EVALUATING ENGINEERING GRAPHICS AND DESIGN EDUCATION: CONTEXTUAL FACTORS, INSTRUCTIONAL PRACTICES, AND TECHNOLOGY BARRIERS

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Article info

Received: 03 March 2024
Accepted: 19 April 2024
Published: 29 April 2024

Keywords:
Technological pedagogical content knowledge; resources, technological knowledge; engineering graphics and design

Abstract

The purpose of this qualitative study was to evaluate the contextual factors that impede the integration of technology in Engineering Graphics and Design (EGD) teaching in selected schools of the Limpopo province. The interpretive paradigm was used to understand the data from the participants of this case study. The Technological Pedagogical Content Knowledge was used as an underpinning theoretical framework for the study. The population of interest included five technical schools of the same quintile where two teachers from each school were purposefully selected. A purposive sample was used to select 10 teachers to take part in the study. The classroom observations showed that not all teachers have digital tools in their classrooms and that some learners have more advanced EGD software than the ones that the teachers have. Teachers also mentioned that they only use WhatsApp as a communication application to provide notifications to learners. The recommendations are that the Department of Education should assist schools in procuring relevant and advanced digital tools and utilizing technology for EGD subjects. To address this, the Department of Education should invest money and provide workshops on technology integration, to train the teachers about gadgets, and how to use them. Regular monitoring of the digital tools will ensure their daily use in the EGD classes.

INTRODUCTION

The influence brought by the emergence of the Fourth Industrial Revolution (4IR) has coerced many teaching and learning institutions to adopt the use of digital tools despite many challenges that come with it. This study investigated the effects of the barriers that technical schools in the Limpopo Province of South Africa, find themselves in,

towards integrating technological tools in the teaching of Engineering Graphics and Design (EGD). According to Madsen and Madsen (2016), engineering drawing, which emanates from EGD is the process through which an engineer creates drawings for any engineering, architectural, or design purpose. They further say that EGD is a kind of communication in which the receiver interprets what you are saying via the use of drawings; as a result, your drawings need to make sense to you before you express the information visually to another person, which is better done through the integration of technology (Madsen & Madsen, 2016). Engineering Graphics and Design (EGD) integrates cognitive and manipulative skills to communicate graphically, using a combination of lines, symbols, and signs to produce products, processes, services, and systems that contribute towards economic growth and enhanced quality of life (Khoza, 2017).

This then demands a special skill from the teacher to teach it (EGD) effectively because as a subject, EGD also needs spatial skills for one to understand it (Mlambo et al. 2023). The use of technology in the 21st century has become a new norm for doing business in all spheres of life, classrooms included (Schwab, 2016). This is because the 21st century brought a new set of rules in which the use of technology was not an option but a matter of must, which at some level disrupted individuals' daily lives (Schwab, 2016). With South Africa as a developing country in the world, and Limpopo Province as one of the most rural provinces in the country, the issue of digital integration is not easy, particularly with the issue of *'power cuts'* being the number one enemy of the adoption of technology. South Africa is confronted with persistent and worsening load-shedding which has become a new normal with daily *'power cuts*' that are affecting all sectors of the economy and society, schools included. These persistent electricity cuts resulted in 2022 being the beginning of South Africa's most unpleasant year for load-shedding with 208 days of power cuts compared to 75 days in 2021 and has continued into 2023 with each day of the new year having load-shedding with higher stages up to stage 6 (Erero, 2023). This has a dire effect on the education sector which makes instructional practices difficult. This then finds even schools with relevant infrastructure being unable to use them because of issues ranging from connectivity and access. Some of these challenges pushed for this study to be conducted to ascertain the effects that barriers to integrating technology in the EGD classrooms, have on the teachers.

Madsen & Madsen (2016) argue that engineering drawings, which are drawn in the EGD subject, work when the person looking at them can understand the design without any chance of misunderstanding. This then calls for technology use because technology provides a hands-on interaction during learning. It is within this notion that without the use of technology in EGD classrooms, due to certain barriers, the teaching thereof would have dire effects and so would the learning hence the undertaking of this study.

