculum delivery in Limpopo Province. The "case" comprised a bounded system of seven secondary schools within a specific provincial context, allowing for rich, contextualised insights (Given, 2008). To strengthen the case study and enhance transferability, researchers sampled school principals from the seven districts in the province with different socio-economic backgrounds, leaner enrolment, different quintiles, and leaners' performance.

Population and Sampling

The study focused on seven public secondary schools in Limpopo Province. Purposive sampling was used to select seven principles (four females and three males) who met the following criteria: currently serving as principals of secondary schools; having at least five years of teaching experience; and directly responsible for overseeing curriculum delivery at their schools.

Participants' ages ranged from 25 to 55 years, and their professional experience spanned between 5 and 25 years (Crossman, 2020). This sampling strategy facilitated an in-depth understanding of principals' perceptions and experiences regarding transactional and transformational instructional leadership styles. Two females and males are between the age 25 and 40. Their teaching experience ranges between 10-17years. While two female and two male principals age range between 45-55yrs. Their teaching experiences ranges between 20-35years.

Data Collection

Data were collected through face-to-face semi-structured interviews with the seven principals over a period of four months. Interviews were conducted at the district office at times convenient for participants. An interview guide, aligned with the research question and theoretical framework, was used to structure the conversations while allowing for probing and follow-up questions.

Interviews lasted between 30 and 40 minutes, were audio-recorded with participants' consent and later transcribed verbatim. The interviews focused on principals' understandings of transactional and transformational instructional leadership, examples of how they applied these styles in their daily work, and their perceived impact on curriculum delivery.

Researchers were able to capture the field notes during the interviews, non-verbal cues, contextual information to enhance collected data during the interviews. The data were used during thematic analysis.

Data Analysis

Thematic analysis was employed to analyse the qualitative data (Caulfield, 2019; Maguire & Delahunt, 2017). The analysis followed these steps: that is , familiarisation with the data through repeated reading of transcripts; Generation of initial codes related to leadership styles, roles, curriculum delivery and contextual factors; Collation of codes into potential themes; Review and refinement of themes in relation to the coded extracts and the entire data set; Definition and naming of final themes; and Selection of salient quotations to illustrate each theme. The analysis was iterative and interpretive, with constant comparison between participants and alignment with the theoretical framework (TLT and RPT). Dependability was enhanced by the independent coding efforts of both researchers, followed by joint discussions to reach consensus on themes. An audit trail of coding decisions and theme development was maintained.

Trustworthiness

Trustworthiness was ensured through attention to credibility, dependability, confirmability and transferability (Creswell, 2014; Jamieson, 2016): researchers ensured credibility through prolonged engagement with participants over several months, member checking of key interpretations, and triangulation through comparison of multiple participants' accounts enhanced credibility. The ensure dependability in this study, the researchers used clear interview guide, systematic thematic analysis and collaborative coding strengthened dependability. Confirmability in this study was grounded on the use of reflexive notes and the use of verbatim quotations supported confirmability by grounding interpretations in participants' voices. Lastly, researchers ensured transferability by using a thick description of the research context, participants and processes to support transferability.

Ethical Considerations

Ethical clearance for the study was obtained from the Research Ethics Committee of the University of South Africa (UNISA). The Limpopo Department of Education granted permission to access the sampled schools. Written informed consent was obtained from all participating principals. Confidentiality and anonymity were ensured using pseudonyms (e.g. SSP@1–SSP@7), and participants were informed of their right to withdraw at any stage without penalty.

FINDINGS

The analysis yielded two main themes, that is, *Principals' understanding of transactional and transformational instructional leadership styles*; and *Principals' perceptions of the role of these styles in promoting curriculum delivery.*

Principals' Understanding of Transactional and Transformational Instructional Leadership:

Principals demonstrated a clear conceptual understanding of both transactional and transformational instructional leadership styles and articulated how these differ in focus and purpose. Transactional instructional leadership was described as an exchange-based style that uses rewards and sanctions to influence behaviour and ensure task completion:

"Transactional instructional leadership style is a style that focuses on exchanging rewards and punishment to control behaviour. Transformational instructional leadership style is a style that focuses on transforming schools and classroom to improve teaching and learning." (SSP@1)

