



## Teaching Graphic Communication and Techniques to senior phase Technology learners: A guide for teachers

Mlondi Thlokomelo Sibiya<sup>1</sup>, Thokozani Isaac Mtshali<sup>2\*</sup>

<sup>1</sup>Department of Basic Education, Tshwane University of Technology, Pretoria, South Africa

<sup>2</sup>Department of Technology and Vocational Education, Tshwane University of Technology, Pretoria, South Africa

### Article History:

Received: February 08, 2025

Revised: April 15, 2025

Accepted: May 18, 2025

Published: June 16, 2025

### Keywords:

Communication,

Drawing,

Graphic,

Teachers,

Technology.

### \*Correspondence Author:

MtshaliTI@tut.ac.za

**Abstract:** This study examined the teaching of Graphic Communication and Techniques to senior phase Technology learners. A quantitative research approach was adopted, and a case study design was employed. To a population of 7 teachers and 156 learners in Capricorn District, Limpopo in South Africa, a convenient sample of 13 teachers and 149 learners were used. This study collected data through questionnaires, observations and archive analysis. This study revealed that 76.92% of sampled teachers taught learners different structures using freehand technique and single point perspective, but this had a negative impact on learners ability to use drawing tools as no teacher attempted to use and encourage learners to draw using adequate set squares. It was interesting to see that only 38.46% of teachers emphasised the need to use different colours in drawings to improve learners spatial and cognitive skills. Some of the learners activities showed that different colours were used even though the drawings were not correct and appealing. Only 69.23% of teachers taught learners the use of correct line types, sadly learners were not receptive of this emphasis as most of them had drawings which were drawn in bold lines and not neat. In light of the emergent findings, this study recommended that teachers should engage in lesson study approaches with other colleagues teaching Technology in order to strengthen their grasp of learner-centred approaches that are appropriate for teaching graphic communication and techniques.

## INTRODUCTION

Teaching drawing concepts tailored for young people requires extensive awareness of learner concentration span and contextualised imagery complications (Carlini, 2021). Young people are prone to learn more using visuals, particularly those they are familiar with (Kekana et al., 2024). However, in the content coverage of Technology for grade 7 in South African schools, it is not always possible (Matsekoleng et al., 2024). Most of the graphical sketches given to learners do not come with stories or scenarios which can assist learners to enhance their memory on where they have seen those structures in real life (Kim, Ham & Lee, 2024). According to Mtshal (2023) Technology learners are given various drawing structures to replicate them on grid papers and this causes metacognitive challenges in understanding and processing drawing techniques for each of the given structures. A study by Fraile-Fernández et al. (2021) attest that learners find it difficult to process drawings especially when there are no contextualized visuals or mobile

technologies to assist them. And so, there is a need to guide teachers on how best to teach graphical communication to Technology learners in order to promote rapid understanding of spatial visualization skills.

Teaching graphical communication and techniques (drawing / draughting for young people/ sketching) requires a teacher who carefully plans and continuously reflect on his or her pedagogical content knowledge (Hlatshwayo et al., 2022). For instance, when teaching learners about isometric drawing, a teacher should show learners a starting point, which is a central corner of the drawing, show learners how to correctly place a 30 by 60 degrees set-square, how to correctly hold a pencil, and interpret well the views and measurements (Mlambo, 2024). This is because the concept of graphic communications and technique involves more drawing expertise at once which a teacher should be aware of. It involves linework, dimensional views, orthographic projection, perspective drawing, freehand sketching, and more (Sibiya et al., 2023). It also covers drawing conventions, exposing them to techniques like outlines, construction lines, hidden detail lines, scaling, and dimensioning (Sibiya et al., 2023). The current Curriculum Assessment Policy Statement (CAPS) on Technology Grade 7 clarifies that graphical communication does not encompass 3D drawings alone, as some Technology education researchers like Hlatshwayo et al., (2022) have mistakenly assumed. It includes various drawings such as freehand sketches, isometric and single point perspective drawing among other things. So, it is important for studies like this to inform the global readers on how teachers have been teaching graphical communication. This will add value to the scarce literature on teaching, learning and assessment activities pertaining to graphical communications.

While graphical communication focuses on two-dimensional representations, graphic techniques encompass concepts that explore three-dimensionality (Kliment et al., 2023). This includes oblique drawing, where learners learn to create a front view with depth at a 45-degree angle using quadrant paper (Hurter et al., 2025). This technique aids in interpreting three-dimensional objects and drawing a single-point perspective view (Hlatshwayo et al., 2022). Additionally, artistic drawing introduces learners to single-point perspective with elements like colour, texture, and shading (Department of Basic Education, 2011). It is crucial to explore both graphical communication and graphic techniques, as the latter builds upon the former (Sibiya et al., 2023) and subsequently guide teachers on how to systematically present it to learners. Hence, there is a need to build literature that will guide teachers on when to draw, shade and interpret measurements, hence this present study.

