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PRACTICAL SKILLS COMPETENCIES FOR MECHANICAL TECHNOLOGY STUDENT TEACHERS IN A TVET ENVIRONMENT.

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Abstract- The need to develop a broad base for technical skills development among the young people in South Africa has seen a huge interest in Technical and Vocational Education and Training (TVET) by the Department of Higher Education and Training (DHET). This is evident the Minister of Finance allocation of more funding to TVET college students than to university students for the 2018-2019 financial year, (DoF, 2017), the recently launched College Lecturer Education Projects (2015-2020) and merSeta-the sector education institutions renewal focus on TVET. The funding of TVET students acknowledges the significance of the TVET sector as an oasis of skills development and employment creation for the majority youth of South Africa who cannot access university education. Government funding of the TVET sector coincides with the National Strategic Plan (NSP) (2015/16-2019/20) goals of ensuring that the graduates of South Africa's universities and TVET colleges acquire relevant skills and knowledge to meet the present and future needs of the economy and country, (DHET, 2015: 6). The purpose of this paper was to establish the level of practical skills competencies among pre-service Mechanical Technology teachers within the TVET context. Special focus was on how the pre-service teachers perceived their own competency levels in teaching Mechanical Engineering after undergoing two years of university training. The self-efficacy theory guided this case study. A total of 20 final-year B.Ed students specialising in Mechanical Engineering at a University of Technology (UoT) who had gone through teaching practice in and around Free State technical and FET high schools were surveyed. A questionnaire, audio and video recordings were used to generate quantitative and qualitative data. The quantitative data was presented and analysed using the Statistical Package for Social Sciences (SPSS), while the Thematic Content Analysis (TCA) was applied to analyse and present qualitative data. The results showed that the pre-service teachers were not familiar with some of the metal fabrication and machining equipment and processes as required in Mechanical Engineering programmes, while others expressed a desire to be re-trained in specific engineering skills which they had not been exposed to during their teacher training programmes or which they felt not competent enough to teach. The study provides for the insight into the professional development requirements of newly appointed Mechanical Technology teachers.
Key words: Technical Education; Vocational Education; Practical skills; Skills competency; In-service training.

1. INTRODUCTION

The need for an appropriately and suitably qualified labour force to drive the commercial and industrial wheels of a rapidly developing South African economy calls for a responsive education system. Skills and manpower development thus fall squarely under the ambit of technical and vocational training institutions such as schools, colleges and universities. Technical and Vocational Education and Training (TVET) institutions find themselves as one of the critical sectors mandated with skills and manpower development roles in response to the needs of industry and commerce. The training of teachers who can effectively and efficiently facilitate the transfer of relevant technical and vocational knowledge, skills and habits of the mind in the TVET colleges in particular, becomes a critical national imperative for analysis and discourse, (DHET, 2015).
The ideal situation would be to have the university training of technical subject teachers synched with the knowledge and skills the teachers teach in the laboratories of technical and vocational schools and colleges. An adequately trained technical teacher is able to stand in front of a class and give instruction with confidence. Conversely, a teacher who lacks the requisite subject, pedagogical and technological content knowledge and skills loses the respect of the learners and ultimately has low self-esteem. Proponents of the self-efficacy theory argue that the way a teacher perceives their capabilities for learning or performing actions at designated levels has a strong correlation to their output in class, (Bandura, 1977, 1986, 1997; Maddux & Rogers, 1983; Schunk & Pajares, 2009). It is under this context that this paper sought to establish how pre-service teachers in Mechanical Technology rated themselves on their competency levels in the discipline-specific practical skills taught in the subject. The fundamental goal of the study was to identify gaps that might exist between the practical skills pre-service teachers develop during teacher training the practical skills they were expected to teach technical and vocational programmes at in Further Education and Training (FET) schools, Technical schools and Technical and Vocational Education and Training (TVET) colleges.

