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Journal of Vocational, Adult and Continuing Education and Training

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The Journal of Vocational, Adult and Continuing Education and Training

The Journal of Vocational, Adult and Continuing Education and Training (JOVACET) recognises the need for critical engagement through studies in technical and vocational education and training (TVET) and adult and continuing education and training, and for encouraging critical scrutiny of this expansive knowledge area on the African continent.

The voices and experiences of practitioners, reflecting on all aspects of teaching and learning within vocational education and adult education settings, should be heard through the publication of empirical and robust research. While the journal wishes to take forward academic scholarship, it also seeks to strengthen opportunities for reflective practice that makes a scholarly contribution to the field. New knowledge emerging out of complex developmental contexts has significant value and needs to be showcased beyond existing geographical and political boundaries. The journal is therefore committed to also supporting the development of emerging researchers by providing them with a space to present and defend their research amongst a network of global scholars. Within the field of vocational and continuing education there is substantive 'grey literature' that remains in project report form. The journal is potentially a vehicle for the translation of this important work into an academic contribution to a wider community of practice, thereby enhancing its value.

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EDITORIAL

Joy Papier
Editor-in-Chief

It gives me great pleasure to present this brief introduction to our 2023 issue of JOVACET, now in its sixth year of publication and seeking to increase its footprint with each passing year. To illustrate these endeavours, this year saw JOVACET being accepted on two more platforms: the first is the Directory of Open Access Journals (DOAJ), and, more recently, our journal has joined the Scientific Electronic Library Online (SciELO), an open-access searchable database that is managed in South Africa by the Academy of Science of South Africa (ASSAf), is funded by the South African Department of Science and Technology (DST), and has the endorsement of the South African Department of Higher Education and Training (DHET; see http://www.scielo.org.za for more information about the broader SciELO initiative). As part of the conditions of the SciELO listing, journals are required to publish individual articles on the platform for online access in advance of the completed journal being published. This was a new challenge for JOVACET, as we had not experimented with this requirement previously, and it meant putting some pressure on our time frames for reviewing and editing (so ably managed by Dr Catherine Robertson) so that at least one article could be published as a stand-alone that would also be included in the full journal for this year. The first article out of the starting blocks was therefore put through its paces and became JOVACET's first article on the SciELO SA database (see Brown & Papier in this issue).

With these two additional hosting platforms, JOVACET is expanding its reach and will be accessible to many more researchers, practitioners, policymakers and other interested parties across the world – which is excellent progress for a mere six-year-old! Of course, there remains a great deal of work to be done. We are constantly striving to increase our submissions, which, in turn, increases the need for peer reviewers who freely donate their time to perform a vital quality assurance role. Many of our editorial board members are leaders in the field who, despite their own pressing schedules, undertake reviews when we call on them, for which we are enormously grateful. They understand that, without rigorous peer review, our journal could not meet its stringent accreditation requirements and quality standards, either

locally or internationally. We remain indebted, too, to past and prospective authors for submitting their manuscripts and being willing to take them through the necessary, often frustrating, processes. In this issue, as in our previous publications, the results of their labours can be appreciated.

We open our 2023 issue with **Mulaudzi**, **Teis and Seleke's** 'Problem-based learning for shifting TVET Electrical Engineering lecturers' practices: A scoping review'. Whereas problem-based learning as a learner-centred approach is not new to education, more generally, TVET (technical and vocational education and training) classrooms have favoured a more didactic teaching style. The authors contribute to practitioner understandings by undertaking a literature review that scopes research and scholarship on problem-based learning in an attempt to tease out essential components that might help Engineering lecturers to foster the problem-solving capacities among their students – a teaching and learning strategy considered essential to the field of Engineering.

What follows is a second theory-focused article entitled 'Vocational pedagogy in Automotive Mechanics: Ontological dimensions and cognitive load theory implications' by **Hugo and Mokoene**. In this contribution, the authors stretch our ontological perspectives relating to vocational pedagogy by causing us to ponder on 'mereology' and 'process ontology', two traditions that might not ordinarily be associated with the science underpinning Automotive Mechanics. Through their qualitative case study of vocational training in Eswatini, their research attempts to draw connections between these various ontological traditions and show how part–whole relationships, often unknowingly, inform lecturers' vocational pedagogy. In addition, they draw on cognitive load theory to explain the mechanisms that students of Automotive Mechanics use to make sense of the volume and complexity of the information they are required to process, absorb and recall. Through creating linkages among what may seem to be somewhat obscure theories, they show how an appreciation of such relationships could lead to more intentional teaching strategies that ultimately benefit trainees.

Continuing with the topic of learning in the engineering trades, in their article, 'Beyond the trade test: Using the COMET Model to build occupational competence', **Brown and Papier** explore the notion of occupational competence, its measurement and what is needed to achieve it. Competence has been a much-debated concept internationally, with many eminent scholars contributing to its definition and theorisation (see the references in the article to, for instance, Weinert, 2001; Winther & Achtenhagen, 2009; Mulder, 2017). Studies abroad and to a more limited extent in South Africa have shown that the use of the COMET Model is appropriate not only to the fine-grained measurement of competence, but also for development if its principles are applied in the teaching, learning and assessment regime. The present authors report on research in which an alternative 'COMET'-inspired methodology was used to assess artisan candidates in two engineering trades, and as a comparative learning approach to preparing candidates for integrated work processes. Their findings were promising in that candidates undertaking the COMET-based learning and assessments showed improved levels of competence and also the emergence of a 'vocational identity'

compared with candidates with those levels of competence on only the traditional pathway to trade-test preparation. Whereas the focus in their research was on determining and enhancing candidates' occupational competence levels, it was noted that the application of COMET as a conceptual model could help artisan trainers and assessors to expand their teaching and assessment repertoire to take into account the many dimensions of competence that candidates could, and should, aspire to achieve.

Moving to the theme of vocational lecturer development, **Holler, Brändle and Zinn** report on research that investigated the self-assessment of the digital competencies of TVET college lecturers and what they would need in order to employ technology effectively in their teaching. The research was part of a partnership project between the South African DHET and the Federal Ministry for Education and Research in Germany for the training of TVET lecturers in Mechanical and Electrical Engineering. The need for the research is justified in the light of the emphasis in South African policies on the critical nature of digital competencies for prospective employment in addition to the competency domains specified for qualified TVET college lecturers. The focus was therefore on the needs of in-service college lecturers that could inform the design of a training programme to improve lecturers' digital competencies and their integration of technologies in their classrooms. In their article 'How do South African TVET lecturers rate their digital competencies, and what is their need for training for a digital transformation in the South African TVET sector?', the authors use the technological pedagogical content knowledge (TPACK) model to survey a sample of lecturers and obtain feedback on the overlapping domains of their pedagogical content knowledge (PCK), technological content knowledge (TCK) and technological pedagogical knowledge (TPK). As might have been anticipated, perhaps, the findings have shown that TVET lecturers are indeed in need of support regarding the ways in which to incorporate technology into their lessons, and also regarding the content with which to do so.

Coincidentally in this issue of JOVACET, there is a second article dealing with TPACK in vocational education, albeit in a neighbouring African country; it is entitled 'Instructors' perspectives of TPACK in a vocational training classroom in Namibia', by **Nepembe and Simuja**. Extracting the findings from a longitudinal study on vocational instructors' development of TPACK, the authors in this article report on the ways in which instructors viewed the integration of technology into their teaching, and what informed their approach. As in the article referred to above, the constructs of TPACK were used to organise and analyse the data obtained through questionnaires and qualitative interviews. The responses from the vocational instructors indicated that they certainly appreciated the importance of incorporating technology into their teaching and that this could enhance the learning experiences of their students; but their responses also revealed that they had had limited exposure to examples of such teaching in reality. Furthermore, while the instructors understood how to use some of the technologies themselves, they were unsure about how they could employ their own knowledge of the technology in teaching their students. This indicated the importance of the complex relationship between technology, pedagogy and content knowledge that the authors point to in their findings.

Changing tack somewhat, the article by **Bester**, 'Exploring inclusive leadership and strategic visioning as pathways to well-being in TVET colleges', focuses on TVET college leaders: more specifically, the ways in which leadership policies and practices promote or inhibit staff and student well-being at their colleges. In a case study that targeted college leaders who were also student participants in a postgraduate leadership development programme, data were generated by a survey of college well-being policies and practices and the factors that enabled or impeded them. While overarching policies were in evidence at most colleges, these were inconsistently applied and appeared to be largely absent in strategic planning with regard to the promotion of well-being, which played out in the manifestation of staff burnout and fatigue, stress-related issues, and so on. As had been noted in other studies referred to by the author, college leaders were often preoccupied with student matters – for example, those that resulted in public scrutiny such as protests in recent times – resulting in staff problems being put on the back burner. Staff perceptions in this instance were therefore that student well-being was prioritised over that of staff, however unintended that may have been on the part of college leaders. The author recognises, however, that committing to an inclusive policy which 'create(s) a culture of well-being that is embedded in a college's everyday activities – and which is embraced by all' is a complex matter that requires purposive and strategic planning.

Aploon-Zokufa and Needham shift our attention to the problem of articulation between TVET and university qualifications, in particular that of mature adult women who are early childhood development (ECD) practitioners. The problem manifests itself in what has been a marginalised sector of education and training in South Africa, that is, the education domain of ECD and the formal certification of ECD practitioners/educators/facilitators (also known as teachers in other contexts). With its history of inequality and racial discrimination, in this sphere formal qualification opportunities have been limited for many ECD practitioners in disadvantaged communities. These are mostly women without school exit certificates or without university teaching qualifications. ECD practitioners do, however, have access to TVET college ECD certificates located at Levels 4 (matric equivalent level) and Level 5 (equivalent to year one at university); however, these college certificates do not enable easy access into the bachelor's degree in ECD at university, except through negotiated articulation arrangements. The topic of the article is therefore adequately explained in its title: 'Recognition of prior learning practices at post-school institutions and the effect of such practices on the learning pathways into higher education of mature women who are early childhood development practitioners: A capabilities approach'. Recognition of prior learning (RPL) is often the only route into a university ECD degree but, in addition to the systemic barriers, mature women face a host of additional impediments to their aspirations that are elaborated on in the article. The lens offered by capabilities theory therefore proved to be a fitting vehicle for exploring and analysing the experiences of mature ECD women as they navigated/did not navigate pathways into higher education qualifications.

We close our 2023 issue with a thoughtful and somewhat hard-hitting article by **Moll** entitled 'A critique of andragogy in the South African TVET context'. Here, the author argues that, in the South African context, the term 'andragogy', which has been used to describe the

teaching and learning of adults, is not appropriate to a modern vocational context. This is a term relating to TVET that, as an Education scholar, he has often been questioned about. He holds that andragogy is not a benign term in that it has, in his view, sinister connotations, being 'culturally biased … because it is based on white, male, middle-class norms of the 1960s'; and that 'its assumptions about adult learning tend to marginalise others on the basis of race, gender, and cultural difference'. Moll proceeds to explain this viewpoint by tracing the history of fundamental pedagogics in South Africa's apartheid ideology-based theorisation of education and its locating of andragogy within that theorisation. Readers, especially those outside of the South African context, will no doubt be interested in the strong standpoint taken by Moll and his assertion that a seemingly benevolent expression such as 'andragogy' may have been permeated and tainted by perverse philosophies and ideations. As with all our published articles, we encourage similarly well-argued pieces that may wish to challenge and provide further intellectual stimulation on this or any other matters that have been embraced by our authors.

Finally, we hope that this JOVACET, Volume 6, Issue 1 of 2023 finds you well and leaves you with many questions that you may wish to research further and write about for the benefit of your peers in the TVET sector. We look forward to your contributions!

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Problem-based learning for shifting and TVET Electrical Engineering lecturers' practices: A scoping review

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ABSTRACT

Problem-solving capacity is continuously gathering prominence in the Engineering education programmes of most institutions of higher learning. Embracing problem-based learning is necessary for Electrical Engineering lecturers in technical and vocational education and training (TVET) so as to shift from teacher-centred to student-centred teaching approaches which engage students in the learning process. Despite this, research on the use of problem-based learning in TVET contexts by Electrical Engineering lecturers is limited. In this study, we conducted a scoping review to identify those key components which are necessary for the effective implementation of problem-based learning in a TVET Electrical Engineering programme. Our findings indicated that the problem, the facilitator and the students are the three components noted as essential constituents that are vital to the effective implementation of a problem-based learning strategy in TVET Electrical Engineering programmes. Our findings stress that, in addition to the three components, the type and nature of the problem, including the philosophy of the subject or the programme, need to be considered before inculcating problem-solving capabilities in TVET Electrical Engineering lecturers.

KEYWORDS

Problem-based learning; technical and vocational education and training (TVET); Electrical Engineering lecturer competence; student-centred; teacher-centred

Introduction

There has recently been an increase in interest in technical and vocational education and training (TVET) globally (Šuligoj & Jerman, 2020; Wattanasin, Chatwattana & Piriyasurawong, 2021) and in South Africa (Blom, 2016; Badenhorst & Radile, 2018; Makhubele & Simelane-Mnisi, 2020; Papier, 2021) due to ever-increasing technical and technological advancement. Since the development of technology is advancing rapidly, the delivery of an Engineering curriculum becomes more challenging for TVET Engineering lecturers (Teis & Els, 2021). The expansion of technology requires that TVET Electrical Engineering lecturers deploy innovative ways of engaging students (Kereluik et al., 2013). It is therefore crucial that TVET Electrical Engineering lecturers devise a pedagogical shift from teacher-centred approaches to a student-centred pedagogical approach in which technology is integrated and adopted as a tool with which to mediate the teaching of learning content that is discipline-specific and appropriate in the 21st century (Teis & Els, 2021). However, the literature indicates that the majority of TVET lecturers lack innovative pedagogy and that they do not possess ideas on how to shift from teacher-centred approaches to innovative student-centred approaches (Ngubane-Mokiwa & Khosa, 2013; DHET, 2013). Research conducted by Abiddin and Ismail (2014), Field, Musset and Alvarez-Galvan (2014), Badenhorst and Radile (2018), and Teis, Els and Tlali (2022) reveals that most South African TVET Engineering lecturers lack teaching qualifications, and that more than half of them have no industry experience that would enable them to design and implement effective teaching in a TVET context.

Moreover, the relevance of TVET Engineering lecturers' knowledge is questionable, as indicated by research conducted by Manyau (2015), whose study revealed that little or insufficient training is being provided to lecturers and that this may have an impact on the quality of teaching. Surprisingly, the study by Teis et al. (2022) also established the same trends, with the authors noting that TVET Engineering lecturers received in-service training which was not focused on the development of their pedagogic content knowledge and skillsets. This does not help the TVET sector to ensure that lecturers undergo in-service training and upskilling in pedagogy, in particular vocational pedagogy. Further evidence in support of Manyau (2015) and Teis et al. (2022) is provided in the relevant literature (Blom, 2016; Badenhorst & Radile, 2018; Van der Bijl & Oosthuizen, 2019).

The study of Teis et al. (2022) strongly recommends that the Department of Higher Education and Training (DHET) and TVET colleges provide lecturers – and particularly Engineering lecturers – with relevant teaching skills development programmes to keep them abreast of the current changes in their area of specialisation. Their study also proposes that there be a philosophical shift from the current Engineering Studies curriculum-delivery practices to include a programme-renewal strategy that seeks to stay abreast of rapid technological advancements and deeper technical and non-technical knowledge that enhance the ability of lecturers to develop effective learner-centred teaching and learning spaces. It is necessary to have competent and properly skilled TVET lecturers if effective teaching and

learning processes are to be introduced in TVET colleges, as the central focus is on equipping students with the technical knowledge and skills required by the job market (Ismail et al., 2018). The process of creating improvements in the TVET field requires professionally qualified, competent and efficient lecturers to be deployed to fulfil this responsibility (Abdullah et al., 2019).

In this article, we argue for the application of innovative and transformative-based teaching approaches in the technical educational learning context, as advocated by Balasubramanian, Wilson and Cios (2006). Balasubramanian et al. (2006) outlined the need to design interactive learning environments that increase student achievement and promote purposeful social collaboration, distributed cognition, and contextual learning. Hung (2009) posits that problem-based learning is conceivably the most innovative instruction method devised and implemented to enhance students' problem-solving skills and stimulate higher-order thinking and self-directed learning skills in educational contexts.

Problem-based learning (PBL) is defined as

> a student-centred pedagogical strategy that poses significant, contextualized, real-world, ill-structured situations while providing resources, guidance, instruction, and opportunity for reflection to learners as they develop content knowledge and problem-solving skills (Hung, 2009:119).

The literature in respect of PBL has shown that this approach may not have been effective and could therefore affect the extent to which students acquire sufficient domain knowledge, activate appropriate prior knowledge, and properly direct their learning. Against this background, the purpose of this study was to identify the key components needed for effective implementation of PBL in TVET Electrical Engineering teaching and learning practices. To this end, the study aimed to identify and analyse the key components of PBL and their respective roles during each phase of the PBL process. Subsequently, the research question guiding this study was: What are the key components of PBL that need to be considered for successful implementation of a PBL intervention or in-service training programme?

Problem-based learning

PBL is a complete paradigm shift towards a student-centred approach in which students' learning is triggered by real-life problems in order to promote problem-solving thinking (Ali, 2019; Sekarwinahyu, Rustaman & Widodo, 2019; Arwatchananukul et al., 2021). Students are motivated to take action and come up with solutions to the issue at hand using this method (Arwatchananulul et al., 2021). They act upon it by identifying and defining the problem, followed by planning the solution and taking decisions after conducting research on their own (Purnamawati, Usman & Saliruddin, 2017; Higuera Martinez, Fernandez-Samaca & Serrano Cárdenas, 2021). Therefore, to resolve a problem, students must make decisions based on their analysis of the alternative solutions that they have uncovered

(Wosinski et al., 2018). Hence, the capability of students to identify and define suitable problems is central to PBL and aligns with the contemporary challenges faced by engineers (Zou & Mickleborough, 2015), particularly TVET Electrical Engineering graduates.

According to Dewey (2008), engineers deal with subject matter which is practical in nature and are concerned with designing solutions to problems through a design process. Engineers often design and make artefacts and processes to solve problems based on incomplete knowledge to be applied in a particular environment (Boelt, Kolmos & Holgaard, 2022). This implies that engineers are solutions-oriented and are often faced with ill-defined problems (De Vries, 2005). For this reason, one of the learning outcomes of Engineering education, in particular TVET Electrical Engineering, is to produce graduates who can identify and solve problems in real life (DOE, 2005). Research indicates that the learning outcomes of a subject or programme can best be achieved when approached through real-life problems and issues.

Therefore, PBL aligns well with TVET Electrical Engineering education because it models the way most engineers work in practice (Smith et al., 2005). Zou and Mickleborough (2015) emphasise that students' ability to identify and solve problems is central to PBL, as it is to Electrical Engineering education. From the goals of the programme, it is evident that the skills associated with the social aspects of Electrical Engineering practice have become a vital aspect of our students' education which PBL claims to provide (Deep, Salleh & Othman, 2019). De Vries (2005) contends that there is a social ingredient in the Engineering programme which implies that future engineers should not only have gained knowledge of technical aspects of their field, but also of non-technical aspects such as problem-solving, collaboration and interpersonal skills. The teaching and learning methods applied in TVET Engineering programmes are often carried out through the traditional four-step approach, that is, describe, demonstrate, try out, and evaluate with feedback (Deep et al., 2020). Through these methods, students are trained in technical skills but lack essential non-technical skills (Deep et al., 2020). Therefore, the application of PBL becomes handy in resolving the issue at hand, as research provides significant evidence of its ability to develop non-technical skills (Anazifa & Djukri, 2017; Tsalapatas et al., 2021; Sousa & Costa, 2022).

However, the majority of TVET lecturers are not qualified to teach at TVET colleges and have not had any opportunities to be exposed to innovative student-centred approaches; yet they are still tasked with training Engineering graduates who are supposed to have gained both technical and non-technical skills upon graduation. Recent research conducted by Teis et al. (2022) shows no sign of lecturers receiving any training in applying PBL during their in-service training. Therefore, the purpose of this study is to conduct a scoping review to identify and analyse the key components of PBL, and the evidence gathered will be used to design a PBL intervention that could be used to shift the teaching practices of TVET Electrical Engineering lecturers.

Barriers that may hinder implementation

The literature has also highlighted the possible barriers that might impede effective implementation that designers of the PBL need to consider when designing and planning the PBL as a teaching and learning approach. Some of the barriers that can hamper the effective implementation of PBL include a lack of resources (Amoako-Sakyi & Amonoo-Kuofi, 2015; Mansor et al., 2015), a lack of facilitation skills, and a lack of knowledge of designing scenarios that can motivate students to learn (Sithole, 2011; Farid & Ali, 2012). Amoako-Sakyi and Amonoo-Kuofi (2015) claim that, for PBL to be implemented effectively, resources such as the availability of specially designed and equipped tutorial and meeting rooms and a well-resourced library or media centre with network connectivity should be provided.

According to Brush and Saye (2017), the main barrier that has the greater potential to impede successful implementation is to shift teaching and learning from teacher-centred to a PBL design, allowing teachers to become facilitators as students direct their learning. This is because the shift may be towards an entirely different type of teaching that would entail relinquishing control of the classroom in order that teaching may be more student-centred. This radical shift might pose a challenge to lecturers who are used to being at the centre of the learning process. Thus, before the PBL process is initiated, training must be conducted, particularly for those lecturers who have not formerly engaged in PBL, so as to ensure its successful implementation in the way the literature suggests (Katwa et al., 2018; Tighe, 2020). During this training, the expectations must be clearly stated and the lecturers must receive detailed notes relating to the PBL process (Malan & Ndlovu, 2014; Al-Drees et al., 2015; Ravindranath, De Abrew & Nadarajah, 2016).

The effective group process must also be explained and information regarding relevant websites that could serve as learning resources must be provided in order to promote the effective implementation of PBL (Golightly & Raath, 2015). Thus, for PBL to be implemented the most effectively in the classroom, lecturers must be prepared to facilitate and guide students' learning rather than control it.

Theory underpinning problem-based learning

Significant evidence in the literature has demonstrated that PBL as a teaching and learning approach works best in a constructivist environment, in particular in a social constructivist environment (Sekarwinahyu et al., 2019; Dupri et al., 2020; McQuade et al., 2020; Sousa & Costa, 2020). Social constructivism is based on Vygotsky's view of learning, which places more emphasis on the social environment in which an individual co-constructs knowledge in interaction with the other. Therefore, constructivists emphasise that collaborative learning facilitates students' ability to construct their own knowledge. For constructivists, knowledge construction is achieved as students negotiate social situations and evaluate their understanding. Thus, a constructivist learning environment allows students to take responsibility for their learning, which aligns with what a PBL learning environment could

provide (Ulger, 2018; Okolie et al., 2020). Therefore, PBL puts students at the centre of learning and develops independent thinking skills (Sekarwinahyu et al., 2019).

In PBL, students work collaboratively in small groups to solve problems presented to them by the facilitator (Wosinski et al., 2018). Thus, students are provided with the opportunity to experience authentic ill-defined problems as well as collaborative-learning formats that require teamwork, collective decision-making, and self-directed learning (Beagon, Niall & Ní Fhloinn, 2019), which is also consistent with social constructivist learning. Collaboration develops 'soft' skills such as cooperation, negotiation and communication, which can be useful for students in future and in practical life within a teamwork environment (Ali, 2019; Tsalapatas et al., 2021; Dupri et al., 2020). In following this approach, students construct knowledge for themselves, make comparisons with their peers' knowledge, debate about the information they have found and learnt, and refine their understanding as a result (Alharbi, 2017; Wosinski et al., 2018; Deep et al., 2019), all of which supports a social constructivist learning environment.

Through social interactions, their shared knowledge is reconstructed and validated until a meaningful resolution is reached for the problem at hand (McQuade at al., 2020). Therefore, PBL promotes active and group learning based on the premise that successful learning occurs when students create or co-construct ideas through social experience and self-directed learning (Sousa & Costa, 2022). Sekarwinahyu et al. (2019) hold that PBL commences with the assumption that learning is an active, integrated and constructive process which is influenced by social factors. Thus, PBL is consistent with the constructivist theory of learning, especially social constructivist learning theory.

Methods

In this study, a scoping review was used to select previous studies related to the implementation of PBL, focusing particularly on its key components. A scoping review is a valuable tool used to identify the key components in the literature related to a concept under scrutiny that researchers may adopt in order to report on the kinds of evidence and to inform practice and the way research was conducted (Munn et al., 2018). A scoping review is a kind of knowledge synthesis that responds to exploratory research questions aimed at mapping key components and kinds of evidence by methodically searching, selecting and synthesising the available literature (Colquhoun et al., 2014; Chang, 2018).

The purpose of conducting a scoping review in this study was to identify the key components of problem-based learning with the intention of informing TVET Electrical Engineering education practice (Colquhoun et al., 2014; Munn et al., 2018). Thus, as a means of knowledge synthesis, a scoping review has the potential to influence practice, policy and research (Colquhoun et al., 2014). However, it is significant to note that a scoping review is less likely to seek to respond to a specific research question or to examine the quality of incorporated studies – which might be perceived as one of its disadvantages (Colquhoun et

al., 2014; Munn et al., 2018). Therefore, in this study, only peer-reviewed journal articles written in English were included in this study for quality purposes and the manageability of the data (Boelt et al., 2022; Daun et al., 2022). In this study, peer-reviewed journal articles written in other languages were excluded because of the cost and time involved in translating articles from other languages into English. This exclusion was made for pragmatic reasons and it is worth noting that possibly relevant peer-reviewed journal articles might have been left out because of this exclusion (Arksey & O'Malley, 2005).

Data collection

The literature search was aimed at identifying and accumulating national and international peer-reviewed journal articles published from 2011 to 2022. The search was undertaken on EBSCO as the database, resulting in a total of 56 studies being gleaned, of which 38 were included for thorough qualitative analysis (see Figure 1). The EBSCO database was used in this study because it provides access to multiple databases (Gusenbauer & Haddaway, 2020), is reliable, and is a credible database which also includes other peer-reviewed journal articles covered by other databases (Oermann et al., 2021). The other compelling reason for using EBSCO was that it does not contain articles in predatory journals (Oermann et al., 2021). However, the EBSCO database included journals that required payment to access them, which introduced another limitation to this study. In this study, to minimise such limitation, the researcher enlisted the services of a librarian to access these articles. The librarian was not only helpful with accessing articles that required payment, but also assisted during every step of the search process. The search terms for this study included PBL, PBL education, PBL in Engineering education, and the implementation of PBL.

Alharbi's (2017) process and procedure for data extraction and management were adopted for this study. Thus, during the scoping review, the abstract of each peer-reviewed journal article was reviewed to make a judgement about the significance of the journal article to the study – particularly regarding the key components of PBL – as an inclusion criterion. If the journal article met the criteria, then the citation was copied into a Word document called 'Draft' that was saved in a PBL folder on the desktop. In a few words, comments were generated about the journal article before saving the PDF file in the PBL folder using the last name of the first author if more authors were involved in writing the journal article. Finally, saved data were exported to a Refworks account.

In this study, several methods of managing the data were adopted. They include, but are not limited to, concept mapping and the use of Microsoft Excel. However, if the information in the abstract did not encompass the key components of PBL, then, before making a decision whether the journal article was relevant, the following steps were taken: (1) the researcher glanced rapidly at each paragraph's opening sentence without attempting to comprehend every word; and (2) read the last paragraph, specifically if it had subtitles such as 'Overview' or 'Conclusions'. The figure below presents the flow diagram of the data-collection procedure.

Identification of studies

Records identified from EBSCO: n = 56
Records screened: n = 56
Reports sought for retrieval: n = 56
Reports assessed for eligibility: n = 56
Studies included in review: n = 38
Reports of included studies: n = 38

Figure 1: Data-collection procedure

Data synthesis and theme generation

Thematic analysis is an approach to qualitative data analysis which involves organising collected data into themes and categorising these so as to better understand the collected dataset (Norton, 2019; Kiger & Varpio, 2020). Thematic analysis is one of the qualitative data analyses used by researchers in qualitative research: the researcher commences by familiarising themselves with the dataset, which entails repeatedly and actively reading through the articles included. This process provided a valuable orientation to the dataset. The researcher then undertook a preliminary synthesis to derive the broad themes inductively, which involved searching for the key components of PBL in the included articles. The choice of using thematic analysis was based on the purpose of the study and on Kiger and Varpio's (2020) assertions. The examination of repeated terms or concepts, concepts with closely linked meanings, text manipulations using cut-and-sort, and, in certain cases, text being highlighted with different colours for each topic, were all employed in this study to find themes in the data. After taking into consideration the core words in the research question and going through whole datasets accordingly, three main themes emerged: the problem, the facilitator or tutor, and the students. Subsequently, subthemes also emerged, as shown in Table 1.

Findings

Through qualitative data analysis, a plethora of components of PBL were highlighted in the included studies. The selected studies were examined again to determine whether the highlighted components were included in each article. After extensive analysis, the final selection of PBL components is as presented in Table 1.

Table 1: Key components of PBL and their respective subthemes

PROBLEM	TUTORS/FACILITATORS	STUDENTS
Ill-structured Complex Ill-defined Contextual Not structured Appropriate scenarios Authentic Hypothetical scenarios Problematic situation Shared problems Open-ended Issues Student-driven Role of the problem	Scaffolding Guiding questions Prompts Guide Providing problems Asking questions Facilitating investigation and dialogues Giving advice Task-setter Project supervisor Providing resources Facilitator–student interaction Demonstration Managing behaviours Teacher–student dynamics Role of tutor	Small-group learning Team dynamics Team learning Collective student engagement Dialogue Teamwork Student-regulated learning Peer support Social interactions Collaborative learning Group work Small-group teaching Group discussions Self-regulation Small groups Role of students Active participation Reflection Evaluation

Discussion

The findings revealed that the problem is a prominent component of PBL: it initiates the interaction between the other two components, namely the tutor and the students, using well-designed, real-life learning activities. However, the design of these learning activities is not an easy task, as many factors must be considered during the design process in order to foster the attainment of the desired learning outcomes. These factors include, but are not limited to, the type and the nature of the problem (Ali, 2019; Adamuthe & Mane, 2020; Naji et al., 2020; Du et al., 2021; Chan et al., 2022), particularly in relation to the open-endedness and real-life applications and the nature of the subject or the programme (Zhao et al., 2020).

Further evidence in support of the importance of these factors in the design of the learning activities is provided by Century, Ferris and Zuo (2020) and by McQuade et al. (2020). These studies pinpointed the critical factors that the designer of PBL can use to shift TVET Electrical Engineering lecturers' practices from teacher-centred to student-centred. Besides the above-mentioned factors, the other factor to be considered is that learning activities must be designed to focus on professional skills, as failure to do so might lead to a lack of opportunities to develop a particular graduate attribute (Beagon et al., 2019).

This study also found that the focus of PBL and the role of the problem must be made explicit during the design of the learning activities. Designers who explicitly understand the focus of PBL can design an effective learning activity with a clearly established purpose statement. The role of the purpose statement is to enable students to know what they are going to learn and how they will be expected to demonstrate their understanding of the learnt content and the non-technical skills (Frey & Fisher, 2011). Therefore, the designers of PBL activities should be clear about the purpose of the learning activities. Frey and Fisher (2011) posit that, by establishing a clear purpose statement, designers make their expectations

for learning clear to their students. Thus, learning becomes visible to students and their motivation to learn can improve accordingly. The purpose statement makes connections between the learning activities and the role of the problem, thus making learning meaningful and relevant to students. From the focus of PBL and the nature of the subject, a well-established purpose statement can be crafted. Research indicates that the focus of PBL is to develop students' problem-solving skills through the application of acquired content but not the teaching of content (Adamuthe & Mane, 2020; Okolie et al., 2020). This is in line with the nature of the Electrical Engineering programme, namely the National Vocational Curriculum: Electrical Systems and Construction, which has as one of its learning outcomes the ability to identify and solve a problem.

It can be concluded in this study that the design of authentic learning activities relies on the type and nature of the problem, its appropriateness to the nature of the subject or programme, and a clearly established purpose for the learning activities (Beagon et al., 2019; Naji et al., 2020).

The second key component of PBL is the critical role played by the lecturers who serve as facilitators of learning during the different stages of the PBL process (Anazifa & Djukri, 2017; McQuade et al., 2020; Trullàs et al., 2022). These findings imply that the role of the facilitator during each phase of the PBL must be clearly stated during the design of the PBL learning activities. Research indicates that facilitators play multiple roles during the PBL learning process (Anazifa & Djukri, 2017; Beagon et al., 2019; Adamuthe & Mane, 2020; McQuade et al., 2020). Some of the roles that PBL facilitators play include, but are not limited to, guiding and supporting students in formulating the learning issues (Al-Drees et al., 2015; Du Toit, 2015), laying down the rules, setting out boundaries, defining assessment (Raath & Golightly, 2017), and designing and planning the PBL activities (Du Toit, 2015; Gao et al., 2018). Therefore, for PBL to be effectively implemented, facilitators must wear different hats relative to each PBL stage while considering the purpose of the PBL learning activity. It is crucial that the stages of PBL be identified during the planning process of the learning activities, as doing so enables the facilitators to organise their roles appropriately and in a flexible manner. For example: What is the role of the facilitators before students receive the learning activities, during problem analysis and reporting, and during the reflective-writing process? Proper planning and the deployment of appropriate roles during each stage of the PBL could contribute positively to the successful implementation of PBL that might lead to students' achieving the learning outcomes of the subject or programme. The importance of the facilitators' roles during each stage of the PBL is also supported by Anazifa & Djukri (2017), Beagon et al. (2019) and Trullàs et al. (2022). Their research confirms that the efficient fulfilment of the facilitators' roles leads to the successful implementation of PBL. This is also supported by Okolie et al. (2020), who posit that the successful implementation of PBL relies solely on the facilitators' competencies and capabilities in fulfilling students' attainment of the learning outcomes. Therefore, it can be concluded that facilitators' knowledge of the required pedagogical processes involved in PBL, and their ability to manage activities during each stage of PBL, is crucial to the successful implementation of the strategy.

The last but not least of the components of PBL is that designers of PBL learning activities should consider having students actively engage with the learning activities in the PBL environment through facilitated sessions. The role of students and what is expected of them should be made visible prior to creation of the actual PBL learning environment. One of the key roles of students in a PBL environment is to form small groups before they collectively engage with their learning process. The goal of group sessions is to facilitate the identification of problems or problematic situations through social interactions (Trullàs et al., 2022). Through social interactions, students share knowledge, participate collaboratively, and contribute initiatives and ideas during group discussions (Naji et al., 2020; Du et al., 2021). Therefore, the students' active participation and the quality of small-group interaction are of critical importance to the success of PBL, supporting the collective and social construction of knowledge. The findings reveal that small-group learning modes encourage student–student and teacher–student communication during the learning process (Century et al., 2020; McQuade et al., 2020; Naji et al., 2020). Thus, the key ingredient of the successful implementation includes the learning and social environment and self-regulated learning coupled with active, engaged students working in small groups to construct and apply knowledge while exploring solutions to real-life problems (Wosinski et al., 2018; Du et al., 2021). However, the effective implementation of PBL, the role of groups, and the role of the student must be made explicit in all PBL tutorial sessions; hence it must be made clear what the role of the students and small groups is during the first PBL sessions, during self-study, during the second PBL sessions, and during group presentations.

If the roles of the students and small groups are explicitly established and followed without deviations, the practices of TVET Electrical Engineering lecturers can be shifted from teacher-centred to student-centred. Thus, TVET Electrical Engineering lecturers should be motivated to adopt PBL as their new teaching and learning strategy. Their adoption of PBL could make significant contributions to their classroom practices and help their students to acquire the desired non-technical abilities that are valued by contemporary industries.

Conclusion

The identification and understanding of the three key components of PBL and their roles in accordance with each stage of the PBL processes as discussed in this article are of the utmost importance to the successful implementation of the PBL strategy in the TVET Engineering classroom. In this study, the key components of PBL were revealed during the scoping review. Besides the three identified key components of PBL, this study also revealed other crucial factors that contribute to the successful implementation of PBL as a teaching and learning strategy. Therefore, the consideration of these factors when planning the design of PBL intervention is essential to the success of a PBL strategy. The focus of PBL as a teaching and learning strategy, the type of PBL, the nature of the subject or programme and its underlying philosophy, and, finally, the competencies of the facilitators who will be supporting students' learning are essential considerations for the designers of PBL interventions. These findings imply that, before designing a PBL intervention, the designers should seek to establish the alignment between the focus of PBL and the learning outcomes of the subject or programme.