On the other hand, Msila (2015) says that older teachers hid their Information and Communications Technology (ICT) flaws from younger people, and as such, they opted for traditional teaching methods. However, such practices saw an escalating drop in academic performance from the learners' side who are known as Generation Y, who are 'kids' born within the digital era (Msila, 2015). The use of ICT in the classroom has

been a recent development but consequently, not all teachers are familiarised with this new technology. In the meantime, Purnomo & Kustandar (2019) discovered that individual barriers, cultural barriers, government policy barriers, support, and technological barriers significantly influenced the acceptance of ICT by teachers. To add to that, Sánchez-Prieto et al. (2019) pointed out that second-order barriers (or internal barriers) are important predictors of behavioral intention. This means that the barriers that teachers find to have towards the integration of ICT in the classrooms vary. While some could be governmental (policy issues), some being individual (perception), they however affect the teaching (pedagogy) agenda. Finally, recent studies emphasize the importance of attitudes and beliefs, crucial factors for technology integration, in teachers' planning and implementing technology into classroom settings (Hamutoglu, 2021). There are many reasons to use technology as an educational tool. Pedagogically, technology has been attracting much attention as a valuable element for enhancing student achievement, motivation, and process productivity (Roblyer & Doering, 2010). In addition to its benefits for students, teachers have also been found to increase their skills regarding the use of technology and its contributions to their expertise in their fields (Cennamo, Ross, & Ertmer, 2010; Minor, Losike-Sedimo, Reglin, & Royster, 2013; Xu & Pershing, 2010). In addition to these benefits, diversity offers teachers new alternatives for teaching methods and techniques, providing them with opportunities to act out their roles in teaching (Izmirli & Kirmaci, 2017).

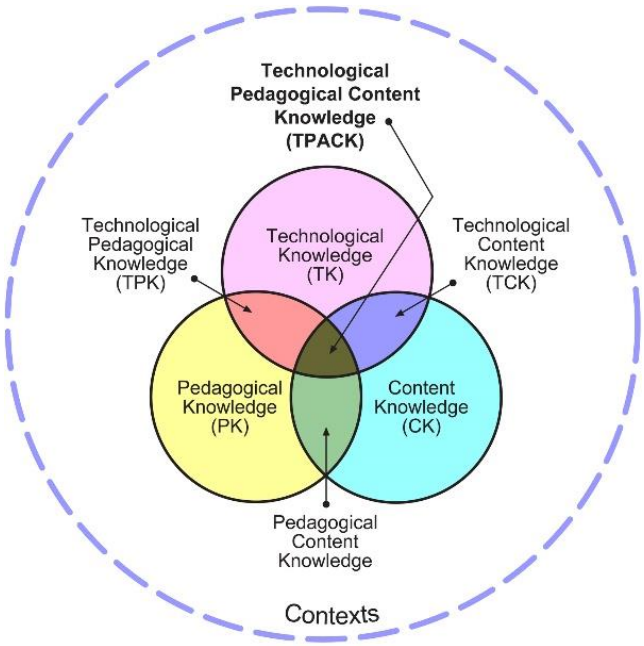
To add to that, a continuing set of limitations is also mentioned because the integration of technology education depends on different dimensions, sources, and variables (Izmirli & Kirmaci, 2017). In the meantime, Kaya & Koçak Usluel (2011) stated that barriers to the integration of technology could be overcome by working on infrastructure, tools, pedagogical beliefs, self-efficacy, skills, ICT use, innovation, and professional development. In the Limpopo Province, many teachers have been found to avoid using technology because of their knowledge, attitudes, and the challenges of the country's digital divide.

Ertmer (1999) defined technology integration barriers as "*first order (external barriers),"* referring to those stemming from external causes, such as a lack of adequate infrastructure and relevant knowledge, and *"second order (internal barriers),"* meaning those stemming from individuals' attitudes and beliefs. Along with these barriers, teachers' lack of design-thinking skills has also been discussed as the third order (Izmirli & Kirmaci, 2017). It is within these issues that this study investigated the contextual factors to the integration of technology in the teaching of EGD in the Limpopo Province technical schools. According to Maluleke (2022), the dynamic interplay between educational technology and student well-being has emerged as a pivotal area of investigation within the realm of educational research. As the educational landscape continues to evolve in response to technological innovation, understanding the nuanced relationship between technology-enhanced learning and well-being status assumes paramount significance. However, the EGD teachers in the context of the study, do not seem to understand that hence their persistent challenges.

