

Teaching and Learning Through Hands-on Activities in Civil Technology Teacher Training Programmes at South African Universities

M.S.A. Maeko

*School of Education Department, Durban University of Technology, 15 F. J Sithole Road,
Imbali, Pietermaritzburg, 3201. South Africa
E-mail: Maekos@dut.ac.za*

KEYWORDS Hands-on Skills. Practical Workshop. Technical Teachers Training. Technical Education. Theory and Practical Skills

ABSTRACT The training of teachers in the Civil Technology course at Higher Education Institutions in South Africa has generated debate regarding the practical-theory alignment. This study probing this aspect of Civil Technology teacher training is critical given the impact it has on curriculum implementation for Grades 10-12 learners. The methodological considerations were demonstrated through mixed methods designs. Quantitative data were analyzed through their means and standard deviation, whilst qualitative data were presented thematically according to respondents' views. It is concluded that due to non-availability of materials, inadequate training facilities and methods for conducting practical, classes teachers graduate without the much needed practical hands-on skills, which are a critical requirement for the implementation of the Grades 10-12 Civil Technology curriculum in schools. From these findings, it is recommended that a meeting be convened between relevant professional bodies to discuss ways in which the practical hands-on skills deficit can be remedied.

INTRODUCTION

The curriculum content for Civil Technology (CVTC) [see Department Basic Education (DBE) 2014] infused some aspects of the National Accredited Technical Diploma (NATED 550) subjects, which included Building Construction, Bricklaying and Plastering, Woodwork, and Woodworking and Plumbing (DBE 2011). The NATED 550 curriculum is a former Technical Colleges qualification, which was on the one hand, primarily knowledge based, with practical skills being acquired through apprenticeship. On the other hand, the CVTC curriculum advocates the integration of theory with hands-on practical work. The subject is studied in Grades 10-12, which are considered the final school years' in South African school system. The subject is divided into specialisation areas of Civil services, Construction and Woodworking (DBE 2014) and schools are at liberty to offer more than one specialisation. Civil services can be construed as plumbing, which centers on the supply of cold and hot water supplies to buildings. The main topics include cold and hot water supply, storm water, roof work, drainage and sanitary fitments. Construction focuses on the development of concrete and brick structures in

the built environment. This covers topics such as concrete, formwork, reinforcements, cavity walls, lintels, waterproofing, piling and scaffolding. And lastly, woodworking focuses on any part of a building that is made of timber. This includes structures such as roof trusses, windows, and doors. It also focuses on providing temporary supporting structures such as formwork, shoring, and centering for constructing permanent structures such as staircases. woodworking thus goes hand-in-hand with construction. All the above CVTC specialisation areas are practical in nature, and, for the curriculum to be taught effectively and efficiently, they require methods of instruction that are grounded in both theory and practice. As part of the technology education focus area, CVTC is viewed as education that equips learners with marketable skills after Grade 12 for sustainable economy (Maeko and Makgato 2014). As affirmed by Joshua (2015), this type of education has the economic role of providing qualified manpower with emphasis on practical, hands-on training within the framework of lifelong education. Thus, the teachers' role in the implementation of the subject in schools cannot be overemphasized. The same can also be said with regards the teaching and learning of the course in Higher Education Insti-

tutions (HEIs). Unfortunately, studies show that the practical aspect of the course in HEIs is compromised, thereby impacting negatively on hands-on skills acquisition by students. From Zimbabwe, Dzenga and Mushava (2016) shows that universities responsible for technology subjects continues to produce graduates who are book smart but lacking the practical aptitude. Corroborating the above, Mokhothu et al. (2015) pointed out that most critical challenge hampering the effective teaching and learning of the hands-on technology skills was rampant lack of training materials and workshops for teacher training. The risks that a hands-on skills deficit pose affect not only graduates but also learners in the schools where university graduates will be employed to teach. If handled carefully, the civil technology curriculum in schools could be a base through which plumbers, carpenters, bricklayers and plasterers could be developed. As reported, South Africa's continued skills deficit is compounded by such a lack of technical skills, which has a negative impact on employment across many sectors of the country's economy (Staff Reporter 2015). Such skills are essential for business and are linked with opportunities (Utting 2010). However, if technical hands-on skills are not transferred to the learners in schools, the gap in technical skills will be potentially increased. The repercussions for the country would be dire; school leavers would be unemployable adding to the skyrocketing unemployment rate which is already a ticking time bomb.

Objectives

The study is aimed at probing how some South African HEIs offering teacher training handle the practical aspect of the Civil Technology course, and probing the impact of such training on graduates and the technical schools in which they would be expected to teach.

An analysis is done of how the Civil Technology teacher training course is structured at the HEIs in terms of the distribution of weighting allocated to the theory and practical components.

