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Innovative Strategies for Integrating Technology into Agricultural Programmes at Technical and Vocational Colleges

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Abstract. The transformation of agricultural programmes warrants that Technical and Vocational Education, and Training (TVET) lecturers use innovative strategies to integrate technology into their teaching. Currently, most training programmes have shifted from the traditional methods of teaching to integrate technology; hence, the strategies for training using these technologies are required. In this study, 20 lecturers from three TVET college campuses were interviewed and their teachings were observed. The ultimate purpose of this qualitative study was to propose innovative strategies for integrating technologies into the agricultural programmes. The research participants who were regarded as being knowledgeable and experienced in agricultural programmes were selected using the purposive and convenient sampling method. Data was thematically analysed and presented using categories such as the exploration of technology integration; the experimentation with technology integration; the adoption of technology integration; and the advanced technology integration that was adopted from the Kotrlik-Redmann (2003) framework. The findings suggest that the innovative strategies, including but not limited to being proactive, improvising, being developmental, and seeking assistance strategies can be used to integrate technologies. The study reveals that the lecturers use various innovative strategies for integrating technologies into the agricultural programmes. We recommend that the TVET colleges offering agricultural programmes, the Department of Higher Education and Training, and the other key stakeholders implement innovative strategies to help in the complete integration of technology. We also suggest the need to provide TVET lecturers with continuous training in the use of innovative technology.

Keywords: Transformation; innovative strategies; agricultural programmes; TVET colleges

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1. Introduction

Technology has brought innovative ways into teaching. Innovation in agricultural programmes is the transformation of knowledge and ideas that may be used to train students such that they acquire the skills they need to either create jobs or fit into the current labour market. The use of innovative technology has brought about new teaching strategies for integrating technology and infused programmes including in agriculture (Buss, Foulger, Wetzel & Lindsey, 2018; Nelson, Voithofer & Cheng, 2019). Advanced technologies with new emerging features have been introduced into the classroom area and lecturers are trying to integrate the technologies into their institution. In the 21st century, the usage of technology such as smartphones, computers, tablets, and other mobile devices for training is common (Cannistraci, 2011). According to Ayed et al. (2022), a new era of innovative technologies enables the advanced level of teaching and learning using but not limited to robotics, Artificial Intelligence (AI), sensors, the Internet of Things (IoT), drones, and smartphones. These widespread applications are relevant to agriculture because they enable lecturers to teach the students how to track conditions and products in real-time and how to gather vital information while practicing agriculture. Therefore, lecturers have to adopt some of the modern technology as a strategy to improve and advance the modern way of teaching programmes (Siegle, 2015).

The innovative idea of using technology is shaped by personal and professional developments. By properly preparing the Technical and Vocational Education, and Training (TVET) lecturers and by evaluating their performance, a significant contribution and greater effects on implementing innovative strategies for integrating technologies into agricultural programmes are realised. The extensive provision of resources, using a motivational approach and emphasising continuous training are among the ideas that can bring innovation by integrating technology into the teaching programmes. According to Karakose, Polat and Papadakis (2021), the lecturers' technological strategies help to foster new ideas and practices for integrating teaching and learning technologies. Several studies have noted the innovative strategies that are used for integrating technology into the teaching programmes. Alghamdi and Holland (2020) conducted a study in the Kingdom of Saudi Arabia and in the Republic of Ireland about the comparative analysis of strategies and programmes for information and communication technology integration in education, while Naiker and Makgato (2018) explored the integration of Information and Communication Technology (ICT) in the TVET college classrooms. World Health Organisation (2022) conducted a study in the Eastern Mediterranean about the strategic action framework to improve access to assistive technology. These studies found that the use of innovative technology provides opportunities to enhance teaching and learning. Furthermore, lecturer's self-esteem improves if the technologies are used effectively.

Although this topic has been studied in other countries, there have been a few studies that were undertaken in South Africa on the strategies but not on the innovative strategies for integrating technologies into the agricultural programmes at the TVET college. For instance, Jaffer, Ng'ambi and Czerniewicz (2007) conducted a study on the role of ICTs in higher education in South Africa

about a strategy for addressing teaching and learning challenges. While Simelane, Blignaut and Van Ryneveld (2007) conducted a study on preparing lecturers to integrate educational technology into their teaching and learning practices. Venketsamy and Zijing (2022) explored the challenges experienced by the foundation phase teachers in using technology for teaching and learning. Hence, all these studies focused on strategies far beyond the scope of the innovative strategies for integrating technologies. In light of this, the aim of this study was to investigate the innovative strategies for integrating technology to understand the technological ways that are being used by the TVET lecturers when training in the agricultural programmes. To achieve the above, the study also attempted to answer the following research questions:

- a) What strategies does colleges have in place to integrate innovative technologies into their agricultural programmes?
- b) What are the current technologies that are being integrated into the agriculture classroom teaching?
- c) How can integrating technology be adopted while maintaining the agriculture learning objectives?
- d) What are the innovative ideas that can be utilised for using technology to enhance agriculture teaching and learning programmes?

2. Theoretical framework

In this study, the theory of technology integration, proposed by Kotrlik-Redmann (2003), was used. The theory was used to understand the innovative strategies for integrating technologies into the agricultural programmes. The theory is relevant because it promotes the general understanding that technology integration is necessary for the agriculture teachers to deliver the most effective educational programs possible (Kotrlik-Redmann, 2003). Furthermore, the theory intends to highlight the distinct and independent phases that were deemed appropriate for discussing technology integration in the agricultural programmes and responding to modern agriculture training. As a result, four distinct and independent phases of technology integration were used as the key variables that influenced a phenomenon of interest in this study. The phases are: the exploration of technology integration; the experimentation with technology integration; the adoption of technology integration; and advanced technology integration. In this study, the exploration of technology integration was used as a strategy to evaluate the lecturer's capacity to integrate technologies. The experimentation with technology integration phase was used to evaluate the lecturers' use of the various technological tools to teach agricultural programmes. The adoption phase of technology integration was used to evaluate how the lecturers use recent technologies in agricultural programmes. The last phase of advanced technology integration was used to evaluate the available and accessible modern technologies that were integrated into their teaching of agricultural programmes. The role of these four distinct and independent phases of technology integration that were utilised was to guide qualitative analyses by suggesting the innovative strategies for integrating technologies into the agricultural programmes.

2.1 Exploration of technology integration

The exploration of technology integration plays a vital role in the modern training of agricultural programmes. Exploring technology provides lecturers with the

opportunities and abilities to integrate technologies and to improve the entire training (Hu, Chiu, Leung & Yelland, 2021). Although having appropriate technological tools presents lecturers with the opportunity to explore and use some of the technology's features to teach programmes, they could use innovative strategies to explore technologies. According to Li, Wang and Lei (2020), exploring technology helps with complex strategies and ideas thereby making teaching more effective and relevant. Furthermore, exploring the technological learning content motivates the development of new techniques for teaching content (Nascimento et al., 2019). Hence, we trust that the use of technology strategies could help lecturers to explore technology in preparation for their teaching content.

