

Difficulties encountered by engineering graphics and design teachers in integrating ICT into classroom teaching: A case study of technical schools in Umgungundlovu

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Abstract

The integration of information and communications technology (ICT) in the engineering graphics, and design (EGD) classroom is essential to enhance learning by providing learners with advanced tools to understand abstract EGD concepts. However, there are few challenges that are proving to be a stumbling block. Hence, this study is to investigate the barriers that prevent effective integration of ICT in EGD classrooms. Nine EGD teachers from technical schools in the uMgungundlovu District of KwaZulu-Natal (KZN) Province in South Africa were purposively sampled. The primary objective of this study was to investigate specific challenges EGD teachers face when attempting to integrate ICT tools into their teaching practices. Therefore, the study was anchored on the unified theory of acceptance and use of technology and self-efficacy theories conceptual framework. To explore the phenomenon, a descriptive research approach was utilized to obtain data. As a result, data was gathered through semi-structured interviews and classroom observations which was analyzed thematically. The findings revealed a lack of ICT tools in some of the technical schools, security breaches leading to the stealing of ICT tools, and had teachers with limited technological skills, all of which contributed to hindering the effective integration of ICT in EGD classrooms. Based on the findings, the study recommends the department of basic education (DBE) in KZN to equip schools without ICT resources and implement stronger security measures to protect these resources. Moreover, the study further recommends DBE to take action to empower teachers with limited technological skills by providing training on ICT usage.

Keywords: information and communications technology, engineering graphics, and design, teachers, teaching practices

INTRODUCTION

Infusing information and communications technology (ICT) in teaching pedagogies is something that has gained prominence over the years, more especially as the world is moving to the 5th Industrial Revolution. Recently, however, there has been an increased emphasis on the need to integrate ICT into teaching pedagogies, particularly in engineering graphics and design (EGD), which has gained

momentum owing to the outbreak of COVID-19, which compelled educational institutions to migrate to virtual learning. Numerous scholars have offered varied definitions of ICT, generally highlighting the integration of software and hardware in education. For example, Bornman (2016) describes ICT as encompassing all technological tools like computers and tablets that enable users to access, create, and modify information. Similarly, Cardullo et al. (2018) characterize ICT as including network devices, computers, and a broad

This work emanates from a thesis study, which was partly presented in an academic conference but without any publication.

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Contribution to the literature

- This research enhances existing literature by focusing on the difficulties encountered by EGD teachers in incorporating ICT.
- This research contributes to the existing literature by addressing a gap in EGD, offering new insights into ICT integration. Anchored on the unified theory of acceptance and use of technology (UTAUT) together with the self-efficacy conceptual framework, the study provides a fresh perspectives, challenge dominant assumptions, and opens new avenues for understanding complex issues. That also helped to address gaps in the literature by framing problems in innovative ways that traditional theories may overlook.
- By employing qualitative data method, this research offers valuable insights and empirical evidence enhancing the understanding of the challenges faced by teachers in infusing ICTs in EGD lessons, and with the potential to hinder learners' understanding of key EGD concepts, their overall academic performance and confidence in the subject.

range of telecommunication technologies designed for interactive communication and data exchange capabilities. Lindén (2013), on the other hand defines ICT by emphasizing its use in communication through devices such as cell phones along with applications meant for transmitting information.

Given the importance of ICT integration in teaching and learning of EGD; however, migrating to virtual learning has prompted a challenge, as some of the schools around the uMgungundlovu District only had access to the photocopying machine. This indicates that integrating ICT is something that would be impossible for those schools; hence, they stick to the traditional methods. While the shift to virtual learning is a beneficial move in light of the global transition to the digital era, some teachers are incapable of conducting online lessons due to various impediments. Msila (2015) supports the idea that teachers strongly believe training is essential for effectively integrating ICT into EGD lessons. While technology has become an integral part of teachers' daily lives (Şahal & Ozdemir, 2020), it has not yet had the expected influence on their classroom practices. In support of the above assertion, Vesisenaho et al. (2024) found that some teachers lack confidence in infusing ICT in their lessons, which poses the question of how much and what way they can integrate ICT for their lessons. Howard and Mozejko (2015) highlight the issue of teachers' diminished confidence, attributing it to their lack of proper training. Adams (2020) asserts that the lack of proper ICT training spells doom for teachers. Barbour (2014) further emphasized the need to provide teachers with ICT skills through development programs and workshops. The effective integration of ICT into teaching and learning relies heavily on proper teacher training. For teachers to effectively implement ICT in education, training is essential. Recognizing the significance of ICT, many countries worldwide have begun offering ICT training to educators in different formats and levels (Bayter et al., 2023).

In South Africa, however, some teachers still assert that they have not received adequate training to effectively use technology in teaching and learning. The

gradual pace of ICT integration can be attributed to several factors, including insufficient training for teachers and their reluctance to adopt ICT tools, which is often linked to their attitudes and lack of confidence. Mashile (2017) argues that the slow ICT integration in South Africa is due to only 26% of teachers possessing the necessary ICT skills, a concerning statistic given the constant evolution of technology. Munje and Jita (2020) further confirm that several schools in South Africa fail to fully integrate ICT into teaching, and in some instances, are underutilizing the available resources, leading to consequences for teaching and learning. This paper focuses on exploring the challenges faced by EGD teachers in the adoption of ICT in their classrooms. The study was conducted in the Technical Schools of the uMgungundlovu District of KwaZulu-Natal Province in South Africa.

Purpose

The purpose of the study was to highlight the difficulties encountered by EGD teachers in integrating ICT into EGD classrooms with a view to identify barriers, assess the impact of these challenges on teaching and learning, and propose possible strategies for effective ICT adoption in EGD classrooms.

Research Questions

1. What are the key difficulties faced by EGD teachers when adopting ICT in their teaching practices? (interviews).
2. What strategies can be implemented to enhance the effective integration of ICT in EGD classrooms? (interviews and observations).