Theoretical framework

For teachers to properly integrate technology into their classes, they need a certain set of skills as well as resources. These skills can easily be judged through the Technological Pedagogical Content Knowledge (TPACK), which is a framework that underpinned the study. even though some of the teachers who took part in the study did not believe in technology integration, the study was not interested in that aspect but in the issues that barred them from integrating technology and the effects thereof (Mishra & Koehler, 2008). The framework that is shown in Figure 1 below was used as an underpinning theory to ascertain how well the EGD teachers know the use of technology (technological knowledge, TK), how well they can teach with technology (technological pedagogical knowledge, TPK), and how well the two latter aspects can enhance them to better deliver the content best to the understanding (TPACK) of their learners who are referred to as the Generation Y.

Figure 1
The TPACK Framework (Mishra and Koehler, 2008)



The TPACK paradigm, like many other models and theories, has both benefits and drawbacks in equal measure. Teachers need to know how technology might change (TCK) the way they teach their subject compared to how they teach (TPK) it now. To keep education relevant in the modern world, teachers need to know how to use technologies (Mhlongo, et al., 2023). To meet TPACK criteria, teachers must use a mix of technology, education, and content. The TPACK framework is comprised of seven distinct components in their unique forms (see Figure 1). Specifically, one may divide this into the following categories:

Technological knowledge (TK): Due to the likelihood that many learners experience rapid disinterest when exposed to traditional methods, teachers must acquire the necessary TK as a fundamental must. Technological Knowledge is the expertise that a teacher needs to possess in technological tools that enable them to teach (Mishra & Koehler, 2008). **Content knowledge (CK)** is defined by Mhlongo et al. (2023), as the "knowledge about the real subject matter. However, this study did not investigate the EGD teachers' expertise in the subject, but it was interested in the effects that come with lack of or no integration of technology during the EGD lessons. **Pedagogical knowledge (PK)** is the **e**xpertise in the art and science of teaching (Mishra & Koehler, 2006). This concept was not of interest to the researcher because it did not form part of the hunch of the study. **Technological content knowledge (TCK)**, according to Mishra & Koehler (2006) defines the term TCK as an individual's familiarity with the many ways in which technology may be utilized to develop new representations of certain categories of information. This concept was investigated by checking how well EGD teachers demonstrate the use of technology in the teaching of EGD. On the other hand, **Technological pedagogical knowledge (TPK)** is defined as that skill in which the teacher demonstrates how they can use technology to teach and make the content better understood by the learners (Anderson, Barham & Northcote, 2013).

To sum it up, TPACK acknowledges the importance of how content, pedagogy, and technology interact. This framework was therefore important to the study because it assisted the researchers in seeing if at all the EGD teachers in the Limpopo Province, which is mainly rural, and affected by a lack of infrastructure and connectivity, fare in using technology to teach and the risks that come with the lack of ICT integration in EGD classrooms. The study aimed to address the following questions:

- *What are the contextual factors that influence the pedagogical integration of ICT in the teaching of EGD in Polokwane's selected technical schools?*
- *What are the teachers' instructional practices in EGD classrooms in Polokwane's selected technical schools?*
- *What are the effects of barriers that teachers have in technology integration in their EGD classrooms?*

METHODS

This study employed a qualitative research approach, utilizing structured interviews and observational methods to gain a comprehensive understanding of the subject matter. The use of qualitative research approaches in this study was motivated by their ability to elucidate the perspectives and interpretations of individuals and collectives on social or human issues. Qualitative research often employs participants' verbatim expressions and is carried out inside their authentic environments. Qualitative research aims to describe a real-life event or situation in depth to improve understanding (Yin, 2014). Qualitative research emphasizes narrative, non-quantitative data gathering, analysis, interpretation,

and presentation. This research approach aimed to gather opinions and views from the EGD teachers on the difficulties in integrating technology in the classrooms, to ascertain the barriers that come with it.

