Available online at: https://jurnal-fkip.ut.ac.id/index.php/ijrse/issue/archive
International Journal of Research in STEM Education (IJRSE)
ISSN 2721-2904 (online)
Volume 8 Number 2 (2026): 17 - 31

Operationalization of Indigenous Knowledge in teaching general drawing principles in Engineering Graphics and Design: A global south perspective

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Abstract

The system of indigenous knowledge has been met with various debates and contradictions in so many disciplines and its relevance into the current education discourse. Teacher's expertise in design plays an important role in communicating drawing messages. The purpose of this study was to explore how is the operationalization of Indigenous Knowledge System in teaching Engineering Graphics and Design (EGD) to teach general drawing principles. This study used a qualitative research approach and phenomenological design to understand participants' experiences. Purposive sampling was used to select five teachers and a total of seventy-three learners. Indigenous knowledge framework was employed to capture all relevant information. Interviews and classroom observations were used to collect data, and thematic analysis was used to analyze it. This study discovered that in EGD classroom, the operationalization was done using vernacular architecture examples, using ancient glyph writing styles to teach numerical and alphabetical printing, as well as contextualized story telling. The study concludes that, through these strategies, strides were made to operationalize indigenous knowledge in teaching general drawing principles and that there is some level of appreciation on how teachers cognitive and wise legacy about indigenous knowledge playout during instruction. As a recommendation, this study for content knowledge structure in STEM subjects that is centered around language, context and culture dynamism in order to capture each indigenous group's social realities.

Keywords: *STEM education, Indigenous knowledge, Engineering Graphics and Design, culturally responsive pedagogy, engineering education*

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INTRODUCTION

The system of indigenous knowledge has been met with various debates and contradictions in so many disciplines and its relevance into the current education discourse. The truth is that every nation has indigenous people that hold knowledge that is rich in context knowledge and have used such knowledge for decades and possible centuries to interact with others and live better with their surrounding environment. For most people, it has been a mountainous task to find resonance with such knowledge given the global shift, knowledge economy and civilization (Estrada et al., 2022). This study too sought to address the knowledge gap that exist in how Indigenous Knowledge (IK) is operationalized in Engineering Graphics and Design (EGD). This contributes to the emerging knowledge development and clarity on the relevance of IK in Science, Technology, Engineering and Mathematics (STEM) education, particularly understanding IK into teaching general drawing principles in EGD.

Engineering graphics and design is a subject that is concerned with graphical communicative ideas by using drawing instruments and computer-based tools (Mteleli et al., 2026). It has little to do with written words but largely concentrates on drawings, meaning that all communication channels are narrowed into a drawing. This study is unique from existing literature because it looks into how indigenous knowledge is used in a subject whose knowledge value is strictly on drawings, symbols and selective printing styles (i.e. numbering and

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DOI: https://doi.org/10.33830/ijrse.v8i2.14446

lettering). It must be known that Hart (2010) describes IK as an established social knowledge of indigenous people, their worldviews and the customs along with traditions that direct them. Such knowledge is best transferred through written text and not so much on Engineering drawings, except for art. Hence, it is important to navigate on how IK is operationalized in an environment where teaching requires spatial visualization skills.

Teacher's expertise in EGD plays an important role in communicating drawing messages thereby providing learners with a chance to develop a skill to visually communicate concepts much quicker using a pencil and paper (Springer, 2023). In retrospection, most global south communities relied on symbolism and freehand sketching ideas they wanted to communicate to a generation that would outlive them. This required a great level of creativity in freehand sketching in big rocks, which required a designer to brainstorm and expand on the draft drawings (Kamel & Khalil, 2023). This indigenous drawing practices qualifies to probe on what mode of indigenous communication is done in the present-day engineering drawing subject.

Sibiya et al. (2023) posit that in EGD, it is expected that each learner engages with engineering drawings sterming from the field mechanical and civil engineering (Sibiya et al., 2023). As a result, teachers need to develop creative ideas to operate IK relating to those fields. Mapara (2022) maintained that indigenous practices can be brought on board to indigenize the Agricultural curriculum and other Sustainable Livelihoods programs. Similarly, this study propound that Indigenous practices can be used to indigenize the teaching of general drawing principles and freehand sketches among others. For instance, Indigenous design represents a single culture's identity and core principles. It provides a significant representation of indigenous creative knowledge in society (Tunstall, 2020). Since indigenous designs are embedded in a community's customs, connections, and practices, creativity serves as the fundamental foundation for design. According to Nkosi, Kola and Mtshali (2023) creativity is broadly viewed as a desired attribute for the quality of thinking that lays a foundation for innovation and change. It is also known as a process of becoming sensitive to a problem, deficiencies, gaps in knowledge, missing elements and disharmonies. Consequently, it is expected that teachers close their societal knowledge gaps through innovative designs and teach learners freehand sketches that resonate with what is indigenously valuable to them.