LITERATURE REVIEW

In academic research, literature is derived from scholarly written works, books, journal and research articles to provide knowledge and perspectives. It serves as a foundation for understanding existing theories, identifying gaps, and supporting new studies. However, this study focused on the following points:

- (1) availability of resources in schools to integrate ICT,
- (2) importance of ICT training for teachers, and
- (3) significance of ICT in EGD classrooms.

Availability of Resources in Schools to Integrate ICT

In order for EGD teachers to integrate ICT effectively into their teaching, they must have access to ICT resources, and classrooms must be adequately equipped to support this integration. Mathevula and Uwizeyimana (2014) support this idea, emphasizing that ICT equipment must be available in schools before teachers can begin using it in their teaching. The ability to teach abstract concepts through ICT is crucial for enhancing learners' understanding of EGD concepts. This view is supported by Mlambo (2024) and Mlambo et al. (2023), who propose tools like AutoCAD software and educational videos on platforms such as YouTube and TikTok. Khubayi et al. (2024) and Mtshali (2023) can enhance students' comprehension of EGD and other technical subjects' concepts. In the same vein, Smith and Brown (2019) highlighted that a lack of proper ICT tools hinders practical learning experiences and impedes learners' grasp of hands-on topics. The importance of incorporating ICT in classrooms extends beyond EGD classes and is crucial for other technical subjects like mechanical technology (Morudu, 2025). Msimango (2024) similarly emphasizes the importance of digitizing education at the secondary level to transform the teaching of civil technology. This highlights how critical ICT integration is, not just in EGD classrooms but across all technical subjects, as noted by these scholars.

By design, EGD is a practical-orientated subject, necessitating a practical approach. Therefore, it is unrealistic to expect developing countries such as South Africa to effectively incorporate ICT into their teaching pedagogies, given that some schools lack even the most basic ICT infrastructure. The lack of ICT resources has consistently been a major issue for teachers across the globe, especially in developing countries such as South Africa. Mathevula and Uwizeyimana (2014) expressed similar views, highlighting the scarcity of ICT resources for integration in schools. According to them, teachers primarily have access to photocopiers, TVs, and either laptops or desktop computers. Nevertheless, Graham et al. (2020) emphasized that having adequate resources and technical knowledge does not necessarily lead to their use in teaching.

According to the Department of Basic Education (DBE) (2011), basic ICT resources like an IWB, AutoCAD, and a projector are essential for schools wishing to incorporate ICT into the teaching and learning of EGD. Alharbi (2021) highlighted that the lack of resources is a key barrier teachers face in ICT integration. The scarcity of ICT resources is a global issue which hinders the successful integration of ICT in teaching and learning

(Sokhulu & Ndebele, 2025), with South Africa being no exception. This assertion is backed by the study on the availability and use of ICT equipment on the teaching and learning in public secondary schools in Delta Central Senatorial District, Delta State, Nigeria (Ubogu & Ogbede, 2023), the lack of the ability of Saudi teachers (Addandani, 2011), Availability of ICT facilities in Indian secondary schools (Prasad, 2018), Integration of ICT in secondary education for better learning: A systematic literature review by Msambwa et al. (2024) in Kenya, these studies agree that insufficient ICT resources in schools worldwide pose a significant barrier to the effective integration of technology. These studies align with the findings of Ubogu (2013), who identified unreliable power supply in some schools as another factor that impacts the use of ICT in teaching and learning.

This is a widespread challenge globally when it comes to integrating ICT into education, and schools that offer EGD in the uMgungundlovu District might be facing similar difficulties. Alharbi (2021) also emphasizes that the shortage of resources includes a lack of educational software, which places teachers at a disadvantage. Although computers may be available, the absence of both educational software and internet access can significantly hinder teachers' ability to teach effectively (Alharbi, 2021). Notably, AutoCAD is the primary software used in EGD to simplify abstract concepts.

For computers to function efficiently and be able to assist teachers in integrating ICT into EGD lessons, those computers must be installed with relevant educational software. Interestingly, Molotsi (2022) found that despite schools providing various ICT tools, some teachers are not utilizing them optimally. This is an indication that EGD teachers can have resources at their disposal but fail to use them in their teaching pedagogies. The objective of this study was to examine the difficulties that EGD teachers face in incorporating ICT into their classrooms at uMgungundlovu Technical Schools.

Importance of ICT Training for Teachers

Effective integration of ICT into education relies heavily on proper teacher training. According to Alazam et al. (2013), when used effectively by a trained teacher, ICT can become a vital tool in the classroom. This underscores the necessity for teachers to receive thorough training in order to incorporate ICT into teaching and learning effectively especially in EGD lessons. Alazam et al. (2013) discovered that the level of teachers' ICT skills and usage was moderate in a study that examined the levels of ICT skills and ICT use in classrooms. Additionally, Rastogi and Malhotra (2013) found that teachers with trained ICT skills are more inclined to incorporate ICTs in their lessons than those without. This underscores the significance of comprehensive training for teachers, enabling them to

integrate ICT effectively. It is troubling that, due to limited access to modern ICT tools and insufficient training, teachers still consider WhatsApp as a main tool for enhancing the teaching and learning process (Asmara, 2020).

The global recognition of teacher training as an essential step in effectively integrating ICT is growing. Tasir et al. (2012) observed that more countries are now offering teacher training programs focused on ICT integration. This highlights that for quite some time, there has been a growing global awareness of the importance of training teachers to effectively use ICT in their teaching pedagogies. With the worldwide surge in ICT usage, there is a clear need for individuals to acquire ICT skills, which are crucial in the modern world. Matongo (2022) pointed out that many teachers lack the confidence to use technology in the classroom due to insufficient ICT training. Furthermore, Matongo (2022) warned that without training, teachers are less inclined to use technology, as they may develop a fear of it. Therefore, ICT training is a key factor in empowering teachers to integrate technology into their teaching. However, most authors have stressed that teachers must be willing to integrate ICT, or the training will have no effect and be just a futile exercise.