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1.2 Statement Of The Problem

Final year Bachelor of Education degree student teachers specialising in Mechanical Technology gave feedback on their 12-week teachers' work integrated learning (WIL) programme, commonly known as teaching practice experiences. The feedback suggested that the pre-service could not teach some of the practical components of the Mechanical Technology (MT) syllabus. The study therefore sought to identify the challenges encountered by pre-service teachers teaching Mechanical Technology during teaching practice. We engaged the pre-service teachers with the intention to establish the perceived practical skills competency levels of MT pre-service teachers. These engagements enabled us to explore the gaps between the practical skills pre-service teachers developed during the training and the competencies that these pre-service teachers need to be able to demonstrate practice.

1.3 Conceptual Framework

The promulgation of the self-efficacy theory to psychology literature has enabled researchers to explore its influence in various walks of life including education, business, sport, careers, health and wellness. According to Schunk and Pajares (2009) self-efficacy in education has been proved to influence students' choices of activities, the effort they apply to a task, persistence, interest and achievement. Bandura's (1986) social cognitive theory, in which self-efficacy is located demonstrates that one can judge their personal competence with some degree of accuracy. Using the self-efficacy theory as a guiding framework for this study, enabled the researchers to tap into the cognitive ability of the student teachers to evaluate their practical skills competencies.

2. REVIEW OF RELATED LITERATURE

We analyse the key concepts that inform different perspectives on technical and vocational education that might influence technical teacher training. We found out that an understanding of the underlying educational philosophy that informs the technical teacher training perspective is critical for both the instruction as well as those who analyse and evaluate the educational trajectory of the programme that consequently affects the educational outcomes of such programmes.

For this enquiry, technology education, technical education and technical vocational education were synonymously taken to belong to one philosophical discipline that combines the mastery of theoretical knowledge with the practical application thereof to produce tangible products and solutions to meet human needs, (DoE, 2011).

2.1 Technology Education

The etymology of the term 'technology' is instructive, (Herschbach, 1995). Herschbach (1995) further explains that the term technology derives comes from the Greek word technologia, which refers to the systematic treatment of an art (or craft). An analysis of technologia outlines two key educational focuses of Technology Education. Therefore, technology education requires the discipline-specific techniques of practical knowing and doing. The root techne combines the meanings of an art and a technique, involving both knowledge of the relevant principles and an ability to achieve the appropriate results. In other words, technical education involves the practical application of skills and knowledge. The root logos, on the other hand has a wider meaning, including argument, explanation and principle. In a Technology classroom, this definition is amply demonstrated in design related activities in which learners apply scientific knowledge and practical skills to solve every day practical challenges.

One the other hand, Teis (2014: 22) argues that technology education should be defined by emphasising the educational viewpoint on the use of technology to develop human interest and understanding. Rossouw, Hacker and De Vries (2010) concur with the educational viewpoint by pointing out that technology encompasses the way humans develop, realise and use (and evaluate) all sorts of artefacts, systems and processes to improve the quality of life. In this case, technology education results in technological literacy, which is what people need to live in, and control the technological environment that surrounds us. This literacy comprises practical knowledge, reasoning skills and attitudes (Teis, 2014). This view of technology education suggests the teaching of manipulative skills to enable learners to design and make various artefacts. The CAPS for Technology (2011: 3) supports this view when it sees technology as the use of knowledge, skills and resources to meet people's needs and wants (Teis, 2014: 23).

2.2 Technical Education

Technical education, on the other hand, is rooted within the philosophy of the training of students for jobs in various technical educational fields. Technical education emphasises the acquisition of knowledge and practical application of basic principles of science and mathematics, skills, attitudes and values (Hartshorne, 1992; Kimbell & Perry, 2001; Kraak, 2002; Stevens; 2003). According to Stevens (2003), the objectives of technical education are to provide students with skills that will enable them to work as skilled artisans, but without the scientific or engineering skills. People employed in this way are referred to as technicians. The philosophy of technical education is underpinned by the behaviourist theory which recognises that learning should happen in authentic situations (Doolittle & Camp, 1999). Although debate has been raging between the behaviourist and constructivist approaches to technical education for a long time, the constructivist perspective seems to be gaining recognition among theorists (Doolittle & Camp, 2003). Some of the most influential epistemological tenets advanced by behaviourists on technical education include that learning should build on what the learner already knows.