It is recommended in this study that the designers of PBL interventions should first seek to understand the nature of the subject and the philosophy underpinning it, followed by establishing the focus and purpose of PBL as a teaching and learning strategy. According to this study, it is strongly advised that facilitators who work with PBL obtain the proper PBL training so that they may carry out their duties admirably and make a substantial contribution to students' learning. It can be concluded in this study that, while the three key components of PBL identified in the literature and their roles during each stage of the PBL stages are crucial to its success, it is of equal importance to consider the other factors that this study revealed. Therefore, the design of PBL interventions has to acknowledge the existence of other factors which are also crucial to the successful implementation of a PBL intervention.

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Vocational pedagogy in Automotive Mechanics: Ontological dimensions and Cognitive Load Theory implications

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ABSTRACT

This research explored the way ontological categories are fundamentally useful for analysing vocational pedagogy, particularly in the context of Automotive Mechanics. Two ontological traditions were found to be especially useful: mereology, with its focus on part–whole systems, and process ontology, which emphasises the dynamics of change. The convergence of ontological categories with learning science in Automotive Mechanics pedagogy is also examined, particularly the way in which cognitive load theory helps to manage the learning complexities tied to ontological automotive concepts. The research, which targeted first-year student training, employed a qualitative case study methodology encompassing three vocational education and training institutions in Eswatini that provide training in Automotive Mechanics. The data collection involved conducting interviews with lecturers, making observations in both classrooms and workshops, and recording the teaching process on video during a one-year period. Field notes and transcriptions were analysed in order to extract key themes connected to the teaching methods. These themes were identified, grouped and further condensed to isolate the most prevalent teaching practices across the institutions. Upon identifying a significant theme pertaining to parts and wholes, the researchers delved into the philosophical and theoretical aspects of part–whole relations and their role in teaching and learning processes. They discovered beneficial interconnections between mereology, process ontology, and cognitive load theory, especially the way the hierarchical structure of Automotive Mechanics pedagogy interacts with the constraints of working memory and chunking. These connections both foster in-depth pedagogic analysis and contribute to the enhancement of Automotive Mechanics pedagogy.

KEYWORDS

Automotive Mechanics pedagogy; ontology; mereology; process ontology; cognitive load theory

Introduction

Teaching and learning in vocational fields such as Automotive Mechanics necessitates understanding the many intricate, interconnected components and systems and the dynamic processes they undergo. This places cognitive load demands on students negotiating the multiplicity of parts and systems in cars. We can phrase the above challenge as a problem statement: How can detailed analytical concepts derived from ontology intersect with recent developments in learning science and be related to Automotive Mechanics pedagogy? In this context, we explore the potential synergies of mereology, process ontology and cognitive load theory in the pedagogy of Automotive Mechanics.

Mereology – the abstract study of parts and the wholes they form (Cotnoir & Varzi, 2021) – can provide a specialised analytical language that helps to delineate key aspects of Automotive Mechanics pedagogy. It serves as an abstract analytical counterpart for the dissection of complex mechanical systems into manageable parts and facilitates a progressive understanding that starts with individual components and incrementally ascends to comprehending an entire vehicle's system. Given the intricate nature of Automotive Mechanics, such a 'parts to parts to system' methodology can prove to be a useful analytical pedagogical tool. It offers an already established and well-developed systematic language of description that aids an understanding of the complex hierarchy of parts, systems and subsystems that make up a vehicle.

Process ontology, a philosophical perspective that emphasises the dynamic nature of reality (Whitehead, 1929), focuses on processes and transformations. Instead of viewing a motor car as, for instance, a static assembly of parts, process ontology encourages us to view it as a complex network of interacting processes that evolve over time. This dynamic perspective is particularly relevant in the automotive field, where systems constantly interact, parts wear down, and mechanical elements fluctuate over time.

Cognitive load theory (CLT) provides insights into the cognitive demands placed on students and proposes strategies to manage these demands so as to enable effective learning (Sweller, Ayres & Kalyuga, 2011). In the context of Automotive Mechanics, the complexity of concepts and the multitude of interrelated parts and systems can exert a high cognitive load on students. CLT-based strategies – such as breaking down a specific task (intrinsic load), reducing unnecessary distractions (extraneous load), and facilitating meaning-making (germane load) – can help to make the learning process more efficient. By managing cognitive load, students can more easily engage in higher-level cognitive processes such as problem-solving and meaning-making without experiencing cognitive overload.

The structure of this article unfolds by first establishing the conceptual framework designed to analyse the pedagogy of Automotive Mechanics. This is presented as three triads:

- Mereology comprises three subconcepts: part of, overlap, and transitivity of parthood;

- Process ontology includes three subconcepts of its own: process, change, and temporality; and
- Cognitive load theory encompasses three core concepts: intrinsic cognitive load, extraneous cognitive load, and germane cognitive load.

Secondly, a brief account is provided of the case study methodology employed, along with the research sites (three TVET colleges in Eswatini) and participants (six highly experienced lecturers), the data having been gathered during a one-year period.

The third section of this article includes a discussion of the study findings using both detailed lesson transcripts and lecturer interviews to illustrate the applicability of mereology, process ontology and cognitive load theory to the analysis of Automotive Mechanics pedagogy. The article concludes by arguing that the framework developed possesses not only analytical utility, but also pedagogic effectiveness, thus providing a 'double bonus' for subject-specific vocational pedagogy.

Conceptual framework for analysing Automotive Mechanics pedagogy

Why use mereology as part of a conceptual framework for Automotive Mechanics pedagogy?

Mereology is not well known as a useful tool in vocational pedagogy. This is understandable, given that its roots lie in mathematical set theory, logic and ontological philosophy.[1] The term originates in the ancient Greek word 'meros', which means 'part' and the wholes built up from parts. Mereology focuses on the ways in which parts relate to parts and how systems are built up and then form parts of larger systems (Cotnoir & Varzi, 2021:1). Put like this, the connection to Automotive Mechanics becomes obvious, given the way engines are made up of subsystems and parts that interrelate. Mereology enables us to use a well-established analytical language with a long historical record going back to Plato and Aristotle and carrying forward to modern figures such as Whitehead. Many of the complexities, contradictions and nuances of the way parts and wholes work have been thrashed out over the ages, with increasing clarity reached on what the basic concepts and processes are in this area. This has enabled us, as researchers in and of education, not just to rely on emergent themes from the data, but to put to use a massive amount of established intellectual work already done in the field. We would argue that there is real virtue in this strategy of respecting the weight of intellectual history rather than using the latest fashionable framework that tends to die with its founder. We shall use only three fundamental concepts from the massive corpus of mereology to reveal its possibilities for Automotive Mechanics pedagogy: they are 'part of', 'overlap' and 'transitivity of parthood'. These are explained in what follows.

1 See Varzi (2019) for a clear introduction and a description in the *Stanford encyclopedia of philosophy*. See, also, Cotnoir and Varzi (2021) for the clearest, fullest and most up-to-date account.

'Part of': This is the most fundamental concept in mereology. It refers to the relation between a part and the whole.

> Parthood is the fundamental relation in Mereology, and it is usually defined as the relation that holds between a whole and its proper parts (Cotnoir & Varzi, 2021:1).

For instance, in Automotive Mechanics, a piston can be considered to be a part of an engine and the engine itself is a part of the car. The 'part of' relationship establishes a hierarchical system where the function of each part is contextualised in the broader system to which it contributes.

'Overlap': This refers to a situation where two or more parts share a common part across different systems (Cotnoir & Varzi, 2021:47). Overlap becomes relevant in Automotive Mechanics when components serve multiple systems. For example, a car's battery overlaps with multiple systems: it provides the spark for starting the engine, powers the electrical systems when the engine is off, and contributes to the charging system when the engine is running.

'Transitivity of parthood': This is the principle that if part A is a part of part B and part B is a part of whole C, then part A is also a part of whole C (Cotnoir & Varzi, 2021:76). In the context of an automobile, if we consider the spark plug (part A) as a part of the ignition system (part B) and the ignition system as a part of the overall car (whole C), then the spark plug is also a part of the whole car. This concept helps us to understand how small, individual parts contribute to the overall functioning of an automobile, even though they are nested within larger subsystems. Transitivity is vital to diagnostics and problem-solving in Automotive Mechanics. It also plays a key role in understanding how chunking works in cognitive load theory (to be discussed below).

Teaching Automotive Mechanics is replete with parts within parts and the systems they form and interrelate with. It is almost too obvious to state, but stating it and providing the analytical subconcepts enables us to name and track an intuitive teaching process explicitly.

When discussing a cooling system, for instance, a lecturer might start by identifying the radiator, the water pump and the coolant (the parts) that collectively make up this system (the whole). The overlap of these parts with other systems, such as the water pump driven by the engine's drive belt, can be highlighted to illustrate their multiple roles. Then, using the principle of transitivity of parthood, the students can be guided to see how each part contributes to the cooling system and the function of the car as a whole. We are not arguing that the lecturers should say in the lessons that they are using transitivity of parthood, but rather that we have and use a rigorous analytical language to support a theoretical interrogation of Automotive Mechanics pedagogy.

Process ontology in the context of Automotive Mechanics with specific attention to its core concepts: Process, change and temporality

Alfred North Whitehead was a key figure in developing mereology in the 20th century. He also sits as a foundational philosophical presence in education, especially through his collection of essays, *The aims of education and other essays*, in which he offered a synthesis of liberal, scientific and vocational education (Whitehead, 1929a:74–75). Whitehead's philosophy of education was deeply informed by process ontology (Whitehead, 1929b), which took mereology and 'made it dance' (author's own choice of words). There are real dangers when dealing with parts and parts in combination that the approach becomes static: parts go together with parts to make up a whole, nicely drawn up and labelled in static diagrams, whereas, actually, it is how they work and what they do that are vital. Process ontology helps us ward off the static, immobile dangers of working with parts and focuses on their actions. As with mereology, we use three fundamental concepts to illustrate this: process, change and temporality.

'Process': As the key concept in process ontology, a process represents a series of actions or operations pushing towards the future. In the Western intellectual tradition, this idea goes back to Heraclitus and his dictum:

> No man ever steps in the same river twice, for it's not the same river, and he's not the same man (Kahn, 1979:91).

As a philosophical concept, process pushes against the tendency to work with things, substances or products in a reified way. Instead, it places them into the stream (or fire) of dynamic transformations (Rescher, 2000:5). In the context of Automotive Mechanics, a process could refer to the steps involved in the combustion cycle in an engine. This includes the intake, compression, combustion and exhaust processes. Rather than simply teaching students about the static components of an engine, a process ontological approach would emphasise the dynamic activities that these parts engage in to power the vehicle, with the focus shifting away from the parts that make up the system to the energetic flows of the system pushing it forward.

'Change': Change is inherent to the process concept and signifies the transition or transformation in a system (Rescher, 2000:22). Change is integral to understanding the operation of a motor vehicle and diagnosing problems in Automotive Mechanics – for instance, understanding how the wear and tear on brake pads can change braking efficiency or how a change in the colour of exhaust smoke can indicate different engine (mal)functions or problems. This focus on change helps students grasp the dynamic nature of automotive systems.

'Temporality': Temporality builds on process and change and pushes towards the realisation that things do not just exist in time; rather, temporality is built into the way the world works. The reality of the world is not static; it is constantly dynamic, changing, temporal and shifting between states. Whitehead puts it this way: 'The actual world is a process, and temporality is the form of process' (Whitehead, 1929b:236). When teaching Automotive Mechanics,

temporality mainly refers to the way the students should come to see the car as always in time, with everything the car does related to movement in time and the inevitable decay that comes with time, as well as the continual innovation and fecundity possible because of these dynamics. This insight goes from the smallest combustion sequence to the timing of different processes, like the precise sequence and timing in a four-stroke combustion cycle, building towards longer-term processes such as the lifespan of certain parts or the maintenance schedule for different systems in the motor car.

Using a process ontological lens in Automotive Mechanics pedagogy gives individuals a holistic, dynamic perspective. As a result, instead of seeing a motor car as merely a collection of parts, to individuals the automobile becomes a network of constantly interacting, changing, evolving and decaying processes over time. Understanding these processes can significantly enhance the students' diagnostic and problem-solving skills, preparing them for real-world challenges in Automotive Mechanics.

How does cognitive load theory relate to mereology and process ontology?

Cognitive load theory (CLT), developed by John Sweller and various compatriots (Sweller, Ayres & Kalyuga, 2011), posits that our working memory is limited. The design of learning tasks should put this limitation of working memory foremost when considering ways to optimise learning outcomes.

Cognitive load is divided into intrinsic, extraneous and germane loads.

'Intrinsic cognitive load': This refers to the inherent complexity of the information or task being learned, which is determined by the number of interactive elements that must be processed simultaneously in working memory. Sweller puts it succinctly:

> Intrinsic Cognitive Load is the amount of mental effort required to process a given amount of information (Sweller, 1999:13).

In the context of Automotive Mechanics, understanding the principles of internal combustion would impose a high intrinsic load because of the various elements involved: fuel–air mixture, compression, spark ignition and exhaust. All these elements must be understood in conjunction with one another, as they interact in a complex process. As a technical aside, intrinsic load depends on a student's prior knowledge of an area being studied, so, if the student already has a strong overall grasp of how the mechanics of a car works, this will reduce the intrinsic load on the student. The more expert the student is in the area being taught, the less the inherent complexity of a task will be compared with that of a novice student.

'Extraneous cognitive load': This refers to the load imposed by how information is presented to students. There will always be some kind of extrinsic load when teaching, as the information needs to be presented in some pedagogic form. When instructions are poorly designed, are

unclear or are unnecessarily complex, the extrinsic load becomes extraneous (excessively high or unimportant to the actual learning process), thereby hampering learning.

> Extraneous Cognitive Load is any Cognitive Load that is not essential for learning and that can therefore interfere with learning (Sweller, 1999:18).

For instance, if an instructor explains the internal combustion process in a long-winded way, or students must refer to multiple resources simultaneously to understand a task, this could create a high extraneous load.

'Germane cognitive load': This involves the mental effort required to construct and automate schemas, which are the mental structures we use to organise and store knowledge. Sweller (1999) puts it clearly:

> Germane Load is the cognitive processing that is essential for meaningful learning to occur (Sweller, 1999:17).

High germane load is desirable because it contributes to meaningful learning. For example, after understanding a car's various parts (a task with a high intrinsic load), a student might start to see how these parts interrelate to make possible the car's functioning. This insight would involve a high germane load, as the student is required to integrate multiple elements into a coherent schema. Schema construction is central to the pedagogy of Automotive Mechanics, enabling problem-solving that is driven by material inferences.

In an effective learning environment, the goal is to manage these three types of cognitive load in order to optimise learning within the limitations of working memory. Optimisation often involves minimising extraneous load (e.g. by providing clear instructions and well-organised learning materials), managing intrinsic load (e.g. by breaking down complex tasks into manageable parts), and maximising germane load (e.g. by encouraging students to make connections between concepts and practice while they are building schemas).

In the pedagogy of Automotive Mechanics, focusing on intrinsic load might involve breaking down a motor car's operation into its parts and systems so that students can focus on understanding one element at a time. Efforts to reduce extraneous load could involve laying out engine parts that can easily be fitted together. Finally, strategies to increase germane load could entail guiding students to connect the parts and systems they are learning about and encouraging them to apply this knowledge in real-world problem-solving tasks such as diagnosing and resolving mechanical issues.

Integration of mereology, process ontology and cognitive load theory to enhance Automotive Mechanics pedagogy

There are real synergies, for both pedagogic analysis and effective teaching, in the ways mereology, process ontology and cognitive load theory work together. Before going on to

demonstrate this in the discussion of the findings, we would like to make this explicit, not as formal integration but as intuitive synergies between them.

Mereology has the danger of becoming static in the breaking up of systems into subsystems and parts. When breaking up things into pieces, it is hard to remember that they are also processes in dynamic change. On the other hand, when working with process flows, it can be difficult to return to the elements making up the flow. This is a continuous productive tension in theorising: the structure of the parts in a system versus the actions the system takes for an outcome; a state of things at a certain point versus a change from one state to another; the static pattern on repeat versus flux in movement; the structure of a system versus the function of a system; and so on. By clearly working with both mereology and process ontology, both ways of working with the real world are present.

Cognitive load theory fundamentally recognises that working memory is limited and that chunking is a key strategy with which to continuously increase the intrinsic complexity of a subject by combining many parts into one whole, and then only having to work with the one whole and not the many parts, thus reducing cognitive load. The more proficient designers of learning are at working with systems within systems within systems, the more they are able to pack increasingly higher levels of complexity into the teaching and learning process while not overloading working memory.

Finally, germane load is all about meaning-making and schema production, where interrelationships and connections to existing knowledge are made. This is exactly how components interact with subsystems and subsequent higher-level systems through recognising patterns and making connections. But, even more importantly, these dynamic connections work with each other, overlapping and intersecting, making it crucial that students make synthetic sense of the ways in which cars function. All of this sense-making and schema-production are ultimately brought to bear in order to meet the key demand that automotive mechanics be able to diagnose and fix a problem with a vehicle.

Methodology

This study is anchored in a multiple case study approach, which formed part of a larger PhD research study (Mokoena, 2017). The objective was to investigate the pedagogical practices employed in teaching Automotive Mechanics across three vocational education institutions in Eswatini. Data for this research were collected primarily through semi-structured interviews with lecturers who specialised in training students in Automotive Mechanics, and also from observations made in classroom and workshop settings over one year.

A case study methodology was used to examine complex phenomena comprehensively within their real-life context (Yin, 2003). While a single case study could have offered a deeper observational understanding of the subject under scrutiny, we chose a multiple case study

across institutions to improve the external validity and dimensionality and to enable the development of more comprehensive theories (Yin, 2003; Barratt, Choi & Li, 2011).

For this study, the participants were selected by means of a purposive sampling approach. This non-probabilistic sampling technique was considered suitable bearing in mind the specialised scope of the study. From each institution, two lecturers were selected based on their length of service – one with the longest service record and another with a minimum of ten years' service. This method ensured the inclusion of a wide spectrum of experiences and viewpoints.

To ensure confidentiality, the participants are represented by their respective institutions and a numerical identifier, as shown in Table 1.

Table 1: Research participant lecturers and their lecturing experience

PARTICIPANT	INSTITUTION	LENGTH OF EXPERIENCE	QUALIFYING CRITERION
ECOT1	Eswatini College of Technology	24 years	Ten-year service period
ECOT2	Eswatini College of Technology	29 years	Longest service period
VOCTIM1	Gwamile VOCTIM	29 years	Longest service period
VOCTIM2	Gwamile VOCTIM	10 years	Ten-year service period
MITC1	Manzini Industrial Training Centre	18 years	Ten-year service period
MITC2	Manzini Industrial Training Centre	22 years	Longest service period

The data-collection methodologies for this study encompassed pre- and post-observation semi-structured interviews with each participant, direct observations of pedagogical practices in classrooms and workshops, and video footage. This multifaceted approach allowed for a deeper examination of teaching practices and facilitated the real-time capture of data on teaching strategies and student–lecturer interactions. All the interviews and observations were limited to first-year training in order to offer a clear reference point for the pedagogical strategies employed at the foundational level of Automotive Mechanics instruction.

The intention was to interview all automotive lecturers at these institutions, but practical constraints and timetable clashes allowed only two lecturers per institution to be included in the study. The distribution of the selected lecturers is represented in the Table 2.

Table 2: Sampling of lecturers by institution

INSTITUTION	TOTAL NUMBER OF LECTURERS IN AUTOMOTIVE MECHANICS	NUMBER OF LECTURERS SELECTED FOR DATA COLLECTION
Eswatini College of Technology	4	2
Gwamile VOCTIM	4	2
Manzini Industrial Training Centre	2	2

In practical terms, only four lecturers were excluded from the study, specifically two each from Eswatini College of Technology (ECOT) and VOCTIM.

The researcher (Mokoena) sought to maintain a low profile so as not to disturb the natural teaching environment. To this end, he adopted the student dress code of blue two-piece overalls for all the lessons, further enhancing the researcher's inconspicuousness. This approach was beneficial in enabling students and lecturers to behave naturally without experiencing the stress of an outsider's presence, especially as the study extended over a year.

Data sourced from interviews, observations, field notes, and transcriptions were coded by grouping related ideas reflecting broader perspectives (Creswell & Plano Clark, 2011). An intensive process of reading, noting key phrases, assigning codes, grouping themes, and identifying common themes across all three institutions was followed. These themes were analysed for their contribution to lecturer pedagogy in Automotive Mechanics.

When the key theme of part/wholes emerged, the researchers investigated which detailed theoretical languages would best help to analyse the data. The gambit was that already well-developed theories on part/whole relations could provide specific and semantically dense conceptual tools to help with the analysis. This was how mereology and process ontology became key analytical tools in the study.

Potential bias introduced due to the selection of participants was limited by the relatively small number of automotive lecturers in each institution. This study's findings, though based on evidence from one developing country in Africa, offer a premise that the theoretical frameworks underpinning the pedagogical practices in Automotive Mechanics teaching could apply to other areas of engineering and to many vocationally oriented subjects with real-world roots.

Discussion of findings: The 'parts-parts-system' pedagogy in relation to mereology and process ontology

What follows is an exemplification, through the data collected, of the way the ontological categories of mereology and process ontology show up in the pedagogic processes of Automotive Mechanics. We begin with a short extract from a practical assessment lesson by the Ministry of Information Technology, Communication and Innovation (MITCI) (16 September 2015) on removing and replacing brake pads.

For those who are not mechanics, a little context is needed on the difference between the two types of braking systems in most cars – disc brakes and drum brakes. When you pull up your handbrake, you use drum brakes; when using a foot pedal, you normally use disc brakes. One of the main parts of a drum brake is a brake shoe, while a main part of a disc brake is a brake pad. In this specific instance, the students are working with brake pads as a part of the disc brake system but will also need to know how brake shoes work in the drum-braking system.

Brake shoes and brake pads lesson extract

Lecturer: Give me one advantage and one disadvantage of brake shoes as opposed to brake pads.

Trainee: [No response] The lecturer notes something down.

Lecturer: [Points] What are these?

Trainee: Studs.

Lecturer: What is this?

Trainee: Brake piston.

Lecturer: … and this?

Trainee: Disc.

Lecturer: What is this?

Trainee: Mmm … it carries the brake fluid … .

Lecturer: What is it called?

Trainee: [No response]

Lecturer: It is called a brake fluid flexible pipe.

[Lecturer notes down something and instructs the trainee to dismantle the brakes so that he can come back and observe him when he reassembles them.]

[Some 15 minutes later, the lecturer comes to the trainee who has dismantled the brakes.]

Lecturer: We don't have new pads to fit, so we will put back the same ones. How do you know which pad goes where?

[Trainee ponders for some time … looks at the pads … . Shakes his head.]

Trainee: [No response]

Lecturer: [Picks up the two pads] … This one has piston marks … . This one has calliper marks?

Trainee: Oh … [points at the one with piston marks] … this one goes inside.

Lecturer: Give me one advantage and one disadvantage of the disc in a disc brake, compared to brake shoes.

Trainee: [No response] Lecturer: The disc brake cools quicker after braking. Let's say you are going down Malagwane (hill). Because the disc is exposed, it can cool faster, but shoes can end up smelling.

The disadvantage is that when you drive through water and have been using the brakes, the disc can crack.

Lecturer: Now … how is the condition of this disc?

[Trainee uses hand to feel it.]

Trainee: … I think this one requires to be replaced.

Lecturer: Why?

Trainee: It is worn out.

Lecturer: Good. Okay, put back everything and replace the wheel.

[The lecturer observes as the trainee reassembles.]

It should be noted that, while the above practical assessment is on removing and replacing disc brakes, the deliberate focus on each part illustrates the essential need for the identification and naming of each part, understanding its role and how it fits in the brake system, as well as understanding how changing dynamics and conditions affect the functioning of the discs. The extract also clearly shows the foundational use of 'types' along with 'parts', enabling the lecturer to differentiate and contrast different braking systems and also to break down and reassemble one braking system.

Mereological discussion of Automotive Mechanics pedagogy

Part of relations in Automotive Mechanics pedagogy

The crucial role of the way in which parts work in pedagogy was clearly expressed when interviewing the lecturers. VOCTIM1 stated:

> Firstly, I want the student to know the parts; then, I want the student to know the parts that make up the system before knowing the systems that make up the car.

The lecturer's strategy exposes the principle of part–whole relationships inherent in mereology. By teaching students about individual car parts first, then progressing to parts that constitute systems, VOCTIM1 underscores the importance of understanding each component and its function. In this way, students are prepared in order to recognise more intricate interactions as they begin to perceive the car as a whole, echoing the mereological concept of part–whole relationships building up in complexity. Similarly, ECOT1 explained:

> We do one by one. We look at each part alone, and look at the next part, before we look at the parts as a system. Now each system links to the other system. You again look at each part of the next system … part by part … then the system … then look at how this system links to the other system.

This lecturer underscores the principle underlying their teaching, as premised on looking at each part alone, initially in isolation, before moving to the next part, until all the parts are considered together as a system. The principle of part–whole relationship, which aligns with the essence of mereology, allows the complex system of a car to be broken down into smaller, more 'digestible' parts on which students can build so as to manage complexity and gradually build towards an understanding of the whole.

Overlapping parts of Automotive Mechanics pedagogy

The concept of overlapping parts also surfaces in VOCTIM1's teaching method, as elucidated in a separate interview:

> I always teach clutch first … what it does … link engine and transmission … why the car jumps when the clutch is released quickly … the engine goes off because there is no smooth connection with the transmission.

In this instance, the lecturer introduces students to overlapping parts that interconnect to constitute more complex systems. By focusing on the clutch, the engine and the transmission, VOCTIM1 exposes students to shared components that function in multiple subsystems. This exercise brings the mereological 'overlap' concept to the fore and highlights the significance of understanding how overlapping parts operate in unison and individually. Grappling with how the clutch operates with other connected parts is important. If the overlap is working well with other parts, then there will be smoother engagement and disengagement of the engine with the transmission. If the clutch does not overlap properly, there will be jerky shifting or difficulty in changing gears. When understanding what a part is, it becomes important to understand what it overlaps with.

In the lesson transcript on disc brakes, we see the lecturer working with how the disc brakes form overlapping parts of the car's hydraulic system (with how brake fluid and the brake piston work), the thermal system of the car (regarding heat), and the safety system of the car

(the danger of a disc brake cracking). But because his first-year students do not yet grasp the basic parts of the mechanical disc brake system, he moves forward and does not elaborate on the overlaps between the different systems and parts.

Transitivity of parthood in Automotive Mechanics pedagogy

Applying the mereological concept of transitivity of parthood becomes more pronounced as the lecturers progressively introduce parts and overlapping parts to complete systems. This process of teaching, involving a gradual transition from parts to systems, allows students to understand how each component is integral to the functioning of the entire system.

Such approach is evident in the teaching method of VOCTIM2, as stated in the interview:

> You start from the part to know the parts that make up the system, then the systems that make up the car.

VOCTIM2 echoes the strategy of VOCTIM1, emphasising that understanding smaller, individual components provides a path to comprehend larger, interconnected systems. By doing so, the transitivity of parthood – a fundamental mereological concept – is mirrored in the lecturers' pedagogical approach.

ECOT1 sums up the teaching of Automotive Mechanics as follows:

> Basically, in Motor Mechanics, you break a car into parts and make a module about these parts, then you teach these parts. So for instance you see the engine as the source of power; now what do you do with the power? You talk about the transmission, the clutch, the gearbox in your Isuzu car, the prop shaft, the diff and how the power is then taken to the wheels.

Thus, essentially, the teaching of Automotive Mechanics is premised on dividing a car into smaller parts that progressively interconnect into subsystems and systems to build towards an understanding of the larger interconnected systems. This pedagogical practice depicts the concept of transitivity of parthood. Transitivity enables the digging down into a fault a car is showing by working down into subsystems, sub-subsystems, and eventually to the individual component, as illustrated in the next section.

Composition and decomposition in Automotive Mechanics pedagogy

Another significant aspect of applying mereology in teaching Automotive Mechanics involves practical composition and decomposition, as was seen in the earlier transcript on disc brakes. This approach involves identifying, disassembling and reassembling the car's systems, as illustrated in the following transcriptions:

VOCTIM1:

> Identifying, disassembling, and reassembling … to know the car, you need to identify parts, disassemble, and reassemble. Assemble the parts to make up the system and assemble the systems to make up the car.

ECOT1:

> I take them there [to the workshop], we dismantle the engine. I show them the parts, then I put the engine together. I encourage them to take pictures using their phones. If you forget, then the picture will remind you how the parts come together. I put the engine together myself, and I let them watch. Next time, I assign group 1 to dismantle the engine; when they do, I come and ask them to identify the parts. I then ask them to assemble the engine again.

The processes that both VOCTIM1 and ECOT1 describe align with the mereological activities of decomposition and composition. Through this method, students experience first-hand how individual parts collectively form a system, further solidifying their understanding of part–whole relationships. These parts and systems interconnect and overlap, making the process of composition and decomposition occur in interrelating chunks. The car makes sense through the build-up of part–whole relationships, interconnection and relations. These activities provide a concrete and tangible way for students to embody the concept of mereology, enhancing their ability to understand the mechanics of a car. Decomposition and composition also give the student first-hand experience of the ways in which these mereological relationships work.

This part–whole relationship, overlapping and transitivity and these composition–decomposition possibilities all point to the hierarchical structure of Automotive Mechanics pedagogy and the usefulness of employing the detailed analytical corpus of mereology for pedagogic analysis.

Routine expertise in Automotive Mechanics pedagogy

One critical vocational outcome in Automotive Mechanics pedagogy is the development of routine expertise. Routine expertise was encouraged in the discussion on dismantling by ECOT1 above, emphasising the repetitive interaction and familiarity with the parts and systems in mastering Automotive Mechanics. This was put as a rule of thumb by VOCTIM1:

> The more you do it, the more you see it, the more you get used to it.

VOCTIM1's comment encapsulates how students can foster expertise and familiarity through constant engagement with parts and systems – concepts at the heart of mereology. This routine expertise forms the basis of students' development, aiming to produce proficient automotive mechanics. Chunking parts into wholes assists directly with developing routine expertise

(Sweller, 1988), as the students can work with the way the systems of the car interrelate rather than struggling with what each part is and does. These vocational outcomes are not static but are continually enhanced through practice and understanding of systems, as ECOT1 indicates:

> … you have not dismantled the parts, but if you are a good mechanic, you try to understand how the parts fit together – even if it takes a long time. A good mechanic will try to understand how the parts work together. You will have things you know, like me, when working with a car; there are things I just know. I still don't know everything. But the things that I know, I know. A good mechanic will have things he knows about cars; he won't know everything, but he has to know certain things, and the more problems you meet when working on a car, the better you will be, and it works to consult other good mechanics when you have a problem [about a car].

In summary, the analysis of the interview data and the lesson transcripts demonstrates that the principles of mereology – the study of part–whole relationships – are deeply ingrained in the teaching of Automotive Mechanics. The analysis reveals that lecturers intuitively employ these principles in their pedagogical strategies, which helps to break down the complex whole into its parts for teaching purposes. From identifying individual parts, understanding the overlapping components, appreciating the transitivity of parthood and developing hierarchical systems to building routine expertise, the application of mereology enhances the understanding of the intricate dynamics of Automotive Mechanics pedagogy.

Process ontology in Automotive Mechanics pedagogy

Many of the quotes used in the mereological analysis have a double face: on the one side, they point to part–whole relations, and, on the other, they show dynamic processes at work.

Engaging with dynamic systems

VOCTIM1 clearly illustrates process ontology:

> I always teach clutch first, what it does, link engine and transmission, why the car jumps when the clutch is released quickly, the engine goes off because there is no smooth connection with the transmission. I talk about the functions of the clutch; when you press the clutch and stop the car, you are breaking the drive from the engine, and the pressed clutch helps the car not to go off.

In this quotation, the clutch is not presented merely as a physical component but as a dynamic entity engaged in constant interaction with other parts of the car. It is not only about what the clutch is but also about what it does in the overall functioning of the vehicle. To understand a clutch fully, the student must grasp what it does: structure and function work together. VOCTIM2 indicated this similarly:

> The more complex topics, like in heavy haulage trucks that carry sugar cane in Swaziland. They use springs at the back where there are concepts like drive thrust and brake thrust … how are they absorbed. Because in these trucks there are springs, fixed shuttle and swinging shuttle. When the truck pulls, we know the drive will start from the clutch to the gearbox, to the propeller shaft to diff. The diff is mounted on the spring through the centre bolt so that when the truck pulls, the diff does not lag behind. Sometimes, the centre bolt, because it is subjected to forces as the truck moves, it wears away, and the diff loosens away; then you see the truck as if it's moving like a crab. Many buses, you see them going sideways, it is because the centre bolt fastening the diff is broken, and the diff has moved.

Here, for trucks, the clutch is not a separate entity but operates in dynamic ways that give a diagnostic reading on how the whole system is functioning and wearing out over time, with all the different parts and systems interacting with one another to get the truck to 'move like a crab'.

Seeing the car as a network of interacting processes

In an observed lesson [Lecturer VOCTIM1] involving a customer's car that was showing signs of overheating, the lecturer's description elaborates on this idea of process ontology. The lecturer moved from part to part, in the engine cooling system of a car, following cost and complexity rules (what is cheapest and easiest first), with the result that the students would use this 'parts approach' to build on their repertoire towards understanding the operation of the engine cooling system.

The process involved looking for leaks in the radiator and the pipes; when none were found, the next step was determining whether the thermostat was performing its role in retaining and releasing water at the correct temperature from the radiator. When the thermostat was found to be okay, two steps remained: the radiator and the cylinder head (in order of cost and complexity). The radiator was taken out for testing and found to be blocked; a new one had therefore to be bought.

Here, VOCTIM1 underscores the dynamic and complex network of processes inherent in the operation of a car's engine cooling system. The car exists dynamically in time, changing and wearing down, needing repairing and replacing, all at different rates in dynamic tension. The engine cooling system is seen as an assemblage of parts, each engaged in complex interactions with the others. Each of these parts, when faulty, affects the overall efficiency of the system, yet each part involves a varying cost and level of complexity when it has to be examined. The student is guided to gradually build up a rich and nuanced understanding of this dynamic system, which requires an understanding of the different parts at the base, but also needs a process-based, dynamic approach that tracks the networked connections to determine the fault.

Dynamic interactions and transformations in setting valve timing

The examples in this section point to how the teaching of Automotive Mechanics involves dynamic interactions and transformations of parts, processes and systems. These interactions and transformations call into play familiarity with and understanding of parts: how each part fits onto the next and how all of them work together to make up a system in play, in movement, in process. Let us consider the following extract from a lesson on setting valve timing by lecturer ECOT1:

> The lecturer moved the 16 students from the Workshop into the demonstration workshop, which houses two engines. One engine is partially cut away to show the clutch assembly, cylinders, camshafts, and prop shaft.
>
> Lecturer [to technician]: Please open the tappet cover, bring Allen key, number 14.
>
> The lecturer then turns the two camshafts at the top of the engine.
>
> Lecturer: Here, we have two camshafts. This one is for the exhaust … and this one is for inlet.
>
> Today we are going to learn how to set the valve timing. [He shows the students the timing belt.]
>
> Many times, when the timing belt is torn, the car will refuse to start. What many drivers will do is keep starting the car many times, hoping it will eventually start. What is happening when you do that, from my experience, is the following: the valves will bend. Why? Because the camshaft is not turning. When you crank, you move the pistons, and they hit against the valves, which are not in sync. Remember, the valves are moved by the camshaft, and the camshaft is moved by the timing belt.
>
> If the valves have been fitted, you now need to set the valve timing.

In the extract, the lecturer simulates a situation where a car can be brought in to a garage for repairs after its valves have been bent. To contextualise this situation, he explains a series of interactions and transformations that can result from a torn timing belt. A driver, unaware that a timing belt is torn, or perhaps not even conscious of what it is for, keeps trying to start the car many times, hoping it will eventually run. What this driver is doing, as they crank, is moving

the pistons. The pistons hit against the valves, which are now out of sync because the camshaft should move them. Yet the camshaft cannot move the valves because a timing belt controls this.

The above components of a valve timing system constitute a fully interacting and functional system. Yet, the breakdown of just one part, the timing belt, brings about a transformation that makes the system dysfunctional and 'transforms' and 'disables' the other components. The camshaft, which controls the valves so that they are in sync with the pistons, cannot turn because there is no timing belt to turn it. The valves are now not synchronous with the movement of the pistons. They hit against the pistons and bend. Hence the setting of the valve timing should follow a series of repairs that correct each part of the valve timing system: the replacement of bent valves and of the timing belt. This setting fine-tunes the dynamic interactions so that the system will once again run optimally.

The above reflections demonstrate the grounding influence of mereological parts playing out in dynamic and changing ways. With each level of teaching – from identifying individual parts to understanding their overlap in different systems to problem-solving and fault finding – the role of part–whole relationships in dynamic processes becomes increasingly vital. This mereological underpinning combined with a process ontology sensitivity enables students to appreciate the intricacies of a motor vehicle as a comprehensive system, setting the stage for a deeper understanding of Automotive Mechanics and the dynamic process involved.