The Theory-practical Balance in South African Civil Technology Teacher Training Courses

A comparison of the weighting given to the theoretical and practical components of the

three-year Civil Technology B.Ed. curricula for South African HEIs is shown in Table 1. It can be seen that the teacher training courses are designed to cater for both theory and practical, in line with the Civil Technology Grade 10-12 policy (DBE 2014).

Table 1: Civil Technology curriculum in selected HEIs

HEI	Topic breakdown	Weight value (%)
A	Theory Component	80
	Practical component	20
B	Theory component	40
	Practical component	60
C	Theory component	90
	Practical component	10
D	Theory component	80
	Practical component	20
E	Theory component	75
	Practical component	25

Sources: CUT B.Ed. Civil Technology course outline (2017), DUT B.Ed. Civil Technology course outline (2019), UNW B.Ed. Civil Technology course outline (2016), TUT Civil Technology course outline (2018) and WSU Technical Education Department Civil Technology course outline (2019).

The weighted values displayed in Table 1 indicate that the practical component is included at all five HEIs in their Civil Technology teacher training courses. Nevertheless, the weighting of the practical component varies considerably between institutions, from 10 percent (HEI C) to 60 percent (HEI B). This indicates that some institutions put much greater value on the practical component of the course than do others. Therefore, it could be construed that students from those programmes with a high percentage of practical work, such as at HEI B, would be advantaged in acquiring practical skills over those from programmes with lower percentages for practical, such as HEI C. practical skills cannot be acquired in a short time; practical activities involve preparation, execution and evaluation and thus adequate time must be allowed for their development, as argued by Auta (2015). However, Essel et al. (2014) contrast the structure of the technical curriculum in Ghana, which consists of 60 percent practical and 40 percent theory, with that in the German system where there is 80 percent practical and 20 percent theory component, and which yields positive results.

Factors Militating Against Effective Teaching and Learning of Civil Technology Practical

As has been argued above, in order to equip students with requisite practical skills in Civil Technology, it is critical that at HEIs teacher training curricula should foster both theory and practical components. However, the data in Table 1 suggests this is not so for all South African HEIs. Furthermore, materials, equipment, infrastructure and educational visits are central to the effective teaching and learning of practical. In this regard, Arokoyu and Charles-Ogan (2017) affirm that practical workshops, equipment and materials are of utmost importance in the teaching and learning of any hand-on practical. They add that practical workshop experiences, which allows students to manipulate equipment, tools and materials offer opportunities for the acquisition of hands-on practical skills. However, in Nigeria, Ugochukwu et al. (2019) asserts that at the few institutions that do have the necessary workshops and tools, the personnel are not suitably qualified to impart the skills needed for student teachers to have practical mastery of technology. Likewise, in Zimbabwe, Gwembire and Katsaruware (2013) show that most tertiary institutions offering technology based education subjects are ill equipped; they have poor teaching resources and outdated equipment. The absence of such critical features will inevitably have a negative impact on the quality of the graduates. Consequently, many of these institutions are producing technology teachers with mere knowledge of the rules of technology, but without practical hands-on experience. To address the problem, and in order to increase the teachers' readiness to effectively teach the practical aspect of Civil Technology, Bandele and Faremi (2012) recommend that fully equipped workshops for practical work need to be provided to complement theory. In support, Audu et al. (2013) mention in particular the need to incorporate in the pedagogy specific machinery; namely, band saws, circular saws, table saws and hand tools such as plough planes, rebate planes, compass planes and tenon saws. Moreover, Kennedy (2011) remarks that the environment in which teacher trainees are taught should accommodate the school environment where they would be expected to teach. It is assumed such prior ex-

posure should familiarize the graduates with the environment in which they will be expected to work. Yangben and Seniwoliba (2014) observed that without the necessary tools and equipment, graduates from technical institutions end up being "half-baked" professionals who lack the required practical hands-on competencies. This is counterproductive; the intentions of technology education programs have always been to develop hands-on technical skills. The consequences for such incompetency will be transmitted to technical schools' learners where graduates will be expected to work as teachers. Kolb (1984) maintains, there should be equal emphasis on the content and the process involved in the acquisition of knowledge and skills.

In South Africa (SA) similar issues of outdated equipment, lack of material and tools have been identified. Without such resources and scheduled time for the manipulation of resources, the goal of acquiring practical skills in technology education remains a fantasy. In the SA context, the study by Maeko and Makgato (2017) established that imparting practical skills in technology subjects is hampered by both lack of resources in schools, and teachers' inadequate practical skills and knowledge in the subject and their use of poor teaching strategies. This indicates that the Civil Technology teacher training at universities is unlikely to have developed teachers to teach the subject's practical skills in schools. Hasan et al. (2014) has argued that to address the question of inadequate resources, universities and industries should jointly engage in skill acquisition through sharing of training facilities.

