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The Integration of ICT in TVET College Classrooms: A Case in Automotive Repair and Maintenance Teaching

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ABSTRACT This paper examines the knowledge and beliefs that TVET lecturers have about teaching automotive repair and maintenance in South African TVET colleges. ICT technology provides the means through which technical vocational education can improve the TVET sector. The success of technology integration in VET depends largely upon lecturers, their professional knowledge, pedagogical and technological knowledge and the relationship between their beliefs about these constructs. In this paper, mixed methods were used to examine how lecturers' knowledge and beliefs influenced their technology integration practices. Questionnaires and interviews were used to collect data from twelve TVET lecturers teaching Automotive Repair and Maintenance in four TVET colleges in Gauteng. It was discovered that specific characteristics or behaviors related to each of the technology integration components of TK, TCK and TPK impact successful planning and implementation of TVET lecturers' technology-enhanced lessons.

INTRODUCTION

Technical Vocational Education and Training (TVET) is an integral component of the South African education system. It is one of the three major sectors of education and training in South Africa designed to meet the skills shortages in South Africa. Technical vocational education that is offered at TVET colleges plays a pivotal role in the attempt to meet the skill shortages and drive the economy of the country. It is therefore important to ensure that vocational education programs provide real world skills required by the private and public sectors. The curriculum of Technical and Vocational Education Training (TVET) is based on a vocation, for example, Automotive Technician, and this plays an important role in producing skilled and semi-skilled manpower for the country.

A paper of lecturers in the South African Technical Vocational Education and Training (TVET) colleges was undertaken by the National Business Initiative (NBI) in 2009 and completed in 2010 (DHET 2011). The paper provided an initial picture of the qualifications of TVET college lecturers and their capacity to deliver the theoretical and practical components of the national (NCV) curriculum. This paper was limited to three fields of learning (construction, engineering and information technology) and just over one-third of the 50 TVET colleges responded to the questionnaire. However, the results of the paper suggested that there were significant weaknesses in the current capacity of lecturers in the TVET college sub-system, which impacted the quality of delivery, as was demonstrated through the national examination results (DHET 2011). These poor results could be attributed to the lecturers' PCK in the engineering fields. Previous research related to training effectiveness and its quality did not emphasize on the pedagogic and didactic processes such as teaching and learning. According to Taylor (2011), the current TVET lecturers' cadre in South Africa is ill prepared to deliver the new curriculum. Many TVET lecturers enter the sector with rich content knowledge of a particular trade or vocation and it is assumed that they bring with them knowledge of the tools and the technology of

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that industry from the workplace. It cannot be assumed that lecturers have developed sufficient pedagogical knowledge to inform their teaching practices, let alone the technological knowledge required to integrate technology with their pedagogy (Wheelahan and Moodie 2010). Due to the poor training of TVET lecturers from the previous apartheid regime, there is great need for TVET lecturers to be competent in both content and pedagogic aspects of their teaching and learning process. This paper is based on the hunch that the current TVET lecturers lack technological and pedagogical content knowledge in their teaching practices. This hypothesis is supported by the Ministry of Education when mandating higher education institutions to work with TVET colleges to empower TVET lecturers in pedagogic aspects. Hence, this paper sought to explore the vocational pedagogy and instructional issues by investigating the integration of technological, pedagogical and content knowledge, which is currently receiving great emphasis in the educational world.

Literature Review

Technological Pedagogical Content Knowledge Constructs and Their Application in the TVET Sector

Pedagogical knowledge refers to teachers' knowledge about the processes of teaching and learning (with or without technology) and how it is realized to achieve educational purposes, values and aims. A teacher with 'deep pedagogical knowledge understands how students construct knowledge, acquire skills and develop habits of the mind and positive dispositions toward learning' (Mishra and Koehler 2006). The need to strengthen TVET pedagogical practices has emerged for several key reasons. As the TVET sector is called upon to deliver more ambitious government objectives, the need for more complex pedagogies to address the needs of diverse students from various backgrounds is paramount (Guthrie et al. 2006; Wheelahan 2010). The technical vocational sector's close association with the workplace makes it more complex than academic teaching, in that it involves working with multiple clients, in multiple contexts and across multiple learning sites. The TVET lecturer's role has therefore extended to developing industry partnerships and working collaboratively with specialist service providers.