Cognitive load theory in Automotive Mechanics pedagogy

Extending beyond the ontological structure of Automotive Mechanics pedagogy has tangible implications for improving teaching and learning using learning science in general and cognitive load theory (CLT) specifically. This can be stated in intuitive terms. Students must remember many parts, subsystems and systems in a dynamic process, resulting in massive strain on their ability to learn how to be a mechanic. However, chunking simplifies things (Sweller, 1988), where several parts come together and can be worked with as one whole (not as many different parts). Chunking enables students to start to work with the subsystems of a motor vehicle as one thing, not as a whole bunch of parts working together. Chunking enables them to work with the way subsystems work with other subsystems, and so they do not have to focus on all the parts of each subsystem simultaneously.

The key reason why this is important is that our short-term memory can hold only a limited amount of information or a limited number of units, famously captured in this quotation: 'The magical number seven, plus or minus two, refers to the number of chunks of information that can be held in short-term memory at any one time' (Miller, 1956:96). The hierarchical structure of Automotive Mechanics pedagogy allows students to simplify a complex interaction of many parts into one system and focus on the way the system works as one unit. The hierarchical structure can then be built upwards and downwards and across dynamically (Sweller, Van Merriënboer & Paas, 1998). Central to this insight is the way in which chunking reduces the cognitive load students have to work with; rather than many parts that overwhelm

working memory, students can work with one system, made up of many different parts that coalesce into one chunk (Hugo, 2016:72–86).

Intrinsic load and the complex nature of Automotive Mechanics

Intrinsic cognitive load pertains to the inherent complexity of the information being learned. For example, Automotive Mechanics, with its wide array of parts and systems, can be intrinsically demanding. The following extracts from an interview with lecturer VOCTIM2 indicate the challenges he faces as he handles the complexity of information:

> Today's cars are advanced; they have sensors for the car not to hit something, for example – electronics.
>
> I first explain components and function, identify components, their purpose in the vehicle, then I move into details, then remedies, e.g. wheel alignment. I do this to help the trainee's understanding. I decide on my own to move from the simple to the complex. If I do that, the students can put all the simple techniques together and apply them to solve a problem in the car.
>
> In fuel injection, this topic is difficult. I teach when I see they are confused. I give an exercise where they will discuss this to help clarify what I was teaching. If they don't [respond well], I have to repeat, maybe slow down, and teach in smaller bits.

In dealing with the inherently complex nature of the processes and interrelationships in Automotive Mechanics, the lecturer faces the arduous task of deciding how best to present information to the student so that the intrinsic cognitive load is better managed. Newer cars are advanced and 'have sensors' and 'fuel injection' – these systems become a 'load' that is intrinsic in their teaching. In this context, there has to be the continuing development of a strategy to move from simple to complex; to let students put together the simple techniques and apply them; to repeat; to slow down; and to teach in smaller chunks.

As VOCTIM1 states in an interview:

> Firstly, I want the student to know the parts, and then I want the student to know the parts that make up the system before knowing the systems that make up the car.

Similarly, another lecturer, ECOT1, indicates in an interview:

> You again look at each part of the next system, part by part, then the system, then look at how this system links to the other system.

Here, VOCTIM1 and ECOT1 are articulating a strategy of managing intrinsic cognitive load by breaking down the complex subject matter into manageable chunks. By beginning

with individual parts and gradually moving on to systems, VOCTIM1 reduces the inherent complexity of Automotive Mechanics, allowing students to process and understand the information sequentially and cumulatively.

Extraneous load and the role of teaching methodology

Extraneous cognitive load is associated with the way information is presented to students. For example, the teaching method can either unnecessarily increase or efficiently decrease cognitive load. In situations where extraneous cognitive load increases cognitive load and negatively affects learning, the lecturer has to provide interventions that will benefit the student. Lecturer ECOT1 presents such a setting:

> … sometimes, you come to teach just theory but find that the students don't follow anything. You have to move the class to the workshop to show them models. Sometimes, many times, you have to dismantle individual small parts, then put them … together [again], and then let them do the same in groups before some can even [gain] some understanding.

The above exemplifies the space that an Automotive Mechanics lecturer operates in when consciously examining their role in relation to extraneous load, stepping away from a high extraneous load towards a more effective demonstration method that enhances the grasping of complex information. In having to 'abandon' a theory class for the workshop, where a model is dismantled into individual parts and put together again a number of times, the lecturer enhances the students' understanding of a complex system by moving away from less efficient ways of teaching at a certain stage (theory) to a more efficient way (demonstrating) at that particular point.

Germane load and the formation of schemas

Germane cognitive load is devoted to processing, constructing and automating schemas. In other words, it is the mental effort of creating long-lasting knowledge structures. The example quoted by Lecturer ECOT1 demonstrates the struggle where sometimes the students

> [d]on't follow anything. You have to move the class to the workshop to show them models. Sometimes, many times, you have to dismantle to individual small parts, then put them … together [again], and then let them do the same in groups before some can even [gain] some understanding.

The long, slow process of building meaningful schemas is clear in the above quotation. Seeing and handling the models, identifying their constituent parts, putting the parts together, and repeating the process are all part of the formation, processing, construction and automation of schemas – where the student internalises new information in a way that can be used later on.

As VOCTIM1 stated:

> The more you do it, the more you see it, the more you get used to it.

Both quotations allude to the importance of repetition and practice in encouraging the development of schemas. Students can better form mental models of how these elements work together by repeatedly interacting with the parts and systems. This engagement increases the germane load, facilitating deeper learning and mastery of Automotive Mechanics.

Germane load and the formation of schemas are vital to developing diagnostic abilities, where a fault in a motor vehicle has to be tracked through various problem-solving strategies. The fault has to be traced, with any spill-on effects understood in the various subsystems of the vehicle. We saw this earlier in our discussion of valve timing settings and the radiator leak:

> The valves will bend. Why? Because the camshaft is not turning. When you crank, you move the pistons, and they hit against the valves, which are not in sync. Remember, the valves are moved by the camshaft, and the camshaft is moved by the timing belt.

Similarly, VOCTIM1 demonstrated to students how to track and solve the overheating problem in a customer's car by systematically tracing the problem, starting with simple leaks, then the thermostat, then the radiator and cylinder head. This gives the students a schema to use to fault-find when presented with an overheating problem.

If the students in Automotive Mechanics do not get a chance to engage fully with germane load and schema construction, their very purpose as car mechanics is threatened. This leads us to the heart of how material inference (Brandom, 2000) is used in diagnostic problem-solving – a second key dimension of Automotive Mechanics pedagogy, which is the subject of another article.

Conclusion

The analysis presented in this article indicates that the instruction of Automotive Mechanics can be significantly understood and enhanced by using ontological categories to support analysis. To put it plainly: both vocational education in general and Automotive Mechanics education specifically engage with things and processes that perform functions; hence the relevance of ontology – the study of how the world is composed – as an aid to learning. Mereology, which examines part–whole relationships in ontology, forms the bedrock for analysing part–whole relations in automotive pedagogy. The findings suggest that the common lecturer tactic of deconstructing a motor vehicle into its component parts for instructional purposes resonates strongly with the ontological categories. Students initially learn about the separate parts of a vehicle, comprehending their essential characteristics and functionalities. This part-centred approach is also vital when these components are assembled

into systems, disassembled and reassembled again, which fosters a broader understanding of a vehicle's overall operation. The concepts of part-of, overlap and transitivity of parthood in mereology offer a valuable initial lens through which to appreciate the pedagogical decisions made by the lecturers. Importantly, it resonates with the existing pedagogic practices of these lecturers. They do not have any issues with the way parts and wholes work – it is, after all, their bread and butter or, more aptly, the nuts and bolts of their practice.

Adopting Whitehead's perception of reality as fundamentally processual, process ontology provides an abstract means of comprehending the dynamic transformative elements of automotive pedagogy. Teaching is not merely about static parts and systems; it is also about the ongoing processes that occur in and between these components and systems. An in-depth comprehension of part–wholes and processes is required for diagnostics, a critical process-oriented activity aimed at identifying non-functional parts. Frequently, mechanics encounter customers entering the workshop with automotive problems that need to be identified and resolved. A companion paper will outline the way material inference (Brandom, 2000) is a crucial concept required to engage theoretically with this essential dimension of Automotive Mechanics pedagogy.

Cognitive load theory (CLT) is particularly relevant in mereology, where the understanding of a motor vehicle evolves from parts to wholes. Segmenting the complex whole into smaller parts is an essential strategy in managing intrinsic cognitive load. By initially learning about individual components, students diminish the cognitive demands of understanding the system when these parts are subsequently combined. This method reduces intrinsic load and creates space for germane cognitive load, which directly aids learning.

Extraneous cognitive load can be mitigated by sequencing practical instruction in ways that echo the part–whole structure intrinsic to Automotive Mechanics. This approach capitalises on 'chunking', where each part becomes a manageable piece of information that, once mastered, can be connected to other chunks so as to form a coherent whole. Reducing extraneous cognitive load enables students to allocate more cognitive resources to germane processes, in this way fostering deeper learning and problem-solving.

By harnessing the part–whole structure and dynamic interactions essential to Automotive Mechanics, lecturers can strategically manage cognitive loads, in the process optimising students' engagement, understanding and problem-solving capacity. Cognitive load theory can work synergistically with mereology and process ontology to enrich pedagogical practices in teaching Automotive Mechanics and facilitate detailed theoretical analysis of subject-specific vocational pedagogies. This extends the rich field of current research on using cognitive load theory for teaching (Tindall-Ford, Agostinho, & Sweller, 2020; Kirschner & Hendrick, 2022). The practical implications are immense, with many well-established ways to improve learning using specific strategies, such as worked examples, goal-free effect, reducing the problem space, dual coding, the expertise reversal effect, spaced practice and metacognition, to mention only a few (Hugo, 2016; Kirschner & Hendrick, 2016, 2022). We shall explore these implications for vocational education in a subsequent article.

While this article focuses specifically on Automotive Mechanics pedagogy, the findings and pedagogic approaches are undoubtedly transferable to other disciplines in the vocational domain. At the University of KwaZulu-Natal, the first author and a group of master's students have analysed more than 150 videos from various subjects in the TVET curriculum and identified the frequent use of ontological categories by lecturers (part/whole, general/specific, type/token, structure/function). These categories resonate strongly with other current analytical traditions that are gaining traction in South Africa, such as legitimation code theory and its use of semantic gravity and semantic density (Maton & Chen, 2016; Rusznyak, 2021), expanding into interesting avenues for collaboration and further theoretical development.

Postscript

The reader may question the use of the term 'vocational pedagogy' as opposed to 'vocational andragogy', especially considering Malcolm Knowles' assertion that adults and children learn differently (Knowles, 1980). Adults often prefer self-directed learning, problem-solving and practical, applicable knowledge. This approach aligns well with the work-oriented focus of vocational education.

Despite these considerations, this study employed the expression 'vocational pedagogy' for several reasons. First, it is the term commonly used in the recent literature, both internationally (Lucas, Spencer & Claxton, 2012) and in South Africa (Blom, 2016). Second, over time, the term 'pedagogy' has broadened its scope to include not only children but also adults, making it more generic. Finally, vocational education frequently employs a blend of direct instruction and problem-based methodologies. Therefore, even though 'vocational andragogy' might seem theoretically more accurate, 'vocational pedagogy' remains the more accepted term, reflecting both historical and current usage, blended teaching approaches and the evolved semantics of the word 'pedagogy'.

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Beyond the trade test: Using the COMET Model to build occupational competence

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ABSTRACT

The South African trade test is a mandatory end-point assessment that certifies an apprentice to practise as a qualified artisan after a specified period of training. Whereas the manufacturing sector has relied on the traditional trade test to provide assurance of an artisan candidate's required level of competence, recent competence-development studies based on the COMET Model of competence development and measurement have challenged the ability of traditional task-based trade tests to prepare candidates adequately for integrated work processes. Studies in other contexts have shown the potential for COMET-based assessments not only to serve as a means of measuring competence, but also to develop it. This article reports on research that investigated how, through the application of COMET assessments, occupational competencies were developed beyond those measured by the traditional apprentice trade test. A mixed-methods, quasi-experimental approach produced strong evidence that COMET-inspired authentic assessments enhanced learners' levels of competence and developed vocational identity among candidates who undertook such preparation for a trade test.

KEYWORDS

Competence development; competence measurement; trade test; COMET; authentic assessment; apprenticeship

Introduction and context

Global industry and innovation

An industrial economy is associated with export promotion, increased trade openings, economic liberalisation and an improved business climate (Kniivilä, 2007), changes that are referred to as 'megatrends' (Achtenhagen & Winther, 2014:281). This world of work is constantly transforming through industrial development that has more recently been characterised by automation, connectivity and technological innovation. Industrial competence in a global context constitutes the engine of economic growth and employment of most nations (Haraguchi, Cheng & Smeets, 2017).

Technical and vocational education and training (TVET) is expected to respond to this global context, and although the occupational trade test is regarded as one of the key instruments of quality assurance in workforce development, it falls short of the requirements for a competent workforce, as reported in a recent South African case study (Hauschildt, 2016). Earlier studies by Grosse-Beck (1998) criticised the content and method of a trade test as having insufficient focus on company work processes due to their

- separation of skills and knowledge into written and practical parts of an examination;
- primary orientation towards theoretical knowledge;
- use of multiple-choice questionnaires; and
- failure to take into account the work process value chain.

Diagnostic assessments of competence, on the other hand, such as those reported on in this article, have recently started to provide a means of measuring levels of competence with sufficient validity and reliability in order to serve as an empirical basis for the planning, evaluation and measurement of competence development (Jenewein, 2017; Peterman, 2018; Rauner, 2017).

Occupational training system in South Africa

Skills development has been a key feature of South African policy over the past two-and-a-half decades (DHET, 2019). Some of the earliest legislation passed by the first democratically elected parliament focused on the complete reorganisation of education, training, and the apprenticeship system that were rooted in a racialised apartheid history (Gamble, 2021; Wedekind, 2013). More recently, the trade-examination system has been undergoing reform under the auspices of the Quality Council for Trades and Occupations (QCTO), but legacy trade tests continue to be administered through trade test centres (TTCs) across the nine South African provinces. A common trade test certificate for all qualifying artisan candidates has been issued by the QCTO since 2015 (QCTO, 2016).

The trade test is defined as

> a final integrated summative assessment for an artisan qualification in a listed trade, at an accredited trade test centre, by an assessor registered by the National Artisan Moderation Body (NAMB) (DHET, 2015).

This instrument relies on candidates having already achieved a domain-specific National Qualifications Framework (NQF) Level 3 qualification and a minimum of 80 weeks or a maximum of 208 weeks of workplace experience in all aspects of the curriculum before they apply to take a trade test. The trade test is conducted by administering trade-specific practical tasks in a controlled environment, at the end of which the candidate must be pronounced either competent or not yet competent for certification.

Prior to taking the trade test, candidates are encouraged by their training providers to complete a preparation course which is not standardised, but the provider of the course generally checks that the apprentice's logbook has been comprehensively completed and fills any gaps identified in the training for each trade test task.

The assessment approach for a trade test is based on the candidate being declared 'competent' or 'not yet competent' in each of seven tasks (in the case of electrician artisans) in order to be awarded the trade certificate issued by the QCTO. If candidates are found to be not yet competent in three or fewer tasks, they may carry credits towards another attempt on tasks not yet mastered; but if they do not achieve 'competent' status in four or more tasks, then all seven tasks must be tested again after a period of at least six weeks.

The resulting feedback is provided after all the required tasks have been completed; and if there is sufficient time, the examiner will explain the errors that contributed to a result of 'not yet competent'. After candidates have been declared competent in all the specified tasks, they are certificated as being able to practise and be remunerated as qualified artisans.

Notwithstanding the significance of the traditional trade test in the certification of artisans, the trade test as an instrument for assessing occupational competence has not been well researched in the South African context. Neither has the trade test been fully investigated as an assessment instrument that could possibly be used to develop domain-specific competence rather than only measuring it. A large-scale competence diagnostics study was undertaken in five engineering-related artisan occupations between 2013 and 2016, with low levels of competence being found among more than 1 200 candidates who formed part of that study (Jacobs, 2015). Data analysis suggested that the artisan trade test as a competence measure had been underestimated as a mechanism with which to promote the development of competence during the learning phases of an apprenticeship (Hauschildt, 2016) – the test having been conducted only as a final assessment for certification purposes. Therefore, the research reported on in this article was intended to investigate whether, and how, the structure

and content of the trade test, in addition to being an end-point assessment, might influence competence development *during* the learning phases of an apprenticeship. The methodology by which this was gauged was through the so-called COMET Model that is explained more fully in the sections that follow.

Towards a comprehensive understanding of competence

Assessment in TVET

Curtis (2010:6) describes assessment in TVET as a component of an 'ecosystem of skills', including their development and deployment by agents who operate in the social and industrial context for which the assessments are developed, certified and deployed. Assessment is therefore part of a larger structure of teaching and learning for a purpose, normally set out in a qualification and its policy. The way in which assessments – and examinations in particular – influence teaching and learning is commonly described as the 'washback' or 'backwash' effect (Pan, 2009:257–263). 'Washback' indicates 'an intended or unintended (accidental) direction and function of curriculum change on aspects of teaching and learning by means of a change of public examinations' (Cheng, 2005:8). On the one hand, positive washback integrates meaningful and innovative learning activities in teachers' educational methodologies, with the result that educators will devote more attention to students' intentions, interests and choices, and students are motivated to work harder. On the other hand, negative washback occurs when teachers teach only for the purposes of the test, narrowing the curriculum accordingly (Pan, 2009:261). The paradigm shift from the assessment 'of' learning to assessment 'for' learning has also brought diversity to educational practices, especially in the propagation of creativity and critical thinking among learners (Pattalitan, 2016).

Assessments are usually expected to produce comparable outcomes, with consistent standards being set over time. However, there are factors that impede both the validity and the reliability of assessment practices in workplace settings: for instance, the inconsistent nature of people; relying on assessors to make judgements without bias; changing contexts or conditions; and evidence of achievement arising spontaneously or incidentally. Public interest in the reliability of educational assessment as well as the complex nature of errors in assessment due to systemic factors or personal circumstances often present challenges for assessment (Gardner, 2013:72–92).

Competence development

Many of the central ideas that shaped the understanding of the development of competence emerged with increasing emphasis from the 1970s onwards – for instance, the theory of complete action. The circle of complete action was the first to challenge the Taylorist approach to the organisation of work in favour of recognising work as a process beyond functional actions of closed and repetitive tasks and requiring the essential element of communication. Boreham (2002) defined work process knowledge as the competence needed

for modern workplaces that is characterised by increased functional flexibility, the use of information and communications technology (ICT), the integration of previously separated production functions, and an emphasis on knowledge creation within normal work activity. Fischer and Boreham (2004) conducted empirical research on the concept of work process knowledge across 22 industrial sectors. Their research yielded three main defining characteristics. First, work process knowledge constitutes an understanding of a complete work process. Second, work process knowledge is used directly in the work process and is an instrumental part of work activity. Third, and finally, work process knowledge is constructed in the workplace itself by synthesising experiential and codified knowledge.

In seeking to understand the development of competence, Rauner, Hauschildt and Heinemann (2013:164) proposed a comprehensive analysis of competence in a four-stage model, where the highest level of competence is defined as 'holistic shaping competence' or

> the level of competence where occupational tasks are considered in their full complexity with due regard to the diverse operational and social conditions in which they are performed, and to divergent requirements in terms of work process and its outcome (Rauner et al., 2013:164).

Rauner (2017) and Rauner et al. (2013) held that holistic shaping competence, if measured as an outcome in TVET, could become a catalyst for finding new ways of teaching, learning and assessment that support industrial competitiveness, growth and innovation in an economy.

The definition of competence as 'context-specific cognitive dispositions that are acquired by learning and [are] needed to successfully cope with certain situations or tasks in specific domains' (Weinert, 2001) became the guiding competence construct for developing models so as to provide a basis for developing measuring instruments and interpreting their results (Hartig, Klieme & Leutner, 2008:10). At the time of the emerging PISA project (Programme for International Student Assessment), only a limited number of competence models existed to provide a basis for comparative measurement.

Competence models for assessment and learning

According to Nickolaus and Seeber (2013), there are three approaches to modelling vocational competence in industrial technical fields (Mulder, 2017:844–845):

1. approaches preferred by companies that use stated levels of competence in self-assessment or external assessment instruments (performance management and recruitment);
2. approaches which use pragmatic reasons for concentrating on professional competence in the narrow sense and modelling professional competence based on item response theories; and

3. holistic approaches that integrate professional, economic, social and creative aspects of professional competence.

Martens and Rost (cited in Deitmer, Hauschildt, Rauner & Zelloth, 2012:160), argue that

> [t]he measurement of occupational competence presupposes a theoretical and standards-based competence model, [and] accordingly, competence models have the following functions: firstly, to operationalise the fundamental criteria that have to be met in the context of problem-solving in the workplace; and[,] secondly, to provide sufficiently concrete guidelines for the formulation of test assignments.

The role of the competence model, according to Rauner (2017), is to connect the guiding principles and objectives of vocational education and the construction of tests and learning tasks. Three empirical studies using multidimensional models of competence have emerged over the past 10 years, illustrating this trajectory of critical enquiry:

4. Winther and Achtenhagen (2009) proposed a model of vocational competence with the achievement of vocational competence as the central goal. They defined levels of competence as conceptual, procedural and interpretative, all of which are governed by dimensions of complexity in modelling, cognition and content categories.
5. An alternative model of vocational competence was proposed by Klotz, Winther and Festner (2015), where a multidimensional model was developed to test 877 industry apprentices in a cross-sectional database using item response theory-based scaling. The resulting four-stage psychometric model represents a systematisation of the development of vocational competence; it is characterised by the degree of occupational specificity and different forms of cognitive processing.
6. The third model, the COMET Model of competence diagnostics, underpins the research reported on in this article. Therefore, this conceptual model is elaborated on in more detail in the next section.

COMET: A conceptual model for competence diagnostics

The COMET Model, with related test instruments and procedures, has been implemented in Germany, China, South Africa, Norway, Switzerland, Poland and Spain. Its implementation has resulted in a number of publications aimed at supporting TVET systems research. In some of the original conceptualisations of the model, the COMET acronym has been used variably to refer to 'competence measurement in education and training' and also to 'competence-based occupational methodology for effective training', depending on the focus of the application. Notwithstanding slight variations in the wording of the acronym, the overriding understanding of COMET is that it is a model for measuring and developing the competence outcomes of occupational qualifications (Rauner et al., 2013), qualifications

that may also include higher-level professions. Most studies describe COMET as a diagnostic instrument that is used to assess or measure competence on a large scale. It possesses an implementation logic similar to that of the well-known PISA but is designed for whole occupations.

In seeking both to develop occupational competence and measure it, the model distinguishes between three dimensions of competence, namely the *requirement* dimension (incremental levels of professional competence based on skills that are associated with professional work tasks); the *content* dimension (teaching and learning in a specific subject as a basis for the development of test assignments); and the *action* dimension (a scientific foundation with which to measure 'complete professional action' … in favour of shaping complete professional action) (Rauner et al., 2013:41–53). The three dimensions are aimed at testing the specific requirements of a learning area across all occupations in the form of competence levels, while at the same time providing a guide to selecting specific content for the construction of test tasks. Building on the concept of work process knowledge and the theory of complete action, Rauner et al. (2013) argued that

> when the steps of a complete professional activity are related to the criteria for holistic solution of professional tasks, the concept of complete professional action is transformed into the category of complete (holistic) problem-solving, which is fundamental for the design of vocational training processes and the modelling of professional competence (cited in Deitmer et al., 2012:163).

In the learning context, the *action* orientation seeks to integrate theoretical knowledge and practical abilities through a reality-based, problem-related learning task rather than through closed and repetitive tasks (Argyris & Schön, 1997). In the context of professional work, the learning assignment and test tasks are designed to provide the space for both rational action and creative-dialogue type of action, which are fundamentally significant in all occupations.

The *content* dimension of the COMET Model relies on occupational fields in order to construct learning tasks and test assignments. Professional validity is a criterion for determining the content of tasks for the respective fields and therefore requires professional groups or expert reference groups to agree on the job description as a reflection of what true mastery looks like (Rauner, 2017:88). The content of learning and test tasks is structured so as to develop learners from novice to expert, with the curriculum content based on a systematic approach of defining relatively simple learning tasks first and then building complexity as the learner passes through progressive learning stages.

The *requirement* dimension builds on the action and content dimensions by defining four levels of competence, namely nominal, functional, processual and holistic shaping. These levels are based on the four-level proficiency model of Bybee (1997), which aimed to improve instructional practices to enhance student learning. Empirical research developed this concept further into six levels, which were applied in the Organisation for Economic Cooperation

and Development's (OECD) project to measure competence in science during PISA 2006 (Bybee, McCrae & Laurie, 2009). The four levels of competence are described as follows:

7. *Nominal competence* reflects superficial conceptual knowledge of the field and individuals at this level can therefore not be considered competent. Indeed, learners at this level are considered a 'risk group' (Rauner et al., 2013).
8. *Functional competence* refers to basic technical knowledge learnt in isolation. It is the elementary subject knowledge and skills that have not yet been integrated and assimilated. The skill of integrating knowledge in order to solve process-related problems in an occupational task is therefore still very limited (Rauner et al., 2013).
9. *Processual competence* relates to the ability to interpret occupational tasks in relation to work processes and workplace situations. Aspects such as economic viability, customer focus and the expression of technical concepts in a clear and organised way through verbal accounts and technical drawings are evident in the solutions proposed for an occupational task (Rauner et al., 2013).
10. *Holistic shaping competence* is a level of competence where due regard is given to the diverse operational and social conditions in which an occupational task is performed, resulting in solutions that are uniquely different and valuable to the workplace organisation. This level of competence incorporates the possible influences of developments and innovations in technology in an occupational specification (Rauner, 2017).

These four competence levels are assessed using a Likert rating scale of 40 items mapped against eight criteria, with the total score indicating the level of competence achieved. The test instruments rely on a practical solution being arrived at to a dynamic workplace scenario. An extract from a scenario used in the study is briefly stated as follows:

> The training department in Company ABC requires an automated motor starter system to simulate a conveyor system that is used in plant operations for the transfer component parts from one station to another. The simulation is required for training purposes which runs 5 days a week (Monday to Friday) from 07H30 to 16H30. There is a 3-phase supply in the building and all the components required are available at the training store.

By way of comparison, the traditional trade test would set six to eight discrete practical tasks where candidates are declared either 'competent' or 'not yet competent' without reference to a particular work process. COMET test instruments are supported by an additional context questionnaire and a questionnaire on the learners' test motivation. And it is not only the learners' competence levels that are assessed through COMET: TVET lecturers and industry trainers are prepared in advance so that adjustments can be made to lesson plans so as to include COMET learning tasks beyond the basic formative assessment requirements. This ensures that teaching is adapted using the action, content and

requirement dimensions to enhance learning before the COMET test assignments (Brown, 2015). In the process, abstract criteria are converted into measurable observations that enable data collection to be performed systematically. Each criterion is converted into an evaluation tool that guides the consistent application of the measurement for each of the COMET sub-competences.

The central constructs of the COMET model as described above not only provided a framework for moving empirically beyond accepted assessment practices in the traditional trade test, but also laid the foundation for the research methodology that was employed in the research described in this article.

Research methodology

Research design

The study reported on here employed a mixed-methods, sequential explanatory design (Cameron, 2009) which connected quantitative and qualitative data collection. The logic of the research design was to measure the influence of the COMET-inspired methodology and assessment on two groups of artisan candidates, labelled A and B, as explained below.

Group A/Path A (the control group) comprised the artisan trade test candidates who were undergoing the standard preparation for taking the traditional trade test. Group A did not undergo COMET test preparation. The Group B/Path B (the experimental group) artisan candidates were introduced to the COMET model methodology and assessments as part of their preparation for taking the regulatory traditional trade test. All the candidates who passed the traditional trade test (i.e. could be certificated as qualified artisans) were subsequently invited to participate in the alternative COMET-inspired 'trade test' that followed. Essentially, then, the difference between the control and the experimental groups was that the former group was not exposed to the COMET test preparation while preparing for the regulatory traditional trade test, whereas the latter group did enjoy such exposure. Both Group A/Path A and Group B/Path B candidates took the traditional trade test that would indicate an exit level of 'competent/not yet competent'. Only those (in Groups A and B) who passed or were declared competent then took the COMET-inspired trade test and had their competencies measured in terms of the model.

The intention of this research design was to try to ascertain whether the learning and assessment methodology of the COMET-inspired tasks, undertaken by half the candidates (Group B) in preparation for the traditional trade test, would influence the competence outcomes when measured by the COMET-inspired alternative trade test. The competence outcomes (measured by the COMET-inspired trade test) of the experimental group would then be compared with those of the control group (Group A) which underwent only the regular learning preparation for the traditional trade test and for whom the COMET-inspired trade test would be an end-point assessment only.

Scope of the study and sample selection

The electrician and millwright trades were targeted for this study because these trades annually conduct the largest number of trade tests. In addition, the millwright trade includes the full electrician trade curriculum and therefore would ensure that more subject-matter experts would be available to participate in the study.

The four trade test centres with the highest number of electrician and millwright trade tests over a 20-month period were identified for participation in this study. Furthermore, consideration was also given to the diversity of locations (both urban and rural) across provinces. For this reason, two centres were located in Gauteng, one in KwaZulu-Natal and one in the Eastern Cape.

Each trade test centre was asked to identify a minimum of 10 candidates who were approaching their trade test date (n = 40). Ten was seen as a reasonable number in relation to the cost and time involved on the part of staff and other resources needed to complete the fieldwork. For various reasons, of the group of 40 candidates, 14 were not successful in the traditional trade test and were therefore excluded from the groups who went on to take the subsequent COMET-inspired trade test. The final research sample across Groups A and B after nine months was therefore 26 electrical artisan candidates, who undertook the COMET-based trade test across the four selected trade test centres.

Quantitative data-collection process

Learning and assessment instrument development and validation

In line with the COMET Model methodology, a group of occupational subject-matter experts was formed in order to conceptualise a number of possible test tasks (for learning and assessment purposes) according to the eight COMET competence criteria. The tasks were then evaluated according to how often these tasks are performed in authentic work situations, the significance of the professional task to the occupation, the level of difficulty, and the significance of the task to personal professional development. Each subject expert used the same questionnaire to evaluate the tasks that had been developed in the group.

On the basis of the evaluation exercise, eight professional work-relevant tasks were selected for the study. The selected tasks were then presented to external professional practitioners for their comment on any industry-specific peculiarities in the description of the skilled work that might need to be amended. As a last step in the validation process, the test tasks were each rated out of 10 for their professional authenticity, representation of competence, and curricular validity.

The final set of tasks was subjected to a piloting process in which candidates completed the assessments and were rated by trained subject-matter experts with a view to establishing

the potential of each professional task to describe competence in all of the eight criteria of the competence model. The piloting process validated four tasks for the COMET-inspired trade test. The expectation was that the problems posed by each task should be solved in the most professional way possible. The degree of complexity had to allow for the assessment of contextual understanding matched with the required level of practical skill. The grading of the test outcomes was ability-based; this made it possible to differentiate between test-takers according to the levels of the solutions they offered – whether they were (in terms of the model) functional, procedural or holistic in nature (Heinemann, Maurer & Rauner, 2010).

Implementation of the assessment instrument

Prior to the formal COMET-inspired trade test, candidates in Group B/Path B (the experimental group) were exposed to three COMET learning tasks over a period of six months, whereas candidates in Group A/Path A (the control group) completed only the traditional trade test preparation.

The formal assessment approach was then made up of two parts: the first part was dedicated to two written tests on validated COMET tasks, each separated by one to two months. The second part was dedicated to the practical implementation of a COMET-inspired trade test. The practical test was expanded into three segments over five days. Day 1 was dedicated to the documented conceptualisation and planning of a solution to the test task. This was done under the supervision of an examiner. Days 2 to 4 focused on the practical implementation of the plan or task and its quality control, supported by the candidate's documentation and explanations of any deviation(s) from the original plan. On Day 5 of the assessment, the candidates presented their solution, which was supported by an expert discussion with the examiners to justify the final result. This segment culminated in an agreed rating by two examiners so that the examination result could be fed back to the candidate artisan. The control group completed the five-day COMET-inspired practical project only as an alternative trade test assessment.

Qualitative data collection

Qualitative questionnaires were administered to both the assessors and the candidates in order to provide additional context for the quantitative data collected through the task-based assessments. Questions aimed at the assessors or examiners related to both their expert views on the content and method of the traditional trade test and their observations of the candidates' commitment to the COMET-inspired task, including factors that might have influenced the candidates' examination performance. Questionnaires aimed at the candidates related to their views on the task's level of difficulty, their interest in the task, the usefulness of the task, the effort applied to complete the task, and the usefulness of the task to their occupation.

Findings

For purposes of this article, only a few of the research findings are highlighted here to illustrate the potential of the COMET Model for going beyond traditional artisan candidate trade testing, and to demonstrate that occupational competence might be enhanced by applying a future-oriented COMET approach instead.

Quantitative findings

Finding 1: The COMET Model rendered fine-grained levels of competence
A substantial part of the study was based on quantitative data generated by applying the COMET diagnostic model in an alternative trade test in order to measure the occupational competence of a group of trade test candidates. In addition, the intention was to ascertain the competence development of candidates who had experienced the COMET learning and assessment methodology in preparation for the trade test, compared with those candidates who took only the practical COMET-inspired trade test as the end-point assessment.

By applying the diagnostic analytics of the COMET Model to candidates who completed the validated test tasks, we found that only eight of the 17 candidates (fewer than 50%) reached a functional level of competence as described by the dimensions of the COMET Model. The 17 candidates represent the sample after test-task validation. The remaining nine candidates achieved a nominal level of competence, which, by international standards, is considered a risk level for occupational competence. These low levels of competence confirm the continuing challenge of dealing with learning and teaching deficits among apprentices in the electrical occupation, which had also been demonstrated in earlier studies (Hauschildt, 2016; Jacobs, 2015).

Further analysis of the results revealed the extent to which all the competence criteria were expressed in the COMET test solutions of candidates in Group A/Path A and those in Group B/Path B, as illustrated in the overall radar graphs below. As shown in Figure 1, the eight competence criteria used to evaluate the candidates' solutions were (Rauner, Heinemann, Hauschildt & Piening 2012:16–17):

K1 – Clarity: Candidates must document and present the results of professional tasks in such a way that both customers and work superiors are able to understand and review the proposed solutions. A core element of communication in the work context is the ability to express one's thoughts in a clear and organised way by giving clear accounts, drawings and sketches.

K2 – Functionality: This refers to the technical competence of instruments or context-independent, subject-specific knowledge and skills. Candidates are expected to provide evidence of the functionality of a solution; such evidence will determine all further requirements that enable work tasks to be solved.

K3 – Use or utility value: Professional activities, workflow, work processes and work assignments must ultimately be usable and oriented towards a customer, whose main concern is the utility of the result. The criterion of use therefore points to the usability of a solution in the entire context of work: a usable solution must be immediately applicable, less likely to fail, and take into account the need for easy maintenance and repair. It should preferably also be sustainable and capable of enhancement.

K4 – Cost-effectiveness: Candidates are expected to consider the context-specific economic viability of a solution, that is, how economically a specific task can be carried out. This should include considering diverse types of costs and influences, including long-term costs, with a view to performing a sound cost–benefit analysis.

K5 – Work process: This criterion refers to the way in which the test task will relate to the preceding and the following operations in the process chain. Candidates will be expected to take into account the linkages with the preceding and following processes in the chain, not just their specific task.

K6 – Social responsibility: Candidates will be expected to include aspects of work safety and the prevention of accidents in addition to the potential impact of a specific solution on the social environment. It should take into account health protection and the often divergent interests of principals, customers and society.

K7 – Environmental responsibility: Here, the candidates should consider whether environmentally friendly materials are used and whether eco-friendly work organisation is employed in arriving at the solution of the work task. And have they considered energy-saving strategies and the possibility of recycling?

K8 – Creativity: The creativity of a solution is an important indicator of professional problem-solving, but a creative or unusual solution has to be interpreted and operationalised in an occupation-specific way, showing sensitivity to the problem(s) to be solved; and it can also be expected to make a meaningful contribution to the attainment of a goal.

All the candidates in Group A and Group B passed the traditional trade test between one and six weeks before the COMET-inspired trade test was taken. The comparisons in Figure 1 offer insights into the outcomes of the COMET-based test procedure: Group A achieved a lower total average score (TAS = 14.4), without all eight competence criteria being equally developed (V = 0.50), particularly the competence criteria representing environmental responsibility (K7) and creativity (K8). The higher variation of scores (V) around the mean (represented by 0) presented in Group A confirmed that the integration of knowledge – for instance, the practical solution considered with regard to the cost-effectiveness of the solution, the work process or the social and environmental responsibilities – inherent in the task had not been adequately demonstrated in the COMET-inspired practical task. The graphs confirmed a higher total average score (TAS = 19.2) for Group B, with a lower variation score

(V = 0.24) across the criteria. The average performance of Group B (experimental group) was therefore able to earn more points for their solution across all eight COMET criteria.