Significance of ICT in EGD Classrooms

Sotsaka (2015) notes that EGD, previously referred to as technical drawing, has undergone significant changes beyond just its name. The alterations included the subject's context, assessment methods, and teaching styles. These shifts highlight a trend of ongoing transformation within EGD; updates in the curriculum necessitated new instructional approaches for delivering content effectively. Specifically, these pedagogical innovations have focused on incorporating technology into both learning and instruction. Supporting this perspective from DBE (2011), one key objective of EGD is integrating computer-aided design techniques to address graphical problems through drawing tasks. This goal can be achieved by embedding ICT into EGD lessons since many concepts involved are abstract by nature—meaning they aren't easily visible or tangible without aid—which ICT integration helps clarify further. By doing so, students can better understand complex ideas and proficiently create accurate drawings with greater ease.

According to a study by Khoza (2013), learners often struggle with spatial skills, which hampers their understanding of certain concepts in EGD. The research highlighted that many students particularly have trouble with rotating objects. Similarly, Makgato's (2016) study reported poor performance among most learners on the Purdue spatial visualization test (PSVT) he conducted. Rodriguez and Rodriguez-Velazquez (2017) noted that PSVT is extensively used for evaluating the

ability to rotate three-dimensional objects. Introducing AutoCAD into EGD could help enhance these spatial abilities in students. Supporting this idea, Pedrosa et al. (2014) argue that information communication technology tools can aid in developing spatial visualization because they facilitate interaction with 3D models.

CONCEPTUAL FRAMEWORK

According to Imenda (2014), a conceptual framework is formed by combining various related theories to explain a research issue. As such, to examine the difficulties that EGD teachers face in incorporating ICT into their classrooms at uMgungundlovu technical schools, the study applied Venkatesh's (2003) UTAUT and Bandura's (1977) self-efficacy theory. Momani (2020) suggests that UTAUT has recently emerged as one of the most advanced and comprehensive models for assessing technology adoption and acceptance. In this study, the UTAUT was used to analyze factors which influence the adoption of ICT by EGD teachers. According to Venkatesh (2003), UTAUT identifies four primary factors for example, performance expectations, effort expectations, social influence, and facilitating conditions that determine whether teachers adopt ICT tools in their classrooms. UTAUT also includes moderating factors such as age, gender, experience, and voluntariness of use, which affect the strength of the primary factors. For example, younger teachers may find ICT tools easier to use (high effort expectancy), while older teachers might need more training and support. In the context of EGD classrooms, UTAUT can be applied to examine how these factors influence EGD teachers' willingness and ability to adopt ICT in their teaching. By analyzing the barriers and motivators affecting ICT adoption, this model helps in developing targeted interventions, such as professional development programs and support to enhance ICT integration in education.

However, for the purpose of the study, only three factors (performance expectancy, effort expectancy and facilitating conditions) were adopted, as they were considered critical to assist the study. For instance, when EGD teachers believe that ICT will improve the quality of their teaching (performance expectancy) and perceive it as user-friendly (effort expectancy), they are more inclined to incorporate it into their lessons. However, challenges such as lack of ICT resources and inadequate training (facilitating conditions) may actually hinder the adoption of ICT tools. Xue et al. (2024) believe that facilitating conditions have a direct relationship to performance and effort expectancies such that the two factors may be dependent on the availability of resources and infrastructure necessary for technology use. Additionally, Venkatesh et al. (2016) state that performance expectancy and effort expectancy within the UTAUT framework affect an individual's intention

Table 1. Biographical data

Name of teachers	Gender	Majors	Teaching experience
Teacher A	Male	EGD and motor mechanics	18 years
Teacher B	Female	EGD and technology	11 years
Teacher C	Female	EGD and mechanical technology	9 years
Teacher D	Male	EGD and technology	14 years
Teacher E	Female	Technical drawing and woodworking	25 years
Teacher F	Female	Technical drawing, mathematics and woodworking	20 years
Teacher G	Male	EGD and mechanical technology	4 years
Teacher H	Male	EGD	19 years
Teacher I	Female	Technical drawing and civil technology	25 years

to adopt technology, whereas actual technological use is influenced by facilitating conditions. By applying the three UTAUT factors, the study could assess which of these factors pose the greatest challenges for EGD teachers, providing insights into specific barriers and opportunities for ICT integration.

Conversely, self-efficacy theory, an element of Bandura's (1977) social cognitive theory put emphasis on an individual's confidence in their ability to utilize technology efficiently. Bhati and Sethy (2022) argue that merely acquiring the necessary skills and competencies is not enough to complete a task, one must also believe in their capability to perform it. Bandura's (1977) theory is frequently applied in research examining gender disparities in teachers' use of ICT, serving as a theoretical framework for understanding teachers' ICT self-efficacy (Šabić et al., 2022). But this study focused on all genders for a balanced data. To corroborate the above, Maddux (2016) attests that self-efficacy is not a biased perceived skill but a belief in what one can do with their skills to perform certain tasks under certain conditions. As such, irrespective of their gender, EGD teachers who possess a strong sense of ICT self-efficacy are more inclined to embrace digital tools, while those with low confidence may avoid them, even if resources are available. This theory can help identify whether lack of training, fear of failure, or limited experience contributes to teachers' reluctance to adopt ICT. By measuring teachers' self-efficacy levels, the study can propose tailored professional development programs and confidence-building strategies to enhance ICT adoption. When combined, UTAUT and self-efficacy theory provide a holistic framework for understanding both external (inadequate training and lack of resources) and internal (personal) issues EGD teachers face in adopting ICT tools for classroom instruction.

METHODOLOGY

A qualitative research approach was utilized in this study to gather data aimed at describing the phenomenon. As noted by Bhandari (2020), qualitative research entails the collection and examination of data that cannot be quantified numerically. The need for an in-depth understanding was clear, as the study aimed to identify the barriers faced by EGD teachers. Therefore,

the most suitable method was to obtain insights directly from the teachers. The selected data collection techniques were intentionally chosen for their effectiveness in capturing detailed information from the participants. This study used convenience sampling to select 9 EGD teachers from 9 different schools. As can be seen from the biographical data in **Table 1**.