In the TVET sector, lecturers are recruited based on their content knowledge which is being taught in colleges. It is assumed that lecturers begin their teaching career with rich content knowledge of a particular trade such as automotive repair and maintenance bringing with them knowledge of the tools and the technology of that industry. Their content knowledge is often highly specialized technical vocational knowledge, and any changes to the industry over time indicate the importance for TVET lecturers to regularly update their content knowledge (Toner 2005; Wheelahan and Moodie 2010). Sometimes many lecturers may not have this required knowledge if they have been removed from that industry for many years (Cornford 1999). Therefore, there is a pressing need for TVET lecturers to develop industry currency and apply this updated knowledge to their teaching (Corbel 2013).

Lecturers' content knowledge (for industry) and lecturers' content knowledge (for teaching) presents certain pedagogical challenges specific to the TVET lecturer. It requires the TVET lecturer to re-contextualize their implicit content knowledge into explicit knowledge forms so that it can be taught (Robertson 2010). According to Salter and Bound (2009), research on content knowledge in the TVET sector is limited. While the TPACK model acknowledges the importance of content knowledge, the heavy involvement of industry in the TVET sector may generate considerable epistemological debate as to who determines the content that is to be taught. As most technologies are not developed for teaching or educational purposes, the teacher's role is to repurpose them for educational purposes (Koehler et al. 2014). Researchers have argued that to include traditional forms of technology, technological knowledge (see Schmidt et al. 2009) clouds the focus (Chai et al. 2013). Others confine technological knowledge to computers as more appropriate and meaningful (see Cox and Graham 2009). In the TVET sector, the definition of technology needs to be expanded to include specific technology, which refers to equipment, and machines, which are used to perform certain tasks in the workplace (Guthrie et al. 2009).

Lecturers need the pedagogical knowledge to teach the content. A recent report on the quality of teaching in TVET recommended the commissioning of research into the develop-

ment of pedagogical content knowledge in different fields or disciplines to develop a distinct TVET pedagogy (Wheelahan and Moodie 2010). Both Wheelahan (2010) and Robertson (2010) addressed the need for teachers to have strong pedagogical content knowledge. The calls have come from a renewed focus on the quality of TVET lecturers. Even in South Africa, according to Taylor (2011), the current TVET lecturer cadre is ill prepared. Furthermore, he added that until recently in South Africa, there was no training based for TVET college lecturers and there has never been a concerted effort to develop a *new* pipeline of lecturers. So far, recruitment has been *ad hoc*, and colleges are often forced to appoint lecturers from the ranks of their own graduates because no other trained personnel are available. In an informal qualification audit undertaken by DHET, it became evident that current lecturers have an array of qualifications, ranging from those with formal teaching qualifications or degrees to those with trade qualifications/trade theory qualifications or industry credentials, but no teaching expertise, and vice versa (SADTU 2011). According to the teacher Union SADTU, all TVET lecturers need general pedagogic knowledge, knowledge about constructing curriculum, knowledge of their specialist area (content knowledge), knowledge of students and their characteristics, and of educational contexts and the broader social purposes of learning, and they also need specialist pedagogic content knowledge, which is knowledge about how to teach in their content area, and support to deepen the underpinning knowledge of their content area. Technological pedagogical knowledge is the belief that teaching and learning changes when technology is applied, while transforming the technology so as to teach with it. Ferdig (2006) asserts that good technological pedagogical knowledge means using innovations that are steeped in good pedagogy.

METHODOLOGY

In this paper, both quantitative and qualitative methods were used. However, priority was given to the qualitative data because it answered the majority of the research questions, which form the backbone of this paper. Quantitative data was collected first from the participants as a means of understanding FET lecturer's TPACK. Using Archambault and Crippen's (2009) original survey was adapted for this paper. Therefore, the 26-item questionnaire was adapted from this model for the purpose of determining the relationship between TVET lecturers' technology, pedagogical and content knowledge. The revised TPACK questionnaire was piloted with a convenience sample made of six of the researchers' colleagues and a supervisor. For the reliability of the scales, Cronbach's coefficient was used, the internal consistency scores for each subscale calculated are determined as 0.946. The advantage of using the survey in the first phase was to provide a representation of lecturers' technology, pedagogy and content knowledge, from which the second, qualitative phase could extend and elaborate in more depth.