Pophiwa and Saidi (2022) have observed that the extant literature does not make any specific mention of Indigenous Knowledge Systems. This study has identified this pattern, which is consistent with prior research showing that Indigenous knowledge systems are still not adequately supported in designed, particularly on general drawing principles. One pertinent study by Mtshali (2023), examined the mastery of content representation (CoRe) by EGD teachers in the context of teaching civil drawing. The study found that teachers could not view civil drawings as a way to advance equity and inclusion, indicating how deep rooted is the problem of EGD teachers in employing knowledge bases in their instruction. This therefore leaves room for the inclusion of indigenous knowledge in freehand sketches in EGD. Moreover, several studies such as those of Maeko and Khoza (2018); Żychowska (2021); Zwane, Simelane-Mnisi and Skosana (2021) conducted on engineering graphics and design lack the aspect of Indigenous knowledge systems integration. Integrating Indigenous knowledge into EGD instruction may therefore strengthen culturally responsive STEM education. It may also create more inclusive learning opportunities by connecting technical drawing principles with learners' cultural knowledge and experiences. Conversely, in their study, Blose and Gumbo (2019), revealed a lack of full advantage of Indigenous graphics knowledge and skills in teaching graphic designs. Singh-Pillay and Sotsaka (2020) saw a similar pattern and identified several elements that improved the spatial vision of female learners. Among those characteristics, they mentioned that working with Indigenous patterns was realized to be helpful in enhancing learners' spatial visualization skills. However, spatial visualization was given more attention. Therefore, the purpose of this study was to investigate how Indigenous Knowledge was operationalized into EGD general drawing principles. Hence this study was guided by the following research question: How is the operationalization of Indigenous Knowledge in EGD's general drawing principles?

LITERATURE REVIEW

Sketches of engineering graphics and design and operationalizing general drawing principles

Sketching is known as a hand-drawn illustration intended to provide details about a specific area or segment of a component or mechanism. It aids in eliminating errors on the drawings later on by having a clear understanding about the details that must be drawn (Mtshal, 2023). It also emphasizes the basic hand movements needed to draw proportional single, Multiview and pictorial drawings on plain paper and/or grid sheets (Peters, 2020). Sketches given to learners in schools are normally from mechanical and civil engineering disciplines because more than 70% of 'EGD's content comes from those two engineering disciplines. Electrical engineering components normally come as part of civil drawings where learners are expected to draw electric features in the floor plan.

Of course, design comes in different forms, such as graphic design, industrial design and built environment design (architecture, landscape architecture and interior design). Design skills can be acquired through simple drawings, such as two-dimensional (2D) and complex three-dimensional (3D) shapes (Sütçü, 2021). Henceforth, sketches can follow the same dimensional pattern.

Operationalizing indigenous knowledge into general drawing principles in most EGD classrooms, there is significant lack an understanding of graphics and its principles. Potentially, this could be caused by teachers switching off learners from their indigenous environments and prioritize completing curriculum. To rule out such speculation, such a study is eminent particularly to understand how teachers navigate their home/local knowledge to learn drawing principles. The general drawing principles pertain to knowing different drawing symbols, line types and their interpretation, printing of letters and numbers and differentiating dimensions between civil and mechanical drawings. This expertise is often influenced by their general knowledge and culture's identity and core principles, which is all part of Indigenous Knowledge. Reflecting on Jones (1997) assertion that brings another aspect of the design subject curriculum to the fore, one that gives the impression that, all too often, we simply have considered the impact of technology on society, rather than considered the different views people have about design; and the way these impressions are influenced by their beliefs, values and ethics. These different views people have about technological design should be applicable when dealing with Engineering Graphics and Design along with IKS. . In fact, learners from the non-indigenous environments are also disadvantaged from learning about alternative knowledge forms and ways of technology. We must remember that aim of design subject is to introduce learners to the world of engineers, and how they apply their skills to solving problems graphically (DBE, 2011). However, in absence of indigenous relevance in the knowledge, such aim of the subject may not necessarily be realized.

A typical example of indigenous graphic design is the design by Esther Mahlangu (De Jager & Loots, 2003). Esther Mahlangu is a South African artist from the Ndebele tribe in Mpumalanga Province. She is known for her bold large-scale contemporary paintings that reference her Ndebele heritage. She is recognized worldwide because of her artwork. Her artwork thrives on indigenous knowledge. Her artwork is hailed worldwide. Her work draws from the integration of different disciplinary knowledge, such as mathematics, design and technology, history and the arts. From the design subject point of view, the artwork portrays the creative skills in the drawing or graphic work that resonates well with the Ndebele culture, which is the indigenous knowledge aspect. She uses basic resources, such as chicken feathers and sticks, as her paint brushes. The design and paintings show the aesthetic aspect of design and has a particular meaning in the Ndebele culture. The aesthetic aspect of design is so important because it makes the designed product appealing in terms of color, shape and patterns. This suggests that, when teachers engage learners to do graphic design work, indigenous aspects should be taken into consideration. Indigenous experts like her could always be modelled as anchors of freehand graphics philosophers.

CONCEPTUAL FRAMEWORK

Indigenous knowledge as a framework

To examine how the operationalization of Indigenous Knowledge in teaching general drawing principles in Engineering Graphics and Design is done, this study employed Indigenous knowledge as its framework. According to Maurial (1999) indigenous knowledge is the peoples' cognitive and wise legacy because of their interaction with nature in a common territory. Hart (2010) defines indigenous knowledge as an established knowledge of indigenous people, their worldviews and the customs and traditions that direct them. With the above distinctive definitions in mind, indigenous knowledge is placed in the light of western orientation, which is not bad. However, given that this study was conducted in the global south, a version of indigenous knowledge from proponents of the global south, such as Odora Hoppers, Gumbo, Shava and many others is equally important. It is in these scholars where the idea of examining how the operationalization of Indigenous Knowledge in teaching general drawing principles was conceived. As a result, Shava (2013) portrays IKS as a context rich knowledge that incorporates key important aspects, such as people, context, culture, language, knowledge, practices and dynamism.