Lectures in agriculture need to use innovative strategies that will assist them in integrating technology into the programmes. These strategies include, but are not limited to, being proactive, improvising, being developmental, and seeking assistance. In this way, the lecturers are able to disseminate the knowledge and skills while being involved in technology integration. A proactive strategy is an innovative way to explore technology and it is an important antecedent for searching and teaching content in a technological manner (Bhatia, 2021). Furthermore, the proactive strategies should foster innovation and institutional capabilities to support the lecturers with available technical resources and equipment to integrate technologies (Yang, Jiang & Zhao, 2019). This means that this strategy relies on the available resources, which helps to plan content before teaching. This creates a flow of improvised actions and strategies that revolve around using the available technical resources to teach and learn content (Zimmer, 2019). Hence, continuous training is a key developmental strategy to improve innovative strategies for integrating technologies into agricultural programmes (Sailer, Hense, Mandl & Klevers, 2017). Innovation has brought about the changes that need support, such as seeking assistance in the form of getting technical tools to assist the lecturers in improving their integration of technology from the relevant personnel (Zhou & Wei, 2018; Newman, 2023). Hence, this study sought to identify the strategies that the lecturers have in place to integrate innovative technologies into the agricultural programmes. The use of proactive, improvised, developmental, and seeking assistance strategies is part of the possible strategies for integrating technology into the agricultural programmes.

2.2 Experimentation with technology integration

Experimenting with teaching and learning content technologically is another strategy that is used by the agriculture lecturers. According to Stach et al. (2021), technological experimentation has recently become a recognised strategy and solution to teaching and learning with the use of technology. As a result, the availability of technological resources and equipment to facilitate technological experimentation during the teaching and learning process, plays a vital role for the agriculture lecturers. While a lack of technological resources and equipment hampers the effectiveness of teaching and learning, which has exacerbated the inequalities in education (Assunção & Gago, 2020). Modern teaching and learning promote experimentation with technology integration. On the other hand, a lack

of technology integration has an impact on the lecturer's technology use and the transformation in education (Nelson, Voithofer & Cheng, 2019). The experimentation with technology using the available resources and equipment promotes technology integration, which is a strategy to engage in the modern ways of teaching programmes.

The experimentation of agriculture with technology will assist lecturers in producing graduates who can produce results beyond the difficult situations. However, the lack of technological resources and equipment, as well as the lack of technology integration, and the ways of integrating technology distract the lecturers from utilising innovative strategies for integrating technologies into the agricultural programmes. The lack of technological resources and equipment hampers the chance for the lecturers to integrate technology when training agriculture. In a study conducted by Chick et al. (2020), several innovative strategies and solutions were recommended to integrate technology into teaching programmes, including online lectures using social media teaching tools. Furthermore, the communication platform technologies, including Zoom, WebEx, Facebook Messenger, Google Hangouts and Microsoft Teams were used as teaching platforms for the teaching programmes (Vargo, Zhu, Benwell & Yan, 2021). The communication platform technologies are beneficial for the quick responses between the lecturers and the students, and they also create an expectation of efficiency (Natale & Lubniewski, 2018). On the other hand, the online platforms are also beneficial for their flexibility, as they allow teaching in any style and at any time (Al Rawashdeh, Mohammed, Al Arab, Alara & Al-Rawashdeh, 2021). The communication platforms are innovative strategies if the technological resources and equipment are available. Hence, this study sought to identify the current technologies that the lecturers are integrating into their agriculture classrooms. Additional technologies are still required to strengthen integration not only in agriculture but in all the programmes at large to implement the integration of technologies.

2.3 Adoption of technology integration

Adopting technology is an important strategy that is used by the lecturers to choose the latest technology that is suitable for teaching programmes including agriculture. Adopting technology allows lecturers to incorporate suitable technological resources to enhance effective and synchronous e-learning (Mpungose, 2021). This adoption of technology strategies help create positive attitudes towards technology, and it also assists in the access to technological resources while promoting the adoption of technology for teaching programmes (Mashile, 2017). Lecturers need to adopt technology integration strategies to training the agricultural programmes. These strategies include aligning the syllabus with technology, incorporating technological resources, understanding the learning content and training using technology. Aligning the syllabus with technology is still a challenge to most of the lecturers teaching the TVET programmes. Some learning programmes are not aligned with technology integration, and they do not fulfil the goals of modern learning and teaching (Cetiner, 2021). Regardless of whether the courses are aligned or not with technology integration, lecturers should be appropriately prepared and developed to use technology as that will assist in technically displaying the

educational content. Hence, this paper aimed to come up with findings that would help the innovative strategies to align the content during the integration of technology.

The adoption of technology while retaining learning objectives should be constantly considered to understand how learning content should be taught when integrating technology. According to Marks and Thomas (2022), adopting new technology helps to improve content understanding and to increase participation in today's teaching and learning processes. This is a fundamental example of transformation that should be taught to every student to improve their lives. To be aligned with transformation, new technology adoption should strongly advocate for quality, which is more involved in the innovation strategies (Ancarani, Di Mauro & Mascali, 2019). This extends beyond training using technology because using adopted technology activates the learning process, as it motivates the students to learn privately, and it increases their interest in the subject matter throughout the training process (Elmurzaevich-TSPU & Rustamovich, 2019). Using the currently adopted technological resources helps to align the syllabus and to understand the learning content, which are the strategies that help the lecturers connect well with the students. Hence, this study sought to investigate how integrating technology can be adopted while maintaining the agriculture learning objectives.

2.4 Advanced technology integration

The usage of advanced technology is another important strategy that is used by lecturers to teach using new technologies. According to Harris (2010), the advanced technologies are the electronic devices that are used to assist with accessing and performing the teaching and learning of subject content that aims to improve the quality of life. On a similar note, advanced technologies are easier, faster, more effective at solving complex problems, and efficient at improving and increasing teaching and learning (Agbo, 2015). Advanced technology helps to modernise the teaching, where the latest technologies are gradually introduced to improve the programmes. However, the use of appropriate innovative strategies for advanced technology integration depends entirely on several strategies to improve the teaching and learning programmes. In this study, the provision of resources, the motivational approaches and the emphasis of continuous training are thought to improve agricultural teaching and learning programmes.

To implement the integration of technology in agricultural programmes, lecturers need strategies that include but are not limited to the provision of resources, using a motivational approach to improve the integration of technology, and emphasising continuous training. The provision of technological resources is a strategy to maintain the degree of excellence in teaching and to produce quality and competent graduates (Onyesom & Umoeshiet, 2013). Once the lecturers are provided with the technological resources, they need to be continuously trained to use them. Continuous training to create and deliver teaching materials for an online platform is a significant challenge that the lecturers need to overcome for them to perform well when utilising advanced technologies (Qurotul, Mukti, Putra & Untung, 2020). Furthermore, the availability of advanced technological resources helps to increase the production costs across some sectors (Litvinenko,

2020). This view is important as a motivational approach for anyone who is willing to study agriculture. Which means that the provision of resources can help lecturers to succeed in imparting quality programmes (Howard, Bureau, Guay, Chong & Ryan, 2021). More achievements depend on the flexible teaching and learning of advanced technology. This is important because using flexible teaching and learning methods helps with the adoption of technology. Furthermore, the use of advanced technologies for flexible delivery is considered as an important component of an open learning approach in all the programmes including in agriculture. On this basis, there is also a need to come up with some innovative strategies for integrating technologies into agricultural programmes. Therefore, this study sought to investigate the innovative strategies for improving the training of agricultural programmes.