Several studies highlight the need for improved pedagogical practices among grade 7 Technology teachers regarding graphic communication (Skosana, 2017; Mtshali, 2021; Sibiya et al., 2023). Sherin (2023) emphasizes the importance of teachers creating discourse during instruction. Sibiya et al. (2023) found that unqualified or inadequately trained teachers struggle to manage effective learning in this area, leading to low learner performance. They further revealed that some teachers skip this topic entirely due to insufficient pedagogical content knowledge (PCK). Gumbo (2020) critiques the "one-size-fits-all" approach of current professional development workshops offered by the

Department of Basic Education (DBE), suggesting they fail to address the specific needs of Technology teachers.

Graphic communication is crucial for fostering innovation, critical thinking, and problem-solving in Technology subject (Calavia, et al., 2021). These skills empower learners to effectively convey ideas and are fundamental to the design process. Therefore, equipping grade 7 Technology teachers with strong PCK in this domain is essential to learners' success. Ultimately, this fosters the development of well-rounded, competent, and adaptable graduates prepared for informed decision-making in Sciences, Technology, Engineering and Mathematics (STEM) careers and a dynamic job market. Mtshali (2023) underscores the importance of graphic communication in STEM education. The study highlights that effective communication during the design process is crucial for ensuring inclusivity and addressing the needs of individuals with disabilities in infrastructure development. Hence, this study emphasizes that graphic communication equips senior phase Technology learners with graphical problem-solving skills and so teachers must be assisted to teach this concept efficiently.

## **METHOD**

In order to investigate Teaching Graphic Communication and Techniques to senior phase Technology learners, this study adopted a quantitative research approach which incorporated qualitative elements that helped to enhance validity and richness of results (Rose & Johnson, 2020). According to Pentang and Pentang (2021) quantitative research approach focuses on quantifying observations and analyzing data numerically, often using statistical methods. This study used this approach to quantify all observations made to Technology teachers when teaching graphic communication lessons. The population of this study were thirteen (13) technology teachers and their learners to a total of one-hundred and fifty-six (156). From this population, this study conveniently sampled 7 teachers and 149 learners, this was because other learners were absent during data collection (Evardone et al., 2021; Yin et al., 2014). The inclusion criteria for this study were all grade 7 teachers and learners residing in Capricorn District in Limpopo province, South Africa.

Data collection methods included classroom observation, questionnaires, and document or archive analysis. Classroom observation provided descriptive insights, while questions were coded, analysed, and discussed statistically to quantify the patterns of events (McIntosh & Morse, 2015). Data from learners' exercise books were analysed using archive analysis to review and evaluate their graphic communication activities (Nelson & Woods, 2013). Ethics approval was granted by the University of Limpopo in South Africa where the first author was a postgraduate student. Risks, benefits and procedure of the study were explained to participants before they willingly gave consent to participate in the study (McIntosh & Morse, 2015). The participants were informed of voluntary participation, and no participant was coerced to participate. Anonymity and confidentiality were guaranteed to all participants. Hence, pseudonyms were used during the phase of data discussion and reporting of results

## RESULTS AND DISCUSSIONS

Based on the research that has been conducted and from the results of data analysis obtained in this research, here is how Technology teachers taught Graphic Communication and Techniques. The results are presented in Table 1 below

**Table 1.** Summary of research findings

Item	Concerns	Percentage	
		Yes	No
1	Taught learners to use freehand sketches through PowerPoint slides	Yes	10 (76,92%)
		No	3 (23,07%)
2	Allowed learners to learn graphical communication using educational technologies	Yes	12 (92,31%)
		No	1 (7,69%)
3	Emphasised to using different colours to show different views in one drawing	Yes	5 (38,46%)
		No	8 (61,54%)
4	Showed learners how to use 30 by 60 degrees set square	Yes	13 (100%)
		No	0 (0%)
5	Emphasised on the line-types to use	Yes	9 (69,23%)
		No	4 (30,76%)

As shown in the above table, some of the teachers (76,92%) preferred their learners to draw freehand sketches as means to learn first how to correctly hold pencil and use different line-types. In figure 1 the teacher is seen presenting to learners the concept of graphic communication and figure 2 starting to assist learners in drawing their first sketches.



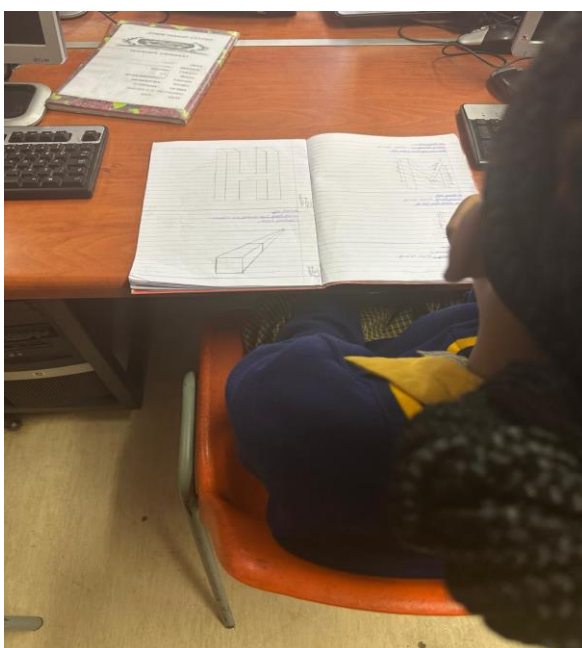
**Figure 1:** Teacher A is presenting the concept of graphic communication to learners