<table>
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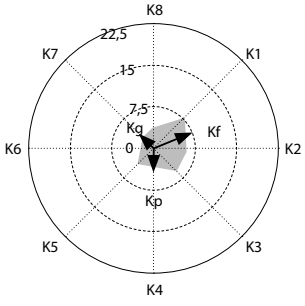
<td> 
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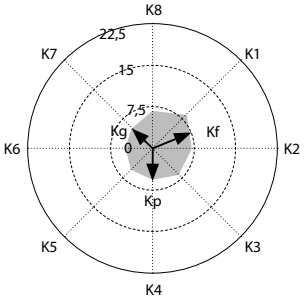
<td> 
</td>
<td>Key:
K1 – Clarity
K2 – Functionality
K3 – Use value
K4 – Cost- effectiveness
K5 – Work process
K6 – Social responsibility
K7 – Environmental responsibility
K8 – Creativity
Kf – Functional
Kp – Processual
Kg – Holistic shaping competence
TAS – Total average score
V – Variation of scores</td>
</tr>
<tr>
<td>TAS = 14.40; V = 0.50</td>
<td>TAS = 19.20; V = 0.24</td>
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<tr>
<td>Group A/Path A (COMET end-point assessment only)
All test scores for T1, T3, T4 and T5 (n = 6)</td>
<td>Group B/Path B (COMET learning and assessment)
All test scores for T1, T3, T4 and T5 (n = 11)</td>
<td></td>
</tr>
</table>

FIGURE 1: Comparative performance of Groups/Paths A and B, excluding non-valid test tasks 2, 6, 7 and 8[1]

Finding 2: Criterion-referenced evaluation through the COMET Model pinpointed learning needs

The usual practice in a trade test is to rate candidates against a defined rubric for a particular set of tasks and then declare them either 'competent' or 'not yet competent' in each task. In the traditional trade test, in the case of six practical tasks the requirement would be to be declared competent in each of the six tasks before being certified as a qualified artisan, that is, there is no grading of each individual task – the overall result is simply competent or not yet competent. In the traditional trade test, functionality is a primary consideration, which is exemplified in the following questions: Did the installation work? Was the earth leakage mechanically strong? Was the overload calculated? Was each eye separated by washers? Were there more than six 'non-critical' or small things identified by the assessor that would place the result of the concluded task in the 'not-yet-competent' category?

1 Each test task should be able to demonstrate the application of all eight criteria. This is normally assessed through the 'V' (variation score). Through inspection of the radar graph, certain criteria could not be scored with evidence, which meant excluding these four test tasks.

In the COMET rating process, on the other hand, such assessment questions would form only one-eighth of the evaluation carried out by the rater in the rating procedure. When rating a COMET solution to a specified task, the whole solution is rated against the eight criteria, that is, five questions are asked per criterion and they are scored using a four-point Likert-type scale from 0 to 3, defined as follows: 0 = criteria not met at all, 1 = criteria mostly not met, 2 = criteria mostly met, or 3 = criteria fully met.[2] This process enables a visual presentation of the distribution of total average scores (TAS) around the mean, as presented in Figure 1.

Even though the apprentices in the study were all at the end of four years of learning and were practising their trade, the diversity of results at the end of their apprenticeships was evident in the high variation of scores around the mean, depicted in the box plot in Figure 2. This presents a substantial challenge for any training provider because mentoring, coaching and training have to be performed in a manner in which both stronger and weaker candidates benefit, to the extent that no one is in a 'risk category' of competence after passing the traditional trade test.

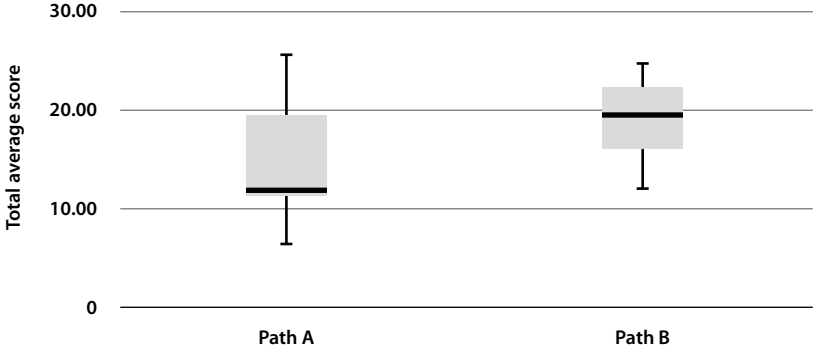

FIGURE 2: Box plot indicating the distribution of scores around the mean

The box plot illustrated in Figure 2 describes the distribution of scores around the mean, with no outliers indicated (Group A/Path A n = 13; Group B/Path B n = 13). The total scores for each group were normally distributed, as assessed by the Shapiro–Wilk's test ($p > 0.05$). Group B/Path B (M [mean] = 18.92, SD [standard deviation] = 4.25) achieved a higher mean average than Group A/Path A (M = 14.38, SD = 6.17), with Group A/Path A scoring more widely than Group B/Path B, thereby confirming a statistically significant difference of $p = 0.39$.

When we consider the variation of candidate scores (or the spread of scores around the mean), it can be seen that the higher average score (TAS) leads to a lower spread of scores around the mean. Therefore, if the trade test is able to give adequate attention to all eight criteria of the COMET diagnostic model, the outcome could be higher average scores and less variation around the mean. Any variation of scores around the means of groups of

2 English translation of the original German rating terminology.

candidates in a year, or of groups of candidates at a location, could also be used to monitor the quality of teaching and learning.

Finding 3: Candidates exposed to COMET methodology showed more holistic task solutions

The COMET-based test procedure confirmed a higher total average score for Group B/Path B candidates compared with Group A/Path A candidates, as illustrated in Table 1.

The results in Table 1 show that the competence outcomes of the traditional task-based trade test favoured task presentation and functionality over a more holistic task solution. There is a small 0.4 average point difference in the functional competence score (K1 and K2). The remaining criteria that represent processual competence and holistic shaping competence have much larger differences in the average score, ranging from 1.8 points to 2.7 points. This indicates that the traditional trade test method is oriented towards, for example, the standardised functioning of an electrical installation rather than improving the performance of the installation that includes considerations of cost-effectiveness (K4), use value to others in a work process (K5), social and environmental responsibility (K6 and K7), and creativity (K8) with regard to technological advancements.

TABLE 1: Difference in individual COMET Model criteria scores between Group A/Path A candidates and Group B/Path B candidates

COMET MODEL CRITERIA	GROUP A/ PATH A AVERAGE SCORE	GROUP B/ PATH B AVERAGE SCORE	DIFFERENCE
K1: Clarity/presentation	8.1*	8.4	+0.3
K2: Functionality	6.6	7.1	+0.5
K3: Use value	5.8	6.8	+1.0
K4: Cost-effectiveness	3.5	5.3	+1.8
K5: Work process	4.1	5.5	+1.4
K6: Social responsibility	2.2	4.9	+2.7
K7: Environmental responsibility	2.5	5.0	+2.5
K8: Creativity	3.9	6.9	+3.0
Total points for functional competence level 1	7.4	7.8	+0.4
Total points for processual competence level 2	4.1	5.9	+1.8
Total points for holistic shaping competence level 3	2.9	5.6	+2.7

* *Note that it is not normal COMET practice to say how many total points could have been scored or how many total points are allocated to each criterion (e.g. 10). The diagnostic capability relies on benchmarking scores, that is, scores of Path B become a new benchmark through which data in future studies could be evaluated.*

Finding 4: COMET methodology assessment feedback helped to identify particular disparities

The diversity of the competence outcomes can be evidenced in multiple ways through results measured between test sites and across gender and age groups. For example, the results across the four different test sites indicated diversity between total average scores and variation measures. Those test sites with somewhat lower average scores (shaded in Table 2) are an indicator of teaching and learning deficits that would benefit from improvement strategies.

TABLE 2: Differentiation of competence scores by test site

TEST SITE	NUMBER OF CANDIDATES	TOTAL AVERAGE SCORE (TAS)	VARIATION COEFFICIENT (V)	HIGHEST CANDIDATE (TAS)	LOWEST CANDIDATE (TAS)
Test site 1	3	20.1	0.17	24.8	16.0
Test site 2	12	18.4	0.37	25.0	11.4
Test site 3	6	16.6	0.37	21.5	9.0
Test site 4	5	9.9	0.74	13.0	6.5

Gender comparisons indicated that the total average score of females compared with their male counterparts was 3.2 points lower for Group B/Path B candidates. However, when the scores on individual competence criteria were examined, females excelled in the criteria of clarity of presentation (K1) and social responsibility (K6) to a greater extent than their male counterparts. Even though the sample was small, this information could be valuable to teachers and trainers in indicating specific areas in which students require additional assistance. Here the 'washback effect' of the COMET Model trade test construction and its feedback has the potential to reveal more particular disparities in the development of occupational competence.

Qualitative feedback

Finding 5: The traditional trade test falls short of developing professional competence

The responses from the examiners revealed that the current learning paradigms which influence content and assessment methods do not fully prepare trade test candidates for the dynamic world of work. Among the concerns mentioned were that the traditional trade test preparation allowed for shortcuts to be taken in the curriculum in that *'[t]he task-based content of the trade test does not test all the knowledge components of the curriculum'* (Examiner 3B)

and that *'not enough embedded knowledge is covered in most of the tasks'* (Examiner 4B), this latter statement suggesting that the knowledge locked in processes, products, culture, routines, artefacts or structures (Gamble & Blackwell, 2001) is not fully exploited in the assessment.

Data from the examiners suggested that the traditional trade test content and method fall short of developing the professional competence of candidates in line with the expectations set by industry. In a traditional trade test, candidates pass the test based on them being found competent in a set number of closed tasks in an examination, but the tasks themselves are not adequate preparation for the dynamic world of work. In this context, candidates are usually not aware of any skill or knowledge deficit and are not encouraged in the preparation phases *before* the traditional trade test to increase their competence in related work processes such as writing a report, planning, finding innovative technical solutions, environmental and social responsiveness, or cost implications.

Finding 6: COMET Model assessments improve candidates' understanding of work processes

The majority of artisan candidates in the study reported that practical applications would enable them to add value to the work process, as the following extracts illustrate:

> *Because it would improve my skills and knowledge [regarding] how to limit unplanned downtime in the plant through planning and reporting everything* (Candidate 037);
>
> and
>
> *It will [better] equip me … [for] my trade and make me a better electrician* (Candidate 062).

On the nature of the assessment using the COMET Model, the following comments represent a majority of similar responses:

> *Because it trains a learner to have an open mind … [and] to be able to think about future challenges instead of focusing on the now only* (Candidate 040); and
>
> *This project helps grow the mind; the way you think changes afterwards* (Candidate 048, Group B/Path B).

The data substantiated candidates' perceptions of the benefits of the COMET-based trade test and also their understanding of the importance of work processes and technology being embedded in occupational tasks.

Candidates commented on how the COMET-based approach to trade testing had influenced their learning strategies, a finding strengthened by the examiners reporting that all the candidates

had demonstrated a high commitment to the COMET-inspired trade test and were focused on meeting the requirements that would demonstrate a working solution for the project specifications.

Discussion

The findings of this study showed that, in South Africa, the model of competence shaping the trade test is not expressed as a construct that is measurable in any of the guiding policy documents. It can be argued that in fact there is no implicit or explicit model for measuring competence that shapes or defines the trade test. The implications of this are that the reliability and validity of the traditional trade test instruments cannot be scientifically measured. For instance, the effectiveness of the traditional trade test instrument is usually relegated to the feedback of examiners or subject-matter experts about:

- whether tasks had clear instructions;
- whether mark sheets matched task-outcome requirements;
- whether the tasks are valid in the context of the occupation; and
- whether each task can be completed in the time available.

The critical opportunity to demonstrate how the assessment instrument responds to the objective of 'holistic shaping competence' is never dealt with or seized upon.

Despite South African education and policy intentions regarding integrated assessment, the results show that candidates who passed the task-based regulatory trade test in this research study were unable to integrate their knowledge and practical skills when presented with the dynamic COMET Model assessment applied to all 26 candidates in the study. No candidate achieved the processual or holistic shaping competence levels as described in the COMET Model, which illustrates that success in the traditional trade test is not a proxy for competence in the dynamic world of work. Each candidate would, given explicit instructions, probably be able to execute a defined task in the workplace, but the potential for acquiring a 'shaping competence' would not have been included in the learning pathway to the traditional trade test.

Work-oriented and integrated assessments should, according to the COMET Model, look past the action dimension of competence (activities such as analysing information, evaluating alternatives, planning, preparing, implementing and reporting) to include a level of expertise that demonstrates the ability of a candidate to 'think like an artisan', as is expressed in the eight criteria of the COMET Model. This study showed that a dynamic assessment approach which emulates the requirements of the occupation in the modern workplace through authentic work-related projects, is urgently required.

How can the current artisan trade testing system be improved?

Trade test examiners participated actively in this study by developing COMET-inspired test tasks and by rating the solutions delivered by the candidates. This involvement provided

valuable feedback on how the current trade test system could be improved. An overall comment expressed was that the policy notion of 'applied competence' needed to be more comprehensively understood, because this was not being achieved through the current trade test. The examiners stated that they were not confident that the traditional trade test is fit for its purpose; nor did they believe that it contains cognitive challenges aligned with the dynamic world of work.

Furthermore, the low levels of holistic shaping competence recorded were indicative of the necessity to reform the current trade testing system. Although the trade test candidates in this study did not achieve processual or holistic shaping competence, they did display high levels of motivation after completing the COMET-inspired trade test and expressed this through positive comments on the value of incorporating real work processes, insights gained into the future of work and technology, and improved learning strategies into their training and testing.

This comparative study demonstrated the potential of COMET-based trade testing that is aligned to the demands of a dynamic world of work. Even though the sample size is too small to make a determination with a high level of confidence, it makes a case for expanding the study to include a much larger sample size.

It can be argued that the COMET Model offers a strategy with which to improve the trade test system in South Africa, as it incorporates a reflective assessment model for evaluating the competence outcomes of trade testing. Such a model for diagnostic analysis would encourage lecturers and trainers to adjust their content and methods of teaching to align them with more fine-grained measures of competence. Without a conceptual competence model, there are very limited points of reference to guide assessment that is suited to dynamic work processes.

Indications for future research

While the electrician occupation was selected for study because it was the most tested occupation in four national accredited assessment centres across three provinces, a broader sample of occupations could yield important comparative insights.

A methodological challenge for the future could be to extend the application of the COMET Model to increasingly expert assessment practitioners, since such expansion will require a higher level of skill in rigorous quantitative analysis. In addition, there would be the need to construct competence profiles, motivational factor analyses and specialist support for generating and analysing quantitative data. The COMET Model approach employs quantitative data, large sample sizes, statistical tests of significance and comparisons of variables related to competence criteria, motivational factors and so on – research activities that would require extensive capacity-building and technical support if such assessments are to be used. In the light of the potential benefits demonstrated by the approach to date, investment in such capacity-building may be well worth the effort.

Conclusions

The intention of the study reported on here was to explore the potential of the COMET Model methodology not only to diagnose and measure competence, but also to build and improve competence development through the assessment methodology offered by the model. The traditional artisan trade test used in South Africa provided a comparative assessment process, in that its overall 'competent/not-yet-competent' outcome presented a counterpoint to the fine-grained analysis of competence espoused by the COMET Model.

The findings of the study also revealed the relationship between competence development and summative assessment in the artisan trade test and the preparation towards taking it. While more detailed findings could not be elaborated on in this article of limited scope, we were able to illustrate, through selected evidence, the potential of a competence measurement model that is aligned to a transforming world of work vis-à-vis the deficits revealed in the traditional trade test. The competence profiles of candidates in the study proved that the traditional trade test system does not adequately equip artisan candidates with the domain-specific occupational competencies needed. Fast-paced technological innovation requires a competence model that accommodates technological transformations in the workplace, which necessitates a responsive end-point assessment approach that is supported by scientific measurement and goes beyond the limited trade testing paradigms.

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How do South African TVET lecturers rate their digital competencies, and what is their need for training for a digital transformation in the South African TVET sector?

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ABSTRACT

Digital-transformation processes pose many challenges for South African technical and vocational education and training (TVET) colleges. In addition to improving infrastructure, lecturers must be equipped with new knowledge and skills to face the challenges in 21st-century classrooms and workforces. Based on the technological pedagogical content knowledge (TPACK) model, this study investigated the ways in which TVET lecturers (n = 364) self-assess their competence in digital teaching and learning, and the kind of additional training or support that they need to increase the effectiveness of their digital teaching. The findings suggest that the lecturers' self-assessments of their digital-related knowledge are generally high. In addition, the sub-dimensions of TPACK differ significantly according to the educational background of a lecturer. Those with a regular teacher education rate their TPACK abilities higher than those who have only subject-specific training or a pedagogical education. Nevertheless, analysis of the qualitative data shows that TVET lecturers need extensive support in planning effective technology-enhanced lessons, including the creation of educational content.

KEYWORDS

Professionalisation of TVET lecturers; technological pedagogical content knowledge (TPACK); digital competence; technical and vocational education and training (TVET); South Africa

Context and theoretical background

A common discourse on digitalisation in South Africa is concerned with opportunities to improve the quality of education, and to offer solutions (e.g. distance education) to long-standing problems, such as the inequalities arising from multilingualism and restricted access in rural areas (Langthaler & Bazafkan, 2020). Furthermore, findings show that the adoption of digital technologies could lead to a threefold growth in productivity in South Africa, which could be expected to generate up to 1.2 million jobs by 2030 (Magwentshu et al., 2019).

The need for digital skills has already increased in most major sectors in post-1994 South Africa. Standard digital technologies such as email or instant messaging for communication, video-conferencing applications, the Internet, and computer hardware and software are already pervasive in the workplace. For this reason, TVET college students must acquire these technologies in order to participate meaningfully in learning activities (Twinomurinzi, Msweli & Phukubje, 2020; Denhere & Moloi, 2021b:232). In addition, there is a growing need for specific or advanced digital technologies (Guthrie et al., 2009) that are related to Industry 4.0: these include artificial intelligence (AI), robotics and/or 3D technologies used specifically to perform certain tasks. In particular, the mining, manufacturing and service sectors are undergoing significant transformation due to the implementation of a range of advanced technologies (DCDT, 2020).

While the share of high-skilled jobs in the economy is increasing, South Africa has faced high unemployment for many years, with a rate of 35.3% in the fourth quarter of 2021, and 44.7% for young people between the ages of 15 and 34 years (SSA, 2022). A higher proportion of highly skilled workers is participating in the labour market, whereas low-skilled workers are struggling to find employment (DHET, 2022). Owing to ongoing digital automation and transformation, it is expected that this gap will widen. This means that an individual's digital competence is critical to their obtaining work opportunities in South Africa (Matli & Ngoepe, 2020). However, in surveys, it has been revealed that even the so-called 'digital natives' can lack basic digital skills (Czerniewicz & Brown, 2013).

Against this background, the South African government has published eight main interconnected elements that respond to the challenges arising from the increasing deployment and adoption of digital technologies (DCDT, 2020). Aligned with the most recent definitions of digital inclusion (Djukic, 2022) and digital competence (Ferrari, Punie & Redecker, 2012; EU, 2018), the strategy includes the aim of improving the ability of South Africa's citizens to access and use digital technologies for multiple purposes. Among them are information, media and data literacy, communication and collaboration, digital-content creation, safety, devices and software operations, and problem-solving. These are all needed for citizens to be prepared for 21st-century learning, the contemporary world or work, and society in the Digital Age (DCDT, 2021:8–9).

In response to these needs, educational systems – in particular TVET – must be transformed in order to respond to the desire to develop digital competence (Naudé, 2017; Makgato, 2020). Consequently, TVET lecturing staff are required to acquire a certain number and degree of competencies, since knowledge and pre-existing beliefs about the educational value of technology have proved to influence the ways in which teachers deal with technologies both as a means of delivery and as content (cf Ertmer et al., 2012; OECD, 2019; Gretch & Camilleri, 2020).

Digital competence of educators

Several frameworks and models which describe educators' competence and skills in relation to digital technology have been developed at the national and international levels. The concepts of these frameworks and models differ in their structure and in the nature and level of competence required by educational staff, in addition to their theoretical connectivity. Often the selection of areas, criteria and aspects to describe and assess digital competence involves unclear criteria and lacks scientific validity and reliability. Most models are claimed to be more practice-oriented than scientific. Nevertheless, the frameworks and models indicate agreement about the fact that teachers need pedagogical knowledge that is relevant to their subject content in order to use relevant technology for educational purposes. The best-known and most influential digital competence frameworks for educators are the European framework for digital competence of educators (Redecker, 2017), the technological pedagogical content knowledge model (Mishra & Koehler, 2006; Koehler et al., 2014), and the UNESCO information and communications technology (ICT) competency framework for teachers (UNESCO, 2018).

In particular, TPACK has become an influential model that is used to describe the required educators' structures of knowledge for the use of technology in the classroom. In the TPACK model, the complex relationship between technological knowledge (TK), content knowledge (CK) and pedagogical knowledge (PK) is described, as are the following three overlapping areas: pedagogical content knowledge (PCK), technological content knowledge (TCK) and technological pedagogical knowledge (TPK). These are in addition to the overarching TPACK (Mishra & Koehler, 2006). Because it can be assumed that the model obeys quality criteria for models such as precision, simplicity, generality and fruitfulness (Kuhn, 1977) for embedding technology and digitisation-related elements in teaching–learning contexts (Tondeur et al., 2021), the model was used as the basis for this study. The criteria of *scope* and *fruitfulness* of this model are considered to be important, since TPACK is the most frequently cited model of the digital competence of teachers (*scope*), and many empirical studies have applied the model. Therefore, the framework facilitates international comparability about teachers' TPACK (Kimmons & Hall, 2018). Furthermore, the model has roots in the standard models of teachers' professional knowledge (e.g. Shulman 1987); and therefore it seems to be fully compatible with theoretical and educational practice.

Based on the Policy on Professional Qualifications for Vocational Education Lecturers, successful South African TVET lecturers are characterised as possessing a combination of

specialised content knowledge, and pedagogical–psychological and didactic skills. Furthermore, professionally qualified South African lecturers 'must be personally competent users of ICTs, as well as being able to integrate ICTs effectively in teaching and learning' (DHET, 2013:36). This integration of ICTs may be the use of language learning applications for first- and second-language education, and the use of a simulation software for learning mathematics (DCDT, 2020:21). Regarding industry-related skills, TVET lecturing staff must also be aware of new and evolving digital trends and tools related to the world of work, and they must acquire specialised knowledge about the equipment and machines used specifically to perform a particular job scope (Guthrie et al., 2009).

However, qualitative research suggests that a qualification gap exists among TVET lecturers and that the use of digital technologies does not meet the requirements of a digital society and the professional world (Ngubane-Mokiwa & Khoza, 2016; Naiker & Makgato, 2018; Denhere & Moloi, 2021a) – even if lecturers' perceptions indicated their readiness and willingness to use digital technologies in their classrooms (Mbanga & Mtembu, 2020; Denhere & Moloi, 2021a). A lack of training for teaching staff on the use of available technologies, a lack of computing equipment and ICT infrastructure, and, above all, a lack of policy directives for TVET colleges are obstacles to the integration of digital technology in these colleges. Similar findings are to be found across international contexts, where such first-order barriers (e.g. limited equipment, training, and support) are necessary but insufficient conditions for the use of technology in the classroom (Ertmer et al., 2012; Schmitz et al., 2022). In contrast, teachers often have positive beliefs about digital technologies (Sailer et al., 2021) and they generally rate their digital skills (including those of TPACK) as 'good' to 'very good' (Chai, Koh & Tsai, 2010). Nevertheless, teachers express a need for training, saying that they want to develop their knowledge of TPACK in their classrooms (Redmond & Lock, 2019). In a South African context, Sherman and Howard (2012) identified barriers to STEM teachers' technology use originating from sociocultural norms (e.g. a desire for control). The authors argued that these factors could have an impact on the teachers' beliefs about technology and teaching and thus inhibit their adoption of more student-centred pedagogies and technology integration.

At a more quantitative level, little is known about South African TVET lecturers' competencies and beliefs related to digital teaching and learning. Teis and Els (2021) have shown that 52.3% of the participating lecturers (n = 577) in Technical Engineering are unaware of any industry-relevant 4IR (Fourth Industrial Revolution) technologies in their area of specialisation. Furthermore, most participants rated their knowledge of the practical use and application of 4IR technologies as being of a very high level. However, considering that almost 50% of the participants did not indicate this test item, the results must be interpreted with caution. It could also be assumed that those non-responses suggest participants' lack of competence (Teis & Els, 2021).

Research goals and methods

In the light of the outlined importance of promoting digital competence for social and economic development in South Africa, and given that lectures are drivers of the development of digital skills, the study aimed to investigate the knowledge TVET lecturers possess of digital technology, pedagogy and content. The lecturers' perceived needs and recommendations for in-service training were also examined. Regarding the limited empirical findings on South African TVET lecturers' knowledge and use of technology, a non-experimental exploratory research design was chosen, using a questionnaire as a data-collection instrument based on the TPACK model elaborated by Mishra and Koehler (2006).

Since teachers need varied professional training to develop their digital competence, depending on their background and stage of developmental (Stroot et al., 1998; Berliner, 2004), the findings of the study are to be used to develop evidence-based training for TVET lecturers, corresponding to the terms of training content and organisation of training. The following research questions (RQs) were raised and responded to in this study:

RQ1: What self-reported digital technology, pedagogy and content knowledge (TPACK) do TVET lecturers possess?
RQ2: How do TVET lecturers make use of digital technology in daily instructional practices with their students?
RQ3: What training content related to digital teaching and learning do TVET lecturers want?
RQ4: What recommendations on the design and delivery of digital competence training for teaching and learning do the lecturers have?

Data collection

The data were collected from May to November 2021, using online questionnaires. The Department of Higher Education and Training (DHET) invited all principals of the 50 public colleges through emails to share the link to the online survey with their lecturing staff. Participation in the study was voluntary and the data were collected anonymously.

Description of the instruments

The survey instrument consisted of five sections, A–E. Section A collected the following background variables from the participants:

- Demographic information (gender, age group, highest level of formal education);
- Major area of study;
- Practical training;
- Teaching qualification;
- Teaching and work experience;

- In-service professional-development activities;
- Teaching subjects; and
- Location of campus.

Section B comprised 12 items measuring their beliefs about teaching and learning (items were adopted from TALIS, 2008). However, the empirical findings from this information category are not reported on in this article. Section C measured the use of technology by lecturers in their lessons. Section D included a closed-question area on the seven knowledge scales of the TPACK questionnaire by Schmidt et al. (2009), and in its extended form by Zinn et al. (2022). The items by Zinn et al. were translated into English via back-translation (Brislin, 1970). The responses were measured on a 5-point Likert scale (from 1 – completely disagree to 5 – completely agree). The reliability values achieved in the individual scales can be described as ranging from 'good' to 'very good' (see Table 1). An open-ended question area in Section D was related to the use of technology and the need for training. The participants were asked to describe a specific episode in a lesson where they combined content, technologies and pedagogical approaches. Section E was composed of 10 items on self-efficacy based on the work of Schwarzer and Jerusalem (2002). The questions used a 4-point Likert scale (from 1 – strongly disagree to 4 – strongly agree).

Table 1: Reliability values of the TPACK scales, and examples of items in the questionnaire

SCALE	ITEM COUNT	RELIABILITY	SUBJECT-RELATED	ITEM EXAMPLE
Technological knowledge (TK)	6	0.89	✗	I know how to solve my own technical problems.
Content knowledge (CK)	3	0.84	✓	I have sufficient knowledge about my first teaching subject.
Pedagogical knowledge (PK)	6	0.93	✗	I know how to assess student performance in a classroom.
Pedagogical content knowledge (PCK)	6	0.93	✓	I can select effective teaching approaches to guide student thinking and learning in my first teaching subject.
Technological content knowledge (TCK)	5	0.88	✓	I know about technologies that I can use for understanding and doing my first teaching subject.
Technological pedagogical knowledge (TPK)	9	0.95	✗	I can choose technologies that enhance the teaching approaches for a lesson.
Technological pedagogical content knowledge (TPACK)	8	0.95	✓	I can combine my first teaching subject knowledge, digital media and teaching methods in the classroom in a way that efficiently supports the teaching process.

Description of the sample

In total, a random sample of lecturers (n = 366) teaching in different subject domains (STEM, Business & Utility Studies, Humanity Studies) at South African public TVET colleges completed the survey instrument. Of these, n = 2 lecturers were excluded due to response behaviour. The gender distribution of the final sample (n = 364) was n = 179 (49.2%) females and n = 185 (50.8%) males. The average teaching experience of the TVET lecturers was 13.27 years (median = 10.50 years). The subjects frequently mentioned were Management, Finance & Marketing (n = 144), Mechanical Engineering (n = 123) and Electrical Engineering (n = 99). The age of the study participants ranged from under 25 years (0.5%) to 60 years or older (12.4%). Most of the participants were in the 30 to 49-year age group. The colleges at which they taught are situated in the Eastern Cape (9), Free State (6), Gauteng (44), KwaZulu-Natal (12), Limpopo (6), Mpumalanga (5), North West (66) and the Western Cape (222). The Northern Cape is not represented. As far as participation in training within the past 12 months was concerned, 50.5% (n = 184) had participated in professional-development activities; 25.5% of the participants (n = 93) referred to training in ICT in Teaching and Management, whereas only 1.15% (n = 4) had attended a programme in digital teaching and learning.

Analysis and results

Descriptive results of the self-assessments

The quantitative data were evaluated using the statistical software R. Overall, the lecturers assessed their teaching-related knowledge (CK, PCK, PK) as being in the upper range of the scale (see Table 2). In the technology-related areas, they consistently rated themselves lower. The overall assessment for each scale is nevertheless above the scale mean of three, with a slightly higher standard deviation than for the teaching-related self-assessment.

Table 2: Descriptive results in the seven knowledge domains

	TOTAL SAMPLE
Scale	mean (SD)
Technological knowledge (TK)	3.65 (0.73)
Content knowledge (CK)	4.30 (0.54)
Pedagogical knowledge (PK)	4.33 (0.51)
Pedagogical content knowledge (PCK)	4.24 (0.51)
Technological content knowledge (TCK)	3.64 (0.75)
Technological pedagogical knowledge (TPK)	3.93 (0.67)
Technological pedagogical content knowledge (TPACK)	3.73 (0.76)

Comparison between subgroups

In order to identify possible differences among the variables in TVET lecturers' backgrounds, an analysis of variance (ANOVA) was used. The results of the ANOVA indicated no significant differences between gender, teaching subject and location of the college.

Stage theory models of teacher development imply that teachers at different career stages may possess different competences and therefore have different training needs (Stroot et al., 1998; Berliner, 2004). Regarding the digital competence of teachers, indications are that older lecturers with more professional experience rate their competence lower (Guggemos & Seufert, 2021). In spite of these results, the lecturers were categorised into three groups according to their teaching experience. The categorisation was based on the theory of Huberman (1989).

Table 3: Results according to the different stages of lecturers' development

	ENTRY & STABILISATION	PROFESSIONAL DEVELOPMENT	CONSERVATISM, SERENITY & PROFESSIONAL ENDINGS	ANOVA	TUKEY-HSD
	mean (SD)	mean (SD)	mean (SD)		
TK	3.74 (0.76)	3.75 (0.71)	3.37 (0.66)	F(2, 361) = 10.30***	ES-PD ES-CSPE** PD-CSPE***
PK	4.25 (0.52)	4.32 (0.51)	4.43 (0.48)	F(2, 361) = 3.33*	ES-PD ES-CSPE* PD-CSPE
TPK	3.86 (0.73)	4.04 (0.61)	3.79 (0.69)	F(2, 361) = 5.04**	ES-PD ES-CSPE PD-CSPE**
CK	4.23 (0.53)	4.31 (0.58)	4.34 (0.47)	F(2, 641) = 1.86	ES-PD ES-CSPE PD-CSPE
PCK	4.18 (0.48)	4.24 (0.55)	4.28 (0.46)	F(2, 664) = 1.75	ES-PD ES-CSPE PD-CSPE
TCK	3.70 (0.76)	3.75 (0.73)	3.37 (0.72)	F(2, 668) = 16.78***	ES-PD ES-CSPE*** PD-CSPE***
TPACK	3.81 (0.72)	3.8 (0.75)	3.52 (0.77)	F(2, 662) = 9.35***	ES-PD ES-CSPE*** PD-CSPE***

ES = Entry & stabilisation; PD = Professional development; CSPE = Conservatism, serenity & professional endings. Significance levels are indicated by asterisks and correspond to the following p-values:
** < 0.05 (significant), ** < 0.01 (highly significant), *** < 0.001 (most significant).*

Lecturers with the most experience in teaching tend to rate themselves lower than new lecturers in the technological and technological–pedagogical areas (see Figure 1 and Table 3). At the same time, they rate themselves higher in all non-technological facets than lecturers with comparatively less professional experience. However, a uniform tendency can be observed only to a limited extent based on this normative differentiation criterion. In order to gain a deeper understanding of self-assessed competence, a cluster analysis was conducted in the following section.

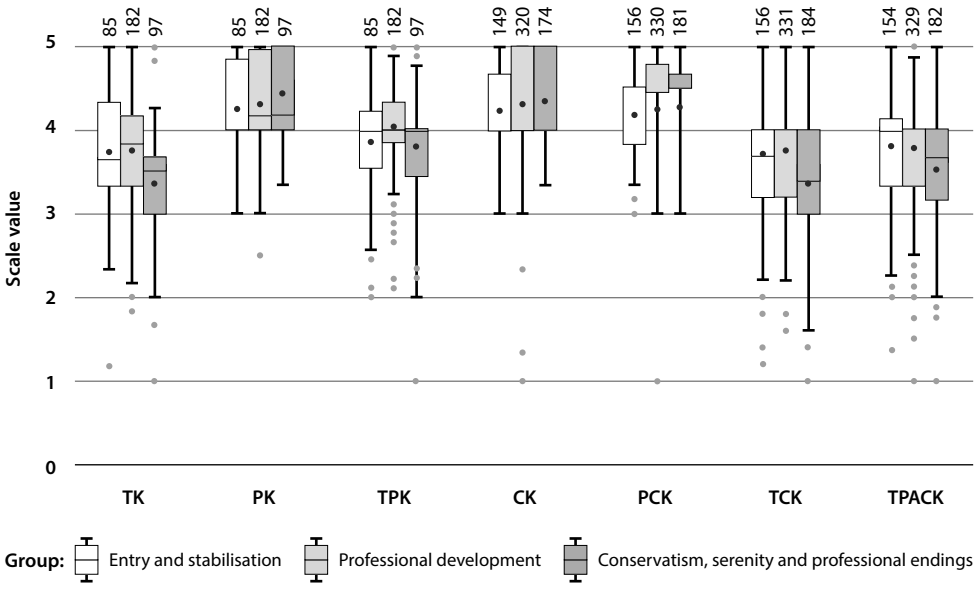

Figure 1: Breakdown of the sample according to stages of professional experience

Cluster analysis for comparison between subgroups

TVET lecturers enter the profession from a range of different backgrounds and possess different competences, and therefore have different training needs. The aim of using a cluster analysis is to exploratively identify groups that rate themselves differently from other groups in the TPACK domains via k-means clustering. Within the clusters, an analysis can be conducted, both quantitatively and qualitatively, in order to group objects or individuals based on similarities. The optimal number of clusters was determined by using the *NbClust* Package, which compares 23 indices in order to determine the best number of clusters (Charrad et al., 2014). Three clusters were suggested as the best fit for the data.

In Cluster 1, there are $nC1 = 80$, in Cluster 2 there are $nC2 = 170$, and in Cluster 3 there are $nC3 = 108$ respondents. It is noticeable that Cluster 1 is the oldest group (24% of the group

is younger than 40 years) and differs significantly in age from Cluster 3 (43% of the group is younger than 40 years). There is no significant age difference between Clusters 1 and 2 and Clusters 2 and 3. Furthermore, there is no significant group difference between the clusters in terms of professional experience. The composition of the clusters shows that in Cluster 1, 55% of the lecturers had not received any concurrent or consecutive teacher training. In Cluster 2, this applies to 41% of the lecturers. In Cluster 3, 54% of the lecturers had not received any concurrent or consecutive teacher training.

