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Exploring Agricultural Sciences Teachers' Beliefs in Integrating Simulations and Hands-On Teaching Methods: A Multi-Case Study

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Abstract. Beliefs are crucial in shaping teachers' approaches to implementing innovative teaching methods. To drive change in educational practices, it is essential to understand the role of teachers' beliefs, which are deeply embedded in their values and influence their classroom practices. This understanding is key to initiating meaningful change. Therefore, this study explores Agricultural Sciences teachers' beliefs regarding the integration of simulation and hands-on instructional methods in South African secondary schools. Using a multiple case study design, three teachers from the Capricorn District were purposively selected and interviewed to examine their beliefs on (i) content comprehension, (ii) learner assessment, and (iii) the role of self-reflection in improving teaching practices. Findings reveal that teachers held predominantly positive beliefs about simulation and hands-on approaches, viewing them as effective tools for simplifying complex content, enhancing learner engagement, and improving academic performance. Although initially sceptical of technology-mediated assessments, teachers experienced a transformation in their beliefs as they began to recognise the value of such approaches in promoting authentic learner understanding. This shift was influenced by their observation of improved learner comprehension and motivation, particularly using simulations and hands-on methods. Furthermore, the teachers emphasised the importance of self-reflection and ongoing professional development in enhancing and refining their instructional practices. The study highlights the dynamic nature of teacher beliefs, shaped by experiential learning and exposure to technological tools. Recommendations include sustained professional development,

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institutional support for digital integration, and further research into scalable implementation strategies. The findings contribute to the broader discourse on technology-enhanced pedagogy in science education, particularly within resource-constrained contexts.

Keywords: Teacher beliefs; simulation-based learning; hands-on instruction and technology integration

1. Introduction

Information and communication technology (ICT) has advanced significantly in recent years, driving substantial transformations across various sectors, including business, education, healthcare, and agriculture. Within the education sector, technological advancements have profoundly influenced teaching and learning, mainly through the integration of ICT (Suleiman et al., 2025). The term 'Use of Simulation' in education generally refers to a technology-enhanced instructional approach in which teachers employ digital tools to facilitate learning in the classroom (Tshewang, 2019). This approach effectively improves learning outcomes for learners with diverse abilities, needs, and learning styles (Henderson, 2020).

Furthermore, it significantly improves teaching effectiveness and learner participation in the learning process (Thaheem et al., 2021). Studies demonstrate that simulation-based learning, for example, improves learners' cognitive comprehension and academic performance (Liu et al., 2022). Moreover, empirical research supports that technology-based tools and resources can enrich learning experiences in diverse subjects such as science, mathematics, languages, the arts, humanities, and other essential disciplines (Demkanin et al., 2005).

Simulations provide a practical alternative to conventional laboratory experiments, which frequently face limitations such as resource shortages, safety risks, inadequate class time, and overcrowded classrooms. According to Khan (2011), interactive computer simulations are 'computer programmes designed to replicate the behaviour of a specific system'. In South Africa's education system, simulations are seen as a valuable tool to improve poor performance in science subjects (Kamaruddin et al., 2017) and are actively promoted by the Department of Basic Education (2022). Their adoption aligns with efforts to enhance science education despite existing constraints.

Teacher' beliefs substantially influence their willingness and ability to integrate simulations and other technological tools to enhance learning in schools (Ama et al., 2020). Research by Ottenbreit-Leftwich et al. (2010) posits that teachers' beliefs about technology strongly predict their likelihood of adopting digital tools in their teaching practice. In this study, belief is conceptualised as the cognitive acceptance or conviction of the truth or validity of a particular concept. It reflects a propositional belief, a mental position that can be articulated as a viewpoint or stance toward an idea (Schwitzgebel, 2010). This understanding of belief is particularly relevant when examining how teachers' beliefs shape their engagement with educational technologies.

In several developing countries, including Tanzania, Rwanda, Malaysia, and Kenya, studies have reported low adoption rates of simulation technology in educational settings (Ama et al., 2020; Kamaruddin et al., 2017; Nzabarilwa & Nduwayezu, 2022). These studies reveal that a significant proportion of teachers, including those in science disciplines where such tools could be particularly advantageous, rarely integrate ICT into their teaching practices. This limited adoption is attributed to a range of systemic barriers, such as inadequate technological infrastructure, low teacher motivation, unreliable internet connectivity, poor classroom conditions, inadequate professional development, and lack of administrative support. Collectively, these interrelated factors significantly hinder the effective and sustained integration of digital learning tools in such educational contexts.

Several diagnostic reports (DBE, 2019, 2020, 2021) from the Department of Basic Education (2019 - 2021) revealed significant learning challenges in Agricultural Sciences, including learners' difficulties in interpreting questions on topics like Animal Nutrition, Basic Genetics, and Agricultural Economics, as well as errors in calculations, formula writing, and misapplication of methods such as the Pearson Square Technique. Research by Raman and Yamat (2014) reveals that some teachers have negative beliefs about integrating information and communication technologies (ICT) into their lesson planning, which directly affects their classroom practices. These beliefs may limit effective teaching strategies, ultimately harming learner performance (Hlatswayo & Ramnarain, 2019). Kriek and Stols (2010) recommend first understanding the beliefs that shape teachers' decisions regarding technology use, including simulations, and exploring strategies to modify these beliefs where necessary to improve instructional practices.