Table 1 shows all the teachers who took part in the study. These teachers are professionally trained to teach EGD, as they are all in possession of EGD as a major subject in their qualifications, which means they are sufficiently qualified to teach EGD. In terms of age, there is a mix of teachers who were born before technology and those who were born after technology, who are referred to as "digital natives."

Of the 141 public secondary schools in the uMgungundlovu District, only 11 offer the EGD as a subject. Although the original plan was to involve all 11 schools offering EGD, only 9 schools consented to participate. Therefore, the study included one teacher from each of these 9 schools. As noted by Taherdoost (2016), convenience sampling refers to choosing participants who are easily reachable and available. Researchers opted for this sampling approach due to its affordability and its capacity to bypass many possible limitations. As Taherdoost (2016) notes, convenience sampling is particularly beneficial because it is quick, easy to implement, and low in cost.

Convenience sampling was used as the only criteria for selecting participants who were willing and available to participate in the study. This method is simpler compared to other sampling techniques because it targets individuals who are accessible. Additionally, the geographical proximity of EGD teachers made it easier to select those near the researcher, which helped save time and reduce costs (Etikan et al., 2016). Subsequently, data was collected through open-ended semi-structured interviews and classroom observations. To protect the true identities of teachers and schools, pseudonyms were used.

Data Analysis

Beyond the differences in data analysis in different qualitative methods, coding, categorizing and developing themes are the essential phases of data

analysis in most methods (Vinitha, 2019). The analysis in this study was guided by Braun and Clarke (2006) six steps of thematic analyses. Thematic analysis, which involves identifying, organising, and interpreting patterns or themes within the data, enables the analysis of interviews and observation data. As data analysis is a process of gathering, cleaning, transforming, and modelling data to extract essential insights (Alem, 2020), the researchers first transcribed the interview and observation notes, then coded the data by identifying and labelling significant segments related to the research questions (RQs). These codes were later organized into broader themes reflecting the participants' experiences. Finally, the themes were interpreted and supported with direct quotes to provide a rich, contextual understanding of the findings. The interview consisted of semi-structured questions designed to explore participants' experiences with ICT integration in EGD classrooms. Sample questions included:

1. Can you describe how you currently use ICT in your EGD lessons?
2. What challenges have you encountered when using technology for teaching?

These questions were aligned with constructs from the UTAUT model, such as performance expectancy and facilitating conditions.

On the other hand, the classroom observations were done in accordance with the frameworks adopted in this study. The observation schedule, containing the criteria that the researcher used to obtain information and the analysis thereof, was done in sequence as per the observation schedule.

Quality Criteria

According to Timenon et al. (2024), quality in research is not achieved simply through checklists but by carefully formulating RQs, obtaining data through reliable methods, analyzing the data credibly, and accurately interpreting it while staying relevant. Despite the inherent limitations of qualitative research, such as subjectivity and limited resources, applying measures to ensure trustworthiness enhances its reliability and precision (Ahmed, 2024). As such, quality in qualitative research should be defined by a network of relationships which are integrated throughout the entire research process. In the context of this study, trustworthiness was essential for qualitative research that uses semi-structured interviews and classroom observations, and this was achieved through four quality criteria in the form of credibility, transferability, dependability and confirmability. The credibility of the study was enhanced and triangulated through comparing data from interviews and observations to ensure consistency and further reinforced through member checking, where participants validated the accuracy of their responses.

Sotsaka and Singh-Pillay (2020) corroborate this, asserting that a study that employs two or more data collection methods constitutes triangulation. To achieve transferability, the study selected EGD teachers from diverse technical schools in the uMgungundlovu District to capture a wide range of experiences and perspectives indicating the applicability of the findings to other similar settings. Dependability was ensured by maintaining an audit trail that documented the research process in detail and by using peer debriefing to review interpretations and coding for consistency. Additionally, to emphasize neutrality, data from respondents were used to enhance the confirmability of the findings. By adhering to these criteria, the study maintains rigor and ensures that the challenges of ICT adoption faced by EGD teachers are accurately and reliably captured.

RESULTS

Findings from Interviews Data

The interviews assisted in responding to RQ1: "What are the main challenges faced by EGD teachers in adopting ICT in EGD classrooms within uMgungundlovu technical schools?" and RQ2: "What strategies can be implemented to enhance the effective integration of ICT in EGD classrooms?"

By using open-ended, semi-structured interviews, interviewees were given the chance to express themselves freely, fostering a conversation with the researcher rather than a simple question-and-answer format. The interview results were transcribed to obtain the themes or patterns of all the results about what the teachers said. The interviews with the nine EGDs took place in their EGD classrooms.

On the question about the challenges teachers experienced in adopting technology, to respond to RQ1, below is how teachers responded:

Teacher H responded,

"I don't have a challenge in using ICT, I am confident. It's just that I do not have the correct equipment for example a projector. Here in school, we do not have a projector, I have to buy it, and a projector is very expensive."

Furthermore, teacher F said the following:

"Our school has lot of subjects that are being offered and there are only two projectors, so sometimes if I prepare a lesson and I wish to use a particular type of technology and the other teacher wants to use it as well, that becomes a challenge. Only a photocopier that I have access to anytime."

When questioned, teacher G said,

"The computer that we have here at school doesn't have AutoCAD. We do not have smartboards nor a whiteboard, what we have is a chalkboard."

Teacher I said,

"The laptop I use is mine. I use my own because here in school there were break ins and the laptops that were provided by DoE were stolen. Besides, we have consistent power outages which is a huge challenge to the use of ICT tools in teaching and learning."

Teacher A said,

"The challenge we have in this school is that we do not have a computer lab where we can use AutoCAD and learners can also AutoCAD for PAT purposes. Though, when resources are available and the conditions allow, I use the resources effectively for the benefit of learners."