According to Maxwell (2016), paradigmatic viewpoint and research objective determine the best research approach. According to Wahyuni (2012), a research design refers to a systematically structured approach aimed at addressing the research question and ultimately resolving the research problem. This study made use of a case study research design in selected schools in Polokwane. Research design employs a diverse array of study techniques, scientific methodologies, and theoretical frameworks. Therefore, the research concentrated on conducting a case study examination of a specific area within the Polokwane region. The schools that took part in the study are in the same quintile and experience the same challenges that range from lack of resources, overcrowding, poor infrastructure, and lack of internet connection. The study made use of interpretivism as a research paradigm. Interpretivism encompasses the examination of many factors such as cultural variations, events, and historical epochs, which might contribute to the formation of diverse social realities (Saunders, et al., 2012). In contrast to positivism, interpretivism aims to capture a depth of understanding rather than striving to establish definitive and universally applicable laws that can be generalized and applied to all individuals, irrespective of certain crucial variables and factors (Saunders, et al., 2012). This paradigm was relevant for the study because the conversations that the researchers had with the EGD teachers made it easy to understand the complexities that the EGD teachers have in teaching EGD under the conditions that they are in.

Participants

Population is defined as the aggregate or totality of all objects, subjects, or members that meet a set of criteria or specifications (Polit & Hungler, 1999). The study population was five technical schools in the Polokwane region, in the Limpopo province. In each school, there were two EGD teachers per school. Therefore, ten (10) teachers teach EGD in the schools that were part of the study. Creswell (2007) claims that qualitative research involving populations involves the deliberate selection of specific locations and communities of individuals who can provide valuable insights to the researcher in comprehending and resolving the research problem. According to Tashakkori & Teddlie (2010), sampling refers to the systematic approach of selecting a sample unit from a larger population or community of interest to conduct research. Sampling is a crucial process in research, as it involves selecting a subset of a larger population and utilizing that subset to make inferences about the entire population (Cohen, Manion, & Morrison, 2018). Therefore, purposive sampling was used to select ten (10) EGD teachers, with two teachers selected from each school. Teachers were given pseudonyms, and a teacher was called T1, T2, etc.

Data Collection Method(s) and Analysis

Data were gathered via classroom observations and face-to-face interviews with the EGD teachers. Data collection is defined by Creswell (2007) as "planning activities to gather pertinent data that will assist in solving significant research problems. The main aim of the said instruments was to check how well EGD teachers make use of technologies that are at their disposal during teaching and hear from them the challenges that they encounter in integrating technology during teaching. This assisted the study in coming to grips with the effects of barriers that the EGD teachers have in ICT integration. The classroom observations assisted the study in answering the following sub-question: What are the contextual factors that influence the pedagogical integration of ICT in the teaching of Engineering Graphics and Design in Polokwane's selected technical schools; what are the teachers' instructional practices in EGD classrooms in Polokwane's selected technical schools? and the effects of barriers that lack of ICT integration have in the teaching of EGD. On the other hand, **i**nterviews were done to discover what people think and to document what they say (Rabionet, 2011). Mclntosh & Morse (2015) say that semi-structured interviews can be used to come up with response-focused interview questions. Interviews aimed at responding to the contextual factors that influence the pedagogical integration of ICT in the teaching of Engineering Graphics and Design in Polokwane's selected technical schools; the teachers' instructional practices in EGD classrooms in Polokwane's selected technical schools, and the effects of barriers that lack of ICT integration have in the teaching of EGD. Each interview with the teacher lasted for no more than 20 minutes and they were carried out in the available and dedicated times that the teachers preferred.

Data analysis includes the process of recognizing patterns, themes, categories, and consistent occurrences within the data. The analysis of collected data may lead to new research questions, which can be explored using different data collection and analysis methods in future investigations (Flick, 2018; Merriam & Grenier, 2019). Throughout the process of data analysis in this study, some of the TPACK components were identified and separated to facilitate future inquiry and focus. The data were subjected to descriptive analysis using the teachers' verbatim quotes. In descriptive analysis, the researchers listened to the participants' verbatim quotes and interpreted them to the satisfaction of the question. This was done by ensuring that the responses of the participants were not misconstrued and misrepresented, but the thorough message was sourced out of the response to avoid bias and misrepresentation of the data.