Based on the 14 completed questionnaires during the quantitative phase, the scores for each participant were calculated and then ranked from highest to lowest. Analysis of the quantitative data was undertaken in two stages. The first stage involved scoring participant results from the TPACK survey, which involved inputting results into a spreadsheet. The TPACK survey contained 26 items. To analyze the results, participants were ascribed a score for each item as 1 - Poor, 2 - Fair, 3 - Good, 4 - Very Good and 5 - Excellent. Overall scores were calculated for each participant. The maximum possible score was 130 and to register this, the participant would have excellent knowledge across all the TPACK domains. Profiles were prepared for each of the 14 participants, from which they were placed into three bands (high, medium or low). These profiles were used to select participants for the interview process. The second stage involved importing the spreadsheet data into SPSS for both descriptive and inferential analysis.

The interviews were video recorded in order to be replayed to establish a pattern that will explore the beliefs and experiences of the lecturers regarding their integration of technology in teaching automotive repair and maintenance. Interview data was transcribed after each interview and typed showing respondents' quotes as they were responding to the questions asked by the researcher (De Vos 2005). Data was then coded and analyzed and discussed thematically.

The selected twelve (12) FET lecturers comprised 11 males and 1 female chosen based on the spread of TPACK scores, and participants

Table 1: Selected TVET lecturers biographical data

Lecturer No.	*Post Level (PL)*	*Age group*	*Qualifications*	*Artisan*	*Teaching experience auto*	*NCV level taught*
1	PL1	46-55 years	Technical- Diploma	No	21 yrs.	NCV 2-4
2	PL1	25-45 years	Technical- Diploma	Yes	3.5 yrs.	NCV 2
3	PL1	25-45 years	Degree	Yes	10 yrs.	NCV 2-4
4	PL1	25-45 years	Other	Yes	4 yrs.	NCV 2-4
5	PL2	46-55 years	Other	Yes	2 yrs.	NCV 2
6	PL1	25-45 years	Other	Yes	1 yr.	NCV 2-3
7	PL1	56-65 years	Technical- Diploma	Yes	2 yrs.	NCV 2
8	PL1	25-45 years	Technical- Diploma	Yes	2 yrs.	NCV 2-4
9	PL1	25-45 years	Technical- Diploma	Yes	1.5 yrs.	NCV 2
10	PL1	25-45 years	Technical- Diploma	Yes	5 yrs.	NCV 2-4
11	PL1	46-55 years	Degree	Yes	19 yrs.	NCV 2-4
12	PL1	25-45 years	Technical- Diploma	Yes	5 yrs.	NCV 2-4
Total	12	12	12	12	12	12

were selected based on the highest, mid and lowest scores. In addition, the stratification of lecturers was made based on their teaching specialization of Engineering Related and Design and the level of instruction namely NCV level 2, 3 or 4. The biographical data of the participants is represented in Table 1.

Considering Mishra and Koehler's identification of TPACK as being a situated, multifaceted, and therefore complex teacher knowledge domain (2006), participants in this paper were from various backgrounds and were the researchers' choice in order to have a more detailed data of TPACK in TVET colleges. Lecturers were from different teaching experiences with different levels of subject matter training. Table 1 represents lecturers' demographic information.

The lecturers' age ranged between 25 and 65 years (N = 12). Among the 12 lecturers, 11 were males and 1 was female. The majority of these lecturers were post level 1 lecturers (90%) whilst a small percent of ten percent hold HOD positions. In terms of their qualifications, sixty percent possess a technical diploma, and only ten percent hold a degree whilst thirty percent have other qualifications. It is interesting to note that ninety percent of the teaching staff has artisan's status, which means that they have passed their trade tests and are rich with practical skills knowledge and have limited pedagogical knowledge.

RESULTS

The researchers conducted face-to-face interviews with the twelve TVET Gauteng lecturers. The interviews with lecturers were recorded and then transcribed (by Top Transcriptions) after which a sequence of repeated themes was extracted in relation to the TPACK theories presented in the literature review. Themes were derived from data obtained to answer the sub-research questions that guided the paper, that is, the main research question and RQ 1, which is, *What is the self-efficacy lecturer's belief about technology integration related to the constructs of the TPACK model?*

The researchers then analyzed the interviews for a second time with the purpose of verifying the themes found in the first analysis. The themes were then used for reporting the results. In reporting themes from the analysis, quotes were cross-referenced back to the researchers' original transcripts. The lecturers' responses to the interview questions were then mapped out according to the TPACK knowledge domains, and are reflected in Table 2.