> *"Transactional instructional leadership style emphasizes exchanging rewards and penalties for certain behaviours and objectives to educators and learners to motivate success. Transformational instructional leadership style involves inspiring educators and learners and motivating them to go beyond their responsibilities to create a positive impactful environment for better performance of the school." (SSP@2)*
>
> *"Transactional instructional leadership style outlines expectation and [wants] to see immediate results as subordinates are monitored. This style is concerned about achieving some end results and if such are not met there will be negative consequences. Transformational instructional leadership style sees the purpose of organisational leadership as inspiring others to change and grow as people." (SSP@3)*

Several principals emphasised the structured and compliance-oriented character of transactional leadership:

> *"Transactional instructional leadership style is based on structured rules, routines, and clear expectations." (SSP@5)*
>
> *"Transactional instructional leadership style is characterised by a more structured approach, concentrating on achieving specific, measurable outcomes… This style is generally effective in ensuring the achievement of short-term goals and maintaining order and discipline." (SSP@6)*

By contrast, transformational instructional leadership was described as developmental, inspirational and collaborative:

> *"TfIL focuses on developing teachers and staff personally and professionally, encouraging creativity, and pushing them to exceed expectations. It is a style where the leader seeks to inspire and motivate staff through a shared vision, fostering an environment of growth, empowerment, and collaboration…" (SSP@6)*
>
> *"A transformational instructional leader seeks to instigate change by empowering staff to take ownership of their responsibilities, fostering innovation, and aligning their personal values with the school's mission." (SSP@7)*

Overall, principals recognised that transactional leadership is effective for achieving short-term objectives and maintaining order, while transformational leadership is essential for long-term school improvement and professional growth.

Perceived Role of Instructional Leadership Styles in Curriculum Delivery:

Principals indicated that both transactional and transformational instructional leadership styles play important roles in promoting curriculum delivery. Regarding transactional instructional leadership, principals highlighted its role in supervision, monitoring and accountability:

> *"For instance, the principal supervises and offer[s] professional advice to staff members. This correlates with the role of a transactional leader who monitors their subordinates. The principals prepare a plan on how academic performance at school will be improved which is in line with transactional instructional leadership style." (SSP@3)*
>
> *"Transactional instructional leadership style focuses on managing the daily operations of teaching and learning through clear rules, structures, and performance expectations. It emphasizes compliance with policies, curriculum requirements, and achieving short-term goals." (SSP@6)*

For transformational instructional leadership, principals emphasised its role in motivation, professional development and school culture:

> *"Transformational instructional leadership style assists principals to develop teachers personally and professionally, encouraging creativity, and pushing them to exceed expectations." (SSP@5)*
>
> *"Transformational instructional leadership style inspires teachers to go beyond their responsibilities thereby creating a positive and impactful environment for learners." (SSP@4)*

Principals thus perceived transactional leadership as instrumental for ensuring curriculum coverage, policy compliance and short-term performance, while transformational leadership was seen as pivotal in fostering a positive learning environment, encouraging innovation and supporting sustained improvements in curriculum delivery.

DISCUSSION

The findings corroborate existing literature which suggests that school principals draw on both transactional and transformational instructional leadership styles in their daily practices (Emma, 2024; Shava & Heystek, 2021; Ralebese et al., 2025). Principals in this study demonstrated conceptual clarity regarding the distinctions between the two styles and articulated their complementary roles in curriculum delivery.

From a Role Perception Theory perspective, principals' descriptions reflect an awareness of the expectations attached to their roles as instructional leaders—namely, to supervise teaching, ensure curriculum coverage, maintain discipline and promote learner achievement (DBE, 2015; Mestry, 2017). Their reliance on transactional leadership for monitoring and accountability aligns with policy-driven expectations emphasising measurable outcomes and compliance.

In line with Transformational Leadership Theory, principals also recognised the importance of inspiring teachers, fostering collaboration and promoting professional growth. Their descriptions of transformational leadership as empowering, vision-driven and relationship-oriented are consistent with the literature (Aniebonam et al., 2023;

Korejan & Shahbazi, 2016). These practices support positive school culture and sustained improvement in teaching and learning (Shava & Heystek, 2021; Agyeman & Aphane, 2024).

The study thus highlights a dual emphasis in principals' perceptions: Transactional instructional leadership is viewed as necessary for ensuring policy compliance and curriculum coverage; maintaining order and discipline; clarifying performance expectations; and achieving short-term goals.