FINDINGS AND DISCUSSION

Findings

Classroom Observations

The researcher observed two lessons in each school, one lesson per teacher that lasted for an hour. Below are the results:

The contextual factors that influence the integration of ICT in EGD classrooms

The classroom observations managed to paint a picture of the contextual factors that teachers face towards the integration of ICT in the EGD classrooms. The observations showed that the EGD teachers lack technological knowledge during the instructional practices. During the process of conducting classroom observations, it was noted that T4 exhibited a lower inclination towards incorporating technology within their teaching practices because of poor digital resources. The teacher made use of an overhead projector as the only medium. On the other hand, T3 displayed adeptness in utilizing a diverse range of technological resources, such as video materials, interactive whiteboards, and PowerPoint software, but her learners only had textbooks. This was also observed with T2 who proficiently used a data projector to demonstrate objects rotating but his lesson was not interactive because the learners were reduced to watching without doing the same on their gadgets. In another school, T7 taught the isometric drawing concept using chalkboard drawing tools. She struggled to handle the drawing tools because of their large sizes. In another school, T5 used AutoCAD, which is a technological tool for EGD in his demonstration. In his demonstration, he managed to show the learners what an object looks like when rotated. This made the learning to be interesting but after demonstrating, the learners did not have any digital tools to emulate what the teacher did. To add to that, T8 from another school, used the data projector where he played a YouTube video when teaching solid geometry. The lesson was also interesting because the YouTube clip had a clear demonstration of how solid geometry is drawn. However, the EGD Grade 11 class that he was teaching was overcrowded and some learners battled to see.

The effects of barriers that teachers have in EGD teaching.

T1 demonstrated their remarkable capacity to effectively use technology in their educational practices, showcasing their versatility and expertise in this area. This guarantees that learners are provided with a high-quality education and can easily traverse the constantly evolving digital platforms but needs learners who have technologies as well which was not the case in his school. The teacher from one school (T4) managed to show an understanding of when to use YouTube and when to use AutoCAD while making use of PowerPoint slides. This could have been an excellent

exercise had the learners had gadgets at their disposal. T6 played a YouTube clip to show learners how and where an object is sectioned *(cut)* and when he resorted to AutoCAD, he demonstrated the steps because in AutoCAD, one is in control of what is happening because the tool itself, needs one to be able to manage and use it. However, learners had devices that had more advanced software on their tablets (scratchpads) which the teacher did not have on his device. According to Fadillah et al., (2023), YouTube offers plenty of authentic material created by people worldwide which is frequently used as learning media. Numerous studies on YouTube have been carried out, some of which examined the effect of YouTube on listening ability, and the use of YouTube as learning media. However, the application itself or the portal becomes invaluable in a situation where teachers lack resources and learners have limited resources in a classroom that is plagued by load shedding.

The concept of TPK demonstrated that T1 can teach using technology however, it was not easy for them to ascertain the learners' level of understanding because of the absence of digital tools from the learners' side. On the other hand, T8 used the data projector effectively when teaching but the barrier was the number of learners in the classroom. T7 on the other hand, did not display any knowledge of technological pedagogical knowledge because of a lack of resources. However, T6 who had an AutoCAD on the classroom desktop, demonstrated a vast knowledge of technological pedagogical knowledge despite learners not having any gadgets with them. The above shows that despite the EGD teachers showing knowledge in technology use, the gaps that learners show in not possessing gadgets become a barrier to academic excellence. This then makes the teachers' TPACK to be difficult to display because of such gaps.