The philosophical arguments presented above suggest that technical education, apart from aiming to equip the learner with knowledge and skills to change their circumstances, it also aims to produce a critical thinker and problem solver who is a life-long learner. Contrasted with technology education, a very thin line separates the two areas. There are more similarities than there are differences. Both technical and technology education use bodies of knowledge that focus on skills acquisition and mastery to modify and control the material world for the betterment of life. An analysis of the CAPS for Mechanical Technology (MT) (DoE, 2011) shows that the ‘mechanical’ component is essentially in the engineering domain which is a technical sphere. On the other hand, MT as a school subject in the South African curricula is classified under technology education; hence, the nomenclature ‘Mechanical Technology’.

2.3 Vocational Education

This study is focused on the challenges encountered by pre-service teachers in the teaching and learning of MT during teaching practice. It has already been established in this study that MT is a subject that involves knowledge on materials, tools and equipment, manufacturing processes and procedures as well as products and services (CAPS for Mechanical Technology, 2012). The study of the subject MT by the learner opens opportunities for mechanical engineering studies at tertiary institutions which include Technical and Vocational Education and Training (TVET) colleges. It then makes it necessary to define the term ‘vocational education’.

Lucas, Spencer and Claxton (2012) define a vocation as a form of work. They maintain that the definition of vocational education is multi-faceted. Instead, Lucas, et al. (2012:21) see vocational education as the “provision of materials, activities and teaching that is designed to prepare people to function, at a specified level, in specific roles in the context of paid employment”. In this case, vocational education is viewed as being concerned with courses, time-tables and qualifications. Its major focus is the development of practical competence within or for a defined ‘work’ domain (Lucas, Spencer & Laxton, 2012:21).

Teis (2014:47) brings to the fore a similar ‘work’ dimension of vocational education by highlighting that vocational education readies learners for manual or practical work. Such practical work was viewed as non-academic and related to a trade, occupation or vocation (Kennedy, 2012; Teis, 2014). Vocational education in South Africa is an alternative to the National Senior Certificate (NSC) and is formally lodged with the Department of Higher Education and Training (DHET) (Teis, 2014).

Literature highlights the lack of clarity about the purpose of vocational education. Others view it as only appropriate for academically less gifted learners, while others think that it is solely meant to equip students with technical skills and knowledge to make them functional adults in the world of work (Lucas et al., 2012). It is apparent from these arguments that vocational education has to do with the transfer of knowledge and practical skills. It is also clear that vocational education, technical education and technology education share common threads of knowledge transfer and practical skills development. Rossouw et al. (2010) point out the difference between technology education and vocational education as being inherent in their purposes. It can thus be argued that technology education promotes technological literacy and this literacy could be learnt in a vocational environment (Rossouw et al. 2010: 410). The teaching approaches used in vocational education are geared towards career preparation and hence on specific knowledge and skills. The elevation of engineering above general technology education is an acknowledgement of the emphasis on specific vocations (Rossouw, et al., 2010). It is argued that this development gave rise to STEM, which is the integration of science, technology, engineering and mathematics education (Rossouw et al., 2010: 410).

Therefore, for this study, vocational education, technical education and technology education will be used synonymously where the discussion of the teaching and learning of MT is concerned, especially where practical knowledge and skills are involved to avoid any misconceptions, but further emphasise the underlying education philosophy of technical and vocational education as a skills training programme that requires the capability to understand, perform and use of knowledge, skills and attitudes..

2.4 Skills competence

Definitions of ‘competence’ vary according to context. Rossouw et.al (2010: 38) define competence as “the capability to perform and to use knowledge, skills and attitudes that are integrated in the professional repertoire of the individual”. Mulder, Weigel and Collins (2007: 68) state that competence is related to the ability to successfully complete a given task with high quality and craftsmanship. We argue that MT teacher educational programmes are designed to capacitate students with the discipline-specific competencies needed to teach the subject knowledge. An important assumption is made in ant teacher training programme that students enrol with NQF level 4 subject content knowledge, and therefore have the requisite minimum subject content knowledge and skills to engage in the programme.