Scholars such as Hoppers (2021) and Gumbo (2017) summarily associates IKS with traditional environmental knowledge that should be seen as a means to understand complex systems to give rise to a greater understanding of IKS. As mentioned earlier, IKS resonate with the aspects of people, context, culture, language, knowledge, practices and dynamism which is at the heart of the indigenous paradigm (Kigozi et al., 2021). Hence, in order to understand how teachers and learners experience the use of IK in their environment, this framework was viewed relevant in that learners and teachers are to draw from their societal and traditional livelihood to make sense of general drawing principles. The incorporation of social factors, such as the arts and indigenous symbols, towards drawing in the teaching of drawing principles and sketching may provide clarity, direction and focus to learners when they are given an opportunity to experience knowledge construction in graphic design and to express their design ideas through graphics as informed by their context-based designs.

METHODOLOGY

Research paradigm

In a pragmatic research paradigm, this study explored how the operationalization of Indigenous Knowledge in teaching general drawing principles in Engineering Graphics and Design is done. According to Borges and Revez (2019) a pragmatic research paradigm is a method that is based on empirical and experimental thought that applies to experience. As a result, this paradigm was found to be relevant as it assisted this study to understand what works in the classroom practice of EGD during the teaching of general drawing principles. This paradigm was deemed relevant because it requires that theories and concepts (i.e. Indigenous knowledge) be examined based on their practical applicability and outcomes.

In terms of ontological stance, this study was concerned with subjective realities of the five teachers and seventy-three (73) learners in the Mpumalanga region of South Africa. This was because the researcher wanted to understand how this group socially constructed realities of basic drawing principles when engaged in Engineering Graphics and Design (Ayton & Tsindos, 2023). Epistemologically, the concern was on how the theory of indigenous knowledge was co-created from everyday classroom observation. This included probing if learners believed that Indigenous Knowledge can be taught in Engineering drawing subjects and provide practical examples relating to the subject to substantiate their responses.

Research approach

In this study, a qualitative research approach was deemed adequate to gather comprehensive rich descriptive data and understand the subject being investigated (Merriam & Grenier, 2019). This qualitative approach further enabled the researcher to explore diverse perspectives within an engineering graphics and design teaching community regarding indigenous knowledge.

Research Design

A phenomenological study design was considered to understand participants' experiences (i.e. teachers and learners). According to Casey (2000) this design is used when exploring how individuals perceive and make sense of their direct and lived experiences of a specific concept. In line with this thought, this study explored how the concept of indigenous knowledge is operationalized and how they make sense of it during the instruction of basic drawing principles in Engineering Graphics and Design.

Sampling

Purposive sampling was used to identify five Engineering Graphics and Design teachers and their seventy-three learners. Campbell et al. (2020) avers that a purposive sampling technique is used where researchers intentionally select participants based on their specific knowledge and experiences to best address the research study's intention. As a result, the study intentionally used teachers and learners who are located in indigenous Ndebele region where indigenous knowledge is well presented. There were studies such as Blose et al. (2026) and Jiyana (2022) who supported the selection of Ndebele group as the most knowledgeable group in indigenous knowledge system. While their study paved a way for this current study, their focus was not on Engineering Graphics and Design, making this study unique and contributing to the school of knowledge. The inclusion criteria were that the participants should be located in the Ndebele region in Mpumalanga province where the language is spoken as a home language. Another inclusion criteria were that the schoolteachers should be known for their appreciation of their culture so that it reflects into their practice. All other schools in the region which did not fall under the criteria were excluded in the phenomenon. This study understands the limitation posed by this inclusion criteria, however, it was essential as a first start to understand realities of people who have been seconded by scholars as having deep connections with their indigenous knowledge.

Data collection and analysis

Data was collected through individual and group interviews and classroom observations. According Mayring (2014) interviews are methods that rely on asking questions in order to collect data. Thus, five teachers were asked how they operationalize indigenous knowledge when teaching general drawing principles. Each teacher's interview was conducted interviews were recorded through a cellular phone and took about ten minutes for each participant. Similarly, group interviews were conducted with the learners of those teachers since they were all in one school. To the advantage of the researcher, group interviews were conducted during enrichment classes which did not temper with normal schooling time. When interviews were conducted with the learners, the teacher was not present. This was done to ensure that learners express their opinions without supervision by their teachers, natural setting took precedence.

For observations, this study followed O'Leary (2020) guide by recording what occurs in the classrooms by systematically observing and keeping records of classroom events. Specifically, the researcher wanted to understand what methods that learners could demonstrate on the board that they learnt through indigenous knowledge. Data was analyzed through a systematic process of identifying recurring themes, interpreting and explaining them, and drawing conclusions. This study subsequently collected, transcribed, verified, collated, coded and categorized the findings (Clark & Braun, 2013).

In terms of Familiarization with the data, the researcher took the collected data and replayed it on the phone recordings and started writing down the notes. This practice was seconded by Brown and Stockman (2013) that for a researcher to familiarize themselves with the research data collected, they should consider replaying and listening to the audio recordings until they appreciate the sense to which such data was presented. This phase was immediately followed by code generation after having the grasp of the data. According to Braun and Clarke (2014) coding involves creating codes for the significant attributes of the data collected, with specific relevance to the research question.