Research Questions (RQs)

1. What impedes the learning of the practical component of Civil Technology in HEIs?
2. What is the ideal classroom situation for the effective teaching and learning of the Civil Technology hands-on activities?
3. What value do practical offer to the Civil Technology course?

Conceptual Framework

In considering the relationship between teaching and learning through hands-on activi-

ties in Civil Technology CVTC teacher training programmes, the conceptual framework for this study is an amalgam of Shulman's (1986) Pedagogical Content Knowledge (PCK) and Kolb's (1984) Experiential Learning Theory (ELT) theories.

PCK is explained by Shulman (1986) in simple terms as knowledge needed by teachers for how to teach their subject, by accessing all that they know about the subject, the learners they are teaching, the curriculum with which they are working and what they believe count as good teaching strategies. In a similar vein, Geddis and Wood (1997) hinted at the interrelationship between a teachers' content knowledge and the strategies that are selected, in light of their knowledge about learners and the subject matter and learners' affective responses to subject matter and different ways of representing it. Accordingly, it can be deduced that teachers' subject content knowledge will influence their choice of teaching strategies.

ELT provides a holistic model of the learning process and a multi-linear model of adult development; both of which are consistent with what we know about how people learn, grow, and develop. This model is relevant in this study, which aims to capture the nature of learning through action. Kolb's (1984) model is a four-stage learning cycle. The cycle consists of:

- (1) concrete experience (CE)
- (2) reflective observation (RO)
- (3) abstract conceptualization (AC) and
- (4) active experimentation (AE).

According to Shulman (1986), the concrete experience, which initiates the cycle, must be an active or interactive event that triggers all of the steps. In Civil Technology this could be the stage where students are first given specifications for a practical model they must make or design from beginning to end. The lecturer's or laboratory technician's demonstrations and illustrations of the equipment and tools required for completing the task should complement those specifications.

According to Kolb (1984), concrete experience is the process wherein students learn by first watching how different formations of the project are illustrated, such as material preparation and use of equipment. Through observation, students learn some components of new information and then fill in the gaps by actually performing the new skill (Jackson 2013). Kolb

(1984) indicates that instructions and demonstrations lead to better acquisition of hands-on experience. Corrales (2008) explains that this stage should lead a student teacher into reflecting on what they have just observed, so as to reinforce a concept. In this stage they use manipulatives, or objects that can be touched or moved by them. Civil Technology objects that can be touched and moved could be machinery, tools or materials.

In the second stage, RO, student teachers reproduce their own explanations from the illustrations and demonstrations in their training. In this regard, Shulman (1986) highlights the perspectives of teacher pedagogy. He indicates that at this stage, students address the learning objective from observation rather than action; in trying to look for the meaning of things they see implications and connections. Accordingly, a student who can observe closely during Civil Technology demonstrations and illustrations might better understand important aspects, such as safety measures applicable in the practical workshop. After several such experiences, students enter the third phase and develop "theories" about how things work, which can be tested by further manipulation of equipment (Korn 2014). From their observations students should now have developed basic practical skills and be able to relate their own theories to apply in new situations to complete a project. At the final stage (AE), students have an opportunity to engage independently with equipment and should be able to move beyond the immediate learning objective by trying out the new knowledge or skill in another environment (Shulman 1986), which for student teachers would be in a school when they graduate. Nevertheless, with regards practical skills, Rollnick et al. (2008) caution that practical skills are best taught in a true apprenticeship; where students are taught authentically on the job. In simple terms, Rollnick et al. (2008) also caution that the teachers' ability to apply their knowledge will depend on how they themselves were prepared. This argument finds support in Kolb's (1984) affirmation that students who learn by doing will learn better in practical classes. It follows that the theoretical framework chosen for this study is relevant because the study is based on the integration of theory to practical knowledge in the CVTC subject.

METHODOLOGY

This study used both qualitative and quantitative research approaches. A qualitative approach was used to gather non-numerical data from interviews, whilst the quantitative approach was used to gather numerical data on questionnaires. According to Ngulube and Ngulube (2015), mixed methods research goes beyond a mere superficial combination of both quantitative to qualitative. Data. It is for this reason that Brannen (2008) advises researchers to give a rationale for combining qualitative and quantitative methods in their study. From such a perspective, this study therefore used a mixed approach to corroborate the findings of the research components, as questionnaires were administered together with interviews.

This study is focused on the teaching and learning of CVTC students at Higher Education teacher training Institutions in SA. In particular, it studied the experiences of students at the programme exit point; that is when students would be ready to enter the employment market to teach the subject in schools. Therefore, the population of the study comprised students at four out of the five HEIs offering the CVTC teacher training course. The fifth HEI was left out of the study for logistical reasons. As explained by Koul (2002), a population is a complete set of individuals, or observable characteristic, in which the researcher is interested. It is worth noting that the CVTC teacher training course is offered at only five of the twenty-five public Higher Education Institutions in South Africa. From the institutions, a sample of participants was selected as described below.