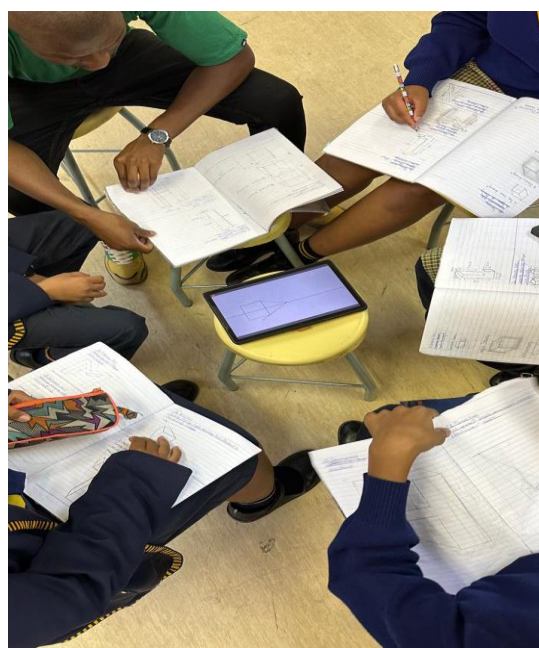
**Figure 2:** Learners are attempting the first activity in their groups

According to Peters (2020) learners should first be taught freehand sketching in order to allow them time to get used to drawing structures. The ability to effectively communicate information and ideas through visual elements such as drawing, images, cartoon-alike, typography, color, and layout is critical in the conception of graphical

communications and techniques (Sibiya et al., 2023). Moreover, learners should be able to apply design principles to produce visual communication that works across print, digital, and motion graphic media platforms (Mtshal, 2023). In figure 3 below we see a learner who has produced his first single point perspective drawing using freehand sketch just as the teacher instructed them and in figure 4, the teacher checks his learners attempts. One of the best ways to check if learners understand what you are teaching, it is through constantly checking their activities individually. Even though Ndlovu (2025) praises this approach to be the most effective for learners who are having conceptual understanding, he cautions that teachers should do this through groups in order to save the lesson time. And in figure 4 we see that Teacher A checked his learners conceptual understanding through group approach.



**Figure 3:** A learner showing his first single point perspective drawing as a freehand sketch.



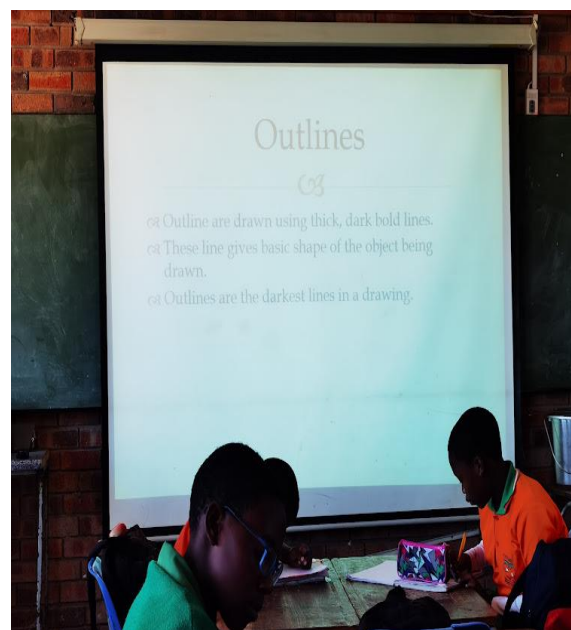
**Figure 4:** The teacher checking learners attempts of their drawings.

In the case of allowing learners to learn graphical communication using educational technologies, Teacher E had not given his learners a chance. It seemed as if the only technological inclusion in his class was an overhead projector where he used slides to teach graphical communications. A study by Sari et al., (2024) indicates that the overhead projectors can contribute to helping the learning process become better. However, this study found that projectors alone were not instrumental in enhancing learner engagement with the concepts of graphical communication and techniques. Teacher E started by presenting the concept of graphical communication, this could be seen in figure 5 below. The most worrisome aspect about his lesson was that it was too theoretical yet teaching this concepts requires active learning. According to Mathabatha et al. (2022) and Kola (2021) too much theory in Technology lessons deprive learners to explore more on their psychomotor skills. As he was teaching, he instructed learners to take notes as seen in figure 6 below. This was disturbing as this lesson was supposed to be from drawing different

structural designs using drawing instruments or auto computer aided drawing. According to Giesecke et al. (2023) the common learning teaching and learning instruments in learning drawing, draughting and sketching concepts are drawing boards, set squares, pencils, digital pads or computers in a case of auto computer aided designs. None of these abovementioned instruments were seen in Teacher E's class, which is why the findings were (7.69%), see table one above. Besides, learners learn better when they are involved in the lesson than becoming passive participants who may forget all being taught because of notes. According to Richardson and Lacroix (2023) learners who are learning through drawings have better cognitive dissonance and recall of concepts than those taught with written texts. Learners were deprived a change to explore educational technologies as well as enacting creative ideas through sketching. This is why we see figure 5 below that Teacher E presents his lesson through a projector and there is no form of other technology for learners. Also, in figure 6 below, learners are simply taking notes which are not simple written texts that do not adequately advance the conception of graphical communication and techniques.