Searching and reviewing data followed which allowed the researcher to sort them and identified those which were similar, ushering the creation of themes. Braun and Clarke (2014) term this process as that which includes grouping of similar codes together so that it can reflect a meaningful pattern in the data. Having examined all the themes in the light of the coded data logical patterns emerged. This allowed the researcher to recognize the distinct themes; and show how they were combined to tell a narrative by using the data. It is in that process where naming themes of the three themes emerged. This was done in cognizant with Friese, Soratto, and Pires (2018) who said that the researcher should be aware of what each theme is about; and that themes must give the person who is reading the report a sense of what the theme is about. Summarily, the whole process assisted the researcher to write a report by interlinking the analytic narrative and data extracts, in order to convey to the reader a story about the data.

The trustworthiness of the study was ensured through various strategies including credibility, dependability, confirmability, and transferability (Adler, 2022). To ensure the credibility of this study, the researcher first re-played the recorded data to the participants and also after transcribing to notes, he took them back to teachers and learners to confirm true representation of the data and they confirmed as true reflection. In terms of dependability, the researcher asked that all the data collected and referred onto could be found and used in this study and where external sources were used, they were acknowledged. This was done for consistency purposes and stability of findings over time and across different conditions (Haq, Rasheed, Rashid, & Akhter, 2023). For instance, where participants showed the digital pictures which were used by teachers in teaching numbering and lettering in the drawing printing principle, the researcher asked learners to refer to that original source on internet, and it was found and used in this study.

Confirmability of this study data was ensured by reviewing and rechecking the data during data collection and processing to ensure that conclusions could be replicated by others (Haq, Rasheed, Rashid, & Akhter, 2023). To ensure transferability, "thick description" of the findings from numerous data collection methods were used, namely interview and observation. Also, the researcher allowed participants of this study to have room for free response to questions asked in detail to ensure greater transferability.

Ethical clearance

The ethical clearance approval (2019/02/13/56712715/17/MC) was granted by the institution affiliated with the leading author. This was to ensure that the study is conducted within acceptable research conducts.

FINDINGS

To determine how Indigenous Knowledge is operationalized during the lessons of general drawing principles in Engineering Graphics and Design, this study used, interviews and classroom observations to gather relevant data. As a result, this study discovered that indigenous knowledge is operationalized through:

- Indigenous housing structure examples (Vernacular architecture)
- Following ancient glyph writing styles to teach numerical and alphabetical printing
- Contextualized story telling
- The themes are elaborated upon below

Indigenous housing structures

Most of the Indigenous housing structures (vernacular architecture) in the global south are typically dome or cone-on-cylinder shaped using low-carbon materials like wood, grass, and stone (Johnson & Ekpo, 2026; Okung, 2025). This shape aligns well with Engineering Graphics and Design content on cones and ellipse construction. So, learners were asked to determine their knowledge and understanding of indigenous knowledge particularly to respond on whether they believed that Indigenous Knowledge can be taught in Engineering drawing subjects, this is how they responded:

> *"My understanding of the word "indigenous" means culture, and based on what we are taught in drawing, there is nothing for me that aligns to my culture". Interview*

While this was a sentiment that most learners concurred with, others had different things to add and clarify

> *"I do not agree with my class [peers] on the position of culture. This is because, while our culture is largely documented through fighting wars and not so much on what we learn here, there are elements of our curriculum that demonstrate that our curriculum reflects our culture. For example, the shape of our traditional hut houses can align with what we learn about Ellipse drawing." Interview*

To put more context and understanding of the above excerpt, the following figures were shown to her peer learners to buttress her views, see Figures 1A and 1B below:



Figure 1A. Indigenous Isizulu hut house (Source: Archdaily.com)

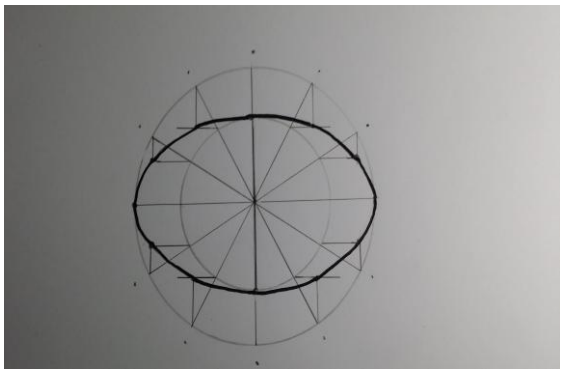


Figure 1B. Ellipse drawing taken for EGD (Source: wikiHow)

Following ancient glyph writing styles to teach numerical and alphabetical printing

Given the above engagement with learners, a further probe was done to them to ascertain whether their teacher would habitually use indigenous knowledge during instruction to explain general drawing principles, this is how they responded:

> *"At the beginning of the year where we were taught how to print letters and numbers in drawings, our teacher told us about glyph series sequence and 'Hindu-Arabic' numbering system. He explained how those number systems and patterns affect our drawing and printing styles. I believe that was taking from ancient Hindu-Arabic people's wisdom and indigenous knowledge" – interview*

Another learner agreed to this, but pointed to a more critical area, see the excerpt below

> *"I agree that our teacher used indigenous knowledge in that way, but he could not use our local knowledge, traits and practices to explain the same thing". Interview*