3. Methodology

This section discusses the research design, the research participants, the data collection instruments, and the data analysis.

3.1 Research design

A qualitative research design was employed with the quantitative components obtained from the lecturer's statistical data to understand the responses from the research questions. This enabled the researcher to compile the frequencies about the innovative strategies for integrating technologies. There are existing similar studies that were carried out by Molefe, Stears and Hobden (2016) as well as by Mtshali (2020). This case study design was guided by the Kotrlik-Redmann (2003) theory of technology integration. A case study herein is defined as research that explores in-depth information and reports case themes and descriptions of innovative strategies for integrating technologies into agricultural programmes (Creswell & Poth, 2016).

3.2 Research participants

The research participants were sampled using the purposive and convenient sampling methods from the non-probability sampling types. The population of this research comprised of all of the 51 South African TVET colleges around the nine provinces. However, only 13 TVET colleges offer agricultural programmes in six provinces, namely, three in the Eastern Cape, two in Limpopo, five in KwaZulu Natal, one in the Western Cape, one in the Northwest and one in the Gauteng Province. However, the Limpopo Province contained the target population of this study because it had the individuals or groups from whom the data was collected (Wiid & Diggines, 2013). Therefore, it was regarded as the target population because three TVET college campuses and the lecturers offering agricultural programmes were reachable to conduct the study (Hair, Anderson, Tatham & Black, 2008). Furthermore, the participants in the TVET colleges around the Limpopo Province possess the information this study was looking for (Green & Thorogood, 2018). The sampling statistics is presented in Table 1 below.

Table 1. The participants from the three TVET college campuses

TVET COLLEGES (N=3)	COURSES OFFERED	NC(V)/NATED LEVELS	LECTURERS (N=20)
College Campus A	Primary Agriculture	NC(V)-Level 2-4	8
	Farm Management	NATED-Level 4-6	2
College Campus B	Farm Management	NATED-Level 4-6	3
College Campus C	Primary Agriculture	NC(V)-Level 2-4	7
Total (N=3)			N=20

The participants from whom data were collected from the three TVET college campuses included 20 Agriculture lecturers who were interviewed. Of the three TVET college campuses, two lecturers from each campus were observed while teaching the agricultural programmes. The observation was carried out while the lecturers were teaching the National Certificate Vocational NC(V) program or the National Accredited Technical Education Diploma (NATED). The main purposes were to observe the lecturers using the innovative strategies for integrating technologies into the agricultural programmes. Furthermore, the class observations were used to complement the semi-structured interviews and to look for the themes and the patterns that could be used to strengthen the findings that were obtained from the semi-structured interviews. The study's framework, was used to group the themes and patterns.

3.3 Data collection instruments

This study employed the semi-structured interview and observation method to collect the data from the TVET college campuses offering the agricultural programmes. The main research tool in this qualitative study was the semi-structured interview approach, which involved asking questions within a predetermined topic framework with the aim of collecting in-depth information from the participants (Ruslin, Mashuri, Rasak & Syam, 2022). The semi-structured interview method allows participants to stay focused on the subject at hand, thereby avoiding distractions and facilitating a two-way conversation. Following an interview with a participant, the classroom observations were conducted to further understand and allow the researcher to directly see what the lecturers do rather than relying on what they said in the interview. The classroom observation items were also adapted from the four pillars of the researcher's framework. The trustworthiness of the instruments used in this qualitative study was such that the findings could not be generalised. However, if this study could be transferred to a particular setting and probed with similar content and research questions, the findings could be achieved because the TVET lecturers could be using similar innovative strategies for integrating the technologies into the agricultural programmes in the other parts of the country.

3.4 Data analysis

The lecturer's interview and observation data were thematically analysed to identify themes that helped to address the research questions. For the agriculture TVET lecturers, the data collection and analysis processes was performed

concurrently. The semi-structured interview data was thematically analysed. The observation data was also thematically analysed, and its data was employed to complement the interview data. The main goal of analysing the interview data was to find the common patterns, which were analysed to gain an understanding of the innovative strategies that were used to integrate technologies into agricultural programmes. Classroom observation was used to see the innovative strategies in action and in a natural context to understand the event, the activity, or the situation. To present the study's findings, the researcher became more engaged in the transcribed data by searching for the patterns that were relevant to the study. The inductive approach helped the researcher find the emerging themes from the participants' statements (Braun & Clarke, 2006, 2013). The inductive essence of the qualitative data analysis implies that the researcher begins the analysis with detailed, tangible raw data before progressing to the next level. According to Ritchie and Spencer (1994), there are various strategies for qualitative data analysis, and most researchers use a combination of strategies, as well as framework analysis, or they incorporate some important steps of framework analysis. However, the various qualitative researchers may use a range of strategies in their quest to understand the world. However, the processes of data organisation, transcription, coding, interpretation and reduction, presentation, as well as drawing helped the researcher verify the conclusion of the study (Braun & Clarke, 2006). In this qualitative study, the data analysis followed the phases that are briefly discussed in the next paragraphs.

3.4.1 Become familiar with the data

The starting point began with the researcher becoming familiar with the qualitative data as part of an essential phase for data analysis, where the researcher would read and re-read the transcripts (Braun & Clarke, 2006). This helped the researcher to become familiar with the entire transcription before going any further. Along with reading the transcription, it was helpful to take notes and to write down initial impressions from the responses to get a sense of the respondents.

3.4.2 Generate initial codes

In the second phase, the researcher organised the data into a meaningful and systematic process. This phase was crucial because it is where the coding breaks down the large amounts of data into small chunks of meaning (Braun & Clarke, 2006). This happened when the researcher labelled the concepts, thereby defining and developing the categories based on their properties and dimensions. However, there are various methods of coding, and the method was determined by the participants' viewpoints. The correct coding techniques are vital for the researcher to interpret the research results (Linneberg & Korsgaard, 2019). In this study, open coding occurred when the researcher interacted with qualitative data with the intention of comparing similar events in the data on a continuous basis. This occurs when the researcher makes notes in the margins of the observation or the interview schedules about the implications of the observations or the comments of the participants on the transcripts (Springer, 2009). As the researcher progressed, new codes were generated, and the existing ones were modified.

3.4.3 Search for themes

In the third phase, the researcher organised the themes that appeared to say something specific about the innovative strategies for integrating technology. The theme's pattern plays a vital role in capturing the required information in this study (Braun & Clarke, 2006). During the coding process, the themes that were significant to the study and that were connected to the research topic emerged.

3.4.4 Review themes

The concepts that were organised in the previous phase were reviewed, updated, and developed throughout this phase. This was important since it enabled the researcher to compile all the information that was relevant to each theme (Braun & Clarke, 2006). The relevance, coherence, and the dissociation of the themes from one another were all examined by the researcher. The goal of this phase was to determine whether the created themes could capture the important aspects of the data.

3.4.5 Define themes

According to Braun and Clarke (2006), the final refinement of the themes and the essence of the themes can be identified with what each theme is about. This phase warrants that the researcher must name and define each of the themes to understand what the organised themes are saying. The researcher evaluated how the themes interact with one another or how they relate to one another or to the main theme at this phase.