Teacher G said,

"In terms of AutoCAD, it is still a challenge because we know how to use AutoCAD, but you cannot put it in any computer. The computer that we have here at school does not support AutoCAD. However, I do use other elementary tools."

In the same vein, teacher D said,

"We do have a computer lab, the only thing we do not have is a license for the AutoCAD."

Interestingly, teacher E said,

"Though we do have all the resources but AutoCAD it is still a challenge for me. I need to be trained because I do not know how to draw using a computer, so it is a big challenge for me."

Based on the quotations above, the emerging theme is the insufficient availability of ICT resources in schools. Many teachers highlighted that the main difficulty they face is the lack of access to ICT resources in their schools. Some teachers claimed they do not face challenges using ICT in their lessons, while others were upfront about their difficulties with critical ICT tools like AutoCAD. Teachers also revealed that other impediments to integrating ICT into their EGD lessons include a lack of resources such as modern computers for installing AutoCAD software, power outages, a lack of training, and a shortage of computer labs, projectors, and even laptops. Alharbi (2021) echoes this viewpoint, arguing that teachers face numerous challenges daily when attempting to integrate ICT into teaching and learning. From the interviews, it appears that teachers believe in the adoption of technology (performance expectancy) to enhance their EGD lessons but are held back by the

unavailability of resources (facilitating conditions). This assumption finds support in Xue et al. (2024), who opined that the UTAUT facilitating conditions have a direct relationship to performance expectancy such that the latter factor is dependent on the availability of resources and infrastructure necessary for technology adoption. In corroboration of a teacher who said,

"AutoCAD is still a challenge because we know how to use AutoCAD, but you cannot put it in any computer. The computer that we have here at school does not support AutoCAD; however, I do use elementary tools."

The teacher's confidence in his abilities is bolstered by Maddux's (2016) assertion that self-efficacy is not a perceived skill, but rather a belief in one's ability to perform specific tasks under specific conditions. Interestingly, one teacher mentioned that all resources are there, but he still needs training. Molotsi (2022) corroborates this finding, asserting that while schools provide various ICT tools to some teachers, they are not using them optimally. Graham et al. (2020) reinforces this argument by stating that the availability of resources and sufficient teacher knowledge does not necessarily lead to the use of ICT. In a related case, one teacher revealed that the DBE (2011) had supplied the school with ICT resources, but they were stolen, indicating that the DBE (2011) is making efforts to provide resources to support ICT integration in teaching.

To respond to RQ2, on the strategies that can be implemented to enhance the effective integration of ICT in EGD classrooms. Below is how teachers responded.

In addition to what is indicated above, teacher H from school H said,

"To try and enhance my lessons under the circumstances, I give learners work using WhatsApp, where you can just send videos or pictures to reinforce certain concepts. WhatsApp is cheap, and everyone has access to it. Additionally, the chalkboard and videos are valuable tools for demonstrating concepts."

Teacher B from school B also confirmed that WhatsApp was the only way she uses to enhance her lessons:

"I created a WhatsApp group, and I send information like, 'Maybe this week you can read your books from this page to that page and try to do those activities that are there.' For example, in isometric drawing in grade 12, I would ask learners to draw it, take pictures, and send it back to me."

Teacher I had the following to say:

"I use my own laptop and the projector to present my lessons. I also confidently use the whiteboard in my teaching. That's supplemented by video calls through WhatsApp, where I record myself presenting a topic and send it to learners. Besides, I also use videos to demonstrate certain concept on TV."

According to the responses above, the theme that emerged is using WhatsApp to enhance lessons. These responses are consistent with Asmara (2020), who showed disapproval that teachers still see WhatsApp as the tool to support the process of teaching and learning because of a lack of modern ICT tools and lacking training in using advanced ICT tools. However, some of the teachers mentioned the use of computers, a projectors, videos and whiteboards to teach. These findings are corroborated by Mathevula and Uwizeyimana (2014) who asserted that teachers primarily have access to photocopiers, TVs, and either laptops or desktop computers.

Findings from the Observation Data

Nine EGD teachers in the uMgungundlovu District participated in the classroom observations, which helped to address RQ2. All the observations were done in the teachers' classrooms, and they lasted for an hour in line with the duration of the lessons. Observations were made against a combination of two factors of the UTAUT and self-efficacy theories to provide a holistic framework for understanding both external (inadequate training and lack of resources) and internal (personal) challenges such as those faced by EGD teachers in integrating ICT into their classrooms.

Below are the observations from different teachers with respect to the components of UTAUT and self-efficacy owing to external and internal factors.

On Teacher I: The observation was through the usage of the whiteboard, the computer and the projector, and he taught using the whiteboard very well but couldn't draw using AutoCAD as there was none. Despite lacking AutoCAD, the teacher exhibited confidence in using the technologies that were at his disposal. The teacher's strategy was exceptional as he exhibited no struggles at all. The researcher can conclude that teacher I displayed a high level of confidence in using technologies that were at his disposal.

Teacher A also exhibited a high level of confidence as far as choosing relevant technologies for the lesson he was conducting. He chose to use a whiteboard instead of a chalkboard, which was his choice of relevant technology for a certain lesson. The teacher drew a sketch on the whiteboard using the set squares and a marker. He created the sketch to explain the hatching. While drawing, he showed a high level of accuracy and competency in using a whiteboard and the drawing instruments. Thereafter, learners proceeded to draw

while he moved around the class to assist struggling learners. The researcher presumes that teacher A also used AutoCAD to prepare the worksheets that were used as classwork by the learners. As far as self-efficacy is concerned, teacher A exhibited a high level of it.

Teacher C also showed a high level of confidence using the technologies that were at their disposal. The teacher used only a projector, a computer, and a whiteboard, with no signs of struggle whatsoever. It is also worth mentioning that in teacher C's class there was no chalkboard; the class had two whiteboards that were used for drawing together with a projector. Teacher E was teaching interpenetration, so at some point during the lesson, Teacher A played a video explaining how the interpenetration occurs, which assisted learners to understand the concept much better. The worksheets given to learners were prepared prior to using AutoCAD, which showed that the teacher's choice of the relevant technologies was exceptional and based on his exposure. Based on the observation, the researcher believes that the teacher was exceptional in infusing the technologies as his tools for teaching and learning, which speaks to high ICT self-efficacy.