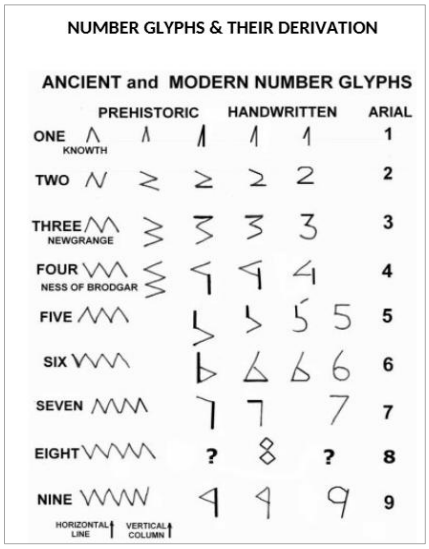


Figure 2: Number glyphs (Source: Neil L Thomas)

To buttress these views, the researcher requested one learner to show the example that was used by the teacher and how the teacher explained on whiteboard and subsequently produce it on their drawings, the above figures 2 display such evidence. After being shown the figure, the researcher asked one learner to contextualized and show how this indigenous (ancient) knowledge affected their current printing skills, and the learner demonstrated the following

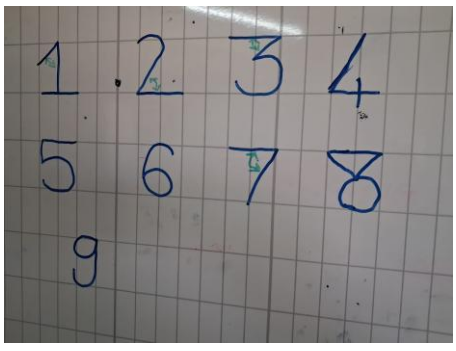


Figure 3. Number prints on whiteboard

The researcher then probed for clarity on why there were arrows in green inside the numbers, and one learner said

> *"The teacher encouraged us that we need to use this printing strategy inorder for anyone to understand the numbers. For instance, others may write "Z" when it is a "2" while others may confuse "1" instead of "I". So, in order to be intentional in our printing, we need to use this method." - interview*

The above passage describes that the teacher understands that learners have different handwriting and to avoid confusion when printing of numbers is done, indigenous knowledge was used to foot stamp current basic dimensioning rules in general drawing principles. As earlier indicated, teachers too were asked to register their opinions on how they operationalize Indigenous Knowledge in teaching general drawing principles in Engineering Graphics and Design. Teachers indicated that part of graphic design is teaching learners critical thinking and problem-solving skills. The teacher used the following figure to configure how he operationalizes Indigenous knowledge.

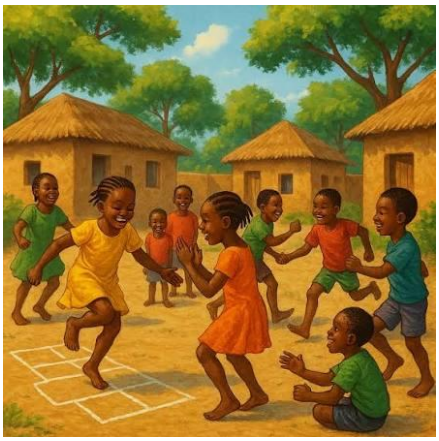


Figure 4. Indigenous games (Source: sidebyside)

Here is his version of how he taught.

> *"With the above picture, I taught my learners how games have been part of graphical design and digital technology. I taught them that before learners could be attached to digital games that makes them to connect with peers across the globe, there were games like this, where freehand sketch was used to make blocks on the ground that learners were using to jump and entertain themselves." – Teacher interview*

Indeed, this teacher' response aligns with current practice where most learners are engaged in digital games, not knowing that it all began with basic designs taught through indigenous graphical communication and techniques. Another teacher indicated that when he teaches freehand sketches, he uses car models and designs from an Indigenous Ndebele culture.

> *"The idea is to teach learners to use their prior knowledge and skills to draw. This is so that our role becomes that of showing them how to adequately use a freehand drawing technique" – interview response.*

It is now evident from the above passage that teachers used these examples as most learners in Mpumalanga region know about Ndebele culture and regard it as the most indigenous culture. So many contemporary designs of the brand BMW have used Esther Mahlangu's Ndebele designs. So, given that leaners love cars, it suffices to use indigenous designs on them as a way to teach how to draw different cars, bring new designs while being proud of where they are coming from.

Storytelling

Spatial visualization is one of the prominent skills required in Engineering Graphics and Design because it focuses on the mental ability to encode and manipulate 2-dimensional and 3-dimensional shapes and spatial configurations (Mteleli et al., 2026). It is in that spatial visual skills realm that some teachers opt to enact them through storytelling. One of the thriving strategies to teach any child in the global south is through story telling. Storytelling comes in various forms (i.e. fairy tales or short stories). What is certain about them is that they create and enhance visual or imagination in a mind of a learner. For example, a teacher reported that

> *"The general drawing principles require learners to visualise where they can be applied. This means that if a learner is tasked to design a stadium, telling them about a story where history in the African continent was made in 2010, when Africa hosted its first world soccer tournament can be a good start. Learners immediately create in their minds how a stadium structure looks like and start to imagine how the present ones can be creatively enhanced. That is where their drawing designs emanate" - Teacher interview*

Choosing an appropriate narrative to tell at the right moment is a crucial educational skill in the EGD classroom (Heyd-Metzuyanim & Shabtay, 2019; Bowman, 2018). The telling of stories speaks to the meaning-seeking nature of humanity. Non-stories provide knowledge in a variety of educational contexts, but powerful narratives engage learners on an intellectual and emotional level, inspiring and motivating learning. The greatest advantage about them is that they increase learner imagination hence the need to increase learner spatial abilities whenever drawings are involved. In essence, the role of a graphical interpretation is that it should be actualized in completeness before it is enacted; meaning that learners should imagine a complete drawing first before they can draw it (Bartlett & Camba, 2023).