Researchers have identified several factors that hinder teachers from incorporating simulations into their instructional practices (Munje & Jita, 2020). However, some scholars argue that these reasons remain insufficiently understood (Ramorola, 2013). Compounding this issue, evidence shows that even in ICT-rich environments, simulations are often not used effectively (Dwived et al., 2019; Ertmer et al., 2012).
Thus, this study aimed to explore the following research questions:

i. What are teachers' beliefs about the comprehension of the content taught through simulation and hands-on instruction?
ii. What are teachers' beliefs about assessing learner understanding through integrated simulation and hands-on methods?
iii. What are teachers' beliefs about the role of self-reflection in improving teaching practices through integrated simulation and hands-on methods?

2. Review of the literature

2.1 Teachers' Beliefs on ICT Integration: Impact on Technology Adoption and Classroom Practices

Numerous studies have explored how teachers' beliefs influence their adoption of technology in the classroom (Bice & Tang, 2022; Ross & Tsibolane, 2017). Research indicates that teachers' beliefs about a specific teaching practice significantly shape their objectives when integrating technology (Silviyanti & Yusuf, 2015). As a result, teachers who view digital tools as valuable for enriching lessons, increasing learner engagement, and driving meaningful pedagogical change are more inclined to embrace technology with greater certainty (Ama Gbemu et al., 2020). In corroboration with this belief, Qaddumi et al. (2023) found that favourable beliefs toward ICT can substantially increase its application in educational settings, reinforcing the critical role of the teacher's mindset in successful integration of technology.

The study conducted by Bice and Tang (2022) in the United States discovered that numerous teachers persist in employing teacher-centred instructional strategies. Their results, which correspond with earlier research by Ertmer (2005) and Wojney (2006), posit that teachers who advocate for learner-centred instructional philosophies are considerably more inclined to incorporate simulations into their educational practices. Despite the enhanced accessibility of educational technology for both teachers and learners, Wojney (2006) indicates that ICT remains insufficiently used in endorsing learner-centred pedagogy. However, Bice and Tang (2022) posit that teachers' beliefs about technology may gradually transform as they become more familiar with digital tools and as educational institutions become increasingly amenable to innovative pedagogical methodologies.

A recent Tanzanian study by Hamoud and Nzilano (2024) investigated the beliefs and classroom practices of science teachers about simulation-based instruction. The researchers used a mixed methods approach with a concurrent nested design, purposely selecting 60 science teachers from five public secondary schools through convenience sampling. Findings revealed significant divergence in teachers' beliefs, with some demonstrating positive beliefs toward simulations, while others held skeptical views. In particular, the study found that despite these varying beliefs, actual ICT integration in classrooms remained largely ineffective. Key implementation challenges included limited technological proficiency and low self-efficacy of teachers, which collectively limited their ability to effectively use simulations in science instruction.

2.2 Barriers to Technology Integration in South African Agricultural Education: Exploring Teacher Beliefs and Implementation Challenges

As a developing nation, South African schools often face first-order barriers to ICT integration, such as limited resource availability. However, with the growing implementation of ICTs in schools, second-order barriers, including teachers' pedagogical beliefs, are becoming increasingly relevant for exploration (Ramnarain et al., 2023). Preliminary findings from a qualitative study by Sherman and Howard (2012), conducted with secondary school teachers in Cape Town, indicated that a range of socio-cultural factors influence teachers' beliefs

and practices regarding technology use. At the time of the study, the use of simulation was not widespread, and no definitive conclusions could be drawn about the relationship between teachers' beliefs and practices.

A subsequent study by Ross and Tsibolane (2017) found that in schools with well-equipped ICT resources, where teachers acknowledged the benefits of simulation, their actual use of simulation was inconsistent with these beliefs. Furthermore, neither of these studies addressed the beliefs of agricultural sciences teachers about the integration of simulation and hands-on techniques, which is the focus of the current research.

In 2013, Kriek and Stols conducted an exploratory study on the beliefs of 46 teachers about educational technology and its actual implementation in mathematics and physical science classrooms. The study focused on dynamic geometry software and PhET as educational technologies. Using partial least squares analysis, the researchers found that teachers' beliefs about the perceived usefulness of these technologies had a significant impact on their intention to use them in their teaching. The study was able to predict the actual use of educational technology by teachers in their classrooms with an accuracy of 78.6%. To the best of current knowledge, no similar study has been conducted with Agricultural Sciences teachers, highlighting the need to address this gap.

2.3 Teachers' Pedagogical Beliefs and ICT Integration in Science Education: Insights from South African Studies

Ramnarain et al. (2023) conducted an exploratory study exploring how the pedagogical beliefs of South African Life Sciences teachers influenced their use of Information and Communication Technology (ICT) in the classroom.