This study used purposive or judgmental sampling technique to select teaching personnel and students at HEIs offering CVTC teacher training course across four provinces of the Republic of South Africa. This sampling technique was chosen in order to focus on the characteristic population that was of interest. Corrales (2008) notes that the validity of samples lies in the accuracy with which they represent their target populations. The sample comprised fifty-seven third year CVTC B.Ed. students from four HEIs combined, together with their four facilitators, that is one facilitator from each HEI.

Data Collection Instruments

Data were generated in three stages, using questionnaires, focus group interviews for students and interviews with facilitators and researcher's observations. In this way, data were sourced separately from facilitators and students at each institution. A questionnaire, based on a list of indicators from Dasmani (2011) was first administered to the 57 students. The questionnaire included only closed response Likert-scale items, for which students were asked to indicate the extent to which they agreed or disagreed with each statement. Rating from 1-5 was as follows: (1) SA=Strongly Agree, (2) A=Agree, (3) DA=Disagree, (4) STDA=Strongly Disagree, (5) I do not know. The questionnaire was designed to respond to RQ 1, by identifying factors which might impede the learning of the CVTC practical component. The questionnaire thus generated quantitative data.

Stage two of data production involved focus group interviews with students as a follow up to the questionnaire, in order to source more in-depth information. The separate focus groups for each HEI comprised six or seven students. Interviews were video recorded. These focus group interviews were designed in response to RQ 1 and RQ 3. Responding to RQ2 and 3, one-one interviews with CVTC lecturers and laboratory technicians were used to source more in depth information. Finally, observations were used to observe and verify what was revealed in interviews. Data from both interviews and observations was qualitative.

Data Analysis

Questionnaire data were presented and analyzed statistically, with responses represented as percentages. The data from completed survey questionnaires were coded and captured showing means and standard deviations (STD). The interviews were transcribed, showing quotes as students or lecturers or laboratory technicians responded to the questions. Data were then coded, analyzed and discussed thematically. Themes, as a set of idea that permeate and highlight a common issue, were then developed and reported in a narrative manner from all the participants' responses; backed up by verbatim quotes. Data

collected from interviews were presented, interpreted and analyzed according to themes drawn from the research questions.

RESULTS

Results from Questionnaire

The results in Table 2 indicate student teachers' responses to the questionnaire with regards the first research question, what impedes the learning of the practical component of Civil Technology in HEIs? The data represent their views regarding the extent to which their universities handle the CVTC learning activities requiring the integration of practical with theory. The table presents the analysis in the form of mean (M) and standard deviation (STD) of the Likert responses. STD indicates the extent to which the individual responses to a question vary or "deviate" from the mean. A low STD indicates that data points tend to be close to the mean of the set, while a high STD indicates that the data points are spread out over a wider range of values.

With reference to Table 2, concerning whether the students use the requisite practical equipment during practical lessons, students responded with $M=2.95$ and $STD=1.025$. The mean indicates that respondents tended to towards 3, which is the numerical value for those respondents disagreeing with the statement.

The standard deviation indicates that few students deviated from the mean response that they did not use the equipment. By not engaging with equipment, students are denied an opportunity to acquire practical skills, which is the

backbone for the course. When using equipment, students can learn skills such as safety and how equipment functions. Responding to the second statement, students agreed that lecturers and laboratory technicians demonstrated the requisite skills during practical lessons with $M=2.12$ and $STD=1.001$. This finding appears contradictory in view of the students alluding to their non-engagement with the equipment. However, the reasoning might be that because of the risks involved, universities do not allow students, for their own safety, to engage personally with equipment. It is worth noting that much equipment such as band saws or circular saws used in Civil Technology, especially the Woodworking specialization, are considered to be very dangerous if not used properly. Responding to the third statement about practical lessons being time tabled, students disagreed, with $M=2.47$ and $STD=1.037$. Responses from students on whether they get enough time for practical lessons, also showed negative responses, with $M=2.85$ and $STD=0.899$. The above findings related to the issues of timetabling and time constraints are fundamentally interwoven. If practical classes are not timetabled, of course there will be no time for practical lessons. For the statement that there was adequate material for practical lessons, students also disagreed, with $M=3.16$ and $STD=0.676$. On whether there was adequate supply of basic hand tools for practical lessons, respondents again disagreed with $M=2.86$ and $STD=0.773$. Students also disagreed that there was appropriate equipment in practical classes with $M=3.00$ and $STD=0.853$. Civil Technology encompasses three specialisations, each one of which requires stu-

Table2: Contributing factors to the learning of the practical component of Civil Technology in HEIs