3.4.6 Writing-up

This is the final write-up analysis of the data, and the researcher tells the data's story. According to Braun and Clarke (2006), the write up addresses the well-thought-out themes and the researcher can now communicate the validity or the analysis to the readers. The write up of the data analysis process starts with a literature review, then it proceeds with the data collection process on the three TVET college campuses.

4. Results and discussion

In this paper, the findings are presented in accordance with Kotrlik-Redmann's (2003) framework. The study's findings indicate that the innovative strategies for integrating technologies can include four distinct and independent phases, as indicated earlier. The complementary findings from the observation confirmed that the agriculture lecturers tried to improvise and proactively integrate technologies, such as using communication platforms including Microsoft Teams, Google Forms, and WhatsApp to populate the learning materials. Table 2 below shows the questions that were responded to in the four distinct and independent phases as well as the themes that emerged for the discussion of the results.

Table 2. Statistical data on the strategies for integrating technologies into the agricultural programmes

Research questions and themes	Percentages
Category 1: Exploration of technology integration	
Research question 1: What strategies does the college have in place to integrate innovative technologies into the Agricultural programmes?	
Theme 1: Proactive strategy	6 (30%)
Theme 2: Improvising strategy	6 (30%)
Theme 3: Developmental strategy	6 (30%)
Theme 4: Seeking assistance	2 (10%)
Total:	20 (100%)
Category 2: Experimentation with technology integration	
Research question 2: What current technologies are being integrated into agriculture classroom teaching?	
Theme 5: Lack of technological resources and equipment	6 (30%)
Theme 6: Lack of technology integration	6 (30%)
Theme 7: Ways of integrating technology	6 (30%)
Theme 8: Communication platform technologies	2 (10%)
Total:	20 (100%)
Category 3: Adoption of technology integration	
Research question 3: How can integrating technology be adopted while maintaining the agriculture learning objectives?	
Theme 9: Incorporating technological resources	5 (25%)
Theme 10: Aligning the syllabus with technology	5 (25%)
Theme 11: Understand the learning content	2 (10%)
Theme 12: Training with technology	8 (40%)
Total:	20 (100%)
Category 4: Advanced technology integration	
Research question 4: What are the innovative ideas for using technology to enhance Agriculture teaching and learning programmes?	
Theme 13: Providing resources	6 (30%)
Theme 14: Using the motivational approach	8 (40%)
Theme 15: Emphasising continuous training	6 (30%)
Total:	20 (100%)

Table 2 shows that the majority of the lecturers use various innovative strategies for integrating technologies into the agricultural programmes. These results imply that lecturers can employ innovative strategies to integrate technologies into their teaching if they are well trained and provided with the technological tools. The results from the research questions and the developed themes from the verbatim responses from the interviews and the observation are covered in the next section. The exploration of technology integration is the first topic presented in the following presentation.

4.1 Exploration of technology integration

Question 1: What strategies are in place to integrate innovative technologies into the agricultural programmes?

In understanding the strategies for integrating innovative technologies in the agricultural programmes, the following themes emerged:

- Proactive strategy;
- Improvising strategy;
- Developmental strategy;
- Seeking assistance;
- Innovative ways.

Proactive strategy

The proactive strategy is an innovative way to help the lecturers to stay prepared and organised when exploring technology and an important antecedent for searching and teaching content in a technological manner (Bhatia, 2021). A proactive strategy for integrating technology can put the lecturers in a position to support the students in any way while they are being taught and while they are studying.

When the lecturers were asked questions about their strategies for integrating technologies, most of the participants stated that they are using proactive strategies to support the students' learning, which include the use of WhatsApp groups and tablets. This is how the lecturers responded to the research question:

We are trying to use group WhatsApp so that after teaching, you can be able to send them some notes so that they can go through them by themselves [Participant 3].

The strategy that I believe will work best is to provide students with tablets so that they can use online technology as a tool for teaching and learning [Participant 4].

Provided these gadgets to students, apart from the NSFAS provision [Participant 10].

This is an indication that the proactive strategies can work to support the teaching and learning of the students when suitable technology is lacking. The use of proactive strategies was also confirmed through observation, where the lecturers would refer students to the learning content that was uploaded through the WhatsApp groups. The students were also observed using their cellphones and tablets to access the learning material that was uploaded to their WhatsApp group. This approach is in line with Bhatia (2021), who emphasises that a proactive strategy is an innovative way to explore technology and it is an important antecedent for searching and teaching content in a technological manner.

Improvising strategy

In general, improvising strategies revolves around using any technical resources to teach and learn content (Zimmer, 2019). This includes but is not limited to using alternative tools to replace the ones that are not available to achieve the outcomes. Many participants indicated another strategy to integrate the innovative technologies into the agricultural programmes including the use of visuals, household materials, and social media platforms. The following comments were made:

Sometimes you can even try to use these household materials, but they're not sufficient [Participant 6].

I believe the strategy is to relocate or accommodate students to college residences that are nearby because we know there is a network on this side [Participant 11].

Sometimes you can record a video of a lesson presentation and send it to students [Participant 12].

This is an indication that improvising the strategies promotes creativity in cases where something is lacking to complement the actual duty. The creative and strategic way to integrate innovative technologies into agricultural programmes, was observed in a practical lesson when the lecturers would use their cell phones to record a practical demonstration and upload it to their students' WhatsApp groups so that they may be accessed by everyone at their own time. This creative way is in line with Zimmer (2019), who stresses that the improvised actions and strategies revolve around using whatever technical resources are available to teach and learn content.

Developmental strategy

Every candidate who is expected to carry out a specific duty should undergo a strategy development process to improve innovative strategies for integrating technologies into the agricultural programmes (Sailer, Hense, Mandl & Klevers, 2017). The participants recognised how important it is to use the strategies to integrate innovative technologies into the agricultural programmes. However, some lecturers expressed their desire for personal training development or capacity building in the use of technological tools, including smartphones:

Students should be trained to access learning information through their smartphones, etc. I also need personal development and can use my laptop to project and display information on the screen [Participant 9].

I think we need a lot of training around the integration of technology. We need to do a lot of workshop interventions and be trained to gradually integrate this technology into the lessons that we're giving students [Participant 14].

I still believe that there is something that management needs to get right for lecturers to be capacitated and developed so that they can continue to give it all [Participant 15].

According to the study findings, the lecturers need development as a strategy to integrate technology during teaching. During observation, some lecturers struggled to project and display information and learning on the smart board. According to Nascimento et al. (2019), exploring learning content using technology motivates the development of new techniques for teaching content.

Seeking assistance

When faced with challenging activities, people typically seek assistance from those who can provide it. Seeking assistance in the form of getting support for technical tools in trying to assist the lecturers to improve their integration of technology, help lecturers to be acquainted with technology (Zhou & Wei, 2018; Newman, 2023). Some participants suggested ways in which lecturers could be assisted in integrating innovative technologies into agricultural programmes. The following responses to the interview question posed to lecturers were thought to be relevant:

The college management may provide resources because if they want lecturers to impart knowledge and skills to students, how can we do it if we don't have adequate resources? [Participant 6].