Table 2: Lecturers interview responses related to TPACK domains

TPACK component	*Themes*
Technological Knowledge (TK)	Use of ICT tools for lecturing Definition of different technologies
Technological Pedagogical Knowledge(TPK)	Lecturer ICT integration competency affects teaching
Technological Content Knowledge (TCK)	Smart technologies enhance auto-motive repair and maintenance

Table 2 represents lecturers' interview responses that generated the different themes ac-

cording to TPACK knowledge domains. From the general coding categories identified from the data of the twelve participants, TPACK characteristics were identified and arranged into the three technology structures of TPACK as identified by Koehler and Mishra (2008). The lecturers were asked the following questions:

- What do you feel are the most important technological competencies for you to properly use technology in lecturing?
- How can you evaluate your own competencies in ICT integration in automotive service and repair?
- Do you know how to select effective teaching opportunities to guide student thinking and learning in automotive repair and maintenance?
- What do you know about technologies that can help you to present your content knowledge?
- What type of technologies do you need to enhance your teaching of automotive repair and maintenance?

The FET lecturer's' responses produced the following themes which are discussed below.

Theme 1: Use of ICT Tools for Lecturing

ICT in lecturing has become a teaching tool in the 21st century. TVET lecturers in this paper noted that they understood the TVET colleges' mandate to develop and promote teaching and learning using the integration of technology. Equally, they acknowledged some pressure to participate in a technological world as the way of the future, for both lecturers and students. This was particularly in Gauteng as illustrated by a lecturer (006) from TVET College 2 who said, *"We must be able to use a computer"*. Consistent with lecturers' conception of technology integration from the lecturers' responses in this paper, it was reasoned that technology opened up the students' world by providing a rich source of knowledge and information. This was common with many lecturers whose responses were: *use of video demonstration (003), use of overhead projectors (006), use Microsoft PowerPoint + tutorial videos + OHP (005),* this was in keeping with previous studies where a vocational education and training teacher is called upon to deliver more ambitious government objectives, the need for more complex pedagogies to address the needs of diverse students from various backgrounds is paramount (Guthrie et al. 2006; Wheelahan 2010). For some TVET lecturers, reasons for teaching with technology were for personal enjoyment, *"I guess I enjoy technology"*, *"Yes I think I do, I do, I definitely do"* whilst lecturer (004) from TVET college 2 felt, *"We don't have much technology in our college, we still lack these in lecturing"*. In this paper, lecturers did indicate limited exposure to the use of technology for teaching.

Theme 2: Definition of Different Technologies

TVET lecturers should possess the following technological competencies of use of video for demonstration, use of overhead projectors, use of personal computers for PPT and tutorial video, for example, simulation. ICT tools are essential for lecturing. An experienced lecturer (012) from TVET College 4 commented, *"For technologies you must be able to use a computer very well and a data projector, normal projector, you must be able to use transparencies so that you can show learners the different steps."* Another lecturer (011) from the same institution confirmed this belief, *"Firstly, I use the overhead projectors and videos to transmit this kind of learning in the classroom and therefore sometimes we used to go to the workshop so that we can do the practical stuff"*. These types of beliefs were consistent with lecturers' response found in the other instruments. TVET lecturers' TK knowledge was limited to traditional technologies as lecturer (010) from institution 4 commented, *"It is when you can get some equipment that you can use, like overhead projectors and screens that you can use, that's that and smart phones so that we look at those other technologies so if we can get those we could put that in place"*. This confirms that technology knowledge will always be a moving target (Hofer and Swan 2008).