The results highlighted the intricate relationship between teachers' pedagogical beliefs and their actual implementation of ICT. Participants identified multiple obstacles to effective ICT integration, including learners' limited access to smart devices and unreliable Wi-Fi connectivity. Similarly, Ajani (2024) observed that teachers expressed a substantial need for professional development centred on innovative strategies for the incorporation of ICT into their teaching practices. Prompted bythese findings, Ramnarain et al. (2023) advocated for the extension of research to include other science-related disciplines. This recommendation provided the impetus for the current study, which seeks to explore teachers' beliefs about learner comprehension and assessment.

A related investigation conducted by Juggernath and Govender (2020) in South Africa examined the correlation between the pedagogical beliefs of natural sciences teachers and their ICT integration practices. The study focused on three purposely chosen teachers from a public school that had a well-established ICT infrastructure. The results contended that within a technology-rich environment, extrinsic factors exerted minimal influence, whereas intrinsic factors, specifically teachers' beliefs, were crucial to shaping the integration of ICTs in science instruction. These beliefs were shaped by three core elements: value judgments, reality judgments, and action judgments.

Of these, value judgements, such as beliefs about the teacher's role and the fundamental purpose of teaching, had the most profound impact on the use of ICT in the classroom. Although reality and action judgments also played a role, their impact was comparatively limited. Building on these insights into value judgments, the present study aimed to explore the beliefs of Agricultural Sciences teachers about the integration of ICT in their pedagogical practices, with a focus on self-reflection.

A further investigation by Juggernath and Govender (2020) from South Africa scrutinised the relationship between the pedagogical beliefs of natural sciences teachers and their incorporation of information and communication technology (ICT). The findings revealed that in environments enriched with technology, extrinsic factors exerted minimal impact. In contrast, intrinsic factors, notably teachers' belief systems, were pivotal in influencing the adoption of ICT in scientific instruction. Expanding on these findings, the current study seeks to broaden this investigative framework by examining the beliefs of Agricultural Sciences teachers regarding the integration of ICT into their pedagogical practices.

2.4 The Role of Teacher Beliefs in Shaping Digital Practices: A Focus on Agricultural Sciences Education in South Africa

Since beliefs exert a stronger influence on behaviour than knowledge alone (Ertmer et al., 2012), establishes a foundational understanding of Agricultural Sciences teachers' beliefs about integrating simulations and hands-on approaches becomes a critical prerequisite for any subsequent belief modification initiatives. In the context of accelerating technological innovation, examining the role of teachers' established belief systems in shaping their adoption of digital pedagogies has become a critical research focus. While existing scholars (Olawale & Hendricks, 2024; Kriek and Stols, 2013; Juggernath & Govender, 2020; Ramnarain et al., 2023) have investigated teacher beliefs in mathematics, physical sciences, natural sciences, and life sciences, the domain of agricultural sciences education in South Africa remains largely unexplored in this regard, presenting a significant gap in the literature.

3. Theoretical framework guiding the study

This study is grounded in Webb's (2002) model of pedagogical reasoning and action, which serves as the theoretical framework for exploring teachers' beliefs regarding simulation and hands-on instruction in their professional practice.
According to Webb (2002), this model illustrates how teachers translate their subject knowledge, educational expertise, ideas, and beliefs into teachable forms of knowledge. Additionally, it explains how this knowledge is delivered to learners, assessed, and subsequently reflected on by teachers, offering opportunities for professional growth. The current study employed three tenets of the framework as a lens to guide the study.

During the comprehension phase, the focus was on exploring teachers' beliefs concerning learners' understanding of content delivered through simulation and hands-on methods. In the instruction phase, the study explored teachers' beliefs about teaching and learning processes involving the integration of simulation and

hands-on instructional strategies. Finally, the reflection phase explored teachers' beliefs related to self-reflection and professional development, particularly about adopting and enhancing simulation–hands-on integrated pedagogies.

4. Methodology

4.1 Research Design

This research used a multiple case study design to explore the beliefs of agricultural sciences teachers about incorporating simulation into hands-on teaching methods (Stake, 1995). A multiple case study involves examining several cases to identify similarities and differences (Creswell, 2015; Stake, 1995). This approach was chosen because it offers deeper insights than a single case study, allowing a more comprehensive understanding of the topic. The cases are selected to help theorise broader applications, documenting different teachers' beliefs and how these beliefs influence simulation and hands-on teaching. The study followed a qualitative and naturalistic paradigm.

4.2 Sampling

This qualitative study utilised purposive sampling, a technique that permits researchers to select participants according to specific attributes pertinent to the research focus (Nieuwenhuis, 2016). In this regard, three teachers were selected, with each treated as an individual case. Specifically, the study focused on teachers who actively taught agricultural sciences in grades 10 to 12 in secondary schools. Purposive sampling involves selecting participants in a way that does not provide every individual in the population with the same chance of being chosen, regardless of factors such as gender, age, or race (Garcia-Alexander et al., 2017). Consequently, the sampling approach of this study prioritised subject specialisation over other variables, ensuring alignment with the research focus.