EGD teachers' interview questions

When asked about the contextual factors that affect the integration of ICT into the EGD subject, the teachers had the following to say:

> *Teacher 1: "There are no resources. The school is in the villages and crime is high. Therefore, resources and equipment may be stolen".*
> *Teacher 9: "I don't know how these new technologies work and I do not have any technology gadgets in my classroom".*
> *Teacher 4: "Learners lose interest in the class. They don't have knowledge of how to use computers, which results in problems when they must do research, and we do not have access to the Internet".*

When asked what the EGD teachers thought of various technological tools in the way they can assist in creating a good classroom environment for teaching and learning, they said the following:

> *Teacher 1: "Using different types of media creates a conducive environment for both teaching and learning. It keeps learners disciplined".*
> *Teacher 2: "We live in a world of social media where learners are always on their phones, which means that they learn more by watching rather than listening. So,*

showing them the videos and presenting lessons via videos makes it easier for them to understand and develop more interest".
Teacher 7: "Since learners are using smartphones, they have apps in their phones and WhatsApp and other apps, so as a teacher, you can use video calls and send learners pictures, or you can download some information for them and send it to their WhatsApp even when our home".

When asked how applications like WhatsApp and other digital tools can be used to teach EGD optimally, teachers have this to say:

Teacher 1: "I can simply share information with the learners. Many learners can be taught at the same time. Information can be accessed easily from various resources to add more to what I will be teaching".
Teacher 5: "Teachers can teach more than one class all at once, e.g., via Zoom, WhatsApp email, and more. With the document camera, a teacher will be able to show learners how to use drawing instruments and how to draw".
Teacher 10: "Each of these technologies can be used differently because of lesson preparations".

When asked how the technological gadgets and various applications are used by the school in terms of teaching and learning, below is how the teachers responded:

Teacher 1: "Learners and other staff members can use the internet to access more information".
Teacher 2: "These technologies may be used as a motivation to these learners, for example, after testing learners in class, feedback may be presented back with their photos displayed on the projector with their results and it will motivate other kids to work harder so they can see themselves there as well".
Teacher 3: "These technologies can also be used in parent and staff meetings by using PowerPoint presentations or can be used as the easiest way of communicating with parents or learners of the school".

Discussion

The study aimed to ascertain the contextual factors that impede the integration of technology in the EGD subject in Polokwane schools of the Limpopo Province. There is no doubt that the results presented show that EGD teachers do integrate technology in their classrooms, and some are keen to integrate it but are restricted by the lack of resources. These are exacerbated by the learners' lack of digital tools which continue to leave a gap between the teaching and learning activity and as such, academic performance is compromised. The classroom observations showed that not all teachers have digital tools in their classrooms and that some learners have more advanced EGD software than the ones that the teachers have. This is because teachers do not have adequate teaching resources that they need to teach and to add to that, learners are found to be more advanced in digital tools' access than the teachers. The lack of digital tools on the side of the teachers affect teaching in that teachers are then coerced to use what

they have, which is traditional way of teaching where they resort to a drawing paper and a pencil to teach, which do not conform to the modern way of instructional practices where technology ought to be integrated as it is one of the priorities that the government has put in place.

According to the academic publications by Koehler and Mishra (2008) and Mishra and Koehler (2006), it is argued that a person may be considered to possess a good TK when they demonstrate proficiency in effectively using a diverse range of technological tools and resources, which may vary from basic to advanced levels of sophistication, which is what most teachers demonstrated. However, technology cannot rescue any school or cure issues on its own, especially when there is a lack of balance in its adoption (Anderson, Barham & Northcote, 2013). This is because much as teachers used technology to teach, learners remained passive because of overcrowding and lack of proper gadgets. This on its own became a contextual factor because of the digital divide that South Africa as a country and Limpopo Province is. The face-to-face interviews shed a different light on where teachers were affected by learners who did not possess digital tools. According to Okafor (2015), there are constraints on the acquisition of skills utilization by teachers, especially where an imbalance in the acquisition of tools exists. Clark & Scales (2009) say that there has been a change towards a learner-centered environment in the classroom because of the incorporation of ICTs into the teaching process, which creates several issues for the various teachers and those fall under contextual factors because of the rurality of schools in the Limpopo Province in this context. This confirms what Leask & Pachler (2013) said that teachers have not made substantial use of these ICT resources in the classroom because of challenges that are beyond their control which range from poor resources, overcrowding, and learners' inability to procure digital tools.