Table 4: Overview of the characteristic values of the individual clusters (Mean values and standard deviations are reported unless otherwise defined by the variable in the left column)

	CLUSTER 1	**CLUSTER 2**	**CLUSTER 3**	**ANOVA/WELCH-ANOVA[W]**	**TUKEY-HSD/ GAMES-HOWELL[W]**
	mean (SD)	mean (SD)	mean (SD)		
NCluster	80	170	108	–	–
Teaching experience	13.34 (9.75)	13.13 (8.99)	13.49 (9.83)	F(2, 355) = 0.05	C1–C2 C1–C3 C2–C3
Age[1]	4.36 (1.08)	4.12 (1.09)	3.95 (1.16)	F(2, 355) = 3.138*	C1–C2 C1–C3* C2–C3
Age subgroup counts: NCat. 1 NCat. 2 NCat. 3 NCat. 4 NCat. 5 NCat. 6	 0 2 17 25 22 14	 1 7 46 51 47 18	 1 6 39 24 27 11	 ––– ––	 –––––
TK	2.94 (0.66)	3.72 (0.51)	4.06 (0.65)	$F^{[W]}(2, 175) = 68.9$***	C1–C2*** C1–C3*** C2–C3***
PK	4.08 (0.55)	4.12 (0.35)	4.86 (0.25)	$F^{[W]}(2, 177) = 228$***	C1–C2 C1–C3*** C2–C3***
TPK	3.10 (0.50)	3.96 (0.30)	4.53 (0.50)	$F^{[W]}(2, 159) = 192$***	C1–C2*** C1–C3*** C2–C3***
CK	4.18 (0.48)	4.05 (0.34)	4.83 (0.25)	$F^{[W]}(2, 181) = 247$***	C1–C2 C1–C3*** C2–C3***
PCK	4.00 (0.50)	4.01 (0.27)	4.79 (0.27)	$F^{[W]}(2, 171) = 294$***	C1–C2 C1–C3*** C2–C3***

	CLUSTER 1	CLUSTER 2	CLUSTER 3	ANOVA/WELCH-ANOVA[W]	TUKEY-HSD/GAMES-HOWELL[W]
TCK	2.73 (0.53)	3.67 (0.40)	4.19 (0.59)	$F^{[W]}(2, 170) = 162^{***}$	C1–C2*** C1–C3*** C2–C3***
TPACK	2.72 (0.67)	3.80 (0.32)	4.24 (0.61)	$F^{[W]}(2, 149) = 132^{***}$	C1–C2*** C1–C3*** C2–C3***

*Significance levels are indicated by asterisks and correspond to the following p-values: * < 0.05 (significant), ** < 0.01 (highly significant), *** < 0.001 (most significant). [1] Age was recorded as a categorical variable. The scale is structured according to the following subdivision: 1 = under 25 years old; 2 = 25–29 years old; 3 = 30–39 years old; 4 = 40–49 years old; 5 = 50–59 years old; 6 = 60 years or older.*

Table 5: Overview of participation in a training course within the past 12 months in Clusters 1–3

	CLUSTER 1	CLUSTER 2	CLUSTER 3	SUM
	Number surveyed	Number surveyed	Number surveyed	Number surveyed
Total in cluster	**80**	**170**	**108**	**358**
Knowledge and understanding of subject field	26	71	36	133
Pedagogical competencies	15	39	27	81
ICT	9	48	33	90
Programmable robots and microcontroller	1	2	6	9
Computer-aided design (CAD)	1	4	8	13

From the results in Table 4 and 5, it is apparent that the composition of Clusters 1 and 3 is very similar regarding initial training but differs as far as age is concerned. It can be concluded that older lecturers assessed their skills at using technologies and their application in pedagogy contexts lower than the group of younger lecturers with the same educational background (cf Seufert et al., 2019). Members of Cluster 2 also self-assessed their knowledge significantly higher than those in Cluster 1 regarding the technology-related facets, but differed from those in Clusters 1 and 3 in the composition according to level of education. Here, lecturers in the consecutive and concurrent level of education achieved a slightly higher competence assessment for the technology-related facets. This suggests that these individuals were exposed to the use of technology in a didactic context during their initial training or had increased their participation in continuing education in ICT. This assumption is also supported by the number of times the lecturers participated in continuing education in the clusters (see Table 5). In Clusters 2 and 3, about 30% of the

lecturers had taken part in ICT training within the past 12 months, whereas in Cluster 1 only 10% stated that they had taken part in such training.

The level of self-assessment in Clusters 1 and 3 is not directly evident from their demographic data but could be related to their previous professional background, current technology use, and training needs.

Qualitative data and analysis of group differences

Owing to the high self-assessment in the technology-related areas in Cluster 3, the clusters were subjected to a qualitative analysis concerning their current use of technology.

In research, it has been indicated that there are differences between the needs of teachers at their various stages of teaching development (Stroot et al., 1998; Berliner, 2004). In order to identify the characteristics of in-service teacher training (see RQ3 & RQ4) that responds to the learning needs of teachers over their career span and arouses the motivation and commitment required to improve teaching standards, lecturers' responses to Section D on their needs and recommendations regarding training, were also analysed. The data were analysed based on a structured content analysis according to Mayring (2015) using the MAXQDA software (Versions 11 & 22).

Technology use

An important difference was found among the three clusters regarding the use of technology. Twenty out of 80 participants in Cluster 1 indicated that they had not used technologies, whereas, in Cluster 2, 10 participants out of 170, and, in Cluster 3, 3 out of 108 had not (regularly) implemented technologies. There were no significant differences among the three groups in respect of technology use for the delivery of instruction. The results show that, in all groups, lecturers frequently used PowerPoint to make presentations, and utilised multimedia content (e.g. videos) to support the students' understanding in or outside the classroom. Usually, the lecturers made use of open multimedia resources and rarely of self-recorded videos (e.g. slidecasts). Along with this, the most frequently used technological device to share content for instructional purposes was the projector, whereas the use of a visualiser and a smart board was less frequently mentioned. Lecturers also deployed instant messaging (e.g. WhatsApp) for sharing content and for communication. Nevertheless, the use and integration of technologies in Clusters 2 and 3 were more multi-variant. Here – even if reported less frequently – lecturers used digital clipboards, blogs and e-books. Lecturers in Cluster 2 and 3 also used standardised tests or quizzes, subject-specific tools (e.g. Geogebra) and simulations (e.g. CAD) during their classes. Two lecturers explained:

> When I taught jewellery, I used Rhino to show the students a model ring and they could clearly see the front, side and top view before they started manufacturing

> it. It helped me because I did not need to physically manufacture the ring, but constructed it on Rhino 3-D software (female, 40–49 years, STEM, 3, 287).[1]

> …[As regards t]he different oil pumps, … I asked a friend to make a drawing into a GIF … [s]o the students [could] see how the part moves. This [was also] circulated to the students via the WhatsApp chat group. I also used the Aver Visualiser to show a part (Motor Technology) on the inside, via the data projector (male, 50–59 years, STEM, 2, 271).

Although many lecturers generally used technology more for presentation and demonstration than to engage in student learning activities, others followed an integrated approach and made more conscious decisions about technological applications in favour of student engagement:

> Teaching public-speaking skills. Student-centred and group approach. Using the Internet to review famous speeches. Conducting research and analysing speeches. Audiovisual sessions using MS Teams and WhatsApp voice notes. Integrated approaches. Whiteboard, laptop, the Internet, WhatsApp (female, 50–59 years, HADS, 3, 274).

> Using Moodle in class, I display the work on the whiteboard while students log in at their end to access the work. This saves paper, time writing the notes, and allows more time explaining but, most importantly, interacting with discussions (female, 30–39 years, BUS, 3, 279).

> As part of teaching Communication in English, I combine it with their ICT unit, where I let the students do research, which they then have to present in a PowerPoint format. I would spend a few lessons to demonstrate and guide them on (a) using various search engines to gain information on a topic, and (b) summarising that information by creating a PowerPoint presentation (female, 50–59 years, BUS/HADS, 2, 9).

Regarding Moodle, lecturers report that they use this teaching tool to share material or quizzes. Video-conferencing units were rarely used by lecturers. Other technologies commonly used in Clusters 2 and 3 included devices and tools associated with occupational areas (e.g. CAD, Office software) or ICT:

> When teaching Entrepreneurship, using computers [and] calculators in trying to make the student understand the real world when doing calculations in [respect of the] finances of the business (male, 25–29 years, BUS, 2, 162).

1 Gender, age, teaching domain (STEM, BUS, HADS), cluster, questionnaire number.

The most frequent activity involving students using technology in the classroom was conducting research (e.g. Internet searches). Other activities commonly described were preparing written text (e.g. doing word processing), corresponding and sharing content with others (e.g. students and lecturers) via instant messaging, and developing and making presentations (e.g. by way of PowerPoint). Often, students engaged in technology-related learning activities when they had to use technologies associated with occupational areas (e.g. CAD, Office software). Fewer lecturers referred to activities using social networking websites or creating their own content (e.g. using presentations and videos).

Training needs and recommendations

Of the 364 answers, 300 (n = 64 missing or not evaluable) could be analysed. The lead author formed categories in an iterative process, based deductively on the question, and based inductively on the responses to Section D. To measure the reliability of the categorical scales, one rater coded them independently. As part of the content analysis of the data, a total of 451 codes were assigned in six categories and corresponding subcategories (see Table 6). The Brennan and Prediger (1981) coefficient is considered substantial, with an average k = 0.72.

Table 6: Categories of recommendations for training in order to improve digital competence

CATEGORY		EXAMPLE	N	KAPPA
1.	**Content for training**		**223**	0.75
1.1	**Overview of digital technologies and their functionalities**		**136**	0.77
	Standard digital technology	How to set up a projector and a laptop; how to use a smart board; setting up work documents in Microsoft Word and Excel; computer or ICT training	62	0.81
	Advanced digital technologies (for industry)	How to use … the PLC program or a drawing program such as AutoCAD	12	0.81
	Teaching and learning technologies	Moodle	24	0.81
1.2	**Digital content creation**	How to record audio on slides; how to record videos to enhance teaching; how to do tests, questionnaires and crossword puzzles online	**25**	0.89
1.3	**Pedagogic strategies or approaches to technology integration**	How to manage a class and create proper assessments (using analysis grids online)	**62**	0.60

CATEGORY		EXAMPLE	N	KAPPA
2.	**Organisation of a training session**		**69**	0.63
	Settings and activities	Easy to understand; step-by-step indication; practical examples that are possible in reality	43	0.60
	Resources and infrastructure	More resources and equipment, with the respective training	18	0.54
	Organisation and support	Subject experts	8	0.70
3.	**Other**		**173**	0.70
	Professional development and engagement	… ALL teacher training programmes, including digital-related courses; continuous training; more time has to be reserved for training	108	0.62
	Resources and infrastructure at colleges	First, we need access to Wi-Fi; … many lecturers do not even have a printer, never mind fancy technology!	60	0.78

Since the results regarding the design of further training are wide-ranging, the following section focuses primarily on important findings.

Training content (223 codes)

Regarding the needs and recommendations in respect of training content development, it became apparent that a training session should provide an overview of a variety of the latest technologies and their functionalities (136 codes). This includes standard technologies ranging from digital devices (20 codes), such as a digital whiteboard, and digital tools (27 codes), such as Office and presentation software and video-meeting apps, to advanced technologies (12 codes), such as robotics, CAD or simulation. There is a noticeable difference between the clusters. Whereas members of Cluster 1 had only a vague notion of what they needed, lecturers in Cluster 2 and 3 mentioned advanced technologies, for example a programmable logic controller (PLC), 4IR technologies, modelling and simulation, robotics or CAD.

Lecturers in all the clusters (24 codes) referred to technologies that enhanced their teaching and students' learning in general (e.g. Learning Management Systems) and technology that can be used effectively in the classroom in relation to their respective subjects (e.g. virtual media for language). The availability and usability of technologies for both lecturers and students were also of concern (n = 6). Moreover, the results showed that lecturers also need basic ICT training (15 codes):

> Ensure that teachers are competent in basic computer work before trying to convert them to digital teaching. Many lecturers are forced to go over to digital

> platforms but are not even comfortable with basic computer functions (male, 30–39 years, HADS, 3, 56).

Some lecturers showed a clear interest in improving their knowledge and skills in order to create engaging and interactive digital content (25 codes) that enhances teaching and learning processes. The selection, creation and modification of video resources (14 codes) were the most common among all the mentions of digital content creation included in this study, followed by the preparation of interesting and engaging presentations. The need for video content creation could be linked to the students' demands for training in video in order to be able to use these technologies (cf Denhere & Moloi, 2021b:233). Other less frequently mentioned technology resources were the development of quizzes, the use of e-books, generating QR codes, and the use of social media for learning and collaboration. Needs regarding digital content creation were mentioned less frequently by lecturers in Clusters 1 and 3 than members in Cluster 2.

In all three groups, the participants gave high priority to training in pedagogic strategies or approaches to technology integration (62 codes), that is, which pedagogic strategies or approaches should be chosen for a specific learning outcome, the methods and concepts of online teaching and learning, and the combination of tools to make education more engaging in order to enhance the student learning experience. Fewer lecturers were interested in using technologies for evaluation purposes. Apart from most lecturers who did not specify the subject, in the study it was found that the use of technology pertains to only a few subjects: language teaching and learning, and Mathematics. For example:

> Basic and advanced computer training not only in using the Microsoft package but integrating it into the teaching of a subject-specific area … . Using technology in the English classroom in a purposeful way, for example (female, 50–59 years, HADS, 3, 69).

> How to make use of the available technology in the classroom to enhance your teaching (male, 60 years or more, BUS,1, 20).

Organisation/course design (69 codes)

The requirements for the organisation of training include the demands for an integrated and multi-modal approach, problem orientation, or work with real cases and best practices. Among the participants, most preferred opportunities to participate in activities. One lecturer responded:

> I would recommend ongoing skill[s] training [with] digital developments to ensure skills are up to date and relevant. Short courses that will provide the necessary exposure, and build the confidence of staff to explore, practise and make use of these technologies within a lesson (female, 50–59 years, STEM/HADS, 2, 105).

The lecturers' requirement for training is also reflected in inclusive training oriented towards target groups. Expert guidance, however, is mentioned by only two participants. Whereas some participants preferred in-house training to be developed, others required better technical equipment and better infrastructure to be installed at the training venues.

Professional development and engagement (108 codes)

The analysis of the results showed that there is an awareness among the lecturers of the need to be in step with the digital evolution and acquire competences for the use of digital technologies in the classroom (56 codes). It is striking that most of those who stressed the importance of digital competencies and their development belong to Clusters 2 and 3. They also argued that the development of digital competencies must be compulsory at all levels of teacher education. In addition, they stressed giving a high level of priority to a lifelong learning mentality and indicated a strong need for permanent training courses to keep up to date with the latest technologies and innovative methods. Some even promoted self-regulated learning for TVET lecturers, as clearly reflected in the following responses:

> I would definitely recommend that ALL teacher training programmes include digital-related courses. … I am a great supporter of continuous lifelong learning and hence would even recommend short courses that can serve to upskill our staff all the time (female, 50–59 years, HADS/STEM/BUS, 2, 9).

> I … recommend that we … equip ourselves with technology, become advanced and implement it[,] as the world is becoming digitalised (female, 40–49 years, HADS, 2, 136).

Resources and infrastructure at colleges (60 codes)

Even if not explicitly covered in the survey, many participants referred to the poor infrastructure and resources at their colleges. The lecturers complained that their colleges were not equipped with a substantial amount of technology to make learning more effective. Limited Internet and Wi-Fi access is a common example of the problems. One lecturer commented:

> Firstly, we need access to Wi-Fi. At our campus many lecturers do not even have a printer, never mind fancy technology! (female, 60 years or more, STEM, 1, 34).

Apart from needing the classroom to be well equipped with digital technologies, some participants require more laboratories – in particular those teaching information technology (IT). Often, the participants referred to having less or no technology use in the classroom or to limited access to technologies at the colleges. These findings align with the requirements of students in TVET colleges to have access to the latest MS Office applications and to improved infrastructure, such as reliable Internet/Wi-Fi and electric sockets to connect electronic devices (Denhere & Moloi, 2021b:233).

Discussion and implications

The purpose of this needs analysis was to identify the in-service TVET lecturers' requirements in order to design a training programme that includes the development of knowledge and skills for digital teaching and learning at TVET colleges in South Africa. Owing to the increasing number of digital processes in society and the world of work, the development of digital competence in TVET has become more relevant. On this point, lecturers play a key role in developing students' digital competence through the integration of technologies in the classroom. Therefore, in the study, the TVET lecturers' self-assessed knowledge of digital technology was measured by using the TPACK framework.

The results obtained show that lecturers at South African TVET colleges value their professional capacity in teaching, and in teaching with digital technologies, but have a continuing need to develop deep knowledge, understanding and application of technologies and their use in educational environments. The findings are consistent with current international research, suggesting that educational staff need more courses aimed at professional development, especially in order to develop their use of the TPACK framework (OECD, 2019; Redmond & Lock, 2019).

This study also provides a first insight into the techniques of integrating technology into TVET lecturers' classrooms. Considering the fact that lecturers must be able to integrate digital technologies effectively, the results suggest that the use of technology in the classroom is far from being an innovation in teaching practices that helps students to be able to use technology in productive ways and prepare them both for work and for participation in society (cf DCDT, 2021). In fact, in the main, the lecturers made only 'basic' use of digital technologies. However, they did implement technologies for teacher-centred purposes, such as preparing content and presenting information. Most lecturers tended not to use technology in a student-centred manner, such as engaging students in creating digital artefacts, in problem-solving and in critical thinking (e.g. using simulation). This is because the TVET lecturers felt that they were not sufficiently equipped with the required knowledge and skills to use digital technologies in the classroom or even 'appropriate' tools to exercise digital-related competence in teaching. These findings are in line with previous studies (Tondeur et al., 2017) which indicate that teachers employ technologies primarily in structured learning rather than to encourage active student engagement.

The results point to various needs for further training, stemming from basic computer skills to effective subject-specific technology integration (e.g. with regard to languages and Mathematics). The predominant needs that the lecturers expressed were competencies in standard digital technology, particularly MS Office and presentation software. These findings correspond to the students' training needs for computer skills identified in a qualitative study on the technology, technological skills and curriculum needs of students at South African public TVET colleges (Denhere & Moloi, 2021b).

However, in comparing these findings with the lecturers' self-perceived needs for pedagogical strategies to integrate technology into the classroom effectively, training must involve more than the development of basic digital skills: it must also offer preparation enhanced by the creation of opportunities for lecturers to experience the technology in practical-application scenarios. To increase the use of technology in teaching and learning, TVET lecturers need to be well informed about the value of technology and what contributes to the effective use of technology in learner-centred learning. In this study, it was also observed that the lecturers require practically oriented training programmes which offer activities that approximate real-world teaching contexts. In such programmes, the participants will be involved in the creation of educational content and in the design, application and evaluation of teaching concepts with technologies in real classroom settings. Allocating training opportunities, offering different levels of training, and forming practice groups should be instituted to help TVET lecturers cope with the multifaceted needs and the different levels of expertise. In particular, these measures should favour those lecturers with lower educational levels and those who seldom participate in training. As digital technology changes both unpredictably and at a rapid pace, TVET lecturers must continually acquire and update their technology-related skills through lifelong learning. The initial step is for TVET college authorities and all stakeholders involved in capacity-building programmes to identify the specific needs annually. In addition to self-assessed skill levels, indicators such as peer assessment, current technology use and integration, lecturer beliefs, the availability of resources, the specific needs and wants, and lecturer backgrounds should be included in a needs assessment.

Even if fewer participants mentioned collaboration and exchanges with other lecturers, in previous studies it has been argued that, apart from an effective form of training, teacher collaboration is a predictor of the daily integration of digital media into the classroom (Drossel, Eickelmann & Gerick, 2017). Therefore, lecturers could share best practices for technology integration and lesson plans among their colleagues, and a lecturer learning community should be instituted. Its modus operandi may include online forums, video conferencing, social networks, or software for collaborative learning.

The quantitative results indicate that there is little potential for the optimisation of the consecutive and in-service training of lecturers. The results also indicate a need for further training among older lecturers who do not possess consecutive or concurrent degrees, for the use of technology on the whole, and for the use of technology in the pedagogical context in particular.

The results of this study also show that a great need exists for higher education institutions to embed digital pedagogy in pre-service teacher education in order to prepare future lecturers for 21st-century classrooms. Consequently, curriculum adjustments would be required for both South African public TVET colleges and the training of TVET lecturers.

Limitations and future research

In this study, data were collected using an online self-report questionnaire. The approach used to measure the lecturers' technology-related knowledge and skills via self-assessment (Schmidt et al., 2009) offers an efficient means of collecting comparatively large amounts of data. However, self-reports present methodological issues that may threaten their internal validity. For example, there is a general tendency to give desirable answers in all self-reports (e.g. socially desirable responding). Furthermore, self-evaluated knowledge is relative to the extent of a persons' knowledge. In previous studies, it has been argued that low-skilled people fail to recognise their own lack of competence and tend to overestimate their knowledge and skill level (Dunning, 2011). In this regard, the measurement of knowledge in the TPACK domains may be limited by the ability and expertise of the TVET lecturers surveyed in this study to self-assess their knowledge across the items appropriately and not by them possessing the confidence to integrate technology (cf Krauskopf & Forssell, 2018). It is also likely that the participants overrate their own skill levels because they link the concept of digital competence to basic technical skills. For instance, the qualitative findings in this study show that the use of technology by lecturers is often limited to videos and presentation slides for demonstration purposes. At the same time, the lecturers perceived a need for their own digital competence to be developed.

In addition, the medium of the online survey could have introduced some self-selectivity to the extent that a few individuals not interested in digital technology, or those who do not have access to the Internet, took part in the first place. The data material of the open-ended questions in Section D of the form for the categorisation of the training needs may be a further limitation. The reason for choosing open-ended questions for the survey was to avoid any preconceived ideas and to obtain a more detailed picture of the lecturers' technology use and needs in respect of training. Yet, most of the answers were very short: some answers often consisted of one or two words only. Even if it were possible to detect some recurring ideas and general patterns, it was not always clear whether a term belonged to the category training content, training design, or resources and infrastructure at a college (e.g. 'technology'). The mixed-methods approach which was used to help critically appraise and synthesise the high level of self-assessment regarding technology use means that the evidence is not observable when viewing results alone from the TPACK self-assessment. Instead, the results must be interpreted in relation to context.

Since the sample size was lower than expected, it is difficult to detect significant differences in some instances. Only 366 of all the in-service lecturers at South African TVET colleges participated in this study; hence the sample is not representative of the total number of TVET lecturers. Because the sample is heterogeneous overall, it would be interesting to look at subgroups in more detail in the context of design-based research. Even if some lecturers considered the technology available to them as being inadequate, it was not possible with this survey to explain fully whether a lack of appropriate infrastructure and a lack of appropriate material resources may be barriers to technology integration, or if lecturers are less likely to use technologies only at the individual level. To gain insight into the lecturers' individual competence

levels, performance-based measurement in addition to the analysis of lesson plans, video-recorded lessons or classroom observations would increase external validity. A longitudinal study could be conducted in order to investigate how the availability and use of technology in TVET change over time. Future research may also consider additional factors such as students' attitude in respect of technology and whether they perceive it as being useful, in addition to the modes through which they engage with specific technologies. Furthermore, examining the effects of these factors on students' academic achievement is crucial.

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Instructors' perspectives of TPACK in a vocational training classroom in Namibia

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ABSTRACT

Over time, vocational education has undergone a paradigm shift due to the integration of technology into teaching and learning. This change renders it necessary for vocational training instructors to have technological pedagogical content knowledge (TPACK) for effective technology adoption and integration into teaching and student learning. However, developing competence in the intersection of technology, pedagogy and content remains a challenge for many lecturers entering vocational education. Instructors' decisions to integrate technology depend on their perceptions of TPACK, which can influence their approach to integrating technology into teaching. This study is part of a longitudinal study that has been examining instructors' development of TPACK in vocational education in Namibia. Using a qualitative approach and the TPACK framework, data were collected through questionnaires and focus-group interviews. The data were analysed thematically using Nvivo software. The findings reveal that instructors' teaching experience expands their knowledge beyond technology integration, leading to a new understanding of TPACK constructs. In addition, the study shows that their disposition towards TPACK shifts with access to teaching technologies and that students' learning needs inform Instructors' TPACK. The study offers insights into the ways in which vocational education instructors integrate their teaching experience with technologies and relate that to the TPACK framework constructs.

KEYWORDS

Instructors, vocational training, technology, teaching and learning, TPACK, ICT

Introduction

Over the years, the integration of technology has caused significant transformation in vocational education. The use of information and communications technology (ICT) in particular has influenced the manner in which teaching is designed, as well as its subsequent learning outcomes. The literature suggests that vocational education and training (VET) instructors must innovate their teaching methods effectively (Karayel & Bozkurt, 2020). Gradually, traditional learning methods are becoming less preferred; in fact, most vocational students tend to believe that the methods used by VET instructors will not be applicable in their future workplaces. Notably, the increased availability and accessibility of ICT have redefined the skills that students in VET require in order to be employable (Deaconu et al., 2018; Tyagi et al., 2020; Jayalath & Esichaikul, 2022).

This change is complex and multifaceted; it is also influenced by other factors such as the generational differences among VET instructors, the availability of learning resources, and the specific traits of VET students. Therefore, it is necessary now for VET instructors to adapt and modify their teaching strategies in line with technological advancements – especially those in industry. The competence of VET instructors in today's teaching and learning processes should include familiarity with technology integration (Ramadan, Chen & Hudson, 2018; Jayalath & Esichaikul, 2022). Advancements in technology in VET have positive effects: improved accessibility, faster learning, and swift information updates (Sangmeister et al., 2018; Karayel & Bozkurt, 2020). The employment of technology in VET also enhances the learning environment, facilitating more effective knowledge assimilation (Ogundolire, 2020). In addition, it promotes stronger connections between teachers and learners during the educational process (Jayalath & Esichaikul, 2022). Scholars contend that understanding how technology can be used efficiently in education is crucial to instructors in the 21st century (Chuntala, 2019; Arifin et al., 2020). In VET settings, particularly, technology advancements shift instructors' perspectives, particularly with respect to creating and presenting content which helps students acquire and refine their practical skills. Therefore, it is vital for VET teachers to have a robust understanding of technology and to pass that knowledge on to their students.

To promote the integration of technology, the Namibian government has, in recent years, invested in ICT resources to foster technology integration in vocational education. This has been complemented by the implementation of numerous professional-development initiatives aimed at enhancing instructors' pedagogical skills. Despite a noticeable increase in ICT usage among instructors, though, empirical studies suggest that the technology's effective application for instruction enhancement and the facilitation of active student learning remains limited (Putro et al., 2020; Callan & Johnston, 2022). Many scholars suggest that possessing technological knowledge alone does not entirely equip these instructors to use ICT as an effective tool to enhance student learning (Mishra & Koehler, 2006; Falloon, 2020). Therefore, there is an increasing need for instructors to develop and possess a specific type of knowledge known as technological pedagogical content knowledge (TPACK). This knowledge enables them to incorporate technology seamlessly into their teaching methods so as to elevate student learning outcomes.

Mishra and Koehler (2006) suggest that for technology to be integrated successfully, instructors should be well versed in the seven key areas of professional knowledge. These include pedagogical knowledge (PK), content knowledge (CK), technological knowledge (TK), pedagogical content knowledge (PCK), technological pedagogical knowledge (TPK), technological content knowledge (TCK) and, certainly, technological pedagogical content knowledge (TPACK).

Understanding how technology, teaching methods and content interact is very important for VET instructors because technology can improve the quality of education. However, according to a study by Polikarpus et al. (2023), most research in the VET field has focused on technology adoption and integration but not specifically on the application of TPACK. O'Brien (2015) recommends that more research be conducted on the perspectives of instructors' use of technology in teaching and how TPACK manifests in VET. In addition, owing to the Namibian government's efforts at introducing educational technologies to VET, and the expectations that instructors will use these facilities, it is important to understand how these instructors perceive the reciprocal connection between technology, pedagogy and content knowledge (TPACK) in their teaching.

Instructors are a key stakeholder group in integrating educational technologies in VET. Prior to implementing any initiative, it is vital to thoroughly investigate and comprehend their perspectives on technology (Wang, 2009). Studies show that, to a considerable extent, an instructor's acceptance and use of technology in the classroom is influenced by their perspective on technology-integration knowledge. Consequently, this study is based on the assumption that knowing instructors' perceptions of TPACK is essential for its successful integration into vocational education processes. The goal of this study was therefore to investigate instructors' perspectives on, and comprehension of, TPACK and its relation to their use of ICT in teaching. The instructors involved in this research have access to, and incorporate, technological tools into their instruction. Their opinions were examined in the context of the growing use of educational technologies in VET and their perception of TPACK as an essential knowledge base for technology integration in teaching.

This article first reviews a broad range of the literature related to the subject in order to arrive at the objective matter. It also introduces a conceptual framework within which to drive the study. Following this, the research methodology, encompassing data collection and analysis, is thoroughly discussed. The findings are subsequently explored in detail. Finally, the study concludes with a presentation of the study's conclusions and recommendations.

Review of related literature

The significant value of technological knowledge cannot be overstated, particularly with regard to the competencies required by TVET instructors. Such knowledge serves to bolster innovative instructional methods in VET education. It has transcended being merely a tool enabling teaching processes, instead becoming a necessity and fundamental knowledge that all instructors must possess (Mishra & Koehler, 2006; Sánchez et al., 2020). Unfortunately,

the lack of technological knowledge among VET instructors is remarkably prevalent, leading to ineffective teaching and learning processes and practices and a lack of integration and cohesion in VET education, as reported in the study by Wang (2009). Wang concluded that it is crucial to investigate the fundamental reasons behind the limited use of technology in the teaching and learning process in VET.

Although VET education prioritises practical training, integrating technology so as to ensure that students grasp the practical learning outcomes is an increasing challenge. In this regard, instructors need to comprehend how to use technology effectively and develop practical teaching strategies. Previous research (Hanapi & Nordin, 2014; Hanafi & Wahidah, 2018; Frady, 2022) has shown that effective teaching is vital to producing quality VET graduates. Indeed, instructors need specific teaching abilities, especially knowledge of the materials and the teaching techniques (Cattaneo, Antonietti & Rauseo, 2022). In today's educational environment, though, learning should not be limited to content knowledge and pedagogy; specifically in the context of VET education, a stronger grasp of technology is called for. In addition, because technology can support the teaching process, it has become an essential tool in teaching and learning.

Mishra and Koehler (2008) highlighted the significance of technological knowledge by evolving a framework known as TPACK (technological pedagogical content knowledge). They suggested the integration of technological knowledge in educators' knowledge base, an idea originally derived from Shulman (1986). They advocated that instructors should possess essential knowledge in three areas: content, pedagogy and technology. The TPACK model underlines the importance of instructors understanding the relationships between content, teaching practices and technology in creating meaningful learning experiences (Fahrurozi, Budiyanto & Roemintoyo, 2019; Putro et al., 2020). Given the focus on technological use in VET, the TPACK framework offers a lens through which to evaluate VET instructors' competency. Many studies demonstrate the efficacy of this model in illuminating the intricate relationship between technology, pedagogy and content.

TPACK research has contributed to understanding technological teaching and learning (Baran & Uygun, 2016; Maor, 2017; Eutsler, 2022). In VET education, researchers use the TPACK model primarily to assess VET instructors' knowledge in implementing the curriculum (Chua & Jamil, 2014; O'Brien, 2015; Mutanga, Nezandonyi & Bhukuvhani, 2018; Torggler, Miesera & Nerdel, 2023). Despite these efforts, existing studies reveal that VET instructors' level of expertise has not reached an optimal level. Evidence from Chua and Jamil's (2014) study suggests that TPACK competency among VET instructors in public institutions is only moderate. O'Brien (2015) concurred, indicating a similar level of TPACK proficiency among VET instructors. This moderate skill level extends to technology-component knowledge, which has been found to fall below expectations (Chua & Jamil, 2014; O'Brien, 2015). Research by Mutanga et al. (2018) emphasises this further, finding that more than half of the surveyed engineering instructors were unsure about incorporating technology into their teaching. This suggests a persistent gap in VET instructors' TPACK.

The TPACK framework and its associated practices have not yet been employed in examining VET instructors' practices in Namibia. TPACK is instrumental in effective technology use in education, as suggested by research. However, studies have found several discrepancies. For instance, one study found that TPACK does not clarify the variance in the way teachers use technology (Torggler, Miesera & Nerdel, 2023). It also fails to explain why educators' perspectives and beliefs sometimes do not match their teaching methods (Shambare & Simuja, 2022; Shambare, Simuja & Olayinka, 2022). In addition, there are discrepancies between what teachers express and their actual classroom practices, and therefore merely enhancing TPACK may not be enough (Mutanga et al., 2018).

Some authors (Maor, 2017; Eutsler, 2022) have suggested expanding the TPACK framework to include varying perspectives and educational shifts in different environments. Maor (2017) argued that assessing TPACK should involve multiple perspectives for a full understanding of its complexity and in order to deal with discrepancies between teachers' attitudes and classroom practices. Similarly, Eutsler (2022) encourages studies that focus on technology-rich environments influenced by TPACK. The context of VET provides one such perspective. Therefore, studying VET instructors' perceptions of TPACK and its implementation in their practice can be beneficial. This is particularly important in the context of the increasing demand for TPACK research in VET in developing nations.

Theoretical framework

To better address the research question, What are instructors' perspectives of TPACK in vocational training schools in Namibia?, the authors of the present article adopted the TPACK framework developed by Mishra and Koehler (2006). The TPACK framework is an extension of Shulman's (1986) PCK. TPACK is widely considered to be a framework for teacher knowledge (Mishra & Koehler, 2006), and one that facilitates effective technology integration in teaching. The TPACK framework comprises six elements, as shown in Figure 1: technological knowledge (TK), pedagogical knowledge (PK), content knowledge (CK), technological pedagogical knowledge (TPK), technological content knowledge (TCK), and technological pedagogical content knowledge (TPACK) integrating into different teaching contexts. By examining the framework depicted in Figure 1, one can conclude that the TPACK model represents an intersection of three key knowledge domains: technological knowledge, pedagogical knowledge and content knowledge. The TPACK framework acknowledges the importance of understanding how these domains interact and overlap to promote effective teaching with the aid of technology. In other words, effective technology integration in teaching requires a balanced consideration of the way technology, pedagogy and content knowledge are interrelated rather than simply focusing on each domain in isolation.

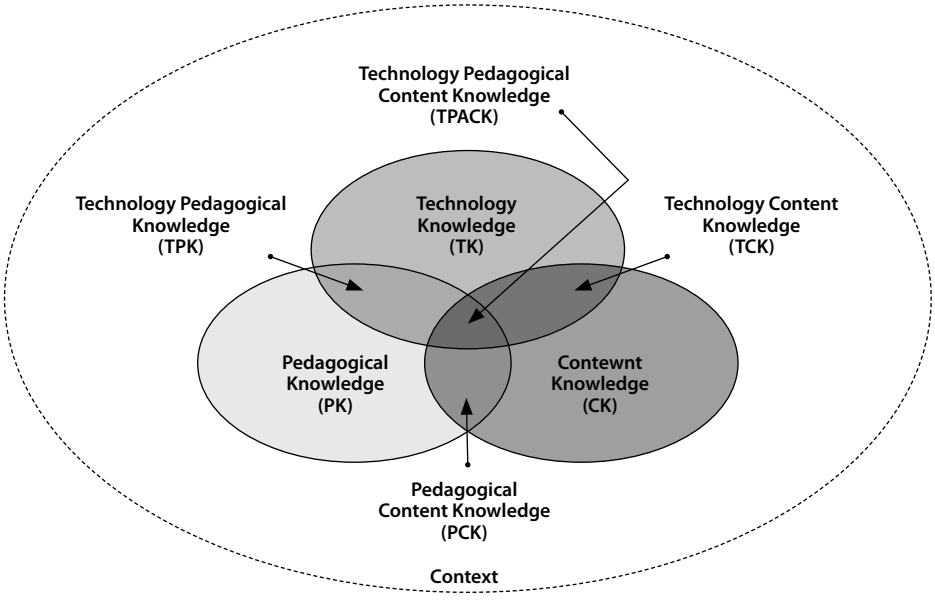

Figure 1: TPACK Framework (Koehler, Mishra, Kereluik, Shin & Graham, 2014)

The TPACK model defines its elements based on their significance in teaching. According to Mulyadi et al. (2020), content knowledge (CK) refers to the subject matter that is being taught, while pedagogical knowledge (PK) refers to the understanding of suitable teaching approaches for specific content (Shulman, 1986). Technological knowledge (TK) involves the use of technology tools for teaching. Moreover, Mulyadi et al. (2020) defined TPK as the ability to select an appropriate technological tool that is applicable to teaching, while TCK is the knowledge required to use technology so that teachers comprehend both the content and PCK.