The college must have resources first. So, if they don't provide us with the resources, I don't think we will be able to keep up with modern technology. [Participant 13].

According to this study, lecturers need assistants in terms of technical support from management so that they can integrate technology successfully. Assisting lecturers with technical support could ensure that their institution's technology is enabling them to stay productive.

Innovative ways

Innovation has brought about changes that need support and ways to use problem-solving techniques in trying to assist lecturers in improving their integration of technology (Zhou & Wei, 2018). The lecturers need to think deeply and come up with something to save the situation. One lecturer stated that coming up with innovative ways could encourage the integration of technologies in the agricultural programmes:

Perhaps curriculum developers should reconsider the current curriculum rather than relying on the old textbooks [Participant 18].

The research findings indicated that the lecturers used innovative ways to integrate technologies during the teaching of agricultural programmes. During the observation, the lecturers tried to improvise and be proactive to integrate technologies, which is good, but further development is needed to keep abreast of the integration of technology.

4.2 Experimentation with technology integration

Question 1: What current technologies are you integrating into your agriculture classroom teaching?

The use of technology as the practical application of knowledge, especially in a particular area, is what this question was looking for. Precisely, the current technologies represent a new way of teaching in higher education. It provides the students with the latest or the most recent advancements in each scientific field. In exploring responses to the question, the following themes emerged:

- Lack of technological resources and equipment;
- Lack of technology integration;
- Ways of integrating technology;
- Communication platform technologies.

Lack of technological resources and equipment

The lack of technological resources and equipment hampers the effectiveness of teaching and learning, which has exacerbated the inequalities in education (Assunção & Gago, 2020). This situation includes lacking the technological tools that can facilitate the integration of technology, such as laptops, computers, projectors, as well as smartboards. Many participants revealed that the lack of technological resources and equipment led to having no innovative strategies for

integrating the current technologies. This is how the lecturers responded to the research question:

We don't have machines here [Participant 2].

There's nothing like technology here. No drones, no Agriculture machines for planting, ploughing, and harvesting [Participant 5].

There is nothing more. But some of the classes have projectors and are busy now with connectivity. So far, students do not have access to gadgets [Participant 7].

Currently, we don't have technological resources and equipment because you can't use a laptop in a big class [Participant 17].

The projectors, screens, and speakers that you see in some of the classes here are used for specific subjects [Participant 6].

This is an indication that the lack of technological resources and equipment hampers the innovative strategies for integrating technology. Without suitable technological resources and equipment, the lecturers cannot integrate technology into their teaching programmes. During the observation phase, some of the lecturers tried to integrate technology but they failed due to a lack of technological resources and equipment, which hampered their teaching and learning effectiveness. This aligns with Assunção and Gago (2020) who highlight that the lack of technological resources and equipment these days hampers the effectiveness of teaching and learning, and this has exacerbated the inequalities in education.

Lack of technology integration

Most educational institutions failed to fully integrate technology because of a lack of training, as well as due to limited resources, and assistance, which impacted the lecturers' integration of technology (Nelson, Voithofer & Cheng, 2019). The participants also stated that they would be unable to integrate technology if there were insufficient technological resources and equipment. This is how the lecturers responded to the research question:

We are currently unable to use technology, but we do use projectors and software [Participant 1].

I have not integrated any technology so far [Participant 8].

There aren't any current technologies that we are integrating into our teaching and learning [Participant 16].

The lack of technology integration is a setback in the teaching of agricultural programmes in some learning institutions. It has an impact on the lecturers' use of technology and the transformation in education (Nelson, Voithofer & Cheng, 2019).

Ways of integrating technology

According to several experts, utilising various technological integration methods necessitates adequate resources. Lawless and Pellegrino (2007); as well as Ramorola (2013) assert that this is a straightforward issue that requires time and resources to find ways to leverage technology. One participant in the study indicated a way of integrating technology by downloading videos from the

internet and using them during the lesson presentation. This is how the lecturer answered the question.

To teach students, we use videos downloaded from the internet and recorded lesson presentations [Participant 12].

The use of videos and recorded lessons is one of the strategies that is being used to integrate technology into the modern teaching of programmes. During the observation, some lecturers would show the students videos and they would display recorded lessons on cellphones, on laptops, and on smartboards. This is in line with Siegle (2015), who stressed that the lecturers should adopt some modern technology as a strategy to improve and advance the modern way of teaching programmes with technology.

Communication platform technologies

The communication platform technologies have brought unprecedented change and they have created an expectation of efficiency in the education, teaching, and learning spaces (Natale & Lubniewski, 2018). The teaching, learning, and communication processes have all benefited from the adoption of various communication platform technologies. The participants stated that some communication platforms, such as Microsoft Teams, Google Forms, and WhatsApp, are currently being used as integrated technologies when implementing the programmes. In response to the question, the lecturers said:

Microsoft Teams, Google Forms, and WhatsApp [Participant 9].

Currently, MS teams are using it not for teaching but mostly for some of the meetings [Participant 14].

WhatsApp to communicate with students and distribute materials [Participant 15].

This is an indication that the technological tools and the communication platforms are used as innovative strategies for integrating technologies. During the observation, some of the lecturers would refer students to the learning material that was uploaded through communication platforms including but not limited to Microsoft Teams, Google Forms, and WhatsApp. According to Natale and Lubniewski (2018), the communication platform technologies are beneficial for the quick responses between the lecturers and the students, and they also create an expectation of efficiency for the learning programmes.

4.3 Adoption of technology integration

Question 1: How can integrating technology be adopted while maintaining Agriculture learning objectives?

This question considers the methods of integrating technology while maintaining the agricultural learning objectives. It presents the perspectives of the participants on how technology can be used to produce quality students. In exploring the responses to the question, the following themes emerged:

- Incorporating technological resources;
- Aligning the syllabus with technology;
- Understand the learning content;
- Training with technology.

Incorporating technological resources

Incorporating technology resources helps lecturers keep their students interested in their lessons and it allows them to enhance their effectiveness by implementing technology integration (Mpungose, 2021). Most of the participants stated that integrating technological resources can be used to adopt technology. The following responses to the interview question that was posed to the lecturers were thought to be relevant:

When doing experiments, there are technical tools or resources that are needed for the completion of the experiments [Participant 4].

Technology can be used for a lot of agricultural activities. For example, if we are talking about irrigation systems, we have systems that are computerized [Participant 11].

There are many resources online that you can access for any objectives that lecturers want to achieve using technology in class as well [Participant 17].

This is an indication that incorporating technological resources enhances the experience of teaching and learning programmes. During the observation, both the lecturers and the students experienced and enjoyed the use of technology that was integrated into the lesson, while some learned from the strategies and the challenges that they experienced. The findings are in line with Mpungose (2021) who emphasises that the adoption of technology allows the lecturers to incorporate the technological resources that are suitable to enhance effective and synchronous e-learning.

Aligning the syllabus with technology

To fulfil the goals of modern learning and teaching with technology integration, the learning programmes should be aligned with the syllabus (Cetiner, 2021). This helps to engage the students in the classroom and the lecturers as well as the curriculum designers should incorporate technology into their methods of teaching (Mason, 2020). The participants stated that integrating technology into the curriculum can also be improved by connecting the curriculum with technology. In response to the question, the lecturers said:

We need to work on the syllabus because it does not address the changing work environment, which includes new technology. You can't have a syllabus without supporting resources [Participant 5].