4.3 Data collection

To collect rich and relevant data for the study, the researcher employed a semi-structured interview guided by a teaching philosophy framework, in line with Stake's methodological approach (1995, 2006). Semi-structured interviews served as an effective tool to examine teachers' beliefs about the integration of simulation and hands-on teaching strategies in their classrooms (Christiansen, 2014; Stake, 2006). Additionally, a teaching philosophy statement was incorporated into the interviews to provide a deeper insight into teachers' pedagogical beliefs. As Simamora et al. (2024) describe, teaching philosophy is a reflective document that captures a teacher's core values, goals and beliefs about teaching and learning. This reflective statement has been displayed to help teachers critically assess their teaching experiences and serves as a broader representation of their instructional beliefs, which may ultimately shape their classroom practices.

4.4 Data analysis

Guided by Webb's (2002) Model of Pedagogical Reasoning and Action, this multi-case study employed inductive thematic analysis (Braun & Clarke, 2006) to explore teachers' beliefs within the collected data. Braun and Clarke (2006) outlined six stages of inductive thematic analysis: transcribing the data, coding the data, identifying themes, reviewing the themes, naming the themes, and writing the analysis. Each case was examined separately using a cross-sectional

synthesis to determine whether common themes or explanations emerged to address the research question. To compare teachers' beliefs, the study employed both cross-case analysis and individual case analysis, as recommended by Stake (2006). This cross-sectional synthesis enabled a comparison of the unique and shared beliefs held by Agricultural Sciences teachers regarding the integration of simulations and hands-on teaching methods.

4.5 Trustworthiness

To enhance the study's trustworthiness, four quality criteria, credibility (internal validity), dependability (reliability), confirmability (objectivity), and transferability (external validity were applied, as proposed by Shenton (2004). Credibility was ensured by employing a team-based approach for data analysis to enhance intercoder reliability. Transferability was enhanced through comprehensive descriptions of the research context and the underlying assumptions central to the present study. The dependability was achieved by allowing other researchers to replicate the study. Confirmability was ensured by meticulously documenting all procedures to facilitate the process of verifying the data throughout the study.

5. Results

5.1 Case 01 Capricorn District Teacher 01

Teacher 01 is a 33-year-old woman with a bachelor's degree in education from a public university. She taught in a semi-urban area at a school with approximately 1,500 learners, 500 of whom are enrolled in Agricultural Sciences from Years 10 to 12. With seven years of teaching experience, she has been using simulations for practical instruction for the past five years. Due to the school's limited resources, she has relied heavily on simulations for practical lessons.

5.1.1 Teachers' beliefs about the comprehension of content taught through simulation and hands-on instruction

Teacher 01 expressed a pedagogical belief that simulation and hands-on integration significantly enhance learners' comprehension by simplifying complex content and capturing learners' attention. The teacher stated, "*I believe that simulation, hands-on integration, is invaluable and at the same time, makes things simple*," disclosing that technology-supported methods break down difficult concepts into more understandable forms. This belief highlighted the pedagogical value of visualisation and interactivity, where learners could grasp ideas more readily when they are presented practically and engagingly.

In addition, the teacher connected the engagement of the learner with comprehension, highlighting the appeal of technology to modern learners. The comment "*once they see these things about technology*", it's one of the things that makes them focus on what you're trying to impart' indicated that technology not only supports understanding but also fosters concentration and interest. This belief attest that the comprehension of the learner is closely related to motivation and attention, which are enhanced by using digital tools.

5.1.2 Teachers' beliefs about assessing learner understanding through integrated simulation and hands-on methods

Teacher 01 believed that integrated simulations and hands-on methods substantially enhance the assessment process by shifting the focus from teacher-centred instruction to learner-centred demonstration of understanding. The teacher noted: "*They improve the process. They provide a better opportunity to assess the understanding of learners, suggesting that these methods offer a more authentic and effective means of evaluating what learners truly grasp".* This belief reflected confidence in practical performance-based assessments in which learners can actively engage with content rather than passively recall information.

Furthermore, the teacher emphasises the facilitator role of the teacher, stating that" it *provided learners with a platform to do more than a teacher. You should facilitate. Learners should do this".* This echoes a constructivist belief in the value of active participation, where learners learn best by doing. The teacher concluded by this highlight, "*Once they do those things, they understand better*", reinforcing the idea that hands-on, experiential learning not only enhances comprehension but also serves as a more accurate measure of the understanding of the learner.

5.1.3 Teachers' beliefs about the role of self-reflection in improving teaching practices through integrated simulation and hands-on methods

The teacher emphasises the importance of self-reflection through ongoing professional development, particularly in the context of using simulation and hands-on methods. The statement "*I think it is very important for me as an individual to go to the workshops, to be trained*" indicated the belief that reflection is not limited to personal introspection but is also embedded in active learning opportunities. This belief binds reflective practice to continuous professional growth, where engaging with new knowledge and instructional strategies helps refine teaching approaches.