DISCUSSION

The findings of this study indicate that in operationalizing Indigenous Knowledge when teaching general drawing principles in Engineering Graphics and Design, teachers used Indigenous cultural writing styles from the ancient glyph approach to teach numerical and alphabetical printing, global south vernacular architecture of housing structures and contextualized story telling. The study further discovered that while some learners agreed to be taught using indigenous knowledge, the teachers could not adequately adjust their teaching concepts to their lived experience enriched by local knowledge. The findings suggest that there are still glaring gaps on how teachers associate their teaching with indigenous knowledge and how learners perceive what they learn to be worthy of indigenous value.

The present findings provide a vivid picture on the current Engineering Graphics and Design classroom realities and partially support existing literature on the superficial integration of indigenous knowledge in STEM subjects. While studies by Matindike and Ramdhany (2025) advocate for the incorporation of indigenous knowledge perspectives in STEM education, the challenge remains in actual practice, and studies that are on ground n practice are still in the emerging stage. The findings revealed that one of the most common fantasies of young people is their general love of cars. Sometimes they use the popular car brands they observe as inspiration to draw their favorite vehicles. It came as a surprise that teachers could use this design to enact learners' drawing abilities. The most interesting part was that they used a female indigenous designer for a product most liked by males. This was an interesting creative approach to teach learners how to draw sketches.

Taneri and Dogan (2021) agree with the teachers' approach in that design learning expands on learners' prior implicit knowledge by creating tasks that aid in the implicit construction of a body of procedural knowledge. It also seeks to transform procedural knowledge into declarative knowledge through the use of panel critics.

Enshrined in the engineering graphics and design curriculum, is the need to apply context in the knowledge and skill acquired. Ndlovu and Gumbo (2024) foot stamps the idea of using Indigenous knowledge to preserve society's norms and conventions into tackling societal and contextualized technological problems. Based on learners' responses, it came as a surprise that the ancient numbering system was not seen as knowledge that is indigenous to them, but to many other global communities. As a result, some learners could not associate the EGD concepts as foregrounded in the indigenous isiNdebele culture, thus could not get to appreciate the need to understand where they come and how they can use their value systems to cope with the contemporary EGD world. Summarily, it is fair to assume that Engineering Graphics and Design was seen as making learners aware of the importance of being culturally and aesthetically sensitive across a range of social contexts, participating as responsible citizens in the life of local, national and global communities. Thusly, teachers were able to use such stories as tasks to infuse indigenous knowledge in their instruction.

CONCLUSION AND RECOMMENDATION

This study concludes that there are strides that have been made to operationalize indigenous knowledge in teaching general drawing principles and that there is some level of appreciation on how teachers cognitive and wise legacy about indigenous knowledge playout during instruction. Learners' interaction revealed that there are still limitations in understanding Engineering Graphics and Design concepts within their common territory, making it difficult to rule out the influence of Eurocentric worldviews, customs and traditions in the understanding of the constitution of indigenous knowledge. There is fact that indigenous knowledge is context rich in knowledge and that incorporates key important aspects, such as people, context, culture, language, knowledge and practices. The group of participants found that some of its elements were not a true representation of their realities, making this an important contribution to literature.

So, considering the above findings, this study recommends for content knowledge structure in STEM subjects that is centered around language, context and culture dynamism in order to capture each indigenous group's social realities. In order to probe a Engineering subject that has significant international standing, this study was limited to Mpumalanga province of South Africa where Ndebele culture is practiced. It is hoped that more studies looking into the STEM discipline across the globe be conducted, in order to have a wholesome appreciation of the benefits that comes with learning and teaching through the lens of indigenous knowledge global discourse.

ACKNOWLEDGMENT

Special thanks to the society of Technical and Vocational Education who continue to push for research that is rare in the field. Also, I offer my appreciation to the teachers and learners who opened an opportunity for such a study to emerge.

REFERENCES

Adler, R. H. (2022). Trustworthiness in qualitative research. *Journal of Human Lactation*, *38*(4), 598-602.

Ayton, D., & Tsindos, T. (2023). Foundations of qualitative research–paradigms, philosophical underpinnings. *Qualitative Research–a practical guide for health and social care researchers and practitioners*.

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.

Blose, P., & Gumbo, M. T. (2024). Developing a Framework for Integrating IKS in Technology Education with Sustainable Development Principles. *African Journal of Research in Mathematics, Science and Technology Education*, 1-13. https://doi.org/10.1080/18117295.2024.2356416.