If you want students to understand the method of soil sampling, they go to the internet and look for videos that explain soil sampling and then watch it, and then they will see without going to the fields to take the samples [Participant 13].

We're really trying to push the objectives of teaching and learning because the students are most interested in technology and will be more interested in participating in class [Participant 14].

The research findings indicated a need to align the syllabus with technology to address the changing work environment, which includes new technology. During the observation, some lecturers would also refer the students to their textbooks, which do not resemble the modern way of having electronic textbooks and the learning materials that are used technologically. To align with transformation,

new technology adoption should strongly advocate for quality, which is more involved in the innovation strategies (Ancarani, Di Mauro & Mascali, 2019).

Understand the learning content

Students can benefit from online learning in a variety of ways, including the ability to replay recorded lectures for a better understanding of the course material (Chung, Subramaniam & Dass, 2020). One participant indicated that understanding the learning content might improve the ability to maintain the Agriculture learning objectives. In response to the question, the lecturer said:

Our main concern with students is the result. Students can just watch the videos for the sake of understanding them, not only with the intention of learning how to use the information from the videos [Participant 15].

This is an indication that the understanding of the learning content is improved by the strategy of displaying learning content. During observation, some lecturers would ask questions about the videos which were displayed during the lesson to make sure that the students understand that watching was not for fun but for the understanding of the content. This is in line with Marks and Thomas (2022) who emphasise that the use of new technology including video watching, helps to improve content understanding and it increases participation in today's teaching and learning processes.

Training with technology

Technology-based training promotes individual learning and enhances students' interest in the subject that they are learning (Elmurzaevich-TSPU & Rustamovich, 2019). Most of the participants indicated that the lecturers are supposed to train the students using the technology. In response to the question, the lecturers said:

We are supposed to use that technology in the class, like teaching them online, and after that, learners are also supposed to be in the field doing practical activities or hands-on [Participant 1].

I think it is to train the people using the old technology, not discourage the old one, because there are some advantages with the old one [Participant 2].

Chemical mixing was supposed to be done by certain technologies because some of those general workers are uneducated in terms of measurements and so on [Participant 3].

We introduce each lesson by making sure that 50% of the lessons use technology because Agriculture is mostly about the practical [Participant 18].

The research findings indicated that the training of agricultural programmes was supposed to be integrated with technology. Every lecturer is expected to teach with the help of technology to implement transformation. During observation, the students would pay attention to their smartphones, and to the smartboards in trying to understand what was displayed over the technological tools. This finding is in line with Elmurzaevich-TSPU and Rustamovich (2019), who emphasise that the use of adopted technology activates the learning process, as it motivates the students to learn privately and increases their interest in the subject matter throughout the training process.

4.4 Advanced technology integration

Question 1: What are the innovative ideas for using technology to enhance Agriculture teaching and learning programmes?

The finding indicated that providing resources for the learning programmes including agriculture, could be an ideal situation to improve the teaching and learning processes. The following responses to the interview question that was posed to the lecturers were thought to be relevant:

- Providing resources;
- Using a motivational approach;
- Emphasising continuous training.

Providing resources

Providing the lecturers with the resources they need to succeed in imparting quality programmes that every student can wish to achieve and succeed in their education is vital (Howard, Bureau, Guay, Chong & Ryan, 2021). The findings indicated that providing resources for the learning programmes including agriculture could be an ideal situation to improve the teaching and learning processes. The following responses to the interview question that was posed to the lecturers were thought to be relevant:

I think that working with students online using current technologies could be very effective as a learning tool [Participant 6].

The use of overhead projectors in class can be handy, as can the internet, where we must download some of the material to supplement what they get from their textbook [Participant 13].

If we can have simulation centres where students can go and simulate how to drive a tractor [Participant 15].

Most of the lecturers indicate that technological resources should be provided to the learning institutions to encourage the integration of technology during teaching and learning. The idea of teaching agriculture as a practical subject that requires tools, including technological resources and equipment, is vital for students' practices and advancement. During observation, some of the lecturers were observed teaching the subject without the integration of technology and referring students to the electronic learning content. According to Onyesom and Umoeshiet (2013), the provision of technological resources is a strategy to maintain the degree of excellence in teaching and to produce quality and competent graduates.

Using a motivational approach

The motivation of lecturers to use technology for teaching is significantly impacted by the professional development technology training, where the lecturers are taught to integrate technologies (Ibrahim & Nat, 2019). Many lecturers indicated that the use of a motivational approach could be a strategy for motivating or stimulating students' interest in using technology. In response to the question, the lecturers said:

I think we must provide laptops and data for the students to stimulate their interest in using technology [Participant 2].

When we go out for training or workshops, let's take a few students and support staff along to see technological progress [Participant 7].

Because we incorporate MS Teams into our courses, lecturers must be proficient in it [Participant 8].

Encouraging students to use the internet to find specific information on their own [Participant 20].

The research findings indicated that the use of motivation acts as a driving force to integrate technology and it gives the incentive to start learning by using technology in a certain way. Looking at the broader scale of agriculture as a subject, technology can be used in different ways, including but not limited to incorporating Microsoft Teams for training or workshops.

Emphasising continuous training

Lecturers need continuous training and competency development for technology-enhanced teaching (Sadler, Foulk & Friedrichsen (2016). This would make it easier for them to stay current and relevant on the changes related to technology integration in the educational system. Some of the participants indicated that the lecturers receive ongoing training. In response to the question, the lecturers said:

Yes, as I always try to emphasise, the issue of lecturers being properly trained and equipped with these abilities is important [Participant 10].

Because we live in a constantly changing world, we need to be trained on occasion [Participant 19].

As stated above, most of the lecturers indicated that they need continuous training as a strategy to integrate technology more intensively into their teaching. Continuous training is important because it ensures that these small gaps are covered and that the lecturers' efficiency in integrating technology and the productivity of quality students are improved. Continuous training helps to create and deliver teaching content for an online platform, which is a significant challenge. However, the lecturers need to overcome the challenge and perform their duties with the use of advanced technologies (Qurotul et al., 2020).

5. Conclusion

The objective this study was to investigate the innovative strategies for integrating technologies into agricultural programmes. The study reported on the current and future innovative strategies that can be used to integrate technology into the learning programmes. The findings revealed that the innovative strategies for integrating technologies can include phases such as the exploration of technology integration, the experimentation with technology integration, adoption of technology integration, and the advanced technology integration. Firstly, we found that the exploration of technology integration may use innovative strategies including being proactive, improvisation, development, and seeking assistance as the strategies for integrating technology. The interview results revealed that these strategies can be put in place to integrate the innovative technologies into the agricultural programmes. Secondly, we found that the phase of experimentation with technology integration has been practiced without technological resources and equipment, which hampered technology integration when training agricultural programmes. The interview results revealed that these strategies and the other strategies of technology integration were used in the form of

communication platform technologies. Thirdly, we found that the phase of the adoption of technology integration was used as a strategy to understand the learning content. The interview results revealed the need to adopt the technical tools or the resources to complement the agricultural experiments. Lastly, we found that the phase of advanced technology integration may use the provision of resources, as well as the emphasis on continuous training, and motivational strategies to enhance agriculture teaching and learning programmes. The interview results revealed that working with students online using advanced technologies could be very effective when training agricultural programmes. The findings can contribute significantly to the use of innovative strategies for integrating technologies into the TVET colleges. The study recommends that the TVET colleges offering agricultural programmes, as well as the Department of Higher Education and Training, which are the custodians of the TVET colleges, and the other relevant stakeholders should incorporate innovative strategies that will assist in the full integration of technologies. We recommend that the TVET lecturers should be continuously trained, encouraged, and adapted to integrate technology more effectively with ongoing training in the use of innovative technologies. We also recommend the support of technological tools and the continuous training of lecturers to fully integrate technologies using innovative strategies.