Additionally, the teacher values informal learning avenues, stating that: "*When you engage in those free courses... It allows you as an individual to grow".* This highlights the belief in self-driven improvement through accessible learning platforms. Although the teacher does not explicitly describe reflecting after lessons, their belief of growth through training implies a reflective orientation that is externally supported. This response indicated that the teacher saw professional reflection as a dynamic process fuelled by exposure to new methods and ongoing learning, which ultimately enhances his or her ability to implement simulation and hands-on strategies effectively in the classroom.

5.2 Case 02 Capricorn District Teacher 02

Teacher 02 is a 39-year-old male with a Bachelor of Technology in Agricultural Management from a public university of technology, along with a post-graduate certificate in education. He taught in a city school with approximately 2,000 learners, including 700 learners who studied agricultural science from grades 10 to 12. With 10 years of teaching experience, he has used simulations for practical instruction for the past three years. Although the school is well-resourced with state-of-the-art computer laboratories and interactive whiteboards (Clevertouch)

in every classroom, he relied heavily on simulations for practical lessons due to the absence of a farm and limited agricultural equipment.

5.2.1 Teachers' beliefs about the comprehension of content taught through simulation and hands-on instruction by learners

The teacher's response reflected a notable shift in belief about how learners comprehend Agricultural Sciences content. Initially, the teacher believed that comprehension was best achieved through direct physical engagement in the field, signifying a strong reliance on hands-on, real-world experiences. The phrase "*I believed that the learners could only understand if we were in the field with them*" highlights this earlier conviction. This belief aligns with a constructivist view, where learning is grounded in authentic, context-rich environments. However, the teacher's exposure to simulation and technology-based teaching transformed this belief.

Through experience, the teacher came to recognise the effectiveness of simulation in improving the comprehension of the learner. The statement "*I realised that they could comprehend a lot more through online demonstrations and simulations. It's a game changer"* indicates not only a newfound appreciation for technology, but also an acknowledgement of its pedagogical value. The use of 'a lot more' emphasises that simulation can even surpass traditional methods in facilitating understanding. The term 'game changer' denotes s a complete re-evaluation of previous assumptions, illustrating how belief is shaped by practical engagement with new instructional strategies. This shift also underscores the dynamic nature of teacher beliefs in response to evolving teaching tools and learners' outcomes.

5.2.2 Teachers' beliefs about assessing learner understanding through integrated simulation and hands-on methods

The teacher reveals an evolution in his belief in assessment through simulation and hands-on methods. Initially, there was uncertainty and scepticism about the reliability of these approaches, as reflected in the statement "*I wasn't sure if it would give me a true picture of the abilities of the learners*". This highlights a common concern among teachers when adopting non-traditional assessment strategies; questioning whether such methods truly reflect the knowledge and skills of learners. This hesitation implies that the teacher originally viewed conventional assessments as the standard for accuracy and validity.

However, through experience and observation, the teacher's belief shifted toward a more positive evaluation of simulation-based assessments. The comment, "*after seeing how they perform and how they can interact with quizzes online, I believe it is a more accurate way to evaluate their understanding*", indicates that technology-mediated assessments not only engage learners, but also provide meaningful insights into their comprehension. The ability of learners to interact dynamically with the content through simulations and quizzes allowed the teacher to gain deeper and more authentic evidence of understanding. This change reflects a belief in the value of interactive and formative assessments that align closely with the practical engagement of learners and the responses in real time.

5.2.3 Teachers' beliefs about the role of self-reflection in improving teaching practices through integrated simulation and hands-on methods

The teacher strongly believes in the importance of self-reflection as a tool for professional growth, especially in the context of using simulation and hands-on methods. The statement "*I believe reflection is essential for growth' positions reflection as a non-negotiable part of effective teaching practice*". This belief aligns with the self-efficacy framework, where teachers evaluate their teaching to build confidence and make informed improvements. The teacher's habit of consistently analysing their instructional strategies, "*After every lesson, I think about how I used simulations, hands-on methods, and what worked and what did not*" demonstrates a proactive and evaluative mindset.

Furthermore, the teacher sees reflection not only as a self-improvement mechanism, but also as an opportunity to enhance learner learning. The phrase "*This helps me refine my practice, so I am always improving and better serving my learners' suggests a learner-centred orientation*". This belief emphasises that teaching is an evolving process where refinement and adjustment, guided by thoughtful reflection, are crucial to achieving instructional effectiveness. The teacher's response reflects high self-efficacy and confidence in their ability to improve results through reflective practice; this also highlights how the integration of simulation and hands-on methods requires continuous assessment of one's teaching choices for meaningful progress.

5.3 Case 03 Capricorn District Teacher 03

Teacher 03 is a 42-year-old woman with a Bachelor of Science in Agriculture (Plant Production) from a public university and a postgraduate certificate in education. She taught at a farm-based school classified as an Agricultural High School, which has approximately 1,700 learners, including 690 learners who studied agricultural sciences from grades 10 to 12. With 15 years of teaching experience, she has been using simulations for the past 10 years. The school is well equipped with state-of-the-art computer laboratories and a fully functional farm. She conducted practical tasks with learners and integrated simulations as an additional teaching tool throughout the year.