Teacher E had a laptop that was connected to a printer, and there was a router as well that was mounted on the ceiling to provide an internet connection. The computers that were for the learners were installed with AutoCAD. Learners came in, but she went to the chalkboard to show the mechanism (crank rocker four-bar). On the chalkboard, she drew the mechanism using markers and set squares and showed the learners how it is done. That was a bit strange, indicating the teacher's low level of ICT self-efficacy. This finding is supported by Maddux (2016), who attested that self-efficacy is not perceived skill but a belief in what one can do with their skills to perform certain tasks under certain conditions.

DISCUSSION

The main purpose of this study was to investigate the challenges faced by EGD teachers in integrating ICT into teaching and learning. The study was able to reveal that teachers face myriad challenges, including a lack of modern computers needed to install AutoCAD software, constant power outages, insufficient computer labs, absence of projectors, and even a shortage of laptops. The findings, supported by the UTAUT framework, highlight how performance expectancy, effort expectancy, and poor facilitating conditions influence teachers' intentions and ability to use technology. The study also found that some teachers lack training to handle ICT tools, which are some impeding factors to integrating ICT in their EGD lessons. This conclusion is consistent with Xue et al. (2024) that facilitating conditions have a direct relationship to performance and effort expectancies such that the two factors may be dependent on the availability of resources and

infrastructure necessary for technological use. This assertion resonates well with Venkatesh et al. (2016), who mention that the UTAUT performance expectancy and effort expectancy influence behavioral intention to use a technology, while facilitating conditions determine technology use. However, what was intriguing from the findings was that, though teachers lack proper ICT tools and because of their strong belief in their abilities and infusion of ICT to enhance their teaching pedagogies, most became creative by adopting alternative strategies like using WhatsApp. The study also found that teachers who had technologies at their disposal did manage to use them effectively, of which the high level of ICT self-efficacy aspect espoused by Bandura (1977) was a part. Simply put, a high level of ICT self-efficacy is an aspect where EGD teachers with high ICT self-efficacy are more likely to adopt digital tools, while those with low confidence may avoid them, even if they have access to various technological resources.

The main purpose of the study was explored through RQ1: What are the main challenges faced by EGD teachers in adopting ICT in EGD classrooms within uMgungundlovu technical schools? and 2: What strategies can be implemented to enhance the effective integration of ICT in EGD classrooms? The data revealed a multitude of challenges and highlighted a lack of professional development training as impediments to the effective integration of ICT in EGD lessons. The study further indicated some of the strategies teachers used to enhance their teaching pedagogies.

CONCLUSIONS AND RECOMMENDATIONS

In conclusion, the study successfully explored the challenges faced by EGD teachers in integrating ICT into teaching and learning within uMgungundlovu technical schools. It revealed that despite significant barriers such as lack of infrastructure, inadequate access to ICT tools, and limited professional training, some teachers showed resilience and adaptability by finding alternative ways to incorporate technology, such as using WhatsApp to support their instructional methods. This creativity reflects their strong belief in the benefits of ICT for enhancing pedagogy, even in the face of limited support and infrastructure.

Moreover, the study emphasized the importance of ICT self-efficacy in influencing teachers' willingness and ability to adopt digital tools. Teachers who were confident and knowledgeable in using ICT were more likely to integrate them effectively. This finding underlines the need for targeted professional development programs aimed at building both technical skills and confidence in using ICT. The failure to incorporate ICTs in teaching EGD has the potential to hinder learners' understanding of key EGD concepts, limiting their preparedness for modern engineering

practices. To successfully use ICT in EGD classrooms, it is important for those involved to focus on both the necessary technology, making sure that teachers have the right tools, support, and confidence to use digital teaching methods as suggested by UTAUT and self-efficacy theories.

In addition, the findings strongly point to several strategies that can enhance the effective integration of ICT in EGD classrooms:

- (1) targeted professional development: training should not only be aimed at using ICT but on their pedagogical application in EGD lessons as well and
- (2) leveraging low-cost and familiar technologies: lack of ICT tools in schools has emerged as the hinderance therefore adoption of basic tools like WhatsApp can ensure adoption of technology is maintained.

These strategies, grounded in both UTAUT and self-efficacy theory, highlight that successful ICT integration is not solely dependent on technology availability. It also requires equipping teachers with the necessary skills, confidence, and institutional support.

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REFERENCES

- Adams, C. (2020). Teachers need lots of training to do online learning well. Coronavirus closures gave many just days. *The Hechinger Report*. <https://hechingerreport.org/teachers-need-lots-of-training-to-do-online-learning-well-coronavirus-closures-gave-many-just-days/>
- Addandani, K. (2011). *The lack of the ability of Saudi teachers* [PhD thesis, University of King Saud].
- Ahmed, S. K. (2024). The pillars of trustworthiness in qualitative research. *Journal of Medicine, Surgery,*