<i>Statements/Indicators</i>	<i>Mean</i>	<i>STD</i>	<i>Interpretations</i>
1. Students use requisite practical equipment during practical lessons	2.95	1.025	Disagree
2. Lecturers/Lab-technicians demonstrate the requisite skills during practical lesson	2.12	1.001	Agree
3. Practical lessons are time tabled	2.47	1.037	Disagree
4. Enough time for practical lessons	2.85	0.899	Disagree
5. Adequate material for practical	3.16	0.676	Disagree
6. Adequate supply of basic hand tools for practical lessons	2.86	0.773	Disagree
7. Appropriate equipment for practical	3.00	0.853	Disagree
8. Incorporate fieldtrips to industry to enhance practical skills	3.30	0.906	Disagree
9. I am confident in teaching the practical component during my teaching practice	3.00	0.853	Disagree

dents to be provided with equipment suitable for practical work. Without basic hand tools, materials and appropriate equipment, practical skills acquisition remains a huge challenge. Student can best learn about tools and materials by engaging with such resources, which then translates into skills acquisition. When it came to asking students whether they were confident in teaching the practical component during teaching practice, there were similar responses from them. The results on students who disagreed that there was appropriate equipment for practicals, corresponded to those for students who disagreed with the statement about teaching the skills subsequently. The strongest disagreement about a statement concerned whether field trips were incorporated in the learning of practicals; a mean score $M=3.30$ and $STD=0.906$. Moreover, this STD is low, indicating a narrow spread in results.

Since the graduates from the CVTC teacher training programmes will be teaching the subject in schools, they should be well equipped with both the theoretical and the practical components. Therefore, the training of these teachers should be carefully planned from their first year, so they may gradually acquire the requisite practical skills before graduation. But, in reality, the responses from students suggest that students are being shortchanged with regard to the practical component.

Results from Focus Group Students' Interviews

The study used a semi-structured focus group interview with students to get richer information than could be obtained through a questionnaire. The following represent students' views concerning their learning of the CVTC practical component, in responding to the research question 1 and 3 respectively named: *What impedes the learning of the practical component of Civil Technology in HEIs?* and *What value does practical offer to the Civil Technology course?* The results below present statements and responses acquired in addressing the above question.

In responding to the Challenges to Acquiring Practical Skills in the Workshop, three intrinsically intertwined themes emerged as follows: Theme: Lack of Time, Material and Equipment is

indicated by the following responses. From HEI A, respondent Kopano said, *"The workshop we use belong to general technology course which causes clashes. We share that workshop and this creates problems for us because we cannot access the workshop anytime we are free to polish our skills. Besides, even if it's free, we can't even access it on our own without our facilitators as it's considered a dangerous place"* Fellow classmate, Thabiso, from another group expressed a similar view: *"Besides the workshop issue, the machines in that workshop are not relevant to Civil Technology teacher training."* Peter from HEI D highlighted a different issue of time: *"Time is an issue. Our timetable does not include practical which is a challenge. For us to go to the workshop, we have to sacrifice theory which is not idealistic. This leaves us exposed in practical workshops when we go to schools."* Without resources like practical workshops, equipment and with limited allocated time, practical skills transfer is impossible. This narrative finds support in Adraj and Quashie (2014), who claimed that all technical subjects such as Civil Technology in universities require more instruction and practical time and more resources than arts and science education, in order to satisfy their practical goals.

As a follow up to the question on Challenges to Acquiring Practical Skills in the Workshop stated above, students were also asked if they could relate the type of training they were exposed to during their training with what they experienced in schools during their school based experience (SBE). This covered the statement: Practical Skills acquired compatible with the Environment in Schools. Notably, the respondents are 3rd year students and have been to schools for their SBE and should have been exposed to how the Civil Technology practical component is handled in schools. Most students responded in accordance with the second theme: *"The training does not resonate with the environment in schools"*. Student A from HEI A said *"I would say yes and no, the yes being that with smaller machinery is not a problem. Some technical schools are advanced and are equipped with the machinery we do not have in our university. That exposes our limited knowledge in front of the learners when we have to operate that equipment we are seeing for the first time."*

Another student from HEI B said *“At the university, most of the practical tasks we do are very small projects. You go to schools and we come across big projects like building walls with real material. I will say mostly the practical tasks the university exposes us doesn’t resonate with tasks we find in some technical schools.”* In responding to RQ3 on whether the practical component is vital for the Civil Technology course, all students confirmed that the practical component is key. This encapsulated in the theme: Practical Work Is Vital in This Course. One student said *“The practical component is essential in Civil Technology teacher training since we will be expected to impart practical skills to learners in schools where we will be working. Besides, Civil Technology is quite practical as a subject.”* However, another student from another HEI had this to say: *“The practical component of Civil Technology is key in our course because with the lack of jobs in our country, we can impart the skills to learners in schools for them to become entrepreneurs and start their own businesses.”*

Results from Facilitator Interviews

The facilitator interviews were used to test conditions affecting the teaching of CVTC practical skills in HEIs. The interview data gave answers to the Research Questions 2 and 3, which are respectively, RQ 2 *What is the ideal classroom situation for the effective teaching and learning of the Civil Technology hands-on activities?* and RQ3 *What value do practicals offer to the Civil Technology course?* In responding to the statement about whether practical is significant for the CVTC course, the following were responses from the CVTC facilitators.