While the TPACK framework is fundamental to efficient technology integration, it has shortcomings in clarifying why technology is used differently and why educators' views on technology may not align with practice. Furthermore, understanding the individual elements of the TPACK framework does not ensure the successful integration of ICT into education. Incorporating technology into the classroom setting is therefore multifaceted: other factors, such as the preparedness or suitability of ICT facilities in schools and students' proficiency in digital skills play a role in the application of this technology. The framework offers too little guidance on the selection of teaching content, instructional methods and relevant technologies. Consequently, TPACK falls short of assisting educators in identifying the appropriate content to teach regarding selected technology and methodologies. Some teachers need support in evaluating and choosing suitable technology for integration into their teaching, an area where the TPACK framework falls short. It also fails to guide teachers on the specific technology to use when teaching specific content.

TPACK is adopted in this study as a theoretical framework that aims to understand the perspectives of instructors on the knowledge necessary to integrate technology effectively (Vivian & Falkner, 2019; Eutsler, 2022). The analysis of data for this study uses the TPACK framework to challenge technocentric approaches that emphasise acquiring technology skills apart from pedagogy and content in favour of the idea that instructors possess knowledge that is complex and multifaceted. In this study, TPACK provides a useful framework for thinking about the knowledge instructors believe supports them in integrating technologies in teaching, and also about the ways in which they acquire this knowledge. The study acknowledges the distinct and interconnected roles that content, technology and pedagogy play in establishing authentic teaching and learning environments.

Methodology

This research adopted a qualitative case study approach (Rashid et al., 2019) that resorts within an interpretive philosophy (Burns & Peacock, 2019) in order to examine instructors' perceptions regarding the constructs of TPACK and in relation to their own integration of educational technologies in teaching in a vocational education setting. The study investigates the phenomenon of technology integration in teaching and learning as it relates to the potential perceptions of instructors' TPACK, making phenomenology the most suitable methodology. The qualitative enquiry is based on the notion that each instructor's perspectives of TPACK stem from their unique experiences of using a variety of technologies in their teaching. To access these experiences, the authors aimed to set aside their own perspectives and experiences as researchers in educational technologies, focusing instead on the participants' interpretations and perceptions. Consequently, the phenomenological research approach, which emphasises exploring conscious awareness by examining individual–technology relationships (Simuja, Krauss & Conger, 2016), was considered the most fitting choice.

As researchers adopting the phenomenological approach, we acknowledge several assumptions that could affect the study's results in capturing the desired perceptions. These assumptions include the notion that instructors ought to be seen as active and enthusiastic contributors who are mindful of their deliberate choice of technology use and who can formulate perceptions and beliefs about these technologies in their work settings. Furthermore, it acknowledges teachers' decision-making abilities and their capacity to consider and ponder their method of instruction. To comprehend the study's participants better, we were attentive to their individual and shared contexts, circumstances and experiences as instructors and students, both individually and collectively (Caena & Redecker, 2019).

The idea that teachers actively participate in their teaching and personal lives, engaging with and adapting to technology while seeking experiences, guided our research in this study. Like everyone else, instructors develop their own meaning and perspectives as they engage with the potential and constraints of technology. Therefore, this study's investigation, interpretation and examination of the phenomenon are based on a group of individual instructors'

experiences. After examining these insights, the research shifted from a personal perspective to a collective understanding of the cohort's unique lived experiences (Webb & Welsh, 2019).

To conduct the study, qualitative methods, including a semi-structured questionnaire and focus-group interviews, were employed. Although it was simple to identify the perspectives and primary goals of these methods for the type of knowledge sought, it was also more difficult to determine the scope of their application. To select the study participants, purposive sampling (Campbell et al., 2020) was adopted and questionnaires were emailed to all 21 instructors who participated in a two-week educational technologies training workshop in Windhoek in 2019. The training was part of the Namibian government's initiative to upskill vocational instructors by enabling them to acquire 21st-century teaching and learning knowledge. Of the 21 instructors who received the semi-structured questionnaires, 18 responded. Ten instructors were then purposively chosen for focus-group interviews (FGIs). Several criteria, including teaching experience, area of expertise and availability to attend an FGI, were taken into account in selecting the ten participants. The aim of this purposive selection was to obtain a rich and varied set of data for a comprehensive analysis instead of a random selection where certain unique viewpoints might have been overlooked. The chosen participants are instructors from two public vocational schools in the Windhoek district in Namibia.

Ethical clearance was obtained from our affiliated university's Ethics Committee and the two vocational schools, as this study forms part of the longitudinal study on working with vocational instructors to develop TPACK. No coercion or deception was used to get people to participate in the study; participation was entirely voluntary. Moreover, individuals were free to exit the study whenever they wished. Key ethical principles such as informed consent, credibility, anonymity, confidentiality and trustworthiness were consistently maintained and ensured in this study.

Data analysis

Before participating in the FGIs and responding to the questionnaire, all the participants voluntarily signed consent forms and were informed of the study's purpose. They were also made aware of their right to decline to answer any questions. Also, owing to the geographical dispersion of the participants, the questionnaires were emailed, as the authors could not personally reach all of the instructors. A concise questionnaire with 14 closed-ended questions was developed so as to capture all the relevant themes for responding to the research question. Open-ended, semi-structured interview questions were developed by the authors to capture all the pertinent themes for answering the research question.

To accommodate all the participants, the FGIs were conducted using Zoom conference technology, and the sessions were also audio-recorded for the purposes of transcription. This approach was taken in order to create a balanced atmosphere and establish a connection of trust with the participants (Kerasidou, 2019); in addition, the participants were empowered

and reassured before the interviews by informing them that the researchers' purpose was to learn from their experiences. Furthermore, each FGI was scheduled at a mutually convenient date and time for both the participants and the authors. The data-analysis process involved the authors using a thematic analysis approach, which aims to identify, organise, analyse and report on patterns or themes in the data (Lochmiller, 2021). Although the authors engaged in distinct processes such as transcription, organisation, coding, analysis and interpretation, the process was complex, iterative and reflexive rather than linear or systematic. Interpretation and analysis, for example, began during the FGIs as potential themes and codes emerged. Microsoft Word was used to transcribe the recorded FGIs.

The transcribed texts were analysed with NVivo (Version 22), a data-analysis software tool for organising and analysing various types of qualitative data. Each transcribed text was uploaded to NVivo and then analysed by categorising or thematically grouping participant responses. The responses of the participants were then coded according to the relevant themes that had been determined beforehand. Each relevant text was assigned to an appropriate theme during the coding process. The researchers used an inductive data-analysis approach (Natow, 2020), and the emerging patterns of themes served as the basis for the study's findings. Table 1 sets out the relevant information (biographical data) for the ten instructors who were chosen purposively.

Table 1: Instructors' background information

PSEUDONYM	AGE	GENDER	TEACHING EXPERIENCE (YEARS)
Annemarie	42	Female	7
Hilya	40	Female	12
Romeo	36	Male	5
Secilia	39	Female	4
Jacob	48	Male	10
Aloysia	38	Female	3
Selma	46	Male	2
Anne	40	Female	15
Angula	37	Female	5
Mate	45	Male	11

Validity, reliability and trustworthiness

The study's internal validity was ensured by prioritising its credibility. This was achieved by conducting a comprehensive literature review on the subject, which led to the selection of a theoretical framework. The questions in the FGI and the participant questionnaire were then

created in accordance with this framework. During the data-analysis process, the authors carefully examined texts with both common and differing meanings and developed themes accordingly, with the internal homogeneity and external heterogeneity criteria of the themes being carefully considered. In addition, just before each FGI and responding to the questionnaire, the participants were informed that their participation was voluntary and they were encouraged to provide sincere answers to the questions asked. After the FGIs, the recordings were transcribed and the participants were asked to review the transcriptions for confirmation of their authenticity (Natow, 2020).

Findings

The aim of the study was to investigate instructors' opinions and perceptions concerning technological pedagogical content knowledge (TPACK). All the instructors involved in the study have access to and integrate technologies in their teaching. The perspectives were examined in the context of the growing prevalence of educational technologies in vocational education and the instructors' views on TPACK as essential knowledge for integrating technologies into teaching. The study adhered to ethical norms and protected the participants' identities by consistently using pseudonyms for the instructors. The primary data used for this research came from questionnaires with open-ended questions and from group discussions. Table 2 provides a breakdown of the instructors' responses to the questions in the questionnaire.

Table 2: Responses from the semi-structured questionnaire

	AGREE	STRONGLY AGREE	NEUTRAL	DISAGREE	STRONGLY DISAGREE
1. ICT tools are readily available at the school.	–	100%	–	–	–
2. I am aware of the constructs of technological pedagogical content knowledge.	20%	60%	20%	–	–
3. I can choose topics that combine the content with technology and teaching methods.	–	100%	–	–	–
4. I can choose technologies that make it easy for students to understand concepts.	70%	–	30%	–	–
5. I know how to use specific technologies to teach specific trade concepts/ topics.	100%	–	–	–	–

	AGREE	STRONGLY AGREE	NEUTRAL	DISAGREE	STRONGLY DISAGREE
6. I know which technologies are best suited for my teaching.	70%	30%	–	–	–
7. I have the technical skills to use a variety of technologies in teaching.	100%	–	–	–	–
8. I have knowledge about technologies that I can use to better understand subject content.	40%	60%	–	–	–
9. I can use technology that promotes pedagogical approaches in my lessons.	70%	–	20%	10%	–
10. I am familiar with the subject content as prescribed by the VET curriculum.	–	100%	–	–	–
11. I know how to use technology to assess students' performance in the classroom.	50%	20%	–	30%	–
12. I have sufficient subject knowledge for all my VET trades.	100%	–	–	–	–
13. I can select technologies to use that strengthen my subject content and pedagogies and support students' learning.	–	90%	–	–	10%
14. I know how to change my teaching styles to suit both theoretical and practical lessons.	–	100%	–	–	–

The semi-structured questionnaire consisted of closed-ended questions, with responses given on a five-point scale: (1) Agree, (2) Strongly agree, (3) Neutral, (4) Disagree, and (5) Strongly disagree. According to the results in Table 2, eight participants (80%) reported being aware of the constructs of technological pedagogical content knowledge (TPACK). The participants' responses suggest that instructors' teaching experience has broadened their knowledge beyond technology integration to encompass a new understanding of the reciprocal relationship between technology, pedagogy and content knowledge. In addition, the study findings indicate that all instructors (100%) have access to ICT tools, as they are

readily available at the school and in the classroom. The specific ICT tools they have access to include learning management systems (Moodle), interactive whiteboards, laptops, projectors, digital educational content and specialised software for various subjects. Some participants revealed that they have access to context-specific tools, including mobile technologies, video-conferencing platforms (such as Zoom and Skype) and other means of digital collaboration.

This finding suggests that the availability of ICT tools is not a significant barrier to technology integration in teaching in VET in Namibia. However, the study also highlights the importance of providing appropriate support and training to help instructors use these tools effectively in their teaching practices. The study's results imply that the instructors' TPACK disposition can shift with access to technologies in teaching and that students' learning needs inform the instructors' TPACK. Specifically, the vocational education instructors connect their teaching experiences with technologies to the TPACK framework constructs, suggesting that their understanding of TPACK evolves as they apply technology in their teaching practice.

During the FGI, most of the instructors were able to relate to the TPACK framework, recognising the interplay between technological, pedagogical and content knowledge in the processes of integrating technologies into teaching. However, one participant, Jacob, mentioned not being familiar with TPACK as a framework, despite having an understanding of the relationship between technology, content and pedagogy. One possible reason might be that the knowledge in the three main components – technology, pedagogy and content – originates from distinct sources. From the FGIs, it appears that most instructors gained their pedagogical and content knowledge from their personal experiences as learners and workers. The majority of the instructors acquired technological knowledge on their own. In contrast, in other educational sectors, technological, pedagogical and content knowledge tended to be acquired through formal educational experience.

Moreover, another participant, Angula, expressed concern that the government's training programmes focused primarily on providing technological knowledge relating to the use of specific technology without emphasising how TPACK knowledge develops when using technology in teaching and content presentation. Angula expressed this as follows:

> … I was not aware that my teaching approach was related to TPACK. For instance, I store my teaching content and documents on Google Drive. Whenever my Head of Department assigned me lessons to teach, I made sure to consider the students' interests because [these] usually involved technology. I searched for appropriate websites to gather more information that could enhance my teaching.

This highlights the need for more comprehensive training and professional-development opportunities that go beyond basic technological skills to enhance instructors' understanding of TPACK and its role in integrating technology into teaching. All of the instructors in the study shared a belief that the TPACK framework is closely linked to enhancing content

presentation through the use of teaching strategies and technology. One instructor, Aloysia, exemplified this viewpoint by stating:

> By combining my content knowledge with my pedagogical knowledge and technological skills, I have been able to create more engaging and interactive learning experiences for my students. One example of this is when I used a virtual welding simulator to teach my welding students. By using this technology, I was able to provide my students with a safe environment to practise their welding skills without the risk of injury or the need for expensive materials. Additionally, the simulator provided real-time feedback on their technique, which allowed me to give targeted feedback and improve their skills faster.

In contrast to Aloysia's perspective, Hilya viewed the TPACK framework primarily as 'part of method planning lessons' to use technology for presenting concepts or content. This perspective highlights the flexibility of the TPACK framework and how it can be adapted to fit different instructional contexts and teaching styles. Aloysia gave an example of her teaching:

> … I was planning a lesson on electrical wiring ... . I first considered the materials to use in the lessons, then how to teach this material effectively, and some of the technologies we have in our laboratory in Section B of the upper campus. ... I decided to use an interactive digital whiteboard to present diagrams and schematics of electrical wiring. This allowed me to engage students visually and interactively, breaking down complex concepts into more manageable pieces that were easier to understand.

The instructors also emphasised that the TPACK framework allows them to align content and technology, especially since various technological tools are available. Annemarie states: 'In my opinion, this framework helps me to stay focused on the advantages and limitations of the technology that I use in my lessons.'

The instructors in the study highlighted the value of the TPACK framework in fostering creativity when integrating technology into pedagogy and content. This underscores the potential of the TPACK framework to inspire innovative approaches to teaching that leverage technology so as to engage students and improve learning outcomes. Jacob stated that the TPACK framework promotes creative ways of '[keeping] up with students' needs and [determining] what they are interested in, as it relates to the VET curriculum'. Mate pointed out that some of the colleagues at the vocational school recognise the importance of having technological knowledge, as it helps them choose and use appropriate technologies to meet the unique needs of their students.

All of the participants in this study, while acknowledging the TPACK framework as a valuable methodological guide, expressed their appreciation regarding the prospect of integrating

various technologies into their classrooms in the future. However, they also recognised that the framework is not static and context-free, and may require adjustments to better suit the VET context. The participants also mentioned that learning to integrate technology into teaching and having the TPACK framework as a guideline was a valuable asset they were content to retain in their professional lives as instructors. Furthermore, most of the instructors agreed that they could help others understand and appreciate the relationship between content, technologies and teaching, and highlighted the potential of the TPACK framework in promoting a deeper understanding of technology integration into teaching practices.

Discussion of findings, and recommendation

According to Mishra and Koehler (2006), teaching with technology effectively is not simply a matter of learning how to use technology. Instead, they emphasise that instructors should understand the interconnections among technology, pedagogy and content knowledge rather than simply acquiring technical skills. The creative integration of content with different technologies should be a priority. Callan and Johnston (2022) agree with this finding, indicating that an instructor's perceptions of 21st-century learning can limit their belief in their students' capacity for creativity and critical thinking. Recent studies have highlighted that merely knowing how to use a specific technology tool does not automatically translate into knowing how to present a topic effectively with it (Paul & Jefferson, 2019; Lee, 2020). In the current study, the instructors possessed knowledge of some of the technologies used in teaching in the vocational education context. However, the findings suggest that preparing to use technology in teaching should also take into account the interplay between technology, pedagogy and content knowledge rather than solely focusing on learning how to use technological tools.

The participants' responses reveal the importance of recognising the complexity of integrating technology into teaching and the need to develop TPACK knowledge to leverage technology effectively in support of student learning outcomes. They recognised its potential to transform learning and expressed positive intentions to integrate technology more in the future. A presentation was made on the instructors' TPACK awareness, its conceptualisation, and best-practice examples in VET. The instructors indicated that quality teaching with technology should focus on delivering a positive learning experience for students. However, their minimal exposure to effective examples of teaching with technology limited their perceptions of best practices. It underscored the significance of pedagogical and content knowledge in integrating technology. The implication of this is that applying this framework to VET instructors' practice may require modification if it is to suit the vocational context better.

The FGI with the instructors revealed that they not only identified all the available technological tools, but also recognised the elements of TPACK in the VET context. This acknowledgement of the linkages between the elements of the TPACK framework aligns with the work presented by Mishra and Koehler (2006). The findings of this study suggest that instructors must possess the required knowledge if they are to combine their expertise in technology, teaching methods and the subject matter. Crucially, they should effectively merge all these TPACK constructs

when using ICT in their teaching practices. Consequently, enhancing instructors' abilities to design learning experiences is vital for the long-term success of ICT integration in vocational education classrooms (Delcker & Ifenthaler, 2021). To this end, instructors should be given ample opportunities for professional development, enabling them to recognise technologies' potential in teaching. Instructors should also use technologies in suitable situations in order to create effective learning plans and scenarios in an actual classroom environment, thereby aiming to enhance their students' subject-specific learning. As technologies for education evolve alongside students' behaviour and thinking patterns, future vocational education classrooms will need to be dynamic. Therefore, to support their students, 21st-century vocational education instructors must adapt their instructional methods in varying contexts, based on an understanding of the capabilities of different digital tools and using ICT in education not as a supplement but as a meaningful and well-supported pedagogical approach.

Based on the findings of the study, it is recommended that professional-development programmes aimed at improving instructors' TPACK should include relevant training centred on designing lesson plans that effectively integrate technology, pedagogy and content knowledge. By focusing on the interplay between these domains, professional-development programmes can help instructors to develop a deeper understanding of the TPACK framework and its potential applications in their teaching practices. Moreover, the study suggests that TPACK can be an effective framework for professional-development programmes for teachers that are aimed at developing instructors' pedagogical reasoning about various information and communication technologies across the curriculum, at encouraging innovative thinking when using new ICT-based teaching methods, and at integrating these tools into their classrooms. By emphasising the role of TPACK in technology integration, professional-development programmes will be able to help VET instructors develop the skills and knowledge needed to leverage technology effectively in support of improved student learning outcomes.

Limitations of the study

Since the study relied on self-ratings to estimate knowledge and TPACK application, we acknowledge that these responses might be more indicative of perceived self-efficacy than actual expertise levels. Future research should therefore consider adopting a mixed-methods approach. The integration of self-ratings with classroom or lesson observations could provide a more comprehensive and accurate measure of VET instructors' TPACK proficiency.

Suggestion for further studies

The findings of this study indicate a need for more comprehensive research. Future studies should employ a stronger theoretical and methodological framework in order to examine instructors' perceptions on a larger scale, such as across Namibia's private and public vocational colleges. It would also be worthwhile to explore whether the perceptions of instructors regarding TPACK differ based on factors such as age, gender, qualifications and/or subject specialisation.

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Exploring inclusive leadership and strategic visioning as pathways to well-being in TVET colleges

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ABSTRACT

This exploratory case study reports on the ways in which staff and student well-being is embedded and promoted in technical and vocational education and training (TVET) colleges through inclusive-leadership practices such as policies that structure and guide well-being programmes, making them part of the strategic vision. Such well-being is also evident in the wellness programmes and initiatives in some colleges. Eleven participants in total were purposively selected from a population of 59 TVET college leaders enrolled in a TVET (PGDip in TVET) leadership development programme at the University of Pretoria during 2021 and 2022. Data were generated during teaching and learning activities when the entire population (n=59) was involved in completing a structured checklist of enablers of, and risk factors related to, well-being for their colleges. From this process, the checklists of 11 campus managers were selected. The depth and the quality of the information the managers provided about the research topic, and the insights it provided in response to the question of how well-being was promoted in their colleges, also determined their selection. The study findings suggest that well-being policies were inconsistently implemented at different colleges, and that there is a perceived lack of strategic thinking about well-being and a lack of guidance and direction from college leaders about how to deal with it. Furthermore, it became evident that student well-being was prioritised over that of the staff, with staff members experiencing burnout and fatigue as a consequence of elevated levels of stress arising from meeting deadlines, unmanageable workloads and unrealistic expectations.

KEYWORDS

Vocational education; leadership; well-being; pathways; wellness programmes; enablers; risk factors; whole-school approach

Introduction

That the well-being of all people in educational contexts is important, is indisputable. Globally, increased emphasis has been placed on the way well-being is conceptualised, how it is contextually determined by culture and circumstances, and how people make sense of what well-being means to them in their unique educational contexts. Educational communities such as schools, colleges and universities are complex ecological systems in which there is a dynamic interplay between the needs of the individual and:

- the ways in which the immediate environment can affect such individuals;
- how people interact with and influence each other;
- the role the environment plays in individual and group functioning; and
- how this is embedded in, and influenced by, societal and life events such as a pandemic and a war.

This complex interplay between people and their environment makes well-being a subjective and complex phenomenon to define and promote (Carter & Anderson, 2023). It also makes it a collective or community undertaking if well-being is to be achieved for all (McCallum & Price, 2016).

The well-being of staff and students has been high on the agenda of educational leaders because it is a well-known fact that positive educational outcomes for students are directly linked to their well-being, which is, in turn, affected by that of those who take responsibility for their academic and career development (Turner & Theilking, 2019; Kaya & Erdem, 2021). This makes well-being a high priority for school leaders and managers. Despite this acute awareness of the importance of well-being in an educational context, many studies globally report on the pervasiveness of the challenges that students, teachers and school leaders experience with it. Some of the problems noted are:

- the deterioration of teacher, student and school leader well-being (Riley, 2014; Acton & Glasgow, 2015; Hogan, Thompson, Sellar & Lingard, 2018);
- high levels of performance anxiety among students and teachers;
- high attrition rates among teachers and dropout rates among students (Global Happiness Council, 2018; Tang, He, Liu & Li, 2018);
- a higher prevalence of mental illness among young people and staff at schools and tertiary institutions (Kessler & Bromer, 2013; Baik, Larcombe & Brooker, 2019); and
- a lack of agreement on the manner in which well-being could be promoted in educational contexts (Powell & Graham, 2017).

The TVET sector in South Africa similarly faces many challenges that pose a risk to the well-being of staff and students (Ronnie, 2023). Some of these include the very complex nature of TVET colleges as a result of their intensive restructuring since the 1990s (Terblanche &

Bitzer, 2018); the difficulties of teaching and learning in the South African context, what with the many societal, political and infrastructural challenges people have to navigate in their daily lives; the perception that TVET colleges are inferior to other higher education institutions such as universities (Ronnie, 2023); reports on the toxic work culture that exists in many TVET colleges (Meyer & Kirsten, 2014; Waddington & Wood, 2019); poor or inadequate leadership (Terblanche & Blitzer, 2018); an implementation gap between policy and practice; low staff morale and general dissatisfaction among staff with their working conditions (Wedekind & Buthelezi, 2016); and a very large student population (DHET, 2018) that is at high risk of developing mental health problems as a result of challenges such as poverty, crime, a lack of resources, and studying at colleges that are clearly under pressure (Munyaradzi & Addae, 2019).

In recent years, there has been a strong shift of emphasis in educational contexts towards a whole-school approach to well-being, with clear evidence in research that wellness initiatives are more successful when they are integrated and reflected in the culture of a school or college system. This includes centralised support services that coordinate wellness initiatives among institutional leaders, teaching staff, administrative staff, parents, students, outside agencies, and the community in which the colleges are situated (Wilson, Dejoy, Vandenbergh, Richardson & McGrath, 2004; Ttofi & Farrington, 2011; Weare & Nind, 2011; Jones & Bouffard, 2012; Barry, Clarke & Dowling, 2017).

According to Carter and Anderson (2023), a sustainable whole-school approach to well-being can be achieved only if there is a shared vision and commitment by all the members of an educational community. The authors identified 12 key pathways that can be used to embed well-being in an educational context. These pathways are:

> expert inclusive leadership; strategic visioning; quality teaching and learning; a supportive, caring, and inclusive educational community; a safe learning environment; social-emotional competencies; a sense of meaning and purpose; using, monitoring and evidencing strengths-based approaches; strategies encouraging healthy lifestyles; programmes that develop pro-social values; and family and community partnerships (Carter & Anderson, 2023:70).

This specific study focuses on only two of these pathways: expert inclusive leadership, which entails giving clear guidance and direction, and a commitment to student and staff well-being; and strategic visioning, which entails having a vision for well-being and well-being as evidenced by policies and intervention programmes.

The role of leaders in educational contexts is paramount in ensuring that wellness programmes and initiatives are embedded in the everyday context of staff and students, and that these programmes and initiatives are capable of dealing with the diverse dimensions of well-being and can create pathways towards an integrated college approach (Barry et al., 2017). This means that leaders should see to it that policies which give direction on what can be done to

ensure well-being, are in fact implemented. Such policies should have clear goals and aspirations regarding well-being; they should also mobilise people to the extent that they will assume responsibility for their own and others' well-being, monitor that of students and staff by assessing the efficacy of such interventions, and ensure the sustainability of well-being programmes (Weare & Nind, 2011; McCallum & Price, 2016; Powell & Graham, 2017; Carter & Anderson, 2023).

In South African TVET colleges, there are three levels of leadership and management. At the top level is the principal, who is the college's chief financial officer and who answers to the DHET minister. The principal's managerial responsibility is to oversee the planning, organisation and direction of the college. Principals have the authority to make the final decisions on all issues pertaining to college management and administration. The middle level of leadership is made up of the deputy principals in charge of various portfolios, followed by the third-level leaders or managers, who are department heads, campus managers and the managers of various units (Sithole, Wissink & Chiwawa, 2022).

The participants who were included in this study were first-level leaders. Although it is important to note these various levels of leadership because doing so will offer insights into the context and background of the study, the level of leadership of the participants was not the specific focus of the study. What was more relevant is that it is acknowledged that TVET leaders have both leadership and managerial duties to perform, and that though the lines between leadership and managerial roles overlap, there are subtle differences between the two roles (Robertson, 2015). The concept of leadership foregrounded in the conceptual framework aligns with the ethos of this study: that leaders must be visionary and innovative if they are to transform educational contexts where well-being is a priority for all.

It is against this background that this study aims to initiate research on the way in which well-being is promoted in TVET colleges along the pathways of expert inclusive leadership and strategic visioning which also encompass wellness programmes and initiatives as evidence of the way well-being is enacted.

Background to this study

This study forms part of a broader five-year project aimed at exploring the efficacy of leadership skills development in the Postgraduate Diploma in Technical and Vocational Education and Training (PGDip in TVET) programme. This programme was developed by the University of Pretoria, with the first cohort of students commencing their studies in 2020 (Smit & Bester, 2022). One of the eight modules in this programme is Emotional–Social Wellbeing. The module was informed by the notion that TVET colleges are key stakeholders in promoting the well-being of the young people and staff at such colleges. These educational communities are increasingly being challenged to position well-being as both a foundation and an integral part of an educational context's structures, processes and learning.

The module is structured around various aspects of well-being and mental health in the post-secondary learning environment. These aspects are that well-being and mental health are everybody's responsibility, and that they require a whole-college approach, are context-specific and are a social–cultural construct. Dealing with well-being and mental health requires leaders to make their attainment a strategic goal, to create a culture that makes well-being a priority, and to engage actively with mental health concerns. All of these are necessary if the stigma associated with mental health problems is to be removed (Carter & Anderson, 2023). The educational approach to instruction in the module is evidence-based and enquiry-led. Enquiry-based learning draws on the latest theories of human learning and instructional practice; it emphasises an active approach to learning which assumes that students are actively involved in their learning, solving problems that are unique to their contexts and constructing knowledge that is new to them. Pedaste et al. (2015) cite several studies that provide evidence to support the effectiveness of enquiry-based learning, and they state that it is generally regarded as a vital element in building a scientifically literate community.

One of the units in the module required the PGDip in TVET students to investigate those enablers or risk factors that promote well-being in their colleges. They had to follow a process of scientific discovery during which they were encouraged to explore existing research on this topic and construct their knowledge. They had to map possible risk factors by completing a structured checklist of enablers and risk factors of well-being (Carter & Anderson, 2023).

Purpose of the study

The purpose of this exploratory case study was to explore and describe the views of 11 TVET campus managers on the extent to which staff and student well-being is embedded and promoted in TVET colleges through inclusive-leadership practices. Included in these measures are policies that structure and guide well-being programmes, making them part of the strategic vision. The study also sought evidence of policies and practices aimed at implementing wellness programmes and initiatives at colleges.

Conceptual framework

Well-being is a highly complex concept to define and various definitions exist. At a subjective level, well-being can be different things to different people based on their world views, values, emotional experiences and subjective judgment of these. It also differs across life stages and it is influenced by culture, context, and life or world events (Diener, 2000).

From a hedonic perspective, well-being is defined as happiness, whereas from a eudemonic world view people may experience it if they feel that they are able to express themselves as good, moral and righteous people who are true to themselves. Constructs such as self-actualisation (Maslow, 1970) and self-determination theory (Deci & Ryan, 2000) have added to our understanding of what constitutes well-being, while some believe that it requires a

more complex definition that could reflect the complexities of human life as 'interwoven, environmental, collective and individual elements that interact across the lifespan' (Carter & Anderson, 2023:22).

Based on their comprehensive review of the various definitions of well-being, Carter and Anderson (2023:22) proposed a broader and more encompassing definition of 'well-being' for educational contexts. They define it

> as a holistic, balanced life experience where well-being needs to be considered in relation to how an individual feels and functions across several areas, including cognitive, emotional, social, physical and spiritual well-being.

It is also important to define 'wellness', since this concept also fits into the broader context of well-being. Wellness is not the same as well-being – although the terms are often used interchangeably. Wellness influences well-being and it refers to the various positive interventions and actions that can be undertaken to ensure holistic and integrated well-being at all the levels of an individual's functioning – spiritual, cognitive, emotional, environmental and physical (Albrecht, 2014).

Various complex and interrelated factors may affect well-being either positively or negatively. These factors may be contextual – community, significant events such as a pandemic; social–cultural – culture, politics, poverty, and violence; and individual or personal – genetic factors such as temperament or psychological mindset. Some of these factors may be within the control of a person, while others fall outside their control. A proactive and positive approach to promoting well-being which is not purely reactive in nature, has been noted as being the most successful approach to follow to ameliorate the negative factors that affect well-being in educational contexts (McCallum & Price, 2016).

International research suggests that educational, context-based well-being programmes, if implemented correctly and effectively, have the potential to produce long-term positive outcomes for both students and staff (Clarke, Sixsmith & Barry, 2015). Currently, the DHET has commissioned Higher Health to develop and implement mental health policies and programmes at 50 TVET college campuses in South Africa. The primary focus of Higher Health is to provide a comprehensive set of preventive services to halt the spread of HIV, tuberculosis, sexually transmitted infections (STIs) and other health conditions, to reduce the impact of mental health conditions, alcohol abuse, substance abuse, LGBTQI+ issues, violence on campus, etc., and to advance reproductive-health rights and economic empowerment. As part of this intervention, a peer-to-peer-led health and wellness programme was introduced on campuses, providing a wide range of services at the doorstep of students and staff (Higher Education & Training Health, Wellness and Development Centre, 2023). However, the well-being initiatives that are currently implemented by the DHET can be successful only if there are also leaders at colleges who support and augment well-being initiatives.

Bingham and Bubb (2017) claim that a leader is crucial to ensuring that a school's culture does not deteriorate, and that school leaders directly affect student performance through their vital role in determining teachers' working conditions. Teachers' opinions of their working conditions and leaders' contributions to developing and preserving a school's culture are crucial to retention, motivation and well-being. A good leader will coordinate the institution's ideals so that everyone can see them and perceive a common thread connecting them to the school. The authors concluded that the most important factor in running healthy schools has to do with culture. Similarly, Sithole, Wissink and Chiwawa (2022) concluded that one of the most important tasks a TVET manager has is to create an organisational culture that encourages staff to function optimally and to attend to the core business of teaching and learning. However, the authors found that TVET colleges face enduring and persistent challenges because of a negative culture and, in addition to this, Balkrishen and Mestry (2016) found that the leadership role of campus managers at TVET colleges needs to improve, because their leadership has direct implications for student success.

According to Bingham and Bubb (2017), leaders in educational contexts can reduce the stress on their teaching staff and therefore benefit students by committing themselves to being part of the change process, being inclusive in their decision-making, and adopting whole-school systematic and practical strategies that are sustainable. This aligns with Carter and Anderson's (2023) 12 key pathways (listed above) that can be used to embed well-being in an educational context.

Study method

Research theory that underpins this study

For this study, interpretivism was used as a meta-theoretical paradigm and qualitative research as a methodological paradigm. Interpretive researchers value subjectivity and believe that reality is shaped by people's varied experiences and points of view. Interpretive researchers value interacting with insiders on the social situation which is being studied in the context in which it occurs (Nguyen, 2019). They also believe that understanding the phenomenon being studied requires the acceptance of different realities (Hammersley, 2013; Pervin & Mokhtar, 2022).

Qualitative methodologies enable researchers to gather data in natural settings where they may speak with people face-to-face about the problem being studied in its true context (Creswell & Creswell, 2018). The goal of qualitative researchers is to present a comprehensive description of the specific issue or problem being studied. This implies that various viewpoints are considered (Creswell & Creswell, 2018).

This researcher believes that each participant has a unique real-life experience determined by their specific college context that could influence their point of view on the factors that influence well-being in their college. What is more, these varied experiences could offer a

deeper insight into the phenomenon being studied. Since TVET leaders play an integral role in managing and leading people and co-contribute to the strategic vision of their colleges, this researcher believes that their perspectives will inform the purpose of this study.

Design

An exploratory case study design was used. The case was limited to one group of participants, namely 11 TVET leaders. The unit of analysis was the participants' views on how staff and student well-being is embedded and promoted in their colleges. Qualitative exploratory case studies are suitable when using interpretivist research paradigms because they offer possibilities to interact with individual perceptions through in-depth data-collection strategies such as using documents in the form of assignments – which was the case in this study (Creswell & Creswell, 2018).

Data generation and selection

Data were generated during teaching and learning activities. The entire population of 59 TVET leaders who were enrolled on the PGDip in TVET leadership development programme at the University of Pretoria during 2021 and 2022, had to complete a structured checklist of enablers and risk factors of well-being as these applied to their colleges. The teaching and learning process also involved a reflection session that was conducted with each year group during the contact sessions in the programme. These reflection sessions mostly confirmed the data that were generated in the checklists: it became evident that data saturation was reached during the compilation of the checklists. The checklists of 11 campus managers or first-level leaders were selected based on the depth and quality of the information they provided about the research topic and the insights it could provide to answer the question of how well-being was promoted in their colleges. The selection strategy was also used to manage the large data set.

The project had ethical clearance for the duration of this period. Due consideration was given to informed consent, ensuring voluntary participation, and managing the power relationship between lecturing staff and students as a potentially captive audience. The participants were approached every year for their consent to participate in the ongoing research project during face-to-face contact sessions and in follow-up emails.

Data analysis

The three themes that are presented later in the findings section were identified based on the existing categories in the structured checklist that the participants used to populate with the information from their colleges. The structured checklist was designed by Carter and Anderson (2023:70, 127) and it consists of the 12 categories listed above.

After these themes were identified, an inductive data-analysis process was followed to analyse the data that were populated on the checklists. This researcher followed a four-phase analysis process adapted from the six-phase process as described by Braun and Clarke (2006). During

phase one, the researcher engaged with a process of familiarisation with the data by carefully reading through and rereading all the documented data to identify relevant ideas. During phase two, the researcher developed initial codes and identified interesting aspects and repeated patterns across data items. During phase three, all the relevant data were integrated into each theme, and the data were checked within themes to ensure that they were meaningful and coherent. During the last phase, convincing extract examples were selected, the selected extracts were analysed, and the analysis was related to the literature.

Findings

In this section, data will be presented according to three themes: the role of policy and strategic visioning as enablers of well-being; the commitment of leaders to well-being; and how staff and student well-being is evident in college programmes.

Theme 1: Role of policy and strategic visioning as enablers of well-being

The participants in this study reported mixed experiences regarding policies that guide and direct well-being. There were views that there are clear policies, indicated in statements such as:

> National as well as college policies are in place that support both student and staff wellness.

> The college has an internal wellness policy aligned to [the] DHET Wellness Policy for students and an employee assistance programme to assist staff with personal or professional challenges. These policies will, however, be more effective with better advocacy of [such policies] and practices.

Opposing views were these:

> There are no specific policies in place and there is a lack of guidance on the part of management.

> Staff well-being is not clearly evidenced in educational policy documents and programmes. Not apparent. Staff must access their medical aid to address health and wellness issues.