- and Public Health, 2, Article 100051. <https://doi.org/10.1016/j.glmedi.2024.100051>
- Alazam, A. O., Bakar, A. R., Hamzah, R., & Asmiran, S. (2013). Teachers' ICT skills and ICT integration in the classroom: The case of vocational and technical teachers in Malaysia. *Creative Education*, 3(8B), 70-76. <https://doi.org/10.4236/ce.2012.38B016>
- Alem, D. B. (2020). An overview of data analysis and interpretations in research. *International Journal of Academic Research in Education and Review*, 8(1), 1-27.
- Alharbi, A. (2021). A review of the internal and external factors affecting teachers' ICT use in classroom. *International Journal of Education and Research*, 9, 105-116.
- Asmara, R. (2020). Teaching English in a virtual classroom using WhatsApp during COVID-19 pandemic. *Language and Education Journal*, 5, 16-27. <https://doi.org/10.52237/pegq5r56>
- Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, 84(2), 191-215. <https://doi.org/10.1037/0033-295X.84.2.191>
- Barbour, M. K. (2014). Training teachers for a virtual school system: A call to action. *Education Faculty Publications*. https://digitalcommons.sacredheart.edu/ced_fac/102
- Bayter, E. M., Elyacoub, H., Saqri, N., & Ouchaouka, N. (2023). Teachers' sense of competence in terms of ICT use: The case of secondary school teachers. *Research in Learning Technology*, 31. <https://doi.org/10.25304/rlt.v31.2874>
- Bhandari, P. (2020). An introduction to quantitative research. *Scientific Research*. <https://www.scribbr.com/methodology/quantitative-research>
- Bhati, K., & Sathy., T. P. (2022). Self-efficacy: Theory to educational practice. *The International Journal of Indian Psychology*, 10(1), 1123-1128.
- Bornman, E. (2016). Information society and digital divide in South Africa: Results of longitudinal surveys. *Information, Communication & Society*, 19(2), 264-278. <https://doi.org/10.1080/1369118X.2015.1065285>
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77-101. <https://doi.org/10.1191/1478088706qp063oa>
- Cardullo, V. M., Wilson, N. S., & Zygoris-Coe, V. I. (2018). Enhanced student engagement through active learning and emerging technologies. In *Student engagement and participation: Concepts, methodologies, tools, and applications* (pp. 399-417). IGI Global. <https://doi.org/10.4018/978-1-5225-2584-4.ch019>
- DBE. (2011). *Curriculum and assessment policy statement: Grades 10-12 engineering graphics and design*. Department of Basic Education.
- Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, 5, 1-4. <https://doi.org/10.11648/j.ajtas.20160501.11>
- Graham, M. A., Stols, G., & Kapp, R. (2020). Teacher practice and integration of ICT: Why are or aren't South African teachers using ICTs in their classrooms. *International Journal of Instruction*, 13(2), 749-766. <https://doi.org/10.29333/iji.2020.13251a>
- Howard, S. K., & Mozejko, A. (2015). Teachers: Technology, change and resistance. In M. Henderson, & G. Romeo (Eds.), *Teaching and digital technologies: Big issues and critical questions* (pp. 307-317). Cambridge University Press. <https://doi.org/10.1017/CBO9781316091968.030>
- Imenda, S. N. (2014). Is there a conceptual difference between theoretical and conceptual frameworks. *Journal of Social Sciences*, 38(2), 185-195. <https://doi.org/10.1080/09718923.2014.11893249>
- Khoza, S. D. (2013). *Difficulties in sectional drawing: A case of student teachers at a university in the Eastern Cape* [Unpublished PhD thesis, Tshwane University of Technology].
- Khubayi, F. L., Ncisana, L., & Mtshali, T. I. (2024). Investigating the effectiveness of using YouTube videos as an alternative learning media for grade 11 life sciences learners. *E-Journal of Humanities, Arts and Social Sciences*, 5(6), 1001-1014. <https://doi.org/10.38159/ehass.20245616>
- Lindén, A. (2013). The importance of technology management in the ICT requirements definition process. In *Proceedings of the PICMET'13: Technology Management in the IT-Driven Services* (pp. 2283-2295). IEEE.
- Maddux, J. E. (2016). Stopping the "madness": Positive psychology and deconstructing the illness ideology and the DSM. In C. R. S. S. J. Lopez (Ed.), *The Oxford handbook of positive psychology* (pp. 72-87). Oxford Academic Press. <https://doi.org/10.1093/oxfordhb/9780199396511.013.5>
- Makgato, M. (2016). Difficulties of student teachers in the engineering graphics and design course at a South African university: Snapshot on sectional drawing. *Eurasia Journal of Mathematics, Science and Technology Education*, 12(4), 703-715. <https://doi.org/10.12973/eurasia.2016.1220a>
- Mashile, T. (2017). *Technology integration and the digital divide: Understanding factors that impact on educators' ability to integrate technology in South African classrooms* [Master's thesis, University of Pretoria].