CONCLUSIONS

The study investigated the impeding factors to the integration of ICT integration in the EGD classrooms in the technical schools in Limpopo Province. The fact that teachers do have an interest in employing technologies while teaching EGD is good enough and is in line with the technological changes that the 4IR has brought into the education sector. However, the EGD teachers are met with contextual factors where they find themselves having to teach in classrooms that are responsive to the EGD curriculum needs. This is because the resources that are in their disposal are not there and or are irrelevant. This then makes the EGD teachers' instructional practices too shallow for the purpose that EGD is meant to do, as espoused in the Curriculum and Assessment Policy document that the country uses as a guiding document. Therefore, the effects of the challenges that have been mentioned are that learners are bound to go through a curriculum that is not responsive to their needs, and since EGD enables learners for career choices, that is most likely not to materialize. However, the fact that there is a lot of digital divide between learners in the Limpopo schools, makes the work of the teachers difficult. The effect of such a digital divide where learners do not possess adequate resources or to some extent, no digital tools at all in overcrowded classrooms has been a barrier to the

academic excellence that each teacher is striving for. If a teacher fails to optimally teach the way they should because of issues that are beyond their control (contextual), academic excellence will be affected and to some extent, learners will develop a negative attitude towards EGD as a subject.

REFERENCES

Anderson, A., Barham, N. & Northcote, M. (2013). Using the TPACK framework to unite disciplines in online learning. *Australasian Journal of Educational Technology*, *29*(4). https://doi.org/10.14742/ajet.24

Cennamo, K. S., Ross, J. D., Ertmer, P. A. (2010). *Technology Integration for Meaningful Classroom Use: A Standards-Based Approach*. Wadsworth, Cengage Learning, CA

Cohen, L., Manion, L., & Morrison, K. (2018). *Research Methods in Education (10th Ed.)*. Milton Park, Abington: Routledge.

Creswell, J.W. (2007). *Qualitative Inquiry and Research Design*. Choosing among five approaches. Second edition. London: SAGE Publishers.

Erero, J.L. (2023). Impact of load-shedding in South Africa: A CGE analysis. *Journal of Economics and Political Economy*. 10 (2). 78-94. DOI: 10.1453/jepe. v10i2.2443

Fadillah, A. S. N., Nasrullah, N., & Rosalina, E. (2023). the Use of Watching Youtube Videos for Acquiring Students' Listening Comprehension. International Journal of Educational Best Practices, 7(1), 92. https://doi.org/10.31258/ijebp.v7n1.p92-104

Flick, U. (2018). *An introduction to qualitative research*. London: Sage Publications.

Hamutoglu, N. B. (2021). Testing the effects of technological barriers on high school teachers' role in technology integration. *Asian Journal of Distance Education, 16*(1), 74-89. https://doi.org/10.5281/zenodo.4661743

Izmirli, O.S., & Kirmaci, O. (2017). New Barriers to Technology Integration. *Eurasian Journal of Educational Research*, 72 (2017) 147-166. DOI: 10.14689/ejer.2017.72.8

Kaya, G., & Koçak Usluel, Y. (2011). Öğrenme-öğretme süreçlerinde BİT entegrasyonunu etkileyen faktörlere yönelik içerik analizi [Content analysis of factors affecting ICT integration in teaching-learning process]. *Buca Eğitim Fakültesi Dergisi,* (31), 48-67.

Khoza, S.D. (2014). The Effects of Diagnosis on Learning Engineering Graphics and Design in a First Year University Degree Course in South Africa. *International*

Journal of Technology and Inclusive Education (IJTIE), Special Issue Volume 1, Issue 1. DOI:10.20533/ijtie.2047.0533.2014.0046

Khoza, S.D. (2017). Identifying the gaps of fourth-year degree pre-service teachers' pedagogical content knowledge in teaching engineering graphics and design. *International Journal of Technology and Design Education. 26 (1):* 537–548. DOI 10.1007/s10798-016-9363-2

Leask, M. & Pachler, N. (2013). *Learning to teach using ICT in the secondary school: A companion to school experience*. New York: Routledge.