When asked to indicate if well-being is a strategic vision in their colleges, the participants agreed that there is a lack of strategic thinking about well-being in their colleges. This is evident in the following responses:

> It is in place for students but not for staff.

> The college community does not have a clear strategic vision for well-being.

> As reflected [in] all documents, … clear goals and objectives for mental health and well-being [are not outlined]. Currently there is no strategic vision for mental health and well-being at the college.

The participants felt that there is also a lack of guidance and direction given to staff by college leaders on how to deal with well-being in their colleges. They indicated the following:

> There is some management support, but staff are largely left to capacitate themselves.

> There is a lack of guidance and direction with regard to mental health and well-being. Individual staff members engage with students in a caring and supportive way.

Theme 2: Commitment of leaders to well-being

The participants were of the view that there was a stronger commitment from leaders to students' well-being than to staff well-being. The commitment was attributed to the role of Student Support Services in their colleges. This is evident in the following statement:

> Well-structured Student Support Department with a manager, a student wellness officer, [and] student supporters on each campus. Student support programmes and initiatives are in place.

One participant indicated that there has only recently been some commitment from leaders in their college to well-being and stated:

> The first meeting was held in October 2021 to open the discussion about mental health and well-being. Campus management, student support staff and SRC members were grateful for this initiative.

There was a clear indication that there was a perceived lack of real commitment to well-being from college leaders. This is evidenced by statements such as:

> The primary focus of executive management is to get the task done. This filters down to staff lower … in the pecking order. In the quest to get the task done, there is not much focus on the people and their well-being.

> Lip service is paid to wellness and well-being, without it translating into real, tangible initiatives or efforts to improve wellness and well-being.

> Educational leaders are committed, as they are accountable for the certification rate (pass rate), retention rate and throughput rate of all students at their campuses

> as well as to the Department of Higher Education and Training (DHET). Managers do not make enough time to engage with staff and address the actual needs of the staff.
>
> Staff wellness resides with [the] HR manager, with no other dedicated post, limited initiatives, and an approach that staff are responsible for their own well-being … .
>
> During traumatic periods such as COVID, perceptions on the ground are that management is 'cold' towards staff needs.
>
> [There are] too many people in leadership positions who are not introspective and could be described as too involved with themselves to acknowledge their blind spots. This impacts on how they engage with staff and [on] the decisions they make.

Theme 3: Staff and student well-being as evident in college programmes

There seemed to be agreement that student well-being is supported effectively by the various wellness projects that are coordinated by Student Support Services (SSS) in collaboration with Higher Health and other organisations as mandated by the DHET. This is evident in the following statements:

> Student Support Services (SSS) were mandated by the DHET to support students at the college and campuses.
>
> … Student Support Services plans and implements various awareness programmes, in partnership with social organisations and Higher Health, to enable students and lecturers to develop resilience.

Apart from the various awareness programmes that are coordinated by the SSS, there are also individual counselling services for students. This is evident in the following statement:

> Student support officers are all qualified counsellors who will counsel students when it is within their scope. They will refer students when they assess there is a need to

The college leaders, at least in some colleges, seem to fulfil their role in ensuring that information about support services is available and accessible to students. This is evident in the following statement by one of the participants:

> Students are made aware of the services offered to them [by using] channels of communication and [by relying on] the supportive role of the lecturers, managers

> and support staff. Having an open-door policy also facilitates good communication at college so issues can be dealt with as early as possible. This instils confidence in the students and lecturers and contributes positively to their well-being.

However, the efficiency of the SSS is affected by what seems to be an inadequate support staff to student ratio. This is evident in the following statement:

> More student support officers must be employed. They are often inundated with appointments, which means that there could be long waiting periods for students to see them.

There also seems to be an inefficient use of the SSS's time in that they are involved in matters that are not necessarily within the scope of their function. This is evident from this next statement:

> Students Support Services [is] sometimes busier with NSFAS applications and administrative work and [does] not have a lot of time to support students

In contrast to student wellness programmes, staff were of the view that their well-being is not prioritised by college leaders. In some colleges, positive steps are taken and some initiatives that seem to be in place are that some colleges subscribe to the Independent Counselling and Advisory Services (ICAS). Two participants indicated that their college subscribes to this service. This is evident in the following statements:

> ICAS (Independent Counselling and Advisory Services) is a wellness service that was secured by the college, which can be accessed by staff for physical and mental health and wellness.

> ICAS Connect: This is an employee health and wellness programme that empowers our employees to take control of their well-being, reducing problems at home and work and facilitating higher levels of productivity. This is an online and face-to-face service that provides professional health, counsellors, [and] occupational therapist and social worker services. These services support resilience development so that staff can cope with tough situations. All staff have free access to this service. My Benefits covers support in the following areas: Counselling, Family, Finance, Health@hand, Legal and Trauma.

There were comments on the limited resources at some campuses to promote staff well-being and it was indicated that a possible solution could be for all colleges to subscribe to ICAS. This is illustrated by the following statement:

> There is no stress management programme available for staff. The college should register with a professional organisation such as ICAS to aid [it].

Apart from the ICAS initiative at some campuses, there is limited evidence that staff well-being is prioritised: it seems to be dealt with by means of very superficial interventions such as:

> An annual staff wellness day.
>
> Quarterly team-building activities are scheduled on the campus. Not all campuses follow this model.
>
> The compassion policy addresses the well-being of staff. It also serves as motivation

Staff clearly felt the need for stronger initiatives to support them, some stating:

> Facilities are made available for students but not staff. Higher Health runs health days six times a year for students, offering services ranging from family planning, general health consultations, sexual education and referrals to professional health services. Staff do not have access to any services on site.
>
> There are limited awareness campaigns regarding ill-health, especially mental health.
>
> The college could also appoint an employee wellness officer, as currently only in an extreme case where an employee is having a mental breakdown can the student support officer assist.

These statements are a reason for concern about staff well-being in colleges against the background of statements about their well-being and mental health such as:

> Burnout and fatigue among employees during peak periods such as examinations, submission of final marks, and teaching and learning delays due to strikes, lead to stress, fear and anxiety.
>
> Staff often experience high levels of stress about meeting deadlines, punctuality, unmanageable workloads and unrealistic expectations.

Discussion

One of the strategies that leaders could use to ensure that there is a structured and organised approach to well-being in colleges would be to make certain that national and college-specific policies are implemented and enacted. The value of policies is that they are guiding documents which exist because there was an exchange of ideas and a coming together of minds to form a basis for making decisions and working towards objectives that are considered important in reaching a goal (Bacchi, 2000). Various studies have reported on the role of policy and strategic visioning as enablers of well-being and on the interface between policy and practice

in the process of promoting well-being by implementing wellness programmes and initiatives (Bacchi, 2000; Birkland, 2016; Carter & Anderson, 2023).

However, one of the barriers that exists for example in student support services in TVET colleges is that policies and procedures are developed in colleges but there is little coordination in the TVET sector to ensure that these policies come to fruition (Munyaradzi & Addae, 2019). This study similarly indicated poor coordination and that a gap exists between policy and implementation. Our study group reported mixed experiences regarding policies that guide and direct well-being: some participants indicated that there are clear policies in place that support both student and staff well-being, while others stated that there are no specific policies in place and that there was a lack of guidance on the part of management. This contrasts with scholarly views that it is the duty of leaders in education to ensure that policies are implemented adequately. When they do not do so, leaders in South African TVET colleges may be putting staff and students' well-being at risk (Weare & Nind, 2011; McCallum & Price 2016; Powell & Graham 2017; Carter & Anderson, 2023).

A strategic vision requires leaders to have a future-orientation and clear goals and aspirations for promoting well-being. The value of having a strategic vision is underscored by Bingham and Bubb (2017), who found that following a well-structured, coherent approach to well-being in a school could reduce the stress on teaching staff. The benefits of following this approach are usually evident in improved teaching and learning and in the students' academic success. However, the participants in this study reported that there is a lack of strategic thinking about well-being in their TVET colleges. There is also a perceived lack of guidance and direction from college leaders about how to deal with well-being, and individual staff members compensate for this shortcoming by engaging with students in a caring and supportive way. Terblanche and Bitzer (2018) are of the view that TVET leaders may lack the capacity and abilities to lead effectively owing to inadequate or inappropriate vocation-related leadership skills to effect change.

The participants were of the view that there was a stronger commitment from their leaders to the students' well-being than the staff's well-being. This was attributed to the role of the SSS in their colleges, which, in collaboration with Higher Health as mandated by the DHET, implemented a comprehensive and integrated programme promoting the health and well-being of students across South Africa's public universities and TVET colleges. This raised the question of how the Higher Health programme could be rolled out consistently across the institutions of higher learning for both staff and students. The question arises because the vision of the programme to support staff and students in TVET colleges does not seem to have been realised for all (Higher Education & Training Health, Wellness and Development Centre, 2023).

There seems to be a lack of real commitment to well-being by college leaders, as evidenced by the statement that 'lip service is paid to wellness and well-being, without it translating into real, tangible initiatives or efforts to improve wellness and well-being'. In addition, managers do not make enough time to engage with staff and to respond to the actual needs

of their staff. During traumatic periods such as COVID, perceptions on the ground were that management was 'cold' towards staff needs.

The role of expert inclusive leadership is to establish wellness programmes and initiatives that are embedded in the everyday context of staff and students in order to promote the diverse dimensions of well-being (Carter & Andersen, 2023). SSSs are mandated by the DHET to support students at the college campuses, and they coordinate various awareness programmes in partnership with social organisations and Higher Health. There are also individual counselling services for students, and the college leaders are responsible for ensuring that information about the SSS is made available and accessible to students. However, the efficiency of the SSS is affected by an inadequate support staff to student ratio and the inefficient use of their time.

Furthermore, TVET college leaders are not prioritising the same level of care for their staff so as to take care of their well-being. However, some colleges have taken positive steps to deal with this neglect by, for example, subscribing to the Independent Counselling and Advisory Services (ICAS Connect), an employee health and wellness programme that provides professional health, counsellor, occupational therapist and social worker services. These services support resilience development and provide free access to support in the areas of counselling, family, finance, health and trauma. However, the services are not available to all staff at all the colleges. There is limited evidence that staff well-being is being prioritised; rather it is dealt with by way of superficial interventions such as annual staff wellness days and team-building activities. Staff also feel the need for stronger initiatives to support them, such as Higher Health days, awareness campaigns and the appointment of an employee wellness officer. This is expressed against the background of statements about their well-being and mental health, including burnout and fatigue among employees and high levels of stress about meeting deadlines, unmanageable workloads, and unrealistic expectations. Wedekind and Buthelezi (2016) believed a comprehensive management strategy was required in the TVET sector to attend to staff dissatisfaction and to promote staff cohesion. However, Robertson and Frick (2018) quite rightly point out that TVET leaders have very complex and demanding tasks to deal with, which they must perform irrespective of adverse and challenging circumstances. This fact, together with their own need for support and well-being, can very easily be overlooked.

Limitations of this study, and future research

This study is limited by the narrow focus on leaders and also the focus on the ways in which they enable well-being through the effective use of policy and strategic visioning, on how committed they are to well-being in their colleges, and on the ways in which the well-being of their staff and students is evident through wellness programmes and initiatives. Other pathways to well-being, such as quality teaching and learning, safety in colleges, inclusive practices and social–emotional competencies – to name but a few – and the views of other staff, must be explored before a more comprehensive understanding of the current

status of well-being at TVET colleges can be arrived at. Moreover, the findings of this study are limited to the views of the participants in this study, who are employees at TVET colleges; they do not reflect the views of the students. These limited findings may therefore be regarded as constituting only one piece of a bigger puzzle that needs further scientific investigation.

Conclusion

This study highlighted the challenges that TVET college leaders have been grappling with, such as how to bridge the gap between policy and its implementation, the need for the development of leaders in TVET colleges to deal more effectively with complex matters such as committing to the well-being of both staff and students, and how to create a culture of well-being that is embedded in a college's everyday activities – and which is embraced by all. Even though the sample and scope of the study were limited, its findings might help to guide the formulation of strategic plans that promote well-being at TVET colleges. This study indicates that a need exists for more structured and organised thinking, and also points to the action that needs to be taken to ensure well-being at TVET colleges. In this respect, it is a starting point for research into other facets of well-being that remain unexplored.

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Pathways of Early Childhood Development practitioners into higher education: A capabilities approach

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ABSTRACT

The creation of professional learning pathways in the field of early childhood development (ECD) is currently a key policy priority in South Africa, especially as research has indicated the critical need that exists for investment in ECD practitioners to resolve previous educational inequalities and poor throughput rates in formal schooling. The option of recognition of prior learning (RPL) often provides the only route into post-school studies for educators in this historically marginalised sector to enable them to pursue formal qualifications. The barriers faced by mature females, who constitute a large proportion of ECD practitioners, include mismatches between occupational and discipline-based qualifications and a lack of understanding of the non-traditional routes into higher education. This article reports on an investigation into the experiences of a sample of mature women who attempted to access higher education with non-traditional qualifications. Using the lens of capabilities theory, we demonstrate the significant efforts made by these ECD practitioners to achieve their goals of personal and economic freedom by accessing further training and higher education through RPL. The article concludes with a discussion on implementing effective RPL for transitions in post-school education and training.

KEYWORDS

Recognition of prior learning (RPL); articulation; mature women students; early childhood development; post-school studies; capabilities theory

Introduction

Poverty among women has been on the rise globally (Moghadam, 1998; Kongolo, 2009; Tao, 2019). Women's access to higher education, particularly in Africa, is crucial to their upward mobility, and, for many, it provides a route out of poverty (Groener, 2019). Inequalities in access and participation feminise poverty and further assign to women much of the menial work in society, as largely unpaid or underpaid labour (Robertson, 1998). Globally, male privilege is also constantly shifting in form and being reinvented under new circumstances (Robertson, 1998). For poor black women, accessing higher education is crucial. This kind of access reinforces women's stronghold against poverty and provides empowerment in marginalised communities.

South African statistics show a close relation between gender, race and class:

> [B]lack working-class women's class, race and gender-based access to resources and opportunities … perpetuate inequality and poverty as a whole, while simultaneously decreasing women's socio-economic status (Kehler, 2001:44).

These three concepts – race, class and gender – are relational concepts that define the political, social and economic functions in society. Women's poverty will continue to increase so long as their participation in the workforce continues to decrease. Poverty is therefore feminised and perpetuated among South African women due to the inaccessibility of socio-economic rights, inclusive of access to higher education, which are supposedly enshrined in the Constitution (Kehler, 2001). Accessing higher education for women is consequently an essential resource to circumvent poverty.

This article provides a brief context of the challenges faced by women in accessing higher education, including challenges with recognition of prior learning (RPL). It then describes South Africa's post-school education and training (PSET) system, which incorporates adult education institutions, technical and vocational education and training (TVET) colleges, and universities. The attempts of mature women to access higher education with non-traditional qualifications is then analysed through a capabilities approach as espoused by Sen (1999) and this analysis reveals the importance of individual agency in obtaining economic and social freedoms in a difficult institutional environment. We conclude with a discussion on further research and the effective implementation of RPL in higher education.

Mature women's access to, and recognition of, prior learning

The limited research on access to higher education for mature women, and the ways in which RPL facilitates it, is a global phenomenon (Cooper & Harris, 2013). However, recent research in South Africa shows funding to be a serious impediment to mature women's access to, and participation in, higher education (Aploon-Zokufa, 2022). Elsewhere, mature women's access has been described as limited, associated as it is with risk and barriers to access,

participation and success in both further education and training and higher education (Reay, 2003; Zart, 2019). The facilitation of access for mature women through RPL has also not been well documented. Research does, however, show that such access is important for skills development and crucial to social justice because of its potential to widen the access and participation of marginalised people such as mature women (Cooper & Harris, 2013).

Mature women's access and learning pathways

According to research, mature women have certain characteristics that make them a unique group in relation to their access, participation and success in higher education (Wyatt, 2011; Lee, 2014; Santos, Bagos, Baptista, Ambrósio, Fonseca & Quintas, 2016). Among these characteristics is the idea that they have dropped out of school early in their lives, re-entered schooling informally in their communities and then moved on to higher education in their later years (Reay, 2003; Kaldi & Griffiths, 2013; Wright, 2013). They mainly lack traditional school qualifications with acceptable pass marks for entrance to universities, which makes their learning pathways more challenging than for those who enter higher education earlier in their lives. The age at which they aim to access higher education deeply affects their participation and success of entry (Santos et al., 2016). Learning informally through communities of practice (Wenger, 1998) is an important characteristic of mature women students because informal learning plays a crucial role in their learning pathway (McGivney, 2003). The flexibility associated with informal learning is what attracts mature women students. However, numerous studies show that mature women students face barriers to their formal learning and their progression (Burton, Lloyd & Griffiths, 2011; Kaldi & Griffiths, 2013). Among these barriers are family and financial responsibilities as well as a lack of financial resources and time to study and to attend classes (Bowl, 2001). Learning informally is therefore one way of ensuring that their high level of motivation to learn (Kaldi & Griffiths, 2013) is achieved and provides hope for access to formal learning.

Mature women's access and articulation

Some of the challenges associated with limited access to higher education in South Africa can be attributed to poor articulation between TVET colleges and higher education. Minister Blade Nzimande (as quoted in Papier, Sheppard, Needham & Cloete, 2016:44) indicated that

> a well-articulated system is one in which there are linkages between its different parts; there should be no dead ends. If a student completes a course at one institution and has gained certain knowledge, this must be recognized by other institutions if the knowledge gained is sufficient to allow epistemological access to programmes that they want to enter.

The South African education system is not well articulated. This view is supported by Papier et al. (2016), who argue that there is minimal articulation between TVET colleges and universities, resulting in TVET graduates struggling to access university.

They argue further that, for TVET to be seen as a first choice for students, articulation needs to be effective both at the systemic level and at the level of the institution. 'Systemic articulation' refers to the joining up of qualifications and all the other elements that are aligned to and support learning pathways. 'Specific articulation' refers to the informal and formal agreements between different institutions within the education system (SAQA, 2017). The South African Qualifications Authority (SAQA) policy also iterates that

> articulation exists through the addressing of boundary-making practices and the support of boundary-crossing practices as individuals encounter 'boundary zones' between the different elements of learning pathways. This support includes reducing the gap between learning pathways-related policy development and implementation; strengthening specific pathways and enhancing the opportunities to access and progress along these pathways … (SAQA, 2017:15).

Currently, colleges and higher education institutions do not provide students with the access and mobility which many need to progress academically. Students face obstacles in moving both vertically and horizontally (Cosser, 2011; Papier et al., 2016). In particular, the lack of articulation in the South African education system is a fundamental factor that prevents mature women students from accessing further and higher education. The purpose of our study is to provide a description of the experiences of mature women who accessed higher education through RPL so that we can assess how they navigated the career and learning pathways in a difficult higher education system in order to realise their own social opportunities.

South African context and background to recognition of prior learning

Evidence of student access to higher education through an RPL route is largely unknown and limited (Cooper & Harris, 2013). Official public statistics (DHET, 2022) also do not include access through RPL as a statistical category. The Council on Higher Education (CHE), which is responsible for university qualifications, has noted that university records conflate students who access higher education through RPL with other students entering with non-traditional schooling qualifications, such as mature-age exemption and foreign qualifications (Papier & Needham, 2021). There is, therefore, no formal statistical evidence that RPL is used as a mechanism to enter higher education.

The manner in which RPL is managed varies across higher education institutions: as is shown in our analysis, some universities have established RPL offices on campus and their records are publicly available. Other universities manage the RPL process virtually (Bolton, 2022). Targets of 10% enrolment of students in undergraduate degrees through RPL processes have also been set. In 2021, a Western Cape research university noted that 27 candidates had applied to study for undergraduate degrees in education, and that, of these, 20 candidates had been successful and had enrolled at the university (Rambharose, 2022).

The current full-time enrolment in the first year of an undergraduate education degree at this university in 2021 was 154. This shows that the target of 10% RPL candidates is possible, although there is no evidence from this university or other higher education institutions that the target of 10% undergraduate enrolment through RPL has been met in other undergraduate programmes. Access through RPL into undergraduate degrees remains a marginal form of mainstream access to these programmes, and to higher certificates and diplomas generally. The following section provides some insight into the candidates applying to enter university undergraduate degree programmes through RPL.

Policies in post-school education and training: Access, mobility and progression

South Africa's first democratic Constitution promises that everyone has the right to further education, which the state, through reasonable measures, must make progressively available and accessible (RSA, 1996:12). A raft of education and training policies was subsequently introduced to realise these aims. The articulation of qualifications in post-apartheid South Africa has received considerable policy attention. For instance, the SAQA Act 57 of 1995 was one of the first pieces of legislation introduced after the dawn of the new democratic dispensation in South Africa in 1994. This led to the introduction of an eight-level National Qualifications Framework (NQF) that encompassed all qualifications in South Africa and a subsequent ten-level framework in 2008. Articulation was one of the key principles addressed in the NQF, its aim being to

> facilitate access to, and mobility and progression within education, training and career paths for all South Africans to accelerate the redress of past unfair discrimination in education, training and employment opportunities (SAQA Act 57 of 1995).

Successive policies were introduced, culminating in the 2017 formal Articulation Policy for the Post-School Education and Training (PSET) system of South Africa.

Similar policies have been developed for RPL as an integral part of articulation between PSET institutions. The 2019 SAQA National Policy and Criteria for the Implementation of RPL notes that 'RPL can include any type of prior learning (non-formal, informal and formal) across all ten levels of the NQF' (SAQA, 2019:8). It further notes the following:

> There are two main forms of RPL that reflect the different purposes and processes within which RPL takes place: a. RPL for access: To provide an alternative access route into a programme of learning, professional designation, employment and career progression; and b. RPL for credit: To provide for the awarding of credits for, or towards, a qualification or part-qualification registered on the NQF (SAQA, 2019:9).

Whereas these appear to be enabling policies that allow the movement of learners to higher education career and learning pathways, a High Level Panel Report produced in 2017 is critical of South Africa's policy formulation, as noted below:

> The sheer number of bodies that have some role in relation to quality, for example, has reached unsustainable proportions (they include, inter alia, the South African Qualifications Authority (SAQA); Council on Higher Education/Higher Education Quality Committee (CHE/HEQC); Umalusi; the Quality Council for Trades and Occupations (QCTO); 21 Sector Education and Training Authorities (SETAs); 93 professional bodies; National Artisan Moderation Body (NAMB); South African Institute for Vocational Training and Continuing Education and Training (SAIVCET); and so forth (RSA, 2017:550).

Each of the bodies mentioned above is a statutory organisation with separate quality assurance mandates, including RPL. Whereas SAQA oversees the implementation of South Africa's NQF, it has limited authority to ensure coherence in and between these quality assurance bodies. More recently, there has been a strong focus on attempting to implement articulation such as the Unfurling Post-School Education and Training (UPSET) project underway at the Durban University of Technology (DUT) and a continuing focus on policy formulation such as Flexible Learning Pathways (Bolton & Blom, 2020). These are emerging initiatives and their impact is still to be assessed. A critical factor affecting articulation into higher education by learners with occupational qualifications is that universities use secondary school exit qualifications as the sole criteria when granting access to undergraduate programmes, while occupational programmes are not recognised. This applies even in cases where occupational programmes are accredited as being on the same level as, or on a higher NQF level than, the secondary school exit qualifications.

Having outlined the central policies affecting articulation, including RPL in South Africa, the following section attempts to provide evidence of any policy implementation of access to higher education through RPL.

A capabilities approach to assessing mature women's access to, and learning pathways into, higher education

The idea of educating for sustainable development draws on a human capabilities approach informed by theorists such as Sen (1999), which approach prioritises human development above economic development. While sustainable development has also been a response to the growing strength of the environmental criticism of conflating development with growth, Sen's approach to human freedom has had considerable impact. Sen's theoretical approach assumed prominence following the criticism of human capital approaches to TVET promoted by theorists such as Psacharopolous (1985), whose research was used by the World Bank to justify an assertion that primary education offered better economic rates of return than TVET in the 1980s. Nussbaum & Sen (1993:30) define the term 'capabilities' as a representation of the 'alternative combinations of things a person is able to do or be – the various "functionings" they

can achieve'. In describing freedom as the primary focus of human development, Sen identifies five main freedoms that require both individual and institutional efforts for their achievement:

- political freedoms;
- economic facilities;
- social opportunities;
- transparency guarantees; and
- protective security.

Sen views these freedoms as interconnected: social opportunities such as health and education facilities can contribute to economic participation, which, in turn, increases wealth and contributes to further resources for social upliftment (Sen, 1999). Sen asserts that this perspective of freedom reinforces the role of individual human agency in achieving freedoms for human development, although institutional contributions are also acknowledged.

Nussbaum and Sen (1993) disagree on the issue of developing a single list of capabilities that would describe essential human freedoms. These authors argue that a single list would have to be over-specified to include all the contexts of human interaction (Nussbaum & Sen, 1993:47). Sen readily concedes, in response to criticism by Cohen (1989:50), that his capabilities approach is not a complete theory of valuation in its own right but that it is a general approach to human development that can be combined with other substantive theoretical approaches, and that it advocates the 'cogency of a particular space for the evaluation of individual opportunities and successes'.

Robeyns (2005:94) states that Sen's capabilities approach is 'not a theory that can explain poverty, inequality or well-being: instead it provides a tool and a framework within which to conceptualise and evaluate *this phenomena* (sic)' (italics in original, 2005). Whereas most academic use of Sen's capabilities approach has focused on individual human agency to achieve capabilities and associated functionings, Sen (1999:142) refers to the importance of institutions in stating that individual 'opportunities and prospects depend crucially on what institutions exist and how they function'. Otto and Ziegler (2006:275) concur with this view and note that 'educational and welfare institutions as well as other policies should be evaluated according to their impact on people's present and future capabilities'. Robeyns (2005:110) similarly asserts that the conceptual framework of the capabilities approach includes institutions and individual human agency, and posits that

> for political and social purposes it is crucially important to know the social determinants of the relevant capabilities, as only those determinants (including social structures and institutions) can be changed.

The capabilities approach has been used to evaluate educational interventions and conditions for learners to achieve educational success (Hoffmann, 2005; Walker & Unterhalter 2007; Wilson-Strydom, 2011; Powell, 2014; Powell & McGrath, 2014).

A critical challenge has been to identify lists of capability and associated functioning that can be used to evaluate whether learners are capable of obtaining educational freedoms in their chosen course of study. Hoffmann (2005) drew on the Dakar Framework for Action (UNESCO, 2000) and the Delors Commission (1996) that identified four pillars of learning aligned to a life-skills education and capabilities approach:

- learning to know (informed action);
- learning to be (individual agency);
- learning to live together (interpersonal skills); and
- learning to do (practical application).

In a South African context, Wilson-Strydom (2011) draws on Walker's (2006) approach that identifies appropriate contexts in which to develop illustrative capabilities for education. Wilson-Strydom (2011:416) argues that a singular focus on educational outcomes at universities can lead to

> new forms of injustice because it is assumed that once equal resources are provided (such as a place at university or financial support) all students are equally able to convert these resources to capabilities and functionings.

From an educational perspective, capabilities theory has been used to identify a range of capabilities that position learners and institutions in ways that supersede the traditional human capital approaches of education for employment. Powell (2014:205–206) developed a capabilities list as entitlements that learners can expect from TVET colleges. These include: economic opportunities that matter; active citizenship; confidence and personal empowerment; recognition and respect; and to upgrade skills and qualifications throughout the course of life. These are expanded capabilities that transcend traditional approaches of education and training for employment in the formal economy. Having outlined the theoretical approach for this article, we now examine case studies of older women's experience of the RPL process to further their higher education studies in pursuit of economic and social upliftment.

Context and methodology of the study

The central research question for this study was: What are the barriers to accessing higher education for mature women early childhood development (ECD) practitioners through the alternative route of RPL?

Our study focuses on the learning pathways of mature women who are ECD practitioners in the Western Cape. Mature women ECD practitioners are defined as 20- to 60-year-old women working as practitioners in the early years of education, that is, those before the Foundation Phase of primary school. In addition, they actively seek access to undergraduate studies at institutions of higher education, specifically the Bachelor of Education (BEd)

undergraduate degree. The qualitative research design (Giddings & Grant, 2009) and the interpretivist framework (Bryman, 2016) of the broader study incorporated three research methods: a research survey, life history interviews, and one focus-group interview. Data from the research survey, which extended across two different institutions of higher education in South Africa, provided the pool from which the participants for the life history interviews were selected. The key criteria for the selection of participants for the life history interviews were that the women had to have worked in ECD centres previously and completed ECD Level 1, ECD Level 4 or ECD Level 5 programmes at TVET colleges. They also had to reside in the Western Cape and had to have applied to a university to register for the BEd programme for a minimum of five consecutive years.

The life history interviews were conducted with 11 mature women ECD practitioners during the COVID-19 lockdown period using the Google Meet application. The interviews were approximately two hours long and were semi-structured. From the life histories, the participants' learning pathways from birth to primary school, from primary school to high school, and from post-high school to the time of the interview were traced and compiled. Our specific focus for this study was on the learning pathways which could show us the RPL route for accessing the BEd programme on the post-school learning pathway of the participants. Therefore, we extracted the data regarding the RPL access route for mature women. In accordance with ethics requirements, the identities of the women have been kept anonymous and pseudonyms have been used to ensure confidentiality. In our analysis, the higher education institutions at which the women applied for access are referred to as Institution 1, 2 and 3. We do this to anonymise the individual and specific experiences the participants had with the processes, staff and policies at these institutions.

Data analysis

Using narrative analysis (Richmond, 2002), we drew up detailed descriptions of the participants' post-school learning pathways. These pathways included the RPL route into the BEd. All 11 ECD practitioners lived and worked in lower-income communities and identified themselves as Black or Coloured, with either Afrikaans and isiXhosa as their mother tongue. The use of these racial identities is included, as South Africa still uses these categories to promote affirmative action and empowerment as a form of redress to overcome discrimination as a result of colonialism and apartheid. They were all women who had commenced their journey in ECD as volunteers and, after obtaining some formal occupational qualification in the field, occupied roles such as teacher assistant, principal, ECD practitioner, and Foundation Phase assistant at primary schools. Although they had been working in this industry for a few years, they had also had other kinds of previous work experience, including administration, debt collecting, and working as cashiers in the retail industry. The only formal qualifications these women had acquired after school were those from TVET colleges. The occupational ECD programmes at these TVET colleges are 18 months in length. In addition to these qualifications, all of the women participated in informal training opportunities at their centres and in their communities. All 11

participants in the life history interviews had applied for access into the BEd programme at three institutions of higher education but only four had gained such access through RPL. One gained access into university. However, it was not into this programme and not through RPL, even though she had applied to do so. The remaining participants had not accessed higher education. The data suggest that a limited knowledge of RPL is related to their status of a lack of access to a higher education institution. Below are the descriptions of the four mature women who had been able to access the BEd through RPL.

PSEUDONYM	AGE	SCHOOL AND OCCUPATIONAL TVET QUALIFICATION	OCCUPATIONAL EXPERIENCE	APPLICATIONS TO ENTER HIGHER EDUCATION	STATUS OF ACCESS ROUTE	NUMBER OF YEARS ON ACCESS ROUTE
Surreya	46	Grade 12 (NQF Level 4) ECD NQF Level 4 (18 months)	Foundation Phase assistant	Two institutions over a period of four years	Accepted through RPL, then moved onto ordinary route	Four years and eight months
Elethu	37	Grade 12 (NQF Level 4) ECD NQF Levels 4 and 5 (2,5 years)	ECD principal ECD teacher isiXhosa facilitator	Two institutions over a period of two years	Accepted through RPL	Six years and six months
Babalwa	33	Grade 12 (NQF Level 4) ECD NQF Levels 4 and 5 (2,5 years)	ECD teacher Grade R assistant	Three institutions over a period of three years	Moved into Grade R diploma (non-RPL)	Six years
Jenna	44	Grade 12 (NQF Level 4) ECD NQF Level 4 (18 months)	ECD teacher	Three institutions over a period of two years	Accepted for RPL; currently in process	Five years and eight months

The learning pathways of the four ECD practitioners described above reveal their participation and success in ECD occupational programmes based at TVET colleges. The pathways also provide clarity with regard to the qualifications these women have obtained and their accompanying occupational experience. The women had applied to different higher education institutions for access over a period of between three and six years and, as mentioned before, had been able to gain access only through RPL. Furthermore, the data reveal that the process of gaining access to higher education for the ECD learning pathway is long and convoluted, and filled with barriers and bridges. For those women who have gained access via RPL, it has provided some light on their journey towards higher education access.

We now continue with the individual descriptions of the ECD learning pathways in relation to RPL for our participants.

Surreya (46)

After completing her schooling and ECD Level 4, Surreya applied for access into the BEd undergraduate degree at two different institutions over a period of four years. She received no feedback regarding her applications and, upon enquiring, was directed to the Adult Learning Centre and the RPL Unit at Institution 1. She first learnt about RPL through a friend. She explains:

> Then somebody, one of the teachers … at Institution 2 … *[who]* was doing a diploma in Grade R … basically said, 'You know, because of your age, why don't you try to get through the RPL?'

After being redirected to this unit by faculty staff, Surreya applied and participated in this programme. Midway through the programme, she describes her experience:

> When I got [to the unit] I still had an interview ... . And then after the interview they realised that I actually … didn't fail any of my [school] subjects, so I passed with exemption. [Then they said,] 'You can actually just go apply as normal, you don't have to apply through the RPL.'

Elethu (37)

Elethu received information about RPL from a friend. She explained that her friend had phoned her and had asked: 'Have you looked at your WhatsApp? I sent you something. Please look at it and then try to follow the link; there is a link there.' Said Elethu, 'And then, when I was looking at it, it was … the RPL programme.' She had applied at two institutions but was told that she did not have sufficient points to qualify for access to university undergraduate qualifications and that she did not meet the requirements. However, she followed the link sent via WhatsApp, applied and was accepted into the RPL programme at Institution 1. She shared her positive experience of participating in this programme:

> [T]hat was a very nice experience because it was actually … *[my]* first time … [at] the university. … [O]n Saturday[s] there [were] no other students … , only the RPL people (faculty staff within a university RPL unit) [who] helped us. [T]hey taught us how to write the essays and everything, preparing us for the first year. But they said, 'Not all of you will be accepted at the university.' You need to work on your portfolio of evidence so that they will [accept] it; … we had to work hard, [v]ery hard. [A]nd then in November … I got accepted [by] the Education Faculty.

Babalwa (33)

Babalwa's learning pathway shows that she gained access into higher education but not into the BEd programme as she desired. She continued:

> I went and looked for a school there [at] Institution 1. I applied there, and I think I applied twice but … was rejected. I think they (the Faculty of Education) [said] I should go to … RPL where there is education for old women. I think I applied twice … [but] was rejected. … I applied at … and [at] … , so I applied [to] two faculties. Luckily for me, I was accepted [at] [Institution 2], … so now I'm doing this Grade R Diploma for Foundation Level.

Jenna (44)

Jenna, who had applied at three different universities, two years in a row, also heard about RPL from a friend:

> I was contacted by a friend and she told me about the RPL programme. I asked her to contact the RPL office for me, and she contacted the RPL office and then sent me all the information … I needed to complete. She copied me into the emails and so I could see that they took very long to respond. We actually had to email a few times … to get them to respond. (Jenna's friend referred her to the RPL unit at Institution 3).
>
> For my application, I [then] had to send all my details, work history, certificates, motivational letters with a payment of R330.
>
> My application was successful, but the lady took very long to respond. Then I had to complete a portfolio for access to an undergraduate qualification. I had to answer a contextual questionnaire, write a motivation letter[, give …] a career timeline and [outline] my teaching philosophy. [I a]lso had to observe two experienced teachers and write about their lessons and the obstacles they faced. I had to prepare three lessons [for] two different subjects … [from] the grade which I am currently teaching. … I [then] had to complete a reflective assessment [and] write about my extramural experience. My mentor and the principal had to write verification letters about me. With the portfolio I also had to make a payment of R2 420.

Findings

The data from the life history interviews show that access to higher education for the group of mature women occurred only through RPL, with the exception of one candidate whose RPL process showed that she had acceptable school grades to access an undergraduate degree. This means that, in the post-school education system in South Africa, RPL provides a rare access route to undergraduate degrees for mature women ECD practitioners. Despite completing their schooling, participating in ECD programmes offered at TVET colleges, and having years of acquired practical experience, these attributes were not recognised by the universities to which the women practitioners applied for access. Only those women who knew about RPL, and applied using their previous experience and post-school qualifications,

were able to access undergraduate studies. Knowledge regarding this access route is therefore key for mature women. However, all of the participants who were able to access RPL learnt about this programme through word-of-mouth from other women in their communities or circles of influence. This indicates that information regarding RPL is not disseminated at grassroots levels in communities where those most marginalised from accessing higher education reside, including mature women ECD practitioners. This is a key barrier to accessing higher education through RPL.