Theme 3: Lecturer ICT Integration Competency Affects Teaching

Lecturer ICT integration competency is essential in TVET institutions. FET lecturers articulated their competency levels when asked, "what do you feel are the most important technological competencies for you to properly use technology whilst you are lecturing?" FET lecturer (003) from TVET College 1 replied, *"Well,*

first of all you must be educated in computers, you must be able to set up PowerPoint presentations and if those things are not available, it is not that easy, if you haven't got the experience to make use of decent and proper transparencies". Still revealing their TK competency level lecturer (011) from institution 4 commented, *"One must be able to use PowerPoint. One should be able to operate video equipment and also, maybe an overhead projector and yes I have the necessary skills, I have been trained."* (010)

Whilst lecturer (012) commented, *"Yes, I am always learning not excellent at the moment, because I am emplaning on the data projector which is a very powerful tool for presentation. I can evaluate myself and I give myself out of ten a six at this stage. I can still develop to be perfect…"* As most technologies are not yet developed for teaching or educational purposes, the teacher's role is to repurpose them for educational purposes (Koehler et al. 2014). In this paper the findings for TVET teaching, the definition of technology needs to be expanded to include specific technology, which refers to equipment, and machines, which are used to perform certain tasks in the workplace (Guthrie et al. 2009).

Theme 4: Smart Technologies Enhance Automotive Repair and Maintenance

TVET lecturers are of the opinion that the integration and the matching of the correct technology for the teaching of automotive repair and maintenance enhance their lessons and these are regarded as smart technologies. Data projectors and computers, PowerPoint presentations including a Wi-Fi environment constitute smart technologies for teaching and learning. To quote a lecturer (012) from TVET college 4, who commented, *"Technologies add value to my teaching I have even introduced students to it because most of the times I bring my own modem and show them that they can get anything from the Internet. I use that to download them then I introduce them, I say that if you are using technology they are very useful, they say that they are very strong education tool"*. Whilst lecturer 5 from TVET college 2 felt, *"With this technology competency, when you are talking about this it is so far important so to use technology to impart this knowledge to your students because sometimes if in automotive, like if we were dismantling, which we call an engine or doing some practical if the students are seeing that in the video and therefore the student tend to concentrate on that and do everything of…"* Lecturer (001) from TVET college 1 acknowledged that his students were advanced with technology and they bring these to lectures. *"Knowing that my students are advanced with technology and they are on their cell phones on a regular basis, I try and use a lot of videos and the data projector, if need be sometimes they use their cell phones as well to do research."* On the contrary, lecturer (010) from TVET College 4 cited, *"Accessibility and flexibility and flexibility as reasons for using technology in the teaching automotive repair and maintenance."* The following comments indicated that technology not only provided accessible and flexible learning, but also provided a range of learning styles and delivery options. *"I use videos and Internet this way, as it gives the flexibility to do it anywhere,"* said lecturer (012) from TVET College 4.

It could be seen in this paper that smart technologies enhance automotive repair and maintenance. There is not enough evidence relating to the way technology enhanced lessons since lecturers still use traditional technologies such as data projectors and PowerPoint presentations and videos in TVET colleges without exploring technologies that are relevant to automotive repair and maintenance such as simulation and training boards.

CONCLUSION

This paper suggests that when addressing the needs for TVET lecturers, a VETPACK be proposed especially for TVET lecturer training. The comfort level with technology and confidence to teach with the technology will positively affect TVET lecturers' practice.

RECOMMENDATIONS

This paper was guided by a framework for understanding FET lecturers' knowledge in terms of their integration of TPACK. This framework or model was grounded in understanding that quality teaching does not occur unless the three bases of technology, pedagogy, and content

knowledge co-exist in a particular context. The TPACK framework allows close examination of lecturers' existing structures of knowledge and the complex relationship between their technology, pedagogy and content knowledge. However, it does not explicitly deal with the instruction of technical vocational education and training. In the instruction of Technical Vocational Education and Training (TVET) "the issue is no longer a decision of whether lecturers should integrate technology into their existing practices but rather how to use technology to transform teaching and create new opportunities for learning." Technological tools are 'not in themselves transformation mechanisms, or vehicles for change', but rather, they are tools 'invoked by its users to reconstruct the subject matter from the knowledge of the teacher into the content of instruction'. A model therefore should provide an analytical lens through which TVET college lecturers can conceptualize the relationships between technology, pedagogy and content matter thus improving their curriculum delivery and implementation of automotive repair and maintenance hence improving their NC(V), Engineering and Related results. Therefore, it is imperative to propose a dedicated model for TVET, and this could be termed the VETPACK model, which speaks to Technical Vocation Education and Training in general.

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