Madsen, D.A. & Madsen, D.P. (2016). *Engineering drawing and design.* Boston: Cengage Learning.

Maluleke, A.F. (2022). The influence of educational technology on well-being status: a literature review. *International Journal of Educational Best Practices.* 7 (2), 152-171. DOI: 10.32851/ijeb

Merriam, S.B., & Grenier, R.S. eds. (2019). *Qualitative research in practice: Examples for discussion and analysis*. John Wiley & Sons.

Mhlongo, K. M., Khoza, S. D., & Skosana, N. M. (2023). The Significance of Hand Tool Skills in the Fourth Industrial Revolution: A Focus on the Construction Concept. *Jurnal Penelitian Dan Pengkajian Ilmu Pendidikan: E-Saintika*, 7(1), 1–17. https://doi.org/10.36312/esaintika.v7i1.1026

Minor, M., Losike-Sedimo, N., Reglin, G., & Royster, O. (2013). Teacher Technology Integration Professional Development Model (SMART Board), *Pre-Algebra Achievement, and Smart Board Proficiency Scores. SAGE Open, 3(2)*. DOI: 10.1177/2158244013486994

Mishra, I., & Koehler, M. (2006). Technological pedagogical content knowledge: A framework for integrating technology in teacher knowledge. *Teachers College Record*, 108 (6), 1017–1054.

Mishra, P., & Koehler, M. J. (2008, March). Introducing technological pedagogical content knowledge. In the *annual meeting of the American Educational Research Association* (Vol. 1, p. 16).

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*

Msila, V. (2015). Teacher readiness and Information and Communications Technology (ICT) use in classrooms: A South African case study. *Creative Education*, 1973-1981. doi: 10.4236/ce.2015.618202.

Okafor, A.C. (2015). Gender inequality in Nigeria. *Journal of research in arts social sciences, 4*(1):69-80.

Polit, D. & Hungler, B. (1999). *Nursing Research: Principle and Method.* 6th ed. Philadelphia: Lippincott Company.

Purnomo, S. H., & Kusnandar. (2019). Barriers to acceptance of information and communication technology in agricultural extension in Indonesia. *Information Development, 35(*4), 512-523. https://doi.org/10.1177/0266666918767484

Rabionet, S. E. (2011). How I learned to design and conduct semi-structured interviews: an ongoing and continuous journey. *The Qualitative Report*, 16(2): 563-566. https://doi.org/10.46743/2160-3715/2011.1070

Robyler, M. D. ve Doering, Aaron H. (2010). *Integrating educational technology into teaching (5. Ed)*. Pearson Education. Boston: MA

Sánchez-Prieto, J. C., Hernández-García, Á., García-Peñalvo, F. J., Chaparro-Peláez, J., & Olmos-Migueláñez, S. (2019). Break the walls! Second-order barriers and the acceptance of mLearning by first-year pre-service teachers. *Computers in Human Behaviour, 95*, 158-167. https://doi.org/10.1016/j.chb.2019.01.019

Saunders, M. N. K., Lewis, P. & Thornhill, A. (2012). *Research Methods for Business Learners*, Harlow, England: Financial Times Prentice Hall. Edited by 6th.

Schwab, K. (2016). *The Fourth Industrial Revolution.* Print ed. Cologny /Geneva: World Economic Forum.

Tashakkori, A., & Teddlie, C. (2010). *SAGE handbook of mixed methods in social & behavioral research*. SAGE Publications, Inc., https://doi.org/10.4135/9781506335193

Wahyuni, D. (2012). The Research Design Maze: Understanding Paradigms, Cases, Methods and Methodologies. *Journal of Applied Management Accounting Research*, 10 (1), 69-80, https://ssrn.com/abstract=2103082

Xu, F., & Pershing, J. A. (2010). A Move towards the Integration between Education and Technology. *Frontiers of Education in China, 5(1)*, 3-3. https://doi.org/10.1007/s11516-010-0002-5

Yin, R. K. (2014). *Case study research: design and methods*. (5th ed.), Thousand Oaks, CA: SAGE