In addition to finding out about RPL from a friend, Surreya was also directed to RPL via university faculty staff after she enquired about the outcome of her application for undergraduate studies. This participant applied to two different institutions over a three-year period but received no feedback from the universities to which she applied. This was the case for all the participants in this study: they applied at different institutions for the same programme over a two- to three-year period. None of them received feedback regarding their application. After applying for RPL access and participating in the programme, Surreya was advised by RPL staff that she could access the BEd undergraduate degree on the basis of her school-leaving certificate alone. Perhaps she was directed to RPL due to her age or her vocational qualifications and work experience. However, she did not need RPL access and she was accepted into the BEd programme at Institution 1 after applying again the following year. In this instance, limited feedback from universities regarding the applications of mature women further hinders their access and participation.

Our data show that institutional differences in providing RPL access to mature women ECD practitioners create barriers to access. At Institution 1, Elethu participated in RPL through a classroom setting. This mature woman indicated that, in this setting, RPL participants were taught valuable skills such as essay writing. However, a barrier at this institution, mandated by the SAQA regulation, is that only 10% of RPL participants per year may be allowed entry to university. This means that, even though students may successfully participate and complete the RPL programme in a given year, they may still not gain access into university due to this SAQA regulation.

At Institution 2, Babalwa was accepted into university for the Grade R Diploma even though she had applied for access to the BEd undergraduate degree. At this institution, despite official policy, RPL was not offered as an access route and, as has been mentioned before, without RPL mature women struggle to gain access into the BEd programme. Babalwa, who had participated in ECD Level 4 and ECD Level 5 for a period of 36 months after her secondary school qualifications, is now participating in a Grade R Diploma programme for another four years. She then faces more years of study if she is successful in entering the BEd undergraduate degree based on her diploma results. At an institutional level, not providing RPL as an access route for mature women through which their previous ECD qualifications can be recognised poses a barrier to their access and participation, in that it lengthens the time they spend trying to access an undergraduate degree. This also results in the need for more funding, as both the Grade R Diploma and the BEd undergraduate degree are full-time programmes at Institution 2 and are

funded through the National Student Financial Aid Scheme (NSFAS). However, NSFAS policies provide funding only for one higher education qualification per student.

Jenna also received the information regarding RPL from a friend. Quite differently from Elethu, who participated in RPL in a classroom setting, Jenna had the option of participating in the programme by completing a portfolio on her own with the help of a mentor. At the time of the interview, Jenna was a Grade R teacher with an ECD Level 5 qualification. Her position in a formal primary school, and having other teachers and staff at the school as mentors, may have provided her with a good support structure for creating lesson plans. However, not all mature women have this support, and completing the RPL portfolio for access without institutional support, such as in the case of the requirements at Institution 3, poses a barrier to marginalised ECD practitioners who work at informal centres in their communities and have limited resources at their disposal.

Discussion

Gaining access to higher education for mature women ECD practitioners should be a primary concern in the South African PSET system, since ECD is a key policy priority for the DHET and research shows the importance of education in the early childhood years before formal schooling commences (Feza, 2012, 2018) in order to overcome educational inequalities and poor throughput rates in formal schooling. RPL provides an articulation route for ECD practitioners into the BEd (Foundation Phase) programme. However, there are barriers to accessing higher education through RPL, which the present study shows is a rare access route to higher education for the women in this context. As noted, even when mature women can access undergraduate studies without the support of RPL, they are often redirected to this programme for access due to a lack of recognition of their post-school studies. Key barriers to RPL for the participants in the study include not receiving information regarding this access route; higher education institutions not providing access through RPL for mature women with occupational qualifications; and the requirement by some institutions to have RPL participants complete a portfolio as a prerequisite for access – in isolation of any institutional support. Our study has described the impact of these barriers on the lived experiences of mature women who aim to graduate as Foundation Phase teachers following their existing ECD practitioner route and TVET college qualifications after they completed high school.

All of the women who eventually gained access to a BEd undergraduate degree took many years to do so, which involved both costs and an inordinate amount of time to achieve this goal. This was the same for the women who are still attempting to gain access. From a human capabilities perspective, their personal routes to achieving access to university showed that their efforts to formalise their qualifications were not primarily based on obtaining qualifications to enter employment. Rather, this reflected the culmination of efforts to achieve their life goals and become qualified and recognised professional teachers. Issues such as dignity and respect in their own families and communities were important drivers, and also the need to make a difference in the communities in which they lived and worked. Each of these women aspired to

achieve their own personal freedoms and were determined to face and overcome all barriers in order to empower themselves, their families and their communities.

Conclusion

This article has focused on mature women's attempts to enter undergraduate degrees in education through an RPL process. These women have spent years after their formal schooling trying to obtain a range of occupational qualifications that allowed them to work in lower-level positions in ECD centres. Their passion for, and commitment to, education led them to pursue higher education opportunities so as to improve their educational status and become fully fledged early childhood educators in their communities. From a human capital perspective, their pursuit of higher education shows a poor rate of economic return, especially considering that these mature women have spent more than three years trying to enter RPL programmes that would lead to their acceptance into undergraduate degrees in the field of education. However, an analysis of their career and learning pathways from a capabilities perspective shows their individual determination to succeed and to achieve both economic and social freedoms despite having to navigate poorly articulated education and training pathways. A final hurdle they faced was to access university education, which proved difficult without sufficient mainstream schooling qualifications and due to the lack of recognition of their occupational qualifications. For these women, the RPL access route for entering higher education was their only way into a university education. Using capabilities as a lens to view these mature women's education and training pathways not only illuminated their individual attempts to achieve their own freedoms, but also sheds light on the institutional and systemic blockages that continue to impede mature women's access to higher education.

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A critique of andragogy in the South African TVET context

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ABSTRACT

Andragogy, the 'art and science of helping adults learn' (Knowles, 1980:43), had some purchase in the South African technical and vocational education and training (TVET) sector, where writers and lecturers have been attracted to the idea that adult education has its own theoretical and epistemological principles. Recently, a notable number of writings in African countries, including South Africa, have advocated the adoption of andragogic methods to overcome the inadequate provision of workplace (procedural) learning in relation to formal (propositional) learning in TVET institutions. However, this article argues that andragogy is culturally biased because it is based on white, male, middle-class norms of the 1960s. Its assumptions about adult learning tend to marginalise others on the basis of race, gender, and cultural difference. This tendency is given a peculiar form in South Africa owing to the historical relationship between andragogy and fundamental pedagogics in the academic theorisation of apartheid ideology. On the strength of these historical, political, and cultural levels of criticism, it is suggested that andragogy has little veracity or credibility for TVET.

KEYWORDS

Adult education; andragogy; apartheid; cultural bias; fundamental pedagogics; gender; race; TVET

Introduction

It has been suggested that andragogy is a 'badge of identity' or an 'article of faith' for many adult educators (Brookfield, 1986:90; Rachal, 1994:3). Central to this sense of identity is the notion that andragogy – the 'art and science of helping adults learn', as defined by Malcolm Knowles (1980:43) – represents a progressive break with the traditional teaching and learning methods of the past, where 'school learners sit, watch, listen, and write' (Macedonia, 2019:par 1). However, the present article argues that this sense of progressive education is misleading because the theory of andragogy is culturally biased in favour of *whiteness* and prejudiced against other races, genders and cultural groups. In South Africa, this bias has a particularly malignant history in the close association of andragogy with fundamental pedagogics, revealing inherited forms of oppression in the South African technical and vocational education and training (TVET) system that are still manifest today.

The article comprises five parts. First, some general background is provided regarding andragogy and its influence on TVET, including reflections on the aims of this article. Second, an account is offered of Knowles' defining theory of andragogy. Third, the optimistic adoption in recent times of andragogy as a guiding principle in TVET is explored, particularly in relation to the political economies of countries of the Global South. Next follows a discussion of the social and cultural assumptions of andragogy, which turn out to privilege white male rationality over the different cultural orientations of people of colour, other genders, immigrant communities, and other marginalised groups. Finally, the close historical association in South Africa of andragogy with fundamental pedagogics – often described as the official theory of apartheid education – is examined.

Background: Andragogy in TVET

My concern here is with various societal dimensions of the idea of 'andragogy' – the political, social and cultural arguments for and against it as the perspective of choice in adult, and particularly TVET, education. It is generally accepted that TVET students – post-school, past the age of 18, and focused on future occupations – are adults (although this notion itself can cynically be politically manipulated, as I shall demonstrate towards the end of the article). The distinction between teaching children ('pedagogy') and teaching adults ('andragogy') has thus had some purchase in TVET.

The notion that adult learning has its own theoretical and epistemological principles resonates with many theorists and educators. Reischmann (2004) observed that 'andragogy' was strongly adopted from the sixties in different parts of the world by amorphous communities of educators who taught adults in a situation in which there was minimal institutional recognition, theoretical knowledge and formal training in adult education: 'To be offered … humanistic values and beliefs, some specific methods and a good sounding label, strengthened a group that felt inferior to comparable professions' (2004:4). In TVET by the 1980s, andragogy was advocated strongly as the basis of programmes in 'occupational assessment', 'vocational training', 'job placement'

and other adult vocational training in the United States (US) (MacFarland, 1985; Henschke, 2016:5), 'human resource development' in Germany (Reischmann, 2004:4), and as common practice in vocational education in Australia (Choy & Delahaye, 2003). A recent United Nations Educational, Scientific and Cultural Organization (UNESCO) publication posits that the principles of andragogy provide the best possible understanding of the aims, purposes and professional identity of adult education in Africa (Nafukho, Amutabi & Otunga, 2005). At the same time, 'andragogy' does not have universal purchase as a working concept in adult education: for example, a recent overview of policymaking in the field, also a UNESCO document, does not use the word at all (Nikolitsa-Winter, Mauch & Maalouf, 2019).

The context of this article is TVET in South Africa, although most of the issues it engages with have global purchase in relation to patterns of inequality within and between countries. Only the final section is distinctively South African. More specifically, it is written as a reflection on my own experiences as a lecturer on a diploma course aimed at developing the pedagogical knowledge and skills of lecturers at South African TVET colleges. Most of these 'lecturer–students' are qualified and experienced craftspersons in particular trades or professions – boilermakers, chefs, electricians, hairdressers, information technology (IT) technicians, office managers, plumbers, etc. – but have no formal educational qualifications. The Advanced Diploma in Technical and Vocational Teaching is intended to provide them with some educational expertise related to TVET. It is designed as a national curriculum framework to be interpreted and recontextualised into actual courses delivered by various university providers. The course I teach is concerned with issues in the philosophy of knowledge (specifically the distinction between procedural, propositional and professional knowledge) and the psychology of learning (behaviourist, cognitivist, constructivist, socioculturalist and embodied perspectives and their implications for pedagogy).

I am constantly asked by students, 'But what about andragogy? Where does andragogy fit in?' or questions of a similar kind. There seems to be some kind of residue left behind by andragogy that is triggered by considerations of adult learning and which enters a mainstream course on psychological theories of learning willy-nilly. I am intrigued by the fact that I do not get asked similarly about, say, Mezirow's (1991) transformative learning, Revans' (2011) action learning or even Freire's (1970) critical pedagogy (*conscientização*), which are equivalent theories to Knowles' andragogy. Bélanger (2011) distinguishes carefully between (a) 'main learning theories' in adult education, such as those in my course, and (b) 'adult learning-related theories' – humanist theory (including Knowles), experiential learning and transformative learning (including Freire and Mezirow). Thus (a) and (b) are not equivalent categories – the axis of cohesion[1] of the theories in (a) is the development of the mind and

1 Andrew Abbott (2001) usefully distinguishes the 'epistemological axis of cohesion' of different academic disciplines and fields, by which he means a symbolic language or pragmatic orientation that gives each coherence as community of scholars. A discipline does not require a single, overarching theory, but requires consensus on its core objects and/or objectives of study. So, for example, 'anthropology is largely organised around a method, political science around a type of [power] relationship, and economics around a theory of action' (Abbot, 2001:140).

conceptual change in adults, whereas in (b) it is the procedures that adult learners engage in that produce learning. So my purpose in researching and writing this article was to understand better this residue, where it comes from, and how best I might be able to respond to my students' questions on andragogy.

Malcolm Knowles' theory of andragogy

The term 'andragogy' was coined in 1833 by a German teacher, Kapp, in interpreting Plato (Reischmann, 2004; Loeng, 2017). Regarding TVET, it is of interest that Kapp's focus was on vocational education for different occupations in which he emphasised the inner building of 'character' through self-reflection rather than the outer 'objective competencies' (Henschke, 2009). The latter observed skills in tool use were for Kapp merely 'shadow figures' of the general, underlying occupational wisdoms, namely knowledge of legislation, the judicial system, gymnastics and medicine (Loeng, 2017:634). This is an echo from the past of the contemporary policy emphasis in TVET on 'soft skills' rather than 'hard skills'. Soft skills, such as critical thinking, project management, teamwork and conflict resolution are general competencies that underlie a wide variety of occupations; hard skills are job- or task-specific technical competencies (ILO, 2021; RSA, 2022).

In the late 1920s, Lindeman (1926) revived the term 'andragogy' to describe teaching methods specific to adults. However, this 'new' concept did not take hold for decades and 'pedagogy' tended to apply to any teaching or learning situation, including adult education. Lindeman's student, Knowles, was later to take up 'andragogy' as the name for his systematic approach to adult learning.

The concept of andragogy is today most closely associated with Knowles, who developed and systematised the theory in the United States in the 1970s. Knowles was strongly influenced by Carl Rogers' (1967; 1969) view that formal education denied self-actualisation: Rogers famously suggested that 'teaching is a relatively unimportant and vastly overrated activity' (Rogers, 1969:103). In the therapeutic context, Rogers' 'person-centred' psychology wanted to break with the idea that a psychotherapist treats 'patients' by modifying their behaviour using an external, often harsh reinforcement technology. In a nutshell, he insisted that his 'clients' were to be treated as adults, responsible for their own behaviour. He advocated a psychotherapy in which people were encouraged and supported to take and implement decisions to change their own behaviour. This was the *zeitgeist* into which Knowles moved as an academic in the 1970s. He described it as

> exhilarating. I began to sense what it means to get 'turned on' to learning. I began to think about what it means to be a facilitator of learning rather than a teacher (Knowles, 1989:14).

Knowles extended the idea of a responsible, self-directed adult into a criticism of traditional education, questioning whether standard pedagogical assumptions in schools also applied to

adult learners. He set out to develop a 'holistic' theory of adult learning anchored in distinctive motivations, interests, capacities and goals of adult learners (1968:386). Across his writings, Knowles developed the following five assumptions (summarised in Table 1) about the characteristics of adult learners that are different from formal schooling: self-concept, the learning process, readiness to learn, orientation to learning and motivation to learn.

Self-concept

Knowles (1980) conceives the human lifespan as a movement from dependency towards independent, mature, 'objective', *adult* understanding. Adults thrive on a sense of autonomy and self-determination in relation to their learning, whereas children feel dependent on the teacher for learning. Andragogy would thus conceive of TVET learners as self-directed, using opportunities provided for them by actual workplaces, college workshops and lectures to shape the course of their own learning. Learning procedural knowledge associated with tool-use, for example, TVET learners will 'learn by doing', refining their skills and correcting mistakes with little need for direct teaching.

The learning process

Knowles (1980) seeks to contextualise adults' learning in previous experience that they bring into the learning environment. They draw upon this reservoir of knowledge even when they encounter new ideas and skills. In contrast, children bring minimal experience to the classroom. They usually learn things for the first time, so pedagogy tends to be based on the instruction of new concepts. In TVET, andragogy implies that the teacher must tie course material to learners' past experience using strategies such as activity-based learning, problem-solving and discussions.

Readiness to learn

The idea of adults being eager to learn relevant tasks is central to Knowles' (1980) thinking. Andragogy assumes adults have jobs, family responsibilities and social location that determine what and when they learn. Adults value opportunities to learn about the specific roles they play in society. In TVET, andragogy would therefore assume that students want task-related know-how for work, unlike the general knowledge that schools emphasise.

Orientation to learning

Adults need to know why they are asked to learn something (Knowles, 1980). Their learning orientation is one of immediacy – they seek 'just-in-time' knowledge to apply directly to practical issues and problems in the world around them. School learning, in contrast, has a 'postponed application' – it is concerned with 'just-in-case' knowledge that is designed to prepare learners for all eventualities in later life. In the TVET context, andragogy therefore emphasises problem-based learning – the implication of Knowles' view is that lecturers ought

to make it clear from the start what the purpose of a learning activity or task is in relation to the knowledge and skills required for the workplace.

Motivation to learn

The learning motivation of an adult is internal (Knowles, 1984:12), driven by their understanding of the knowledge and skills necessary to achieve their potential; a school child's motivation to learn, on the other hand, is mostly external. So adult TVET learners would be understood as putting themselves into new situations to pursue their technical and vocational qualification goals, and they seek andragogic learning experiences that will allow them to do so.

Table 1: Knowles' distinction between andragogy and pedagogy (distilled from 1968, 1973, 1980)

	ANDRAGOGY	**PEDAGOGY (i.e. SCHOOLING)[2]**
Self-concept	Adults are self-directed learners moving towards independence.	Teachers are responsible for the learning of the children, who are dependent beings.
Learning process	Adult learning is problem-centred and grounded in experience.	School learning is based on the instruction of unfamiliar subject content.
Readiness	Adults want specific learning about their work and other roles in society.	In school, children need generic learning to prepare them for the future.
Orientation	Adults are interested in 'just-in-time' learning immediately related to their lives.	School learning is 'just-in-case' preparation for an adult future.
Motivation	Adult learners are internally motivated.	In schools, children are externally motivated.

Knowles does not consider andragogy as an epistemology so much as an approach that can draw on different theories. He encourages adult educators to realise fully the assumptions of andragogy by setting up the classroom or learning environment to facilitate a cooperative learning climate. This entails involving learners in diagnosing their needs, interests and skill levels and formulating learning objectives together. Knowles argues that adult educators should design a sequence of tasks to achieve these objectives, working collaboratively with learners to select methods, materials and resources for learning (Blondy, 2007:117).

2 Rogers (1980; Rogers & Lyon, 2013) later developed strong criticisms of the way children were taught in schools, along similar lines to Knowles' criticism of pedagogy.

Andragogy in contemporary TVET contexts

At the systemic level, andragogy holds out the promise of a progressive teaching and learning methodology that can overcome the constraints of traditional education and be responsive to the needs of adult learners in relation to their lives, careers and workplaces. In post-school formal and non-formal TVET circles, it has been a prominent concept to try to account for the distinctiveness of this terrain. Although also not widespread throughout the literature – for example, it is absent in recent influential accounts of TVET 'pedagogy' published by supranational states (OECD, 2015; UNEVOC, 2020) – much contemporary use of the term 'andragogy' in TVET tends to conceive of it as the learning and teaching approach necessary for a successful workplace learning component in the TVET curriculum.

The TVET issue here is 'the gap between academic abstractions and situated [workplace] knowledge' (Shalem & Allais, 2018:8). Most contemporary writing on TVET grapples with the problem of the integration of theoretical learning in institutions with practical on-the-job training (Billett, 1993; Papier & Vollenhoven, 2017; Hordern, Shalem, Esmond & Bishop, 2022). There are strong suggestions that there is increasingly insufficient curriculum coverage of the *procedural* knowledge acquired in the workplace, in relation to formally acquired *propositional* knowledge, to achieve occupational expertise. Obviously, this debate about learning in real-world work settings is engaged through a range of theoretical lenses: 'workplace learning, internships, simulation, education with production, training with production, mentorship, coaching, apprenticeship and so on' (Russon & Wedekind, 2023:100). However, amid this broader literature, an expanding corpus of writing looks to andragogy to provide teaching and learning methods for TVET that will foster a 'paradigm shift' away from rigid formal institutional learning to more flexible workplace learning (Kanwar, Balasubramanian & Carr, 2019).

This seems to be particularly the case in countries of the Global South. In South-East Asia, there appear to be expanding cross-national networks advocating applied andragogy as a 'real-world' instructional strategy to effectively bridge the *practical skills students acquire in workplace learning to the formal curriculum of a TVET college* (Arifin et al., 2020; Rubayet & Imam, 2021). Numerous local studies in African countries recommend an andragogical approach as the basis of a move away from traditional subject-matter-centred curricula and associated academic assessment systems, to a competency-based curriculum centred on 'more practical' job-related skills acquired by direct experiential learning in industrial or community contexts (Lloyd, 2018; Med & Lukyamuzi, 2019; Ngwacho, 2019; Odigiri et al., 2019; Ngozwana, 2020; Akintolu & Letseka, 2021; Mutambisi et al., 2021; Anyiendah, Odundo & Ganira, 2023). Johnstone suggests, referring to Tourism TVET in South Africa, that andragogical thinking takes us definitively beyond reliance on only the formal knowledge of the lecture theatre to a recognition that 'imitation and observation in the workplace produces experts in a specific technical or vocational field' (2021:108).

To pull together the strands of the argument thus far: Knowles' andragogy claims to offer an instructional methodology in tune with the distinctive needs of adults. These ideas, when translated into principles for an education system such as TVET, envisage teaching and learning that are more closely tied to the everyday work and life needs of adults than formal schooling is able to do.

Political and cultural critique of the theory of andragogy

Contrary to this optimistic social promise, however, andragogy has faced severe criticism of its conception of and implications for political and cultural change related to education. Brookfield (2003) regards the theory as 'culture blind', arguing that its key notion of *self-directed learning* (see Table 1) marginalises people with racial and cultural identities that value the teacher as the source of knowledge and guidance. Dantus (2021) and Duff (2019), echoing this sentiment in more recent debates on the decolonisation of adult learning, both argue that andragogy is permeated ideologically by the discourse of universality and individualism characteristic of the dominant white male culture of the Global North. Many authors regard andragogy as predicated on the *individualist* norm of a white middle-class, US male of the mid-20th century, who was supposedly a self-motivated, self-starting, independent, resourceful problem-solver (Pratt, 1993; Flannery, 1994; Johnson-Bailey & Cervero, 2000; Birden, 2003; Lee, 2003; Sandlin, 2005; Brookfield, 2014; Duff, 2019; Dantus, 2021). Lee (2003) suggests that marginalised groups of people socialised in relatively different contexts tend to view learning and teaching in ways not compatible with the methodological assumptions of andragogy. 'What happens,' ask Johnson-Bailey and Cervero (2000:154), 'when the learner's culture places more emphasis on the community and therefore encourages the individual to refrain from sharing personal ideas or concerns?' Their answer is that andragogy, in its tacit, historically rooted white male individualism denies women, black (the cultural contexts of 'people of colour' – Lee, 2003), working-class and immigrant learners their situatedness in the actual hierarchies of everyday social life:

> [T]he unspoken assumption [is] that the activity of teaching and learning must happen in a parallel universe to the real world because the power relationships based on race that are omnipresent in the social and organizational settings of everyday life have been obliterated (Johnson-Bailey & Cervero, 2000:149–150).

In other words, Knowles' notion, in relation to the orientation and motivation of adult learners (Table 1), that individual learners – and teachers, for that matter – are naturally inclined to want to speak freely in a 'problem-solving' mode, further alienates already marginalised groups.

Lee (2003:15) charges that Knowles drew on 'a population that was not unlike himself' to provide samples of his approach. Reading Knowles, it does indeed appear that his research on the developing theory of andragogy tended to focus on white men as research subjects, as

pointed out by Flannery (1994), Duff (2019) and Dantus (2021). Certainly, the collection of case studies in business, industry, government and education that he introduces in *Andragogy in action* (1984) tends to be focused on educated middle-class white males (or white women in the 'female professions' such as nursing and social work). Even the two non-US chapters in the book – set in Brazil and Africa – reveal no strong sense of engagement with diversity along the lines of race, gender, class, citizenship or national origin. Knowles, however, takes them to be evidence that andragogy 'does not appear to be culture bound' (1984: 417). Critics have pointed out that there is hidden sampling bias in the book's 36 exemplars that generalises *whiteness* as a 'universal' principle of adult learning (Flannery, 1994; Duff, 2019). The bias was 'hidden' simply because mainstream US society, including academia, of the time did not recognise cultural diversity and attendant oppression among adults – an adult was an adult was an adult, to paraphrase Gertrude Stein.

Generally, research shows that women tend to be sidelined in andragogy because the 'speak freely' modality assumes political neutrality in relation to male privilege and domination brought into the learning environment (Lee 2003; Sandlin, 2005). In relation to Africentrism and race more generally, critics suggest andragogy's assumption of the individual pursuit of rational self-knowledge works against the more collective, emancipatory orientations of adult learners of colour (Guy, 1999; Merriweather-Hunn, 2004; Brookfield, 2014). Several research studies demonstrate this in relation to Chinese immigrant learners in the United States (Hvitfeldt, 1986; Pratt, 1991; Lee, 2003). These studies emphasise that alternative cultural configurations display a respectful attitude towards teachers and knowledge that is 'usually marked by an absence of questioning and critique of instructors in the classroom' (Lee, 2003:13). One might say, ironically, that a different kind of pedagogy to that of andragogy may be called for by these adult learners, perhaps one that recognises the more active, even activist, role of the teacher as a facilitator and mediator (Selepe & Moll, 2016; Russon & Wedekind, 2023).

Ironically, andragogy suffers from these theoretical flaws at the societal level precisely because of Knowles' search for the idealised or 'pure' adult at the level of learning. Because he focused intensively on defining the individual adult learner, he ignored the implications for learning of the diverse sociocultural contexts in which adults are necessarily situated. Andragogy assumes that adults operate in 'splendid solitude', entirely self-directed and internally motivated 'in learning settings apart from the constraints and impediments of their circumstances' (Lee, 2003:13). There is, of course, a paradox here: much of our knowledge is constructed without apparent help from others. However, the reason for this is that we have internalised *operative* knowledge and social structures as the forms of our own knowing and being, as both Piagetian and Vygotskian constructivism have shown (Moll, 2022). In similar terms, Pratt (1993:18) describes the neglect of the cultural context of learning in andragogy as the learner 'operating as if he/she has risen above the web of social structures'.

In this individualism, andragogy stands in stark contrast to the 'critical pedagogy' of Freire (1970; 1993), whose conception of the teaching of literacy was socially situated, embodied

and contextualised: he taught adults to read and write *in the process* of coming to understand and criticise their own workplace and socio-economic circumstances (*conscientização*). In contrast, the only sense of context that Knowles intimates is direct life experience (including work experience) and the preparation of the learner for an occupation.

There is a robust and deepening local literature in South Africa concerned with exposing and challenging inherited forms of oppression in the TVET system along the lines of race, gender and ethnicity, many of which arose under the peculiar South African conditions of segregation, apartheid and enduring coloniality (Gewer, 2016; Nkomo, Tshikovhi & Warchal, 2016; Soudien, 2018; Gamble, 2021). Some important examples of this literature engage with sustained tensions that mirror 'apartheid exclusion, discrimination, and alienation of people based on race' (Wedekind & Buthelezi, 2016:68), gender inequalities that permeate the experiences of women in TVET (Bonzet & Frick, 2019; Daniels, 2019; Matenda, 2020), the marginalisation of community voices and cultural wisdom (Hendricks & Aploon-Zokufa, 2021), and linguistic access in TVET (Lück & Magxaki; 2019; Stander, Du Plooy & Scheckle, 2022). However, insofar as 'andragogy' has any purchase in South African TVET today, it still seems to operate within the white middle-class male norms that influenced Knowles – it seems to me that there is something of this in the 'residue' that I mentioned earlier.

Historical distortion of adult learning in South Africa

There is an unfortunate history to the use of the term 'andragogy' in South Africa, in the doctrine of fundamental pedagogics, considered to be the theoretical formulation of apartheid education ideology. In politics, Verwoerd's notorious racist proclamations on education for black South Africans in the 1950s are well known. Perhaps less well understood is that these are the earliest formulations of TVET policy under apartheid:

> The Bantu[3] must be *guided to serve his own community* in all respects … there is no place for him in the European community *above the level of certain forms of labour* … . What is the use of teaching the Bantu child mathematics when it cannot use it in practice? … In the Native territories, … Bantu education can complete its full circle, by which the child is taken out of the community by the school, *developed to his fullest extent in accordance with aptitude and ability and thereafter returned to the community to serve and to enrich it* (SAHO, 2016; emphasis added).

In government, the Christian National Education (CNE) *beleid* (policy), which drove education after the whites-only election that brought the apartheid regime to power in 1948, was as blatantly racist and ethnocentric. Among its 'principles' were that all learners:

3 Technically, 'Bantu' is a description of a subsection of the Sintu languages spoken by the Nguni people of South Africa (isiZulu, isiXhosa, siSwati, isiNdebele, Xitsonga). It also, for example, in isiZulu, means 'the people'. However, apartheid authorities used the term to refer to African people in general – as in 'Bantu education' – and it took on derogatory and even racist connotations as used by whites in the context.

> should be taught in the light of God's decreed plan for the human race … separate nations and peoples … . [Therefore] Native education should be based on … trusteeship, non-equality, and segregation; its aim should be to inculcate the white man's view of life, especially that of the Boer nation, which is the senior trustee (Tatz, 1961:20; Hirson, 1979:42).

Education and training, instructed the *beleid*, must preserve the 'cultural identity' of black populations and lead 'the native' from 'a state of cultural infancy' to acceptance of Christian and national principles (Enslin, 1984).

In academia, fundamental pedagogics (FP) emerged to prop up these political and governmental machinations in justifying apartheid ('separate development'). In the heyday of apartheid education, FP was the prevailing dogma at white Afrikaans-medium universities and it dominated the curriculum at technical colleges and colleges of education that trained black teachers (Enslin, 1984:141–142). Its proponents sought to give it respectability beyond the nakedly racist, to be recognised in academic terms. The fundamental pedagogicians conceived FP as a 'universal science' that distils the 'essences' of education through contemplation of *pedagogical* practices that 'penetrates beyond culture, race, religion and time, for example, to find that which is universal' (Du Plooy, Griessel & Oberholzer, 1982:50). It supposedly reveals to us what any and every educational practice must be like in order to be authentic.

Fundamental pedagogicians needed a concept to justify the 'universal' idea of education as 'leading the educand [the child] to maturity', and this they found in a strong concept of *pedagogy*. So the pedagogic 'essence' of the child is that of 'becoming-a-person', 'becoming an adult', an 'adult-in-the-making', a 'not-yet adult' (Nel, 1974:70; Griessel, 1987:69; Du Plooy et al., 1982:86). It follows, then, that the 'essence' of education becomes the *achievement of adulthood* (Viljoen & Pienaar, 1971:131; Landman, Van Zyl & Roos, 1975; Griessel, 1987:64–65), and not just adulthood, but 'civilized adulthood' (Du Plooy et al., 1982:166). 'School education … [is] directed at accompanying pupils to proper adulthood' (Landman, 1985:105). And therein lies the rub: what is 'civilised' and 'proper' adulthood? For FP, it is the *philosophy of life* (or 'lifeworld') that

> every cultural group gives expression to *in its own individual way* … . Within a given cultural pattern every man [*sic*] in his own particular way gives shape to the idea of adulthood (Griessel, 1987:79).

A symptomatic reading of FP texts makes it clear that these 'philosophies of life' are the distinct 'nations' that must be educated separately and kept apart culturally (hence *apart*heid). Fundamental pedagogicians put forward the notion as a thinly disguised justification of racial segregation in education. Griessel (1987), for example, describes a philosophy of life as an ethnically distinct hierarchy of values:

> As a member of a group [the educand] must always choose the values and must accept personal responsibility for this choice. … [as] Afrikaner, English-speaking South African, Jew, Indian, Black … in national coexistence (1987:75).

In education, it is to be founded in a

> common language, common tradition or history and participation in a common mission. [These] are factors that are decisive … we talk, for example, of a typical Zulu, Englishman or Indian. … [an individual] must always choose the valid values (Du Plooy et al., 1982:152).

Thus, the function of education is to inculcate this basic ideology:

> An authentic educator brings up a child according to his deepest convictions as to what is proper for the child to do … in terms of the aim of education and the ingredients of parents' philosophies of life (Du Plooy & Kilian, 1981:50).

The 'science' of FP reveals these 'essences' to us, says Landman, stressing that *adulthood* is the aim of education:

> Education is in reality the actualization of a philosophy of life. It is the particular scientific task of Fundamental Pedagogics to expose the characteristics which determine the viability of a philosophy of life. … [Education is] completely unthinkable without the directive and normative force of a philosophy of life (Landman, 1985:101–102).

The salient point here, ideologically speaking, is that there is a strong concept of adulthood in the 'revelation of the pedagogic essences' that served to justify *apartheid* education.

In this context, fundamental pedagogicians seized on the term 'andragogy' to refer to the education of people who had achieved this understanding of otherness ('proper' adults, as it were). The general context was, of course, the increasing recognition of lifelong learning, which FP had to take into account. Two of the leading FP writers, Landman and Oberholzer, took this on in 'reconsidering FP' papers in the 1980s (Oberholzer & Greyling, 1981; Landman, 1989) in which they brought *andragogy* to the fore as a theorised practice within FP (strictly speaking, 'fundamental agogics' in their terms). However, both clung strongly to the firm distinction between pedagogy and andragogy in service of the ideological work of FP. Landman differentiated pedagogy as 'compulsory education' from andragogy as 'life obligation', suggesting that, in the latter, adults as human beings 'can reach a state of *more proper adulthood* without the agogic intervention of another adult' (1989:7). Oberholzer & Greyling (1981:71) introduced 'fundamental andragogics' in which the 'essential humanity' of dialogue between adults – 'human beings as persons with the potential to create, design and transcend their worlds' – determines the successful educational outcome What is

remarkable here is the affinity between these conceptions of the 'self-actualising educand' (Vrey, 1979) and Knowles' conceptions of self-determining learners (Table 1). This affinity probably accounts for the rapprochement between FP and andragogy (see Robb, 1990) and carries forward Knowles' construal of the difference between formal and non-formal learning.

One cannot end this reflection on andragogy and FP without mentioning the characterisation of TVET learners that FP seems forced into: Vrey points out that, in the contemporary college context, a youth is 'an independent adult', but 'he [sic] is economically dependent':

> The extended period of dependence *has forced the post school youth into the area of pedagogic concern.* Pedagogics … must define the characteristics of this group as incipient adults. … Help to this group cannot be defined as andragogic support: they are still dependent in too many ways and cannot be saddled with full responsibility (Vrey, 1979:190).

BF Nel (1974:246), another FP luminary, suggests that this 'cultural phenomenon' requires an extension of the period of pedagogy in response to the 'new social forces of an industrial urban society … [causing] an extended period of puberty'. FP finds it difficult to account for the failure of pedagogy – implicit in all its exaggerated accounts of successful education being the attainment of mature adulthood. Ironically, it is in the terrain that TVET occupies in South Africa that this can best be discerned.

This analysis of FP, in the unique South African political and social context, reinforces the sense that andragogy is implicated in a colonial and neocolonial bias towards whiteness. Far from being 'universally valid' knowledge about educating adults, it has contributed ideologically by virtue of its association with FP to the ongoing reproduction of inequality in this society. Given that the residue of FP still appears in TVET colleges, it seems it will be difficult to overcome this legacy for some time to come.

Conclusion

The argument in this article is that andragogy fails to realise the progressive potential that its proponents envisage in overcoming the legacies of formal institutionalised TVET. Rather, andragogy seems to lead us into oppressive practices in its implications for and applications in adult education. An account was provided of Knowles' defining theory of andragogy, showing the basis of his claim that andragogical methods break with the 'teacher-dependent, just-in-case, externally motivated' learning of traditional schooling and formal education. This promise of progressive change has been taken to be the basis of TVET programmes that can provide more adequate workplace learning opportunities: examples of this in Africa and other countries of the Global South were discussed. However, while andragogy is widely advocated for this purpose, especially in such political economies, it has been shown to be theoretically, politically and culturally flawed. Its ideological dependence on the cultural and learning-related norms of *whiteness* tends to marginalise

persons of other race, gender and sociocultural origin, and can privilege white male educational aspirations. Moreover, the article has revealed the sinister historical association of 'andragogy' with the educational doctrines of apartheid in South Africa, adding further to its legacy of racist and ethnocentric bias in this context. There might be important principles to be learnt from this regarding the future of TVET and other adult education systems in neocolonial contexts of the Global South. Andragogy seems to have little credibility in the contexts of increasing diversity of the TVET terrain. The argument suggests that our most productive route is to join Davenport (1987:19) and to conclude that TVET education 'could survive quite nicely without andragogy'.

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EDITORIAL POLICY AND PROCEDURE

The *Journal of Vocational, Adult and Continuing Education and Training* (JOVACET) recognises the need for critical engagement through studies in TVET and Adult and Continuing Education and Training, and for encouraging critical scrutiny of this expansive knowledge area on the African continent.

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