Blose, P., & Mtshali, T. I. (2025). Fostering the use of Indigenous Knowledge System to teach freehand sketches in engineering graphics and design. *Jurnal Pendidikan Teknologi Dan Kejuruan*, *31*(2), 130-146. https://doi.org/10.21831/jptk.v31i2.77379

Blose, P., & Gumbo, M. T. (2019). The integration of indigenous graphics knowledge and skills into the teaching of graphic design in grade 9. *Rethinking Teaching and learning in the 21st Century*, 260.

Borges, L. C., & Revez, J. (2019). Pragmatic paradigm in information science research: a literature review. *Qualitative and Quantitative Methods in Libraries*, *8*(2), 179-188. https://qqml-journal.net/index.php/qqml/article/view/485/516.

Bowman, R. F. (2018). Teaching and Learning in a Storytelling Culture. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, *91*(3), 97–102. https://doi.org/10.1080/00098655.2017.1373547.

Brown, N., & Stockman, T. (2013, September). Examining the use of thematic analysis, as a tool for informing the design of new family communication technologies. In the 27th International BCS Human Computer Interaction Conference (HCI 2013) 27 (pp. 16).https://www.scienceopen.com/hosted-document. http://doi.org/10.14236/ewic/HCI2013.30

Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., ... & Walker, K. (2020). Purposive sampling: complex or simple? Research case. Journal of research in Nursing, 25(8), 652-661. https://journals.sagepub.com/doi/pdf/10.1177/1744987120927206

Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., ... & Walker, K. (2020). Purposive sampling: complex or simple? Research case examples. *Journal of Research in Nursing*. 2020;25(8):652-661. 10.1177/1744987120927206

Casey, E. S. (2000). *Imagining: A phenomenological study*. Indiana University Press.

Chedi, J. M. (2015). Technical drawing/graphic skills acquisition for teaching and learning and challenges in technology education. *ATBU Journal of Science, Technology and Education*, *3*(3), 128-133. https://atbuftejoste.com/index.php/joste/article/view/187

Clark, V. and Braun, V. (2013). Teaching thematic analyses: Overcoming challenges and developing strategies for effective learning. *The Psychologist*, 26(3), 120-123. https://uwe-repository.worktribe.com/preview/937606/Teaching%20.

De Jager, F. R. & Loots, A.G. (2003). Esther Mahlangu, This exhibition the work of Esther Mahlangu, internationally acclaimed South African artist. Available at: Vgallery.co.za/Esther press/default.htm.

Department of Basic Education. (2011). *National Curriculum Statement: Curriculum and Assessment Policy Statement (CAPS) Technology Grades 7 – 9.* Pretoria: Government Printers.

Estrada, A., Garber, P. A., Gouveia, S., Fernández-Llamazares, Á., Ascensão, F., Fuentes, A., & Volampeno, S. (2022). Global importance of Indigenous Peoples, their lands, and knowledge systems for saving the world's primates from extinction. *Science advances*, *8*(31), eabn2927.

Friese, S., Soratto, J., & Pires, D. (2018). Carrying out a computer-aided thematic content analysis with ATLAS. ti. https://hdl.handle.net/21.11116/0000-0001-364E-C

Gumbo, M.T. (2017). Rethinking teaching of Technology: An approach integrating indigenous knowledge systems. In De Vries, M.J. (Ed.). *Handbook of Technologyeducation,* pp. 1-19. Singapore: Springer.

Gumbo, M. T. (2016). A model for indigenising the university curriculum: A quest for educational relevance. in V. Msila & M. T. Gumbo (eds.), *Africanising the curriculum: Indigenous perspectives and theories,* (pp. 33-56). Sun Press.

Gumbo, M.T. (2015). Indigenous technology in Technology education curricula and teaching. In Williams, P.J., Jones, A. & Bunting, C. (Eds.). *Contemporary issue in Technology Education,* pp. 57-74. Singapore: Springer.

Haq, Z. U., Rasheed, R., Rashid, A., & Akhter, S. (2023). Criteria for assessing and ensuring trustworthiness in qualitative research. *International Journal of Business Reflections*, *4*(2), 150-173.

Hart, M. A. (2010). Indigenous worldviews, knowledge, and research: The development of an Indigenous research paradigm. *Journal of Indigenous Social Development*, *1*(1A). http://www.hawaii.edu/sswork/jivsw.

Heyd-Metzuyanim, E., & Shabtay, G. (2019). Narratives of 'good' instruction: Teachers' identities as drawing on exploration vs. acquisition pedagogical discourses. *ZDM*, *51*(3), 541-554. https://doi.org/10.1007/s11858-018-01019-3

Hoppers, O.C. (2021). Research on Indigenous knowledge systems: The search for cognitive justice. *International Journal of Lifelong Education*, *40*(4), 310-327. https://doi.org/10.1080/02601370.2021.1966109.

Jiyana, M. W. (2022). *The Role of Traditional Storytelling in the Teaching and Learning of IsiNdebele in Grade 3* (Master's thesis, University of Pretoria (South Africa)).

Johnson, M., & Ekpo, E. S. (2026). Indigenous Interior Design Practices and Dialectics: Refiguring Indoor Space and Materiality to Enhance Well-being. In *The Routledge Handbook of Interior Architecture Research* (pp. 26-37). Routledge.

Jones, A. (1997). Technology Education in the New Zealand curriculum. In Burns, J. (Ed.). *Technology in the New Zealand curriculum: Perspectives on Practice.* Palmerston North: Dunmore Press.

Kamel, M. A. E., & Khalil, M. W. I. (2023). The Impact of using Computer-Aided Design (CAD) on the Creativity of Architecture Students. *JETT*, *14*(4), 245-256.