- Mathevula, M. D., & Uwizeyimana, D. E. (2014). The challenges facing the integration of ICT in teaching and learning activities in South African rural secondary schools. *Mediterranean Journal of Social Sciences*, 5(20), Article 1087. <https://doi.org/10.5901/mjss.2014.v5n20p1087>
- Matongo, M. (2022). Teacher readiness to teach using ICT in classroom pedagogy in Zimbabwean primary schools. *Journal of African Education*, 3, 45-66. <https://doi.org/10.31920/2633-2930/2022/v3n2a2>
- Mlambo, P. B. (2024). Instructional practices by engineering graphics and design teachers: A focus on teaching and learning of isometric drawing. *Research in Social Sciences and Technology*, 9(2), 359-376. <https://doi.org/10.46303/ressat.2024.41>
- Mlambo, P. B., Maeko, M. S. A., & Khoza, S. D. (2023). Factors contributing to resistance in the use of information and communications technology: A snapshot on engineering graphics and design teachers. *International Journal of Learning, Teaching and Educational Research*, 22(10), 271-289. <https://doi.org/10.26803/ijlter.22.10.15>
- Molotsi, A. R. (2022). The use of ICT resources to transform teaching at secondary schools in the Bojanala District, Northwest Province. *South African Journal of Education*, 42(1), Article 2098. <https://doi.org/10.15700/saje.v42ns1a2098>
- Momani, A. A. (2020). The unified theory of acceptance and use of technology: A new approach in technology acceptance. *International Journal of Sociotechnological and Knowledge Development*, 12(3), 79-93. <https://doi.org/10.4018/IJSKD.2020070105>
- Morudu, K. (2025). Investigating teachers' integration of technology in automotive: A case in technical schools. *Research in Social Sciences and Technology*, 10(1), 426-441.
- Msambwa, M. M., Daniel, K., & Lianyu, C. (2024). Integration of information and communication technology in secondary education for better learning: A systematic literature review. *Social Sciences & Humanities Open*, 10, Article 101203. <https://doi.org/10.1016/j.ssaho.2024.101203>
- Msila, V. (2015). Teacher readiness and information and communications technology (ICT) use in classrooms: A South African case study. *Creative Education*, 06, 1973-1981. <https://doi.org/10.4236/ce.2015.618202>
- Msimango, S. M. (2024). Digitization of civil technology practical lessons for project-based learning at Ekurhuleni east, South Africa. In *Proceedings of the EDULEARN24* (pp. 1843-1852). IATED. <https://doi.org/10.21125/edulearn.2024.0550>
- Mtshali, T. I. (2023). The impact of TikTok videos in creative designs of house plans in civil technology's practical assessment tasks. *INSANIA: Jurnal Pemikiran Alternatif Kependidikan*, 28(1), 115-132. <https://doi.org/10.24090/insania.v28i1.7887>
- Munje, P. N., & Jita, T. (2020). The impact of the lack of ICT resources on teaching and learning in selected South African primary schools. *International Journal of Learning, Teaching and Educational Research*, 19(7), 263-279. <https://doi.org/10.26803/ijlter.19.7.15>
- Pedrosa, C. M., Barbero, B. R., & Miguel, A. R. (2014). Spatial visualization learning in engineering: Traditional methods vs. a web-based tool. *Journal of Educational Technology & Society*, 17, 142-157.
- Prasad, V. V. S. N. V. (2018). Availability of information and communication technology (ICT) facilities in secondary schools. *Journal of Emerging Technologies and Innovative Research*, 5(8), 588-593.
- Rastogi, A., & Malhotra, S. (2013). ICT skills and attitude as determinants of ICT pedagogy integration. *European Academic Research*, 1, 301-318.
- Rodriguez, J., & Rodriguez, L. G. (2016). Comparison of spatial visualization skills in courses with either graphics or solid modeling content. In *Proceedings of the 70th EDGD Midyear Conference, American Society for Engineering Education* (pp. 51-56). New Orleans, LA.
- Šabić, J., Baranović, B., & Rogošić, S. (2022). Teachers' self-efficacy for using information and communication technology: The interaction effect of gender and age. *Informatics in Education*, 21(2), 353-373. <https://doi.org/10.15388/infedu.2022.11>
- Şahal, M., & Ozdemir, A. S. (2020). Pre-service primary teachers' views and use of technology in mathematics lessons. *Research in Learning Technology*, 28. <https://doi.org/10.25304/rlt.v28.2302>
- Smith, A., & Brown, K. (2019). The importance of laboratory resources in life sciences education. *Science Education*, 36(4), 289-305.
- Sokhulu, L. H., & Ndebele, N. C. (2025). Students' perceptions of digital technologies' efficiency for research during and before the COVID-19 era. *African Perspectives of Research in Teaching and Learning*, 9(1), 135-149. <https://doi.org/10.70875/v9i1article11>
- Sotsaka, D. S. (2015). *An exploration of the interface between Grade 11 engineering graphics and design teachers' understanding of assembly drawing and their practice: A case study of the uThukela District, KwaZulu-Natal* [Unpublished master's thesis. University of KwaZulu Natal].
- Sotsaka, D., & Singh-Pillay, A. (2020). Meeting the challenges first year engineering graphic design pre-service teachers encounter when they read and interpret assembly drawing. *Journal of Education*,

- 2020, 72-86. <https://doi.org/10.17159/2520-9868/i80a04>
- Taherdoost, H. (2016). Sampling methods in research methodology; how to choose a sampling technique for research. How to choose a sampling technique for research. *International Journal of Academic Research in Management*, 5(2), 18-27. <https://doi.org/10.2139/ssrn.3205035>
- Tasir, Z., Abour, E. A., Halim, N. D., & Harun, J. (2012). Relationship between teachers' ICT competency, confidence level, and satisfaction toward ICT training programmes: A case study among postgraduate students. *The Turkish Online Journal of Educational Technology*, 11(1), 138-144.
- Timenon, V., Foley, G., & Conlon, C. (2024). Quality in qualitative research: A relational process. *Qualitative Research Journal*. <https://doi.org/10.1108/QRJ-07-2024-0153>
- Ubogu, J. O. (2013). Impact of information technology in Nigerian university libraries. *Open Access Library Journal*, 6(4), 1-13. <https://doi.org/10.4236/oalib.1105340>
- Ubogu, R., & Ogbedo, I. O. (2023). The availability and utilization of information and communication technology (ICT) equipment on the teaching and learning of students in public secondary schools in Delta Central Senatorial District, Delta State, Nigeria. *World Journal of Advanced Research and Reviews*, 19(01), 174-180. <https://doi.org/10.30574/wjarr.2023.19.1.1226>
- Venkatesh, V. (2003). Determinants of perceived ease of use: Integrating control, intrinsic motivation, and emotion into the technology acceptance model. *Information Systems Research*, 11(4), 342-365. <https://doi.org/10.1287/isre.11.4.342.11872>
- Venkatesh, V., Thong, J. Y. L., & Xu, X. (2016). Unified theory of acceptance and use of technology: A synthesis and the road ahead. *Journal of the Association for Information Systems*, 17(5). <https://doi.org/10.17705/1jais.00428>
- Vesisenaho, M., Kyllönen, M., Kukkonen, K., Valtonen, T., & Häkkinen, P. (2024). Teacher educators' and pre-service teachers' confidence toward the use of ICT in education. *Media, Technology and Lifelong Learning*, 20(1). <https://doi.org/10.7577/seminar.4687>
- Vinitha, R. (2019). Data analysis in qualitative research. *Indian Journal of Continuing Nursing Education*, 20(1), 40-45. https://doi.org/10.4103/IJCN.IJCN_1_19
- Xue, L., Rashid, A. M., & Ouyang, S. (2024). The unified theory of acceptance and use of technology (UTAUT) in higher education: A systematic review. *SAGE Open*, 14(1). <https://doi.org/10.1177/21582440241229570>

<https://www.ejmste.com>