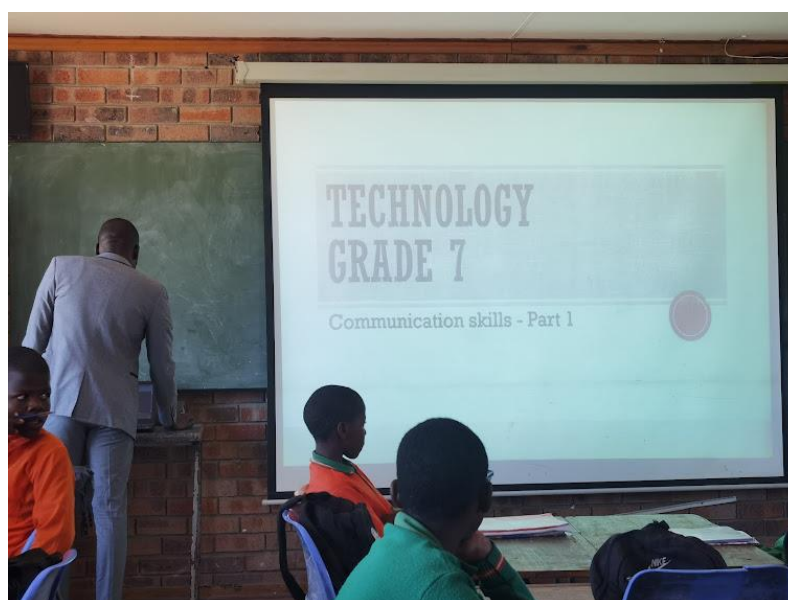
**Figure 5:** Teacher E presenting his lesson on graphical communication to learners



**Figure 6:** learners taking notes on the PowerPoint presentation during the lesson

Another point to be made about this kind of teaching is that the teacher cannot capture and maintain his learners concentration span. At some point, the teachers spent more time on his laptop (see figure 7) than checking what learners were doing just as Teacher A was doing in figure 4. When teachers move around the classroom while teaching, they become more reachable and consequently increase learner engagement and on-task behaviours (Reschly, 2020; Seechaliao, 2017). For this lesson, the main activity was learners taking notes from the PowerPoint presentation that the teacher had prepared. A study by Khulaifayah et al. (2021) and Kola (2021) indicate that when a lesson is good and learners understand activities, they start to take charge of their own learning during lessons. In the case of this lesson, learners took notes and when they got distracted, they

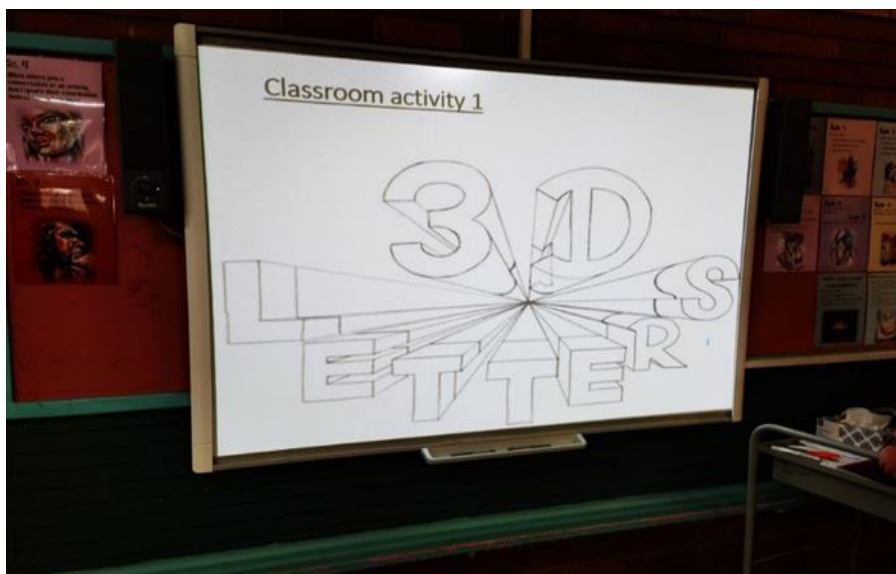
simply talked to their peers than to ask questions about the work. Even the teacher had not persuaded learners to ask questions than to focus on his laptop. It is for this reason that Ndwandwe et al. (2023) posit that even when a teacher is using smartboards to deliver his lessons, he or she must prepare questions that can enact prior knowledge and enhance contextual learning. Contextual learning in technology subject is praised by Blose (2025) who state that learners in Technology unconsciously understand concepts through their lived experience, so it is important for a teacher to create scenarios that will make learning interactive. Figure 7 below shows the teacher busy with his laptop and some learners folding hands to indicate that no one is paying attention to them about the present lesson.