Kigozi, F., Otulaja, F., Risenga, I., & Dukhan, S. (2021). *Teachers' Indigenous Knowledge awareness and how to implement it in teaching and learning sciences in South African schools* (Doctoral dissertation, Doctoral dissertation). https://hdl. handle. net/10539/37773.

Maeko. M. S. A, & Khoza, S.D. (2018). Identifying synergies in Civil Technology practical activities and Engineering Graphics and Design in a University Technology Course in South Africa. *International Journal of Engineering and Technology (IJET), 9*(6), 4154-4159.

Makgato, M. & Khoza, S.D. (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 & Technology Education,* 12(4): 609-621.

Mapara, J. (2022). Indigenous Knowledge Across the Curriculum in the Global South: An Epistemic and Cognitive Shifting Process. *Re-imagining Indigenous Knowledge and Practices in 21st Century Africa: Debunking Myths & Misconceptions for Conviviality and Sustainability*, 41.

Matindike, F., & Ramdhany, V. (2025). Incorporating indigenous knowledge perspectives in integrated STEM education: a systematic review. *Research in science & technological education*, *43*(3), 1022-1042.

Mayring, P. (2014). Qualitative content analysis: Theoretical foundation, basic procedures and software solution (free download via Social Science Open Access Repository SSOAR). Forum Qualitative Sozialforschung/Forum: Qualitative Social Research, 10, 1–143. https://www.semanticscholar.org/paper/Qualitative-content-analysis%3A-theoretical-basic-and-Mayring/18882a33873fc61b0f026f8ee31440a934eaa4a9

Maurial, M. (1999). Indigenous knowledge and schooling- a continuum between conflict and dialogue. In Semali, L.M. & Kinchaloe, J.L. (Eds.). *What is indigenous knowledge? Voices from the academy,* pp. 59-78. New York: Routledge

Merriam, S. B., & Grenier, R. S. (2019). Qualitative Research in Practice: Examples for Discussion and Analysis, 2nd Edition (Second Edi). Jossey-Bass.

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.

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.

Mtshali, T. I. (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* (pp. 306-318). IGI Global.

Ndlovu, E. C., & Gumbo, M. T. (2024). Decolonising Technology Education: Integrating Indigenous Knowledge for Sustainable Development in Electrical and Mechanical Systems and Control. *African Journal of Research in Mathematics, Science and Technology Education*, 1-11. https://doi.org/10.1080/18117295.2024.2381984.

Ndwandwe, K. P., Ramaligela, M. S., & Mtshali, T. I. (2024). Smartboard enhanced creativity in the technology classroom: lessons on mechanical systems and control. *Jurnal Pendidikan Teknologi dan Kejuruan*, *30*(1). http://dx.doi.org/10.21831/jptk.v30i1.72289.

Nkosi, P. B., Kola, M. I., & Mtshali, T. I. (2023). The Paradox of Creative Thinking Skills in the Vocational Technology Classroom: Where do Technology Teachers go Wrong? *Journal of Positive Psychology and Wellbeing*, *7*(4), 486-497.

O'Leary, M. (2020). *Classroom observation: A guide to the effective observation of teaching and learning*. Routledge.

Okung, A. (2025). *Form follows culture: decolonizing Nigerian dwellings through neo-vernacular design* (Doctoral dissertation, Laurentian University Library & Archives). https://laurentian.scholaris.ca/handle/10219/4373

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.

Pophiwa, N. & Saidi, U., 2022, 'Approaches to embedding indigenous knowledge systems in Made in Africa Evaluations', *African Evaluation Journal 10*(1), a623. https://doi.org/10.4102/aej.v10i1.623.

Ramose, M. B. (2004). In search of an African philosophy of education: perspectives on higher education. *South African Journal of Higher Education, 18*(3), 138-160.

Shava, S. (2013). The representation of indigenous knowledges. *International handbook of research on environmental education*, 384-393.

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.

Sıngh-pıllay, 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.

Springer, L. (2023). The value of sketching in teaching graphic design.: Developing skills in a higher education institution. *grafica*, *11*(21), 113-119.

https://www.researchgate.net/publication/364488043_value_of_sketching_in_teaching_graphic_design_Developing_skills_in_a_higher_education_institution.

Sütçü, N. D. (2021). Examining the two- and three-dimensional spatial visualization skills of secondary school students. *Milli Eğitim Dergisi*, *50*(231), 427-448. https://doi.org/10.37669/milliegitim.737639.

Taneri, B., & Dogan, F. (2021). How to learn to be creative in design: Architecture students' perceptions of design, design process, design learning, and their transformations throughout their education. *Thinking Skills and Creativity*, *39*, 100781. https://doi.org/10.1016/j.tsc.2020.100781.

Thomas, N. CELTIC NUMBER GLYPHS. https://www.academia.edu/29148678/CELTIC_NUMBER_GLYPHS

Tunstall, E. D. (2020). Decolonizing design innovation: Design anthropology, critical anthropology, and indigenous knowledge. In *Design anthropology* (pp. 232-250). Routledge.

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).*06-08 October 2021, pp. 391-398.

Żychowska, M. J. (2021). Classroom-based and distance teaching of freehand drawing: a comparative analysis. *World Trans. on Engng. and Technol. Educ*, *19*(3), 276-280.