Lecturer A said *“Indeed, according to me students were supposed to have a day for site visit or industrial visit to connect theory to practice in a real world on a weekly basis. At least for students to understand new technology in a real world.”* However, Lecturer B from another HEI said *“Certainly, there must be practical lessons as the syllabus is both theoretical and practical.”* Lastly, a staff member from the fourth HEI responded: *“The practical component of Civil Technology is key in our course because with the lack of jobs in our country, we*

can impart the skills to learners in schools for them to become entrepreneurs and start their own businesses.”

When questioned about what would be an ideal situation for CVTC student teachers to acquire practical skills in their training, some facilitators’ responses were as follows.

Lecturer A: *“I would like to see my students being taken to site visits and industries to learn some new technology in a real world. For example, when we talk of reinforcement we still use the first method we know of but nowadays the world is experiencing earthquakes and there is new technology in the real world. Unfortunately, that’s real world exposure which the university cannot afford to take the students to because of budget constraints. Also time is a factor, as the way practical was allocated on the timetable does not give time for such”.* Lecturer C from another HEI said *“The ideal situation is to have theory and practical time set aside for the benefit of students and with a trained artisan.”*

Results from Observations

The researcher observed that the time allocated for practical and theory differed among the institutions. Of the four sampled Civil Technology Higher Education teacher training Institutions, two HEIs (C and D) had practical workshops belonging to the department. That means students should have been able access the workshops anytime to perfect their practical skills. However, that was not the case because workshops were locked when lecturers are not there, because the lecturers considered the practical workshops a dangerous place, and not to be used in their absence. The other two HEIs (A and B) had practical workshops belonging to other departments, which inhibited access by the Civil Technology B.Ed. students.

Inconsistencies was also observed regarding the integration of the practical component with theory. Most of the HEIs (B, C and D) concentrated their practical only on woodworking, whereas HEI D only did construction. This selectivity is contrary to the relevant HEI study guides, which indicate that the subject comprises all of three specialties of construction, civil services and woodworking. That meant that at

all four HEIs, two aspects had been side-lined in favour of one aspect of practical work. This was evidently due to the lack of material, equipment, tools and infrastructure. There was also no proper co-ordination between theory and practical at any of the sampled HEIs. As a result, the practical component was addressed on a haphazard schedule. In essence, students were not exposed to practical as they should have been.

DISCUSSION

Looking at the results, although it has been argued that the integration of practical improves student teachers' chances of acquiring hands-on practical skills, these results indicate that the integration of practical in the CVTC module delivered in the B.Ed. curriculum is deficient. These findings about inadequate practical instruction in technology education courses are similar to those found in Zimbabwe by Erisher (2013) and reflect the same inadequacy of equipment reported by Gwembire and Katsaruware (2013). Results from Nigeria reported by Ugochukwu et al. (2019) are similar. Because of the practical nature of the Civil Technology course, students are expected to engage with materials and equipment for them to acquire practical skills to be imparted to learners in schools where they will be employed as CVTC teachers. According to Kolb's (1984) experiential learning theory, instructions, demonstrations and being hands-on all lead to better acquisition of hands-on practical skills. As in other African countries, these findings have revealed a disturbing tendency among HEIs teachers to graduate without hands-on practical experience and they therefore feel and perhaps are incompetent to teach the practical component in schools. Adjrah and Quashie (2014) claim that in order to satisfy the practical goals of all technical subjects such as Civil Technology at universities, they need more instruction and practical time and more resources than do arts and science education. In this regard, Shulman's (1986) PCK theory indicates that the best teacher training process should lead to teachers knowing how to teach their subject according to what they believe count as good teaching strategies. That is because, good teaching strategies regarding skills acquisition in schools are critical to develop a foundation for

learners who do not want to continue with the academic route, because they should equip them with the skills needed to make a living, perhaps as entrepreneurs.

Both Civil Technology student teachers and their facilitators have acknowledged the significance of the practical component of the course, as shown by Arokoyu and Charles-Ogan (2017), practical workshop experiences provide opportunities for hands-on activities, and exposure to standard workshop equipment and technology. Furthermore, facilitators indicated that such practical exposure would help the students understand theory. Furthermore, both students and facilitators emphasized that the student teachers needed to acquire practical skills so as to feel confident and to be effective Civil Technology school teachers, thereby benefitting the learners in schools. By equipping learners in schools with such skills, the learners could become entrepreneurs; thus reducing the rate of unemployment amongst the youth. But all three sources of data (the questionnaire given to students, interviews with students and lecturers or laboratory technicians and observations) revealed that in the B.Ed. course at South African universities, the teaching and learning of the CVTC course is largely theoretical with little emphasis on the practical component. Students consequently had little confidence in teaching the practical aspect of the subject in schools, with adverse consequences for practical skills development among learners in schools.