**Figure 7:** the teacher is on his laptop while learners are doing their own things

One of the most popular drawing techniques in Technology is called perspective drawing (Mtshal, 2023; DBE, 2011). The point of interest in perspective drawing is that learners should understand the role of vanishing point (Bartlett & Dorribo Camba, 2023). A vanishing point in a perspective drawing makes an object look more realistic in the sense that the drawing becomes smaller along the lines called vanishing lines (Stenalt, 2021), and Teacher C on figure 8 reflected that the on the lesson. According to Zwane et al, (2021) Grade 7 learners need to be taught various designs on how vanishing point works. This is because the designs that learners are exposed to on digital networks give them more drawing ideas but lack how to present them using single point perspective where vanishing point becomes the centre to which a drawing is connected (Cuic et al., 2023). The results show that Teacher C students like the concept of graphic communication and want to transfer the creativity they have learned outside the classroom, which clearly shows that the concept plays a very important role in creating good and quality art learning so that teachers must really pay attention to this part as an inseparable part during the learning axis. Learning will be meaningful if the concept and experience become a whole unit that can provide a better and quality idea and education must provide this space, especially in the learning

process. In the figure 8 below, he presented his creative idea on learners to show how vanishing points can be used creatively.



**Figure 8:** Teacher C showing creative ways of using vanishing point in a drawing

According to Mtshali (2023) supporting Biwer et al. (2020) engineering graphics and design teachers need a pedagogically viable teaching approach that can assist with planning and implementation procedures. Mastery of Content Representation then becomes the source of departure in guiding teachers on all the odysseys to teaching drawing concepts (Fahmi & Ali, 2022). To comprehend how Technology teachers bring together the aspects of pedagogical content knowledge in the context of teaching graphic communication, an exploration of the mastery of content representation of these teachers is crucial (Magolego, et al., 2023). So as part of teaching graphical communication and techniques it is expected that teachers should adequately plan their activities and mode of delivery to avoid unnecessary drawing misconceptions. A study by Hattan, MacPhee and Zuiderveen (2025) cautions us that unsystematic presentation of concepts is largely caused by teachers inability to master content representation, and this could be seen in Teacher E's lesson. Furthermore, this teacher had no means to assist her learners to correctly draw the shown activity using all drawing instruments (Anderson & Putman, 2020; Purkayastha et al., 2019). As a result, the PCK of Grade 7 Technology teachers require improvement in graphic communication. Suboptimal practices, such as finger illustrations and a lack of diverse teaching strategies, hindered learners' comprehension and discouraged effective learning (Magolego et al., 2023). The incorporation of active learning techniques, formative assessments, and individualized support is crucial for refining optimal learning outcomes in graphic communication

## CONCLUSION

In light of the emergent findings, the study found that Grade 7 Technology teachers had a fair share in strength and weaknesses when it comes teaching Graphic Communication and Techniques to senior phase Technology learners. This study revealed

that 76.92% of sampled teachers taught learners different structures using freehand drawing technique and this had a negative impact on learners' ability to use drawing tools. The evidence to this was reflected where 100% of the teachers had not attempted to use and encourage learners to draw using adequate set squares. It was interesting to see that only 38.46% of teachers emphasised the need to use different colours in drawings to improve learners spatial and cognitive skills. Some of the learners activities displayed that different colours were used even though the drawings were not correct and appealing. Only 69.23% of teachers taught learners the use of correct line types, sadly learners were not receptive of this emphasis as most of them had drawings which were in bold lines and not neat. Summarily, these teachers had demonstrated to somehow know how to teach some graphic communication concepts. However, they could not follow up on their lesson outcomes extensively. As a result, this study recommends that teachers should engage in lesson study approaches with other colleagues teaching Technology in order to strengthen their grasp of learner-centred approaches that are appropriate for teaching graphic communication and techniques.