5.3.1 Teachers' beliefs about the comprehension of content taught through simulation and hands-on instruction

The teacher expresses a strong technophilic belief that the integration of simulation and hands-on instructional methods substantially enhances the comprehension of learners. This belief is based on the view that combining these approaches creates a more engaging and meaningful learning experience. The teacher asserts, "*I believe that the combination will assist our learners and will also help us improve the results*', indicating a conviction that these methods not only support instructional delivery but also contribute to improved academic performance. The emphasis on learner outcomes asserts that the teacher sees these tools as both pedagogically sound and outcome driven.

Additionally, the teacher highlights the crucial role of ICT in facilitating understanding, particularly for complex or abstract content. The affirmation, "*using ICT in education is very important, it is very useful,"* reinforces the belief that

digital tools are essential to make content accessible and interactive. The teacher also recognises the value of simulations as substitutes for practical, stating that "*simulation helps when practicality is limited, and combinations yield better results since I started using these integrative methods*". This statement exhibits both a practical awareness of classroom constraints and a belief in the pedagogical power of simulations.

5.3.2 Teachers' beliefs about assessing learner understanding through integrated simulation and hands-on methods

The teacher strongly believes that the evaluation using integrated simulation and hands-on methods substantially improves the understanding and retention of the learners. This belief is rooted in the principle that learners learn best through visual and experiential engagement, as illustrated by the statement: "*Learners, in most cases, believe in seeing. If you teach them and show them, they will remember everything*". The teacher emphasises that practical, experience-based assessments make learning more memorable and meaningful, as active participation deepens comprehension and facilitates the application of knowledge. This belief aligns with a constructivist view that hands-on involvement strengthens cognitive connections and long-term retention.

Furthermore, the teacher values the feedback of the learners as an essential measure of the effectiveness of the evaluation, noting: "*The feedback from the learners has been positive; they like it*". This implies a learner-centred belief that assessment should not only evaluate understanding, but also foster motivation and confidence. The teacher also highlights the advantages of technology in making assessments more flexible and accessible, stating: "*These technologies have opened up the assessment as one can assess anywhere without having to physically be with them*". This reflects a progressive view of assessment that embraces digital tools to enable remote evaluation, real-time feedback, and continuous learning. Together, these beliefs signify a commitment to using simulation and technology to create engaging, practical, and adaptable assessment practices.

5.3.3 Teachers' beliefs about the role of self-reflection in improving teaching practices through integrated simulation and hands-on methods

The teacher expresses a clear conviction that self-reflection is essential for improving teaching practices, particularly when integrating simulation and hands-on methods. This belief is expressed in the statement, "you need to reflect on what you did and check where you went wrong to improve", which highlights reflection as a critical process for identifying instructional weaknesses and fostering continuous improvement. The teacher believes that regular self-assessment is a mechanism that enables teaching to evolve dynamically, ultimately leading to better learning outcomes and more effective classroom practices.

Additionally, the teacher links self-reflection with ongoing professional development and the necessity of staying current with technological advancements. The remark, "*we need to keep up with new technology and innovation through professional development*", reveals a wider understanding of reflection that extends beyond classroom experiences to include engagement with emerging

tools and pedagogical strategies. This belief emphasises the importance of adaptability and lifelong learning to maintain instructional relevance, especially as digital technologies increasingly support simulations and practical learning.

Table 1: Summary of results in all cases

Focus Area	Case 01	Case 02	Case 03
Teachers' beliefs about learners' comprehension of content taught through simulation and hands-on instruction	- Simulation and hands-on methods simplify complex content and enhance learner engagement. - Simulation supports the focus and motivation of the learner, enhancing comprehension.	-Initially, he believed that real-world fieldwork was essential for comprehension. -Changed to view simulation as a 'game changer ', improving understanding.	- Strong belief that simulation and hands-on methods improve comprehension and academic results. --ICT is crucial to make complex content accessible.
Teachers' beliefs about assessing learner understanding through integrated simulation and hands-on methods	-Hands-on assessments provide authentic learner understanding. -Teachers act as facilitators, encouraging active learning.	-Initial scepticism about simulation assessments shifted to confidence after observing learner performance. -Interactive assessments offer meaningful insights.	Hands-on assessments enhance retention and learner motivation. Technology enables flexible, remote, and real-time assessment.
Teachers' beliefs about the role of self-reflection in improving teaching practices through integrated simulation and hands-on methods	-Reflection is linked to professional development and training opportunities. -Growth occurs through ongoing external learning.	-Reflection is essential for continuous improvement. - Teachers evaluate lessons to refine practice and better r better serve learners.	-Reflection helps identify teaching weaknesses and promotes growth. -Professional development ensures adaptability to new technologies.