6. References

- Agbo, I. S. (2015). Factors influencing the use of information and communication technology (ICT) in teaching and learning computer studies in Ohaukwu local government area of Ebonyi state-Nigeria. *Journal of Education and Practice*, 6(7), 71-86.
- Al Rawashdeh, A. Z., Mohammed, E. Y., Al Arab, A. R., Alara, M., & Al-Rawashdeh, B. (2021). Advantages and disadvantages of using e-learning in university education: Analyzing students' perspectives. *Electronic Journal of E-learning*, 19(3), 107-117. DOI: <https://doi.org/10.34190/ejel.19.3.2168>
- Alghamdi, J., & Holland, C. (2020). A comparative analysis of policies, strategies and programmes for information and communication technology integration in education in the Kingdom of Saudi Arabia and the republic of Ireland. *Education and Information Technologies*, 25(6), 4721-4745. <https://doi.org/10.1007/s10639-020-10169-5>
- Ancarani, A., Di Mauro, C., & Mascali, F. (2019). Backshoring strategy and the adoption of Industry 4.0: Evidence from Europe. *Journal of World Business*, 54(4), 360-371. <https://doi.org/10.1016/j.jwb.2019.04.003>
- Assunção Flores, M., & Gago, M. (2020). Teacher education in times of COVID-19 pandemic in Portugal: national, institutional, and pedagogical responses. *Journal of Education for Teaching*, 46(4), 507-516. <https://doi.org/10.1080/02607476.2020.1799709>
- Ben Ayed, R., Hanana, M., Ercisli, S., Karunakaran, R., Rebai, A., & Moreau, F. (2022). Integration of Innovative Technologies in the Agri-Food Sector: The Fundamentals and Practical Case of DNA-Based Traceability of Olives from Fruit to Oil. *Plants*, 11(9), 1230. <https://doi.org/10.3390/plants11091230>
- Bhatia, M. S. (2021). Green process innovation and operational performance: The role of proactive environment strategy, technological capabilities, and organizational learning. *Business Strategy and the Environment*, 30(7), 2845-2857. <https://doi.org/10.1002/bse.2775>

- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, 3(2), 77-101. <https://doi.org/10.1191/1478088706qp063oa>
- Buss, R. R., Foulger, T. S., Wetzell, K., & Lindsey, L. (2018). Preparing teachers to integrate technology into K-12 instruction II: Examining the effects of technology-infused methods courses and student teaching. *Journal of Digital Learning in Teacher Education*, 34(3), 134-150. <http://dx.doi.org/10.1080/21532974.2018.1437852>
- Cannistraci, L. (2011). The value of instructional technology in a K-12 district. *Distance Learning*, 8(1), 9.
- Cetiner, C. (2021). Designing a syllabus for the translation technology course: with theoretical considerations and hands-on assignments. *International Journal of Language Academy*, 9(2).
- Chick, R. C., Clifton, G. T., Peace, K. M., Propper, B. W., Hale, D. F., Alseidi, A. A., & Vreeland, T. J. (2020). Using technology to maintain the education of residents during the COVID-19 pandemic. *Journal of surgical education*, 77(4), 729-732. <https://doi.org/10.1016/j.jsurg.2020.03.018>
- Chung, E., Subramaniam, G., & Dass, L. C. (2020). Online learning readiness among university students in Malaysia amidst COVID-19. *Asian Journal of University Education*, 16(2), 45-58. <https://doi.org/10.24191/ajue.v16i2.10294>
- Creswell, J. W., & Poth, C. N. (2016). *Qualitative inquiry and research design: Choosing among five approaches*. Sage publications. <https://doi.org/10.1086/317417>
- Elmurzaevich-TSPU, M. O., & Rustamovich, A. J. (2019). The benefits of using information technology in the education system. *European Journal of Research and Reflection in Educational Sciences Vol*, 7(12).
- Green, J. & Thorogood, N. (2018). *Qualitative methods for health research*. London Sage.
- Hair, J.F., Anderson, R.E., Tatham, R.L., & Black, W.C. (2008) *Multivariate Data Analysis*, (7th ed.). Prentice Hall Publisher, Upper Saddle River, New Jersey.
- Harris, J. (2010). The use, role and application of advanced technology in the lives of disabled people in the UK. *Disability & Society*, 25(4), 427-439. <https://doi.org/10.1080/09687591003755815>
- Howard, J. L., Bureau, J., Guay, F., Chong, J. X., & Ryan, R. M. (2021). Student motivation and associated outcomes: A meta-analysis from self-determination theory. *Perspectives on Psychological Science*, 16(6), 1300-1323. <https://doi.org/10.1177/1745691620966789>
- Hu, X., Chiu, M. M., Leung, W. M. V., & Yelland, N. (2021). Technology integration for young children during COVID-19: Towards future online teaching. *British Journal of Educational Technology*, 52(4), 1513-1537. <https://doi.org/10.1111/bjet.13106>
- Ibrahim, M. M., & Nat, M. (2019). Blended learning motivation model for instructors in higher education institutions. *International Journal of Educational Technology in Higher Education*, 16(1), 1-21. <https://doi.org/10.1186/s41239-019-0145-2>
- Jaffer, S., Ng'ambi, D., & Czerniewicz, L. (2007). The role of ICTs in higher education in South Africa: One strategy for addressing teaching and learning challenges. *International journal of Education and Development using ICT*, 3(4), 131-142. <http://hdl.handle.net/11427/9845>
- Karakose, T., Polat, H., & Papadakis, S. (2021). Examining teachers' perspectives on school principals' digital leadership roles and technology capabilities during the COVID-19 pandemic. *Sustainability*, 13(23), 13448. <https://doi.org/10.3390/su132313448>
- Kotrlík, J. W., Redmann, D. H., & Douglas, B. B. (2003). Technology integration by agriscience teachers in the teaching/learning process. *Journal of Agricultural Education*, 44(3), 78- 90. <https://doi.org/10.5032/jae.2003.03078>
- Lawless, K. A., & Pellegrino, J. W. (2007). Professional development in integrating technology into teaching and learning: Knowns, unknowns, and ways to pursue better questions and answers. *Review of educational research*, 77(4), 575-614. <https://doi.org/10.3102/003465430730992>