## REFERENCE

- Anderson, S. E., & Putman, R. S. (2020). Special education teachers' experience, confidence, beliefs, and knowledge about integrating technology. *Journal of Special Education Technology*, 35(1), 37-50. <https://doi.org/10.1177/0162643419836409>
- Bartlett, K. A., & Dorribo Camba, J. (2023). The role of a graphical interpretation factor in the assessment of Spatial Visualization: A critical analysis. *Spatial Cognition & Computation*, 23(1), 1-30. <https://doi.org/10.1080/13875868.2021.2019260>
- Biwer, F., oude Egbrink, M. G., Aalten, P., & de Bruin, A. B. (2020). Fostering effective learning strategies in higher education—a mixed-methods study. *Journal of Applied Research in Memory and Cognition*, 9(2), 186-203. <https://doi.org/10.1016/j.jarmac.2020.03.004>
- Blose, P. (2025). Pedagogical Approaches for Teaching Education for Sustainable Development in the Technology Education Curriculum. *Research in Social Sciences & Technology (RESSAT)*, 10(1). <https://doi.org/10.46303/ressat.2025.12>
- Calavia, M. B., Blanco, T., & Casas, R. (2021). Fostering creativity as a problem-solving competence through design: Think-Create-Learn, a tool for teachers. *Thinking skills and creativity*, 39, 100761. <https://doi.org/10.1016/j.tsc.2020.100761>
- Carlini, L. (2021). *Drawing as intervention to improve concentration in the classroom at four schools in the Western Cape* (Doctoral dissertation, Stellenbosch: Stellenbosch University). <http://hdl.handle.net/10019.1/109848>
- Cuic Tankovic, A., Kapeš, J., & Benazić, D. (2023). Measuring the importance of communication skills in tourism. *Economic research-Ekonomska istraživanja*, 36(1), 460-479. <https://doi.org/10.1080/1331677X.2022.2077790>
- Department of Basic Education. (2011). Curriculum and Assessment Policy Statement (CAPS) of Technology Grades 7-9. Pretoria: *Department of Education*.

- Department of Basic Education. (2015). *Action Plan to 2019: Towards the Realisation of Schooling 2030: Taking Forward South Africa's National Development Plan 2030*. Pretoria: Government Printer.
- Evardone, C. J. A., Dignadice, E. P., & Parco, E. G. (2021). Assessment on event management service competencies of selected event managers in Taguig city. *Asia Pacific International Events Management Journal*, 2(1), 46-54. <https://ejournal-medan.uph.edu/apiemj/article/view/453>
- Fan, J. E., Bainbridge, W. A., Chamberlain, R., & Wammes, J. D. (2023). Drawing as a versatile cognitive tool. *Nature Reviews Psychology*, 2(9), 556-568. <https://www.nature.com/articles/s44159-023-00212-w>
- Fahmi, I., & Ali, H. (2022). Determination of Career Planning and Decision Making: Analysis of Communication Skills, Motivation and Experience (Literature Review Human Resource Management). *Dinasti International Journal of Management Science*, 3(5), 823-835. <https://doi.org/10.31933/dijms.v3i5.1222>
- Fiesler, C., Garrett, N., & Beard, N. (2020, February). What do we teach when we teach tech ethics? A syllabi analysis. In *Proceedings of the 51st ACM technical symposium on computer science education* (pp. 289-295). <https://doi.org/10.1145/3328778.3366825>
- Fraile-Fernández, F. J., Martínez-García, R., & Castejón-Limas, M. (2021). Constructionist learning tool for acquiring skills in understanding standardised engineering drawings of mechanical assemblies in mobile devices. *sustainability*, 13(6), 3305. <https://doi.org/10.3390/su13063305>
- Giesecke, F. E., Lockhart, S., Goodman, M., & Johnson, C. M. (2023). *Technical drawing with engineering graphics*. Peachpit Press.
- Gumbo, M. T. (2020). Professional development of technology teachers: Does their training meet their needs? *Perspectives in Education*, 38(1), 58-71. <https://hdl.handle.net/10520/ejc-persed-v38-n1-a6>
- Hattan, C., MacPhee, D., & Zuiderveen, C. (2025). Vocabulary Instruction During Elementary Classroom Discourse: Observing 1st Through 3rd Grade Teachers' Instructional Practices. *Literacy Research and Instruction*, 1-27. <https://doi.org/10.1080/19388071.2025.2457679>
- Hlatshwayo, B. H., Skosana, N., & Khoza, S. (2022). Teachers Pedagogical Content Knowledge in Graphical Communication Concept: A Case of Four Selected Township Schools. *Journal of Curriculum Studies Research*, 4(2), 44-58. <https://doi.org/10.46303/jcsr.2022.11>
- Hurter, C., Carbon, C. C., Martino, M., & Rogowitz, B. E. (2025). Art, Visual Illusions, and Data Visualization (Dagstuhl Seminar 24301). *Dagstuhl Reports*, 14(7), 81-114. <https://doi.org/10.4230/DagRep.14.7.81>
- Kauffman, J. M., & Hornby, G. (2025). Extremism and the potential dismantling of special education: Or moving forward with inclusive special education. *Support for Learning*. <https://doi.org/10.1111/1467-9604.12519>
- Kekana, E. K., Mtshali, T. I., & Ramaligela, M. S. (2024). Inventive Ways of Teaching Mechanical Systems and Control to Grade 9 Learners with Special Learning