6. Discussion

6.1 Teachers' beliefs about the comprehension of content taught through simulation and hands-on instruction.

The results of our analysis reveal that teachers believed that simulation and hands-on methodologies, when augmented by technology, were effective in simplifying complex subject matter and improving the understanding of the learners. Teachers consistently highlighted that visual and interactive approaches contribute to making abstract concepts more accessible and engaging. In addition, they correlated increased learning engagement with enhanced understanding, noting that technology plays an imperative role in elevating learning motivation and concentration.

These insights align with the findings of Ajani (2024), who assert that teachers are confident in and aware of the extensive benefits that technology confers on science education, particularly through its visualisation capabilities. Additionally, their

study reinforces s a definitive relationship between teachers' beliefs and their pedagogical proficiency in effectively incorporating technology into instructional practice. Overall, teachers in our study perceived simulation and hands-on strategies as especially effective when they align with learners' technological preferences and learning styles.

Contrary to our findings, the study conducted by Acosta-Manzano and Mercer (2024) identified that certain teachers had negative beliefs about the effects of technology integration on the lives of learners. These teachers expressed fears about the absence of support for learners outside the classroom, as well as the difficulties that learners face in differentiating between genuine and superficial engagement, in both physical and digital settings.

Moreover, our analysis revealed that teachers initially believed that learner comprehension in Agricultural Sciences was primarily dependent on hands-on, real-world field experiences. However, through exposure to simulation tools and technological resources, this belief evolved, with teachers recognising that online demonstrations can, in some cases, enhance understanding even more effectively.

This shift expresses a dynamic process in which teachers' beliefs are reshaped through experience and participation in new instructional practices. Consistent with the findings of Acosta-Manzano & Mecer (2024), our study identified a notable pattern of belief transformation, supporting the belief that teachers often hold complex and sometimes contradictory beliefs that evolve as they encounter and acknowledge the pedagogical benefits of technology in their practice.

The analysis of the present study indicated that teachers had displayed robust technophilic beliefs, perceiving the integration of simulation and hands-on methods as effective in enhancing learners' comprehension and academic outcomes. Simulations were particularly valued as alternatives when opportunities for real-world practice had been limited, with teachers having observed improved outcomes from integrative methodologies. A distinct commitment to amalgamating technology with experiential learning to increase instructional effectiveness was evident.

These beliefs were illustrated to exert a significant influence on classroom practices. Consistent with Kasa et al. (2024), the study proposedd that sustained professional development could have facilitated the transformation of deeply held negative beliefs towards technology. Ultimately, the enhancement of teacher expertise was expected to result in more effective integration of technology within science education.

6.2 Teachers' beliefs about assessing learner understanding through integrated simulation and hands-on methods

The beliefs of the three teachers reflect broader pedagogical shifts in assessment, aligning with contemporary constructivist and experiential learning theories (Hwang et al., 2023). Teachers 01 and 03 emphasise active engagement and authentic assessment, consistent with research demonstrating that simulations and hands-on tasks improve retention and conceptual understanding (Freeman et

al., 2020; Mayer, 2021). Their beliefs support the notion that learner-centred approaches foster deeper cognitive processing and intrinsic motivation (Ryan & Deci, 2020), reinforcing the value of assessment methods that prioritise application over rote memorisation. Teacher 03's observation of increased learner confidence further underscores the metacognitive benefits of experiential learning (Zimmerman, 2013), postulating that such methods not only assess but also reinforce comprehension.

The evolving beliefs of Teacher 02, from scepticism to acceptance, illustrate a common path in teacher adoption of innovative assessment practices (Guskey, 2002). Initial reservations about reliability mirror historical debates on the trade-offs between standardised testing and authentic assessment (Wiliam, 2018). However, the teacher's eventual endorsement of technology-mediated methods aligns with recent findings on the efficacy of digital tools in providing adaptive immediate feedback (Hwang et al., 2022).

This shift highlights the importance of experiential evidence in overcoming pedagogical resistance, suggesting that professional development should incorporate hands-on demonstrations to facilitate belief transformation (Desimone, 2023). Communally, these cases underscore the growing emphasis on teacher roles and technology-enhanced assessment in modern education (Ifenthaler, 2023). Although the benefits of simulations and active learning are well-supported, challenges remain in scalability and equitable access (Selwyn, 2022).

6.3 Teachers' beliefs about the role of self-reflection in improving teaching practices through integrated simulation and hands-on methods

Self-efficacy beliefs also play a crucial role, since teacher 01's commitment to reflective practice aligns with Bandura's (1997) theory that self-regulation empowers teachers to refine their strategies. Teacher 02's focus on self-reflection for pedagogical improvement reinforces the idea that confidence in one's abilities predicts the willingness to adopt innovative methods (Gbemu et al., 2020). Contrary to the findings of Gbemu et al. (2020), which associated low self-efficacy with avoidance of technology, the current study revealed that teachers in the Capricorn District actively engage in professional development to strengthen their ICT competencies. This shows that self-efficacy is not static but can be cultivated through collaborative learning and institutional encouragement, ultimately fostering greater technology adoption.