- Li, Y., Wang, Q., & Lei, J. (2020). Exploring technology professional development needs of digital immigrant teachers and digital native teachers in China. *International Journal of Information and Communication Technology Education (IJICTE)*, 16(3), 15-29. <https://doi.org/10.4018/ijcte.2020070102>
- Linneberg, M. S., & Korsgaard, S. (2019). Coding qualitative data: A synthesis guiding the novice. *Qualitative Research Journal*. <https://doi.org/10.1108/QRJ-12-2018-0012>
- Litvinenko, V. S. (2020). Digital economy as a factor in the technological development of the mineral sector. *Natural Resources Research*, 29(3), 1521-1541. <https://doi.org/10.1007/s11053-019-09568-4>
- Marks, B., & Thomas, J. (2022). Adoption of virtual reality technology in higher education: An evaluation of five teaching semesters in a purpose-designed laboratory. *Education and information technologies*, 27(1), 1287-1305. <https://doi.org/10.1007/s10639-021-10653-6>
- Mashile, T. (2017). *Technology integration and the digital divide: understanding factors that impact on educators' ability to integrate technology in South African classrooms* (Doctoral dissertation, University of Pretoria). URI: <http://hdl.handle.net/2263/59868>
- Mason, M. E. (2020). *Design and Delivery of Online Learning for Employees* (Doctoral dissertation, Capella University).
- Molefe, L., Stears, M., & Hobden, S. (2016). Exploring student teachers' views of science process skills in their initial teacher education programmes. *South African Journal of Education*, 36(3). <https://doi.org/10.15700/saje.v36n3a1279>
- Mpfungose, C. B. (2021). Lecturers' reflections on use of Zoom video conferencing technology for e-learning at a South African university in the context of coronavirus. *African Identities*, 1-17. <https://doi.org/10.1080/14725843.2021.1902268>
- Mtshali, T. I. (2020). Critical thinking skills for Civil Technology practical assessment tasks (PATs). *World Transactions on Engineering and Technology Education, WIETE*, 18(2), 237-241.
- Naiker, V., & Makgato, M. (2018). The Integration of ICT in TVET college classrooms: A case in automotive repair and maintenance teaching. *International Journal of Educational Sciences*, 20(1-3), 25-32. <https://doi.org/10.31901/24566322.2018/20.1-3.04>
- Nascimento, D. L. M., Alencastro, V., Quelhas, O. L. G., Caiado, R. G. G., Garza-Reyes, J. A., Rocha-Lona, L., & Tortorella, G. (2019). Exploring Industry 4.0 technologies to enable circular economy practices in a manufacturing context: A business model proposal. *Journal of Manufacturing Technology Management*, 30(3), 607-627. <https://doi.org/10.1108/jmtm-03-2018-0071>
- Natale, K., & Lubniewski, K. (2018). Use of communication and technology among educational professionals and families. *International Electronic Journal of Elementary Education*, 10(3), 377-384. <https://doi.org/10.26822/iejee.2018336196>
- Nelson, M. J., Voithofer, R., & Cheng, S. L. (2019). Mediating factors that influence the technology integration practices of teacher educators. *Computers & Education*, 128,330-344. <https://doi.org/10.1016/j.compedu.2018.09.023>
- Newman, R. S. (2023). Adaptive help seeking: A strategy of self-regulated learning. In *Self-regulation of learning and performance* (pp. 283-301). Routledge. <https://doi.org/10.4324/9780203763353-12>
- Onyesom, M. & Umoeshiet, E. A. (2013). Strategies considered effective for quality assurance in business education programme in Nigerian universities. *Nigerian Journal of Business Education*, 1(2), 141 - 150.
- Qurotul Aini, Q. A., Mukti Budiarto, M. B., POH Putra, P. O. H., & Untung Rahardja, U. R. (2020). Exploring e-learning challenges during the global COVID-19 pandemic:

- A review. *Jurnal Sistem Informasi (Journal of Information System)*, 16(2), 47-65. <https://doi.org/10.21609/jsi.v16i2.1011>
- Ramorola, M. Z. (2013). Challenge of effective technology integration into teaching and learning. *Africa Education Review*, 10(4), 654-670. <https://doi.org/10.1080/18146627.2013.853559>
- Ritchie J & Spencer L (1994) Qualitative data analysis for applied policy research. In *Analysing Qualitative Data*, pp. 173-194 [A Bryman and RG Burgess, editors]. London: Routledge. https://doi.org/10.4324/9780203413081_chapter_9
- Ruslin, R., Mashuri, S., Rasak, M. S. A., Alhabsyi, F., & Syam, H. (2022). Semi-structured Interview: A Methodological Reflection on the Development of a Qualitative Research Instrument in Educational Studies. *IOSR Journal of Research & Method in Education (IOSR-JRME)*, 12(1), 22-29. DOI: 10.9790/7388-1201052229.
- Sadler, T. D., Foulk, J.A., Friedrichsen, P.J., (2016). Evolution of a model for socioscientific issue teaching and learning. *Int. J. Math. Educ. Sci. Technol.*, 5 (1), 75. <https://doi.org/10.18404/ijemst.55999>
- Sailer, M., Hense, J., Mandl, H., & Klevers, M. (2017). Fostering development of work competencies and motivation via gamification. *Competence-based vocational and professional education: Bridging the worlds of work and education*, 795-818. https://doi.org/10.1007/978-3-319-41713-4_37
- Siegle, D. (2015). Technology: Learning can be fun and games. *Gifted Child Today*, 38(3), 192-197. <https://doi.org/10.1177/1076217515583744>
- Simelane, S., Blignaut, S., & Van Ryneveld, L. (2007). Preparing lecturers to integrate educational technology into their teaching and learning practices. *South African Journal of Higher Education*, 21(7), 940-953. <https://doi.org/10.4314/sajhe.v21i7.25753>
- Springer, K. (2009). *Educational research: A contextual approach*. Wiley. <https://doi.org/10.1007/s11191-011-9420-x>
- Stach, E., DeCost, B., Kusne, A. G., Hattrick-Simpers, J., Brown, K. A., Reyes, K. G., ... & Maruyama, B. (2021). Autonomous experimentation systems for materials development: A community perspective. *Matter*, 4(9), 2702-2726. <https://doi.org/10.1016/j.matt.2021.06.036>
- Venketsamy, R., & Zijing, H. U. (2022). Exploring challenges experienced by foundation phase teachers in using technology for teaching and learning: a South African case study. *Journal for the Education of Gifted Young Scientists*, 10(2), 221-237. DOI: <https://doi.org/10.17478/jegys.1085660>
- Wiid, J & Diggins, C. (2013). *Marketing Research*. 2nd Ed. Cape Town: Juta.
- World Health Organization. (2022). Strategic action framework to improve access to assistive technology in the Eastern Mediterranean Region. 9789290226604-eng.pdf (1.253Mb).
- Yang, D., Jiang, W., & Zhao, W. (2019). Proactive environmental strategy, innovation capability, and stakeholder integration capability: A mediation analysis. *Business Strategy and the Environment*, 28(8), 1534-1547. <https://doi.org/10.1002/bse.2329>
- Zhou, Y., & Wei, M. (2018). Strategies in technology-enhanced language learning. *Studies in Second Language Learning and Teaching*, 8(2), 471-495. <https://doi.org/10.14746/ssllt.2018.8.2.13>
- Zimmer, M. P. (2019). Improvising digital transformation: strategy unfolding in acts of organizational improvisation.