- Needs. *Jurnal Penelitian dan Pengkajian Ilmu Pendidikan: e-Saintika*, 8(1), 40-57. <https://doi.org/10.36312/esaintika.v8i1.1424>.
- Khulafiyah, K., Widati, U., Anugerahwati, M., & Suryati, N. (2021). Autonomous learning activities: The perceptions of English language students in Indonesia. *Pegem Journal of Education and Instruction*, 11(3), 34-49. <https://www.pegegog.net/index.php/pegegog/article/view/1362/385>
- Kim, J., Ham, Y., & Lee, S. S. (2024). Differences in student-AI interaction process on a drawing task: Focusing on students' attitude towards AI and the level of drawing skills. *Australasian Journal of Educational Technology*, 40(1), 19-41. <https://doi.org/10.14742/ajet.8859>
- Kilmer, R., & Kilmer, W. O. (2021). *Construction drawings and details for interiors*. John Wiley & Sons.
- Kliment, M., Lachvajderova, L., Svantner, T., & Matiscsak, M. (2023). Exploration of 3D objects: methods for simulation, application, and presentation. *Acta Simulatio*, 9(1). <https://doi.org/10.22306/asim.v9i1.94>
- Kola, M. (2021). Pre-service teachers' action research: technology education lesson planning in a South African University. *Educational Action Research*, 29(1), 99-117. <https://doi.org/10.1080/09650792.2019.1686043>
- Magolego, M. P., Mtshali, T. I., & Ramaligela, S. M. (2023). Enhanced creativity with Mini-PAT: a case of grade 9 technology teachers in Sekhukhune East. [https://conf.ul.ac.za/aportal/application/downloads/2023\\_march\\_7\\_Article\\_9.pdf](https://conf.ul.ac.za/aportal/application/downloads/2023_march_7_Article_9.pdf)
- Martin, N., Wray, M., James, A., Draffan, E. A., Krupa, J., & Turner, P. (2019). Implementing inclusive teaching and learning in UK higher education—utilising universal design for learning (UDL) as a route to excellence. <https://www.srhe.ac.uk/downloads/reports-2017/Nicola-Martin-SRHE-Research-Report.pdf>
- Mathabata, L. N., Kola, M. I., & Mtshali, T. I. (2022). Simulations for junior engineering and technology students: teachers' ability to use design process to promote psychomotor skills. *Nigerian Journal of Technology*, 41(6), 930-939. <https://doi.org/10.4314/njt.v41i6.2>
- Matsekoleng, T. K., Mapotse, T. A., & Gumbo, M. T. (2024). The role of indigenous games in education: a technology and environmental education perspective. *Diaspora, Indigenous, and Minority Education*, 18(1), 68-82. <https://doi.org/10.1080/15595692.2022.2160436>.
- McIntosh, M. J., & Morse, J. M. (2015). Situating and constructing diversity in semi-structured interviews. *Global qualitative nursing research*, 2, 2333393615597674. <https://doi.org/10.1177/2333393615597674>
- 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://eric.ed.gov/?id=EJ1440807>
- Mtshal, T. I. (2023). Students Metacognitive Challenge in the Interpretation of Mechanical Drawings in Engineering Graphics and Design. *Journal of Positive Psychology and*

- Wellbeing*, 7(4),189-203.  
<https://mail.journalppw.com/index.php/jppw/article/view/17788>
- Mtshali, T. I. (2021). Occupational Training for TVET College Civil Engineering Students in the Modern Era: Has Anything Changed? *Journal of Technical Education and Training*, 13(4), 82-91.  
<https://penerbit.uthm.edu.my/ojs/index.php/JTET/article/view/8588>
- Mtshali, Thokozani Isaac (2023). "Mastery of Content Representation (CoRe) by Engineering Graphics and Design Teachers: Promotion of Equity and Inclusion Through Civil Drawing Tasks." *In Handbook of Research on Advancing Equity and Inclusion Through Educational Technology*. IGI Global, 2023. 306-318.  
<https://doi.org.10.4018/978-1-6684-6868-5.ch015>
- Mujahid, A., Awan, M. J., Yasin, A., Mohammed, M. A., Damaševičius, R., Maskeliūnas, R., & Abdulkareem, K. H. (2021). Real-time hand gesture recognition based on deep learning YOLOv3 model. *Applied Sciences*, 11(9), 4164.  
<https://www.mdpi.com/2076-3417/11/9/4164#>
- Nafie, G., Rosi, G. A., Mai, A., & Johnston, K. (2022). Building Engineering Fundamentals in an Active Learning Environment. *Proceedings of the Canadian Engineering Education Association (CEEA)*.  
<https://doi.org/10.24908/pceea.vi.15944>
- Nelson, C., & Woods Jr, R. H. (2013). 1 CONTENT ANALYSIS. *In The Routledge handbook of research methods in the study of religion* (pp. 131-143). Routledge.  
<https://www.taylorfrancis.com/chapters/edit/10.4324/9780203154281-16/1-content-analysis-chad-nelson-robert-woods-jr>
- Olugbenga, M. (2021). The learner centred method and their needs in teaching. *International Journal of Multidisciplinary Research and Explorer (IJMRE)*, 1(9), 64-69. <https://ijmre.com/index.php/IJMRE/article/view/62>
- Pentang, J. T., & Pentang, J. (2021). Quantitative data analysis. *Holy Angel University Graduate School of Education: Research and academic writing*. <http://dx.doi.org/10.13140/RG.2.23906.45764>, 1.  
<http://dx.doi.org/10.13140/RG.2.23906.45764/1>
- Peters, O. R. (2020). Assessment methods in free-hand sketching and drawing related courses in visual communication education. *International Journal of Research in Education Humanities and Commerce*, 1(1), 56-71.  
[https://ijrehc.com/doc/ijrehc01\\_06.pdf](https://ijrehc.com/doc/ijrehc01_06.pdf)
- Purba, R., Herman, H., Purba, A., Hutauruk, A. F., Silalahi, D. E., Julyanthry, J., & Grace, E. (2022). Improving Teachers' competence Through the Implementation of the 21st Century Competencies in A Post-Covid-19 Pandemic. *Jurnal Masyarakat Mandiri*, 6(2), 1486-1497. <https://journal.ummat.ac.id/index.php/jmm/article/view/7340>
- Purkayastha, S., Surapaneni, A. K., Maity, P., Rajapuri, A. S., & Gichoya, J. W. (2019). Critical Components of Formative Assessment in Process-Oriented Guided Inquiry Learning for Online Labs. *Electronic Journal of E-learning*, 17(2), 79-92.  
<https://eric.ed.gov/?id=EJ1220140>