According to Kolb's (1984) ELT, students who learn by doing will learn better in a practical context. The finding further accords with Shulman's (1986) view of teachers' PCK; that students can best acquire practical skills when they are on the job. So the reported deficiencies in university CVTC courses have a negative impact on the quality of graduates. As pointed out earlier, Yangben and Seniwoliba (2014) assert that graduates from such technical institutions cannot graduate as with appropriate competencies to teach a practical subject. Although the data in Table 1 indicated that some HEIs do allocate more weight and time to practical lessons than do others, even at those HEIs the lack of resources still remains a factor impeding the realization of practical skills acquisition by students. As indicated by Ugochukwu et al. (2019), in

Nigeria, even the few HEIs with the necessary resources like workshops and tools, there were still personnel who are not suitably qualified to impart the skills needed for student teachers. The findings also revealed that none of the HEIs for CVTC teacher training in this study had an established relationship with industries, that is despite CVTC lecturers and laboratory technicians concurring with Hasan et al. (2014) about such partnerships being ideal for the effective teaching and learning of the course. Nevertheless, university administrators are seemingly unaware or apparently tolerate the situation of student teachers graduating without practical skills. The consequences of such poorly educated teachers will cascade down to school learners, to whom these ill-equipped graduates will be unable to impart practical hands-on skills. Consequently, as reflected in The Mail and Guardian (Staff Reporter 2015), such deficiencies will have a negative impact on the South African economy, thereby exacerbating the already serious problem of youth unemployment.

CONCLUSION

The study shows the unfortunate neglect of hands-on practical learning in Civil Technology teacher education, leading to teachers graduating without such skills. This is clearly revealed in both students' questionnaires and interviews, and interviews with facilitators, also backed up by the researchers' observations. This neglect poses a serious threat to skills development in learners at school, leading directly to the skills mismatch found in industry. This has a potential to compound the ever increasing unemployment rate amongst the youth in South Africa.

RECOMMENDATIONS

Because of the importance of infusing the practical component into the teaching of the subject, it is therefore recommended that a meeting be convened, as a matter of urgency, between all HEIs offering technology education teacher training degrees and industrial associations, in order to discuss ways in which the deficit can be remedied. As long as the identified deficit remains in place, the realization of skills acquisition by both teachers and learners will remain an illusion.

ACKNOWLEDGEMENTS

The author is grateful to staff and students who participated in the study.

REFERENCES

- Adjrah J, Quashie MA 2014. Technical and vocational education stakeholders' perceptions on professional skills acquired in private "Brevet de Technicien Supérieur (BTS)" schools in Togo. *Asia-Pacific Journal of Cooperative Education*, 15: 157-321.
- Audu R, Musta'amal AH, Kamin YB, Saud MSB 2013. Provision of Workshop Tools and Equipment: Necessity for Technical Vocational Education Graduates Skills Acquisition. *Paper presented at Management in Education: 2nd International Seminar on Quality and Affordable Education in Malaysia*. University of Technology, Malaysia, 20-22 October 2013.
- Autu MSA 2015. Strategies for evaluation of students' proficiency in practical skills in NCE (Technical) building technology education. *International Journal of Vocational and Technical Education*, 7: 96-99.
- Arokoyu AA, Charles-Ogan GI 2017. Availability and utilization of laboratory kits for practical teaching of Mathematical Skills in Chemistry. *American Journal of Mathematics and Statistics*, 7: 160-165.
- Bande SA, Faremi YA 2012. An investigation into the challenges facing the implementation of Technical College curriculum in South West, Nigeria. *Journal of Education and Practice*, 3: 14-20.
- Brannen J 2008. The practice of a mixed methods research strategy: Personal, professional and project consideration. In: MM Bergman (Ed.): *Advances in Mixed Methods Research: Theories and Applications*. California: Thousand Oaks, pp. 53-65.
- Central University of Technology (CUT) 2017. *Civil Technology Course Outline*. Department of Mathematics, Science & Technology Education, South Africa.
- Corrales K 2008. Getting your hands on learning: manipulative tools in content ESL/EFL instruction. *Latin American Journal of Content and Language Integrated Learning*, 1: 60-65.
- Dasmani A 2011. Challenges facing technical institutes' graduates in practical skills acquisition in the Upper East Region of Ghana. *Asia-Pacific Journal of Cooperative Education*. 12: 67-77.
- Dzenga L, Mushava S 2016. Vocational education is the future. *The Herald, Daily*, April 30, 2020, p.8.
- Durban University of Technology (DUT) 2019. *Civil Technology Course Outline*. School of Education Department. Indumiso Campus. *Civil Technology Course Outline, South Africa*.
- Essel OQ, Agyarkoh E, Sumaila SM, Yankson, PD 2014. TVET stigmatization in developing countries: Reality or fallacy? *European Journal of Training and Development Studies*, 1: 27-42