The study also gave insight to transformational instructional leadership as central to motivating teachers to exceed expectations; creating positive and collaborative learning environments; supporting teacher professional development; and enhancing learner performance over the longer term.

These findings echo the argument that effective instructional leadership in complex schooling contexts requires an integrated approach that combines transactional and transformational elements (Steward, 2006; Agyeman & Aphane, 2024). However, the study also raises questions about principals' preparedness to enact these styles consistently and strategically.

While principals appear to understand the theoretical importance of both styles, the data do not fully show the extent to which their practices are shaped by contextual constraints, such as large class sizes, resource shortages, administrative workloads or insufficient leadership training.

CONCLUSION

This qualitative single case study explored the perceptions of seven secondary school principals in Limpopo Province regarding the use of instructional leadership styles to promote curriculum delivery. The findings indicate that principals possess a nuanced understanding of transactional and transformational instructional leadership and recognise their complementary roles in supporting teaching and learning.

Transactional instructional leadership was perceived as vital for maintaining order, ensuring compliance with curriculum and policy requirements, and achieving short-term performance goals. Transformational instructional leadership was viewed as essential for inspiring teachers, promoting collaboration, fostering positive school cultures and enabling continuous improvement in curriculum delivery.

Collectively, these leadership styles contribute to enhanced curriculum delivery and improved learner performance, aligning with national policy expectations for effective principalship (DBE, 2015). However, the extent to which principals are formally empowered and professionally developed to apply these styles optimally remains an open question.

The study underscores the need for deliberate and sustained professional development interventions that equip principals with practical strategies to integrate transactional and transformational instructional leadership in their daily work in ways that are responsive to their specific school contexts

RECOMMENDATIONS

Based on the findings and discussion, the study proposed the following recommendations:

Targeted Professional Development on Instructional Leadership Styles to the Department of Basic Education, in collaboration with provincial education departments and universities, should design and implement structured professional development programmes focusing on transactional and transformational instructional leadership for

principals. These programmes should include practical examples, case-based learning and mentoring components to support principals in applying theory to practice.

Embedding Instructional Leadership in Principal Preparation Programmes to function as Pre-service and in-service principal preparation programmes should explicitly integrate modules on instructional leadership styles, curriculum leadership and change management, aligned with the *South African Standard for Principalship* (DBE, 2015).

Supporting Principals' Reflective Practice should be encouraged to engage in reflective practice, using tools such as leadership self-assessment, peer coaching and professional learning communities to critically examine their leadership styles and their impact on curriculum delivery.

Balancing Accountability and Professional Growth using Policy frameworks and district-level monitoring systems should be implemented to enhance accountability demands (e.g. curriculum coverage, performance targets) with support for teacher professional development and collaborative school cultures, thereby enabling principals to enact both transactional and transformational instructional leadership.

Contextually Responsive Application of Leadership Styles by Principals should be supported to adapt instructional leadership styles to their specific contexts, considering socio-economic conditions, resource constraints and community dynamics.

Further Support for Teacher Professional Development is necessary since transformational instructional leadership emphasises teacher growth, school systems should allocate time and resources for ongoing teacher professional development, including workshops, mentoring and collaborative planning focused on curriculum delivery.

Districts should consider establishing principal mentorship networks where experienced instructional leaders support newly appointed principals in navigating the practical application of transactional and transformational leadership styles in diverse school contexts.

LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

This study has several limitations. First, it involved a small, purposive sample of seven secondary school principals from a single province, which limits the generalisability of the findings. Second, data were generated solely through interviews with principals; the perspectives of teachers, district officials and learners were not included.

Future research could address these limitations by Including multiple stakeholders and incorporating the views of teachers, heads of departments, district officials and learners to provide a more comprehensive understanding of how instructional leadership styles are perceived and enacted in schools. Expanding the sample and settings through conducting comparative studies across provinces or including both primary and secondary schools to explore variations in instructional leadership styles across phases and contexts.

Linking leadership styles to learner outcomes through employing mixed methods designs to examine the relationship between principals' use of transactional and transformational instructional leadership and learner performance data. Exploring instructional leadership and inclusivity to investigating how instructional leadership styles are used to promote inclusive education, including support for learners with barriers to learning and those from marginalised communities. Examining the impact of professional development interventions to evaluate the effectiveness of specific professional development programmes in enhancing principals' capacity to implement instructional leadership styles that improve curriculum delivery.

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