Furthermore, this analysis indicates that teachers strongly believe in the importance of self-reflection as a crucial element of professional growth, especially in the context of using simulation and hands-on instructional methods. Participants reported routine participation in post-lesson evaluations to assess the effectiveness of their teaching strategies, demonstrating a proactive and reflective teaching attitude. This reflective practice is regarded as essential in refining instructional approaches and enhancing learner outcomes, emphasising a learner-centred pedagogy.

Such beliefs illustrate a high level of self-efficacy, with teachers dedicated to continuous improvement through deliberate and thoughtful reflection. These findings correspond to those of Yang et al. (2024), who noted an increase in teacher self-efficacy related to the integration of AI-based technologies, particularly in aspects such as classroom management, learning engagement, and instructional strategies. Overall, these results imply that reflective practice, combined with technology integration, can facilitate the shift from traditional to more innovative, technology-enhanced teaching methods.

In contrast, these findings diverge from those of Olawale and Hendricks (2024), who reported that despite teachers' confidence in their instructional strategies, their beliefs about self-efficacy were negatively influenced by contextual factors such as the type of school they taught and their level of education. However, in this study, teachers consistently expressed a strong belief in the value of self-reflection as a key mechanism to improve instructional practice, particularly when implementing simulation and hands-on teaching methods. They viewed reflection as essential to identify areas of weakness and promote continuous professional growth.

Fundamentally, teachers characterised reflection as an ongoing process that not only enhances classroom effectiveness but also contributes to improved learning outcomes. They also associated reflective practice with professional development, emphasising the importance of staying up to date with emerging technologies and pedagogical innovations. In general, reflection was perceived not only as an instructional tool but also as a personal and professional responsibility, central to fostering growth, adaptability, and future-oriented teaching practices.

Notably, this analysis highlights the essential role of teacher beliefs in promoting self-reflection to improve teaching practices, particularly through the integration of simulation and hands-on instructional strategies. The findings emphasise the importance of ongoing professional development, such as workshops and formal training, as a foundation for effective reflective practice. Teachers regarded reflection as an active learning process that greatly contributes to the refinement of pedagogical approaches. In addition to structured professional development, participants also valued informal, self-directed learning opportunities, such as free online courses, as essential tools for personal and professional growth.

Overall, professional reflection was viewed as a dynamic and continuous process, bolstered by regular exposure to new methodologies, which, in turn, enhances the effective implementation of simulation and practical teaching strategies. These findings complement those of Wyatt (2024), who emphasised the need for further research on teacher beliefs and self-efficacy, particularly in the context of technology integration. As recent studies (Yang et al., 2024; Gbemu et al., 2020) have shown, understanding these evolving belief patterns is crucial for addressing the challenges and implications associated with contemporary teaching practices.

7. Conclusions

The findings of this study aver that teachers in the Capricorn District have overwhelmingly positive beliefs about the role of simulation and hands-on instruction, especially when complemented by technology, in enhancing the comprehension of learners. Teachers viewed visualisation, interactivity, and learner-centred engagement as crucial to breaking down complex Agricultural Sciences content. These beliefs reflect a broader awareness of the pedagogical value of aligning instructional methods with learners' digital preferences, supporting the assertion that belief systems significantly influence classroom practice. Additionally, the transformation of beliefs was evident, particularly as teachers engaged with new tools and observed improved learning outcomes, indicating that beliefs are not static but responsive to practical experience and evolving educational paradigms.

The study also revealed a meaningful shift in teachers' beliefs about assessment methods, with many transitioning from traditional approaches to favouring technology-enhanced and experiential assessments. Teachers increasingly recognised the value of authentic performance-based evaluation in promoting deeper understanding and motivation of learners. While initial scepticism was present, particularly regarding the reliability of these methods, experiential evidence and professional development contributed to shifts in belief. The endorsement of these practices aligns with constructivist and experiential theories, reinforcing the role of technology not only in teaching but also in effectively assessing learner comprehension in meaningful and contextually relevant ways.

Moreover, self-reflection emerged as a fundamental belief that informs teacher professional growth and instructional decision-making. Teachers expressed a deep commitment to reflective practice, perceiving it as essential for evaluating and refining pedagogical strategies, particularly in the integration of simulation and hands-on methods. These beliefs were underpinned by strong self-efficacy and a proactive attitude towards continuous improvement. Teachers viewed reflection as a dynamic process facilitated by both formal training and informal learning opportunities. These findings reveal a professional identity grounded in adaptability, lifelong learning, and openness to innovation, recommending a solid foundation for sustained technological integration in agricultural sciences education.

8. Recommendation

Based on these findings, it is recommended that ongoing, context-sensitive professional development programmes be implemented to support and sustain positive teacher beliefs about simulation, hands-on instruction, and technology integration. These programmes should prioritise experiential training, reflective practice, and peer collaboration to reinforce belief transformation and practical application. Similarly, schools should create supportive environments that promote equitable access to digital resources and encourage teacher-led innovation, ensuring that the integration of simulation-based and hands-on

methodologies continues to evolve in response to both learner needs and emerging technological possibilities.

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