- Geddis AN, Wood E 1997. Transforming subject matter and managing dilemmas: A case study in teacher education. *Teaching and Teacher Education*, 13: 611-626.
- Gwembire J, Katsaruware RD 2013. Challenges and Reflections of Implementing the Technical and Vocational Education Policy: A Case for Secondary Schools in Rural Communities of Rushinga District, Mashonaland Central Province. *Greener Journal of Vocational and Technical Education*, 1: 001-010.
- Hasan M, Clement CK, Amagir SM 2014. Relationship between occupational skills provided to polytechnic diploma engineers by BTEB and requirement of industry in Bangladesh. *International Journal of Vocational and Technical Education*, 6: 43-50.
- Jackson J 2013. *Hands-on or Hands-off: Effective elements of elementary Social Studies Hands-on Lessons*. Senior Hons Thesis, Published. *The Spectrum: A Scholars Day Journal*, 2.
- Joshua JJ 2015. Challenges and prospects of vocational and technical education: Most important tool for enhancement and innovations in higher education in Nigeria. *Journal of Research Development*, 24: 1-7.
- Kennedy OO 2011. Philosophical and sociological overview of vocational and technical education in Nigeria. *American-Eurasian Journal of Scientific Research*, 6: 52-57.
- Kolb DA 1984. *Experiential Learning: Experience as the Source of Learning and Development*. Prentice-Hall, Inc., Englewood Cliffs, N.J.
- Korn J 2014. *Teaching Conceptual Understanding of Mathematics via a Hands-on Approach*. Honours Thesis, Unpublished. Lynchburg: Liberty University.
- Koul L 2002. *Methodology of Educational Research*. New Delhi: Vikas Publishing Ltd.
- Maeko MSA, Makgato M 2014. Skills training through hands-on practical activities in civil technology: a case study of three technical schools in South Africa. *TD: The Journal for Transdisciplinary Research in Southern Africa*, 10: 293-309.
- Maeko MSA, Makgato M 2017. The transfer of requisite Civil Technology hands-on practical skills to student teachers in South African Civil Technology Teacher Training Universities. *International Journal of Educational Sciences*, 18: 147-157.
- Mokhothu K, Maimane JR, Rankhumise MP 2015. The Integration of Technical Subjects in Civil Technology Curriculum with Special Reference to Further Education and Training (FET) Technical Schools. *International Journal of Educational Sciences*, 9: 11-18.
- Ngulube P, Ngulube B 2015. Mixed methods research in the South African Journal of Economic and Management Sciences: An investigation of trends in the literature. *The South African Journal of Economic and Management Sciences*, 18: 1-13.
- North West University (NWU) 2016. Mathematics, Science and Technology Education Department. Civil Technology course outline. Potchefstroom.
- Official Home Page of the Department of Basic Education (DBE) 2014. Curriculum Assessment Policy Statements (CAPS) - Civil Technology. From <<http://www.education.gov.za>> (Retrieved on 10 March 2019).
- Official Home Page of the Department of Basic Education (DBE) 2011. National Curriculum Statements (NCS) General - Civil Technology. From <<http://www.education.gov.za>> (Retrieved on 10 March 2019).
- Rollnick M, Bennett J, Rhemtula M, Dharsey N, Ndlovu T 2008. The place of subject matter knowledge in pedagogical content knowledge: A case study of South African teachers teaching the amount of substance and chemical equilibrium. *International Journal of Science Education*, 30: 1365-1387.
- Shulman LS 1986. Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15: 4-14.
- Staff Reporter 2015. SA' s skills deficit has a negative effect on employment. *The Mail & Guardian, Weekly*, May 18, 2015, P. 15.
- Tshwane University of Technology (TUT) 2018. *Civil Technology Course Outline*. Department of Mathematics, Science and Technology Education. Soshanguve North Campus, South Africa.
- Walter Sisulu University (WSU) 2019. *Civil Technology Course Outline*. Technical Education Department. Butterworth, South Africa.
- Ugochukwu CO, Paul AI, Elisha NE 2019. Improving graduate outcomes for technical colleges in Nigeria. *Australian Journal of Career Development*, 28: 21-30.
- Utting P 2010. The risks of skills shortage in construction. *The paper presented at the 5th Built Environment Conference in South Africa*. Durban, 28-30 July 2010.
- Yangben PN, Seniwoliba AJ 2014. Career challenges in construction craft training in technical vocational education and training in Ghana. *International Journal of Vocational and Technical Education*, 6: 13-29.

Paper received for publication in September, 2019
Paper accepted for publication in December, 2019