- Reschly, A. L. (2020). Interventions to enhance academic engagement. *Student engagement: Effective academic, behavioral, cognitive, and affective interventions at school*, 91-108. [https://link.springer.com/chapter/10.1007/978-3-030-37285-9\\_5](https://link.springer.com/chapter/10.1007/978-3-030-37285-9_5)
- Richardson, L., & Lacroix, G. (2023). Which modality results in superior recall for students: Handwriting, typing, or drawing?. *Journal of Writing Research*, 15(3), 519-540. <https://doi.org/10.17239/jowr-2024.15.03.04>
- Rodríguez, S., Núñez, J. C., Valle, A., Freire, C., Ferradás, M. D. M., & Rodríguez-Llorente, C. (2019). Relationship between students' prior academic achievement and homework behavioral engagement: The mediating/moderating role of learning motivation. *Frontiers in psychology*, 10, 1047. <https://doi.org/10.3389/fpsyg.2019.01047>
- Rose, J., & Johnson, C. W. (2020). Contextualizing reliability and validity in qualitative research: Toward more rigorous and trustworthy qualitative social science in leisure research. *Journal of leisure research*, 51(4), 432-451. <https://doi.org/10.1080/00222216.2020.1722042>
- Sari, I. A., Zulaikha, S. ., Puska, N., & Norza, M. . (2024). Utilization of Projector Technology in 21st Century Learning: What is the Impact on Student Learning Outcomes?. *International Journal of Education and Teaching Zone*, 3(2), 131–142. <https://doi.org/10.57092/ijetz.v3i2.191>
- Seechaliao, T. (2017). Instructional strategies to support creativity and innovation in education. *Journal of Education and Learning*, 6(4), 201–208. doi: <https://doi.org/10.5539/jel.v6n4p201>.
- Sherin, A. (2023). *Introduction to Graphic Design: A Guide to Thinking, Process, and Style*. Bloomsbury Publishing.
- Sibiya, M. T., Mtshali, T. I., & Ramaligela, M. S. (2023). The Use of Augmented Reality to Promote Equity and Inclusion: A Case of Teaching and Learning Graphical Communication and Graphical Techniques in the Technology Classroom. *In Handbook of Research on Advancing Equity and Inclusion Through Educational Technology* (pp. 170-188). IGI Global. <https://doi.org/10.4018/978-1-6684-6868-5.ch009>
- Singh-Pillay, A., & Sotsaka, D. (2020). An exploration of first year pre-service engineering graphics and design teachers' spatial visualisation ability at a university of technology. *Journal for the Education of Gifted Young Scientists*, 8(2), 681-690. <https://doi.org/10.17478/jegys.639351>
- Skosana, N. M. (2017). Effective Teaching-learning Methods for First-year Engineering Graphics and Design Education Students. (*Doctoral Thesis. Tshwane University of Technology, Pretoria*).
- Stenalt, M. H. (2021). Digital Student Agency: Approaching Agency in Digital Contexts from a Critical Perspective. *Frontline Learning Research*, 9(3), 52-68. <https://eric.ed.gov/?id=EJ1309730>
- Supena, I., Darmuki, A., & Hariyadi, A. (2021). The Influence of 4C (Constructive, Critical, Creativity, Collaborative) Learning Model on Students' Learning Outcomes.

*International Journal of Instruction*, 14(3), 873-892.  
<https://eric.ed.gov/?id=EJ1304598>

Yin, Robert K. "Validity and generalization in future case study evaluations." *Evaluation* 19, no. 3 (2014): 321-332.  
<https://doi.org/10.1177/1356389013497081>

Zwane, T. T., Simelane-Mnisi, S., & Skosana, N. M. (2021). Exploring the Practical Application of Course Drawing Among High School Engineering and Graphics and Design Learner. International Conference on Public Administration and Development Alternatives (IPADA).  
<https://univendspace.univen.ac.za/server/api/core/bitstreams/1489aaf2-83f0-447a-92eb-285b7d60f732/content>