Competence can be determined using three approaches (Lucas, et al., 2012). The first approach is the behaviourist approach, which distinguishes between successful task performers from their less successful counterparts. Secondly, the generic approach defines common abilities that that are measured using set criteria. Last, but not least, is the cognitive approach, which classifies the cognitive skills used to master tasks, gain knowledge and apply the skill successfully. In the teaching of MT in South Africa, teacher- skill competence would be taken in this study to mean the attributes of teachers that enable them to demonstrate how to execute a specific practical skill to a class of learners with an acceptable standard as stipulated in subject guidelines. Such competence would be complemented by the correct use of tools and equipment and appropriate subject pedagogy.

2.5 Four Perspectives On Technical Education (Te)

Literature indicates at least four perspectives on technical education. Although not mutually exclusive, each view seems to be the result of a different philosophy of education. A discussion may provide an appropriate perspective for South Africa's technical education system.

2.5.1 Technical Education as content

Proponents of the content view see technical education as providing learners with knowledge about technology. To them, technology is an academic discipline which can be taught without the practical application of skills (Wright, 2000). According to Dugger (2002, cited in Akoojee, 2007), the subject content should be quantifiable and universal in nature. Proponents of this viewpoint such as De Vries (1994: 35) refer to technical education as technology education. He calls this the "technology concepts approach" which usually refers to science teachers who wish to teach science with relevant ideas from technology, but who lack the practical workshops or practical experience required to fully explore the design and product development process.

It is notable that a training system that views TE as content does not necessarily focus on practical skills competencies, but merely applies the technological concepts in the teaching of Science.

2.5.2 Technical Education as a process

Another view regards technical education as a process during which skills need to be taught to learners (Akoojee, 2007). Learners are then required to replicate the process. Learning activities typically involve making artefacts based on prescribed designs in classrooms equipped with machines and tools from the woodworking, metalworking and similar trades. It differs from the content view in so far as that it focuses on technical skills rather than on knowledge. Proponents of this viewpoint such as Ault (1993) refers to technical education as "design technology" or "children's engineering". Ackerman (1997) sees this approach as identifying needs, generating ideas, planning and creating, testing and finding the best solutions. In other words, it is about applying technical knowledge and skills in product development. De Vries (1994: 34) uses the concept "craft-based approach" which stresses traditional practical skills based on psychomotor skills, but design is neglected. This approach was typical of the technical subjects as prescribed by the Cape Education system that was applied in South Africa until 1994.

It can be argued in this paper that in South Africa, TE has elements of both TE as content and TE as a process. FET schools and TVET colleges offering technical subjects have workshops in which students produce tangible products using the design process which is both a scientific and a technological process.

2.5.3 Technical Education as a method

Proponents of this approach take existing syllabi and build technical education skills around it. According to Kirkwood and Price (2013) three aspects are important: first, the learner; secondly, the school curriculum; and thirdly, appropriate technical activities based on existing curriculum content. New syllabi are therefore just an extension of implemented syllabi. For example, Iipinge and Kasanda (2013) note that this approach was used by technical teachers (by ignorance) after independence to develop Namibian technical education syllabi based on the RSA Cape Education Department's syllabi.

2.5.4 Technical Education as vocation

This approach involves a high degree of hands-on transformation of materials into products, but emphasises current industrial practice rather than traditional craft skills, though it can overlap. De Vries (1994: 37) refers to this approach as the "industrial oriented approach". Classrooms are usually equipped with modern industrial equipment and teachers have usually been trained in industry. Learners are usually attached to industry in some way, for example by means of an apprenticeship, to gain practical experience. This approach is used where education links learners and teachers with preparation for work and an economically active life.

In South Africa, TE pre-service teachers enrol for training with at least a Technology specialisation subject pass at Grade 12. During their training, the pre-service teachers are not necessarily engaged in industry-based work integrated learning (WIL). They only engage in WIL for a total of nine weeks in their 3rd and 4th year of training. This could mean that if their training did not expose them to specific technical skills they are to teach in the schools, then they would encounter difficulties implementing the curriculum. Hence an effective TE approach argued for in this paper would be one that has a balanced mix of the elements from each of the four perspectives discussed above. Thus, this paper advocates for a teacher training curriculum that is grounded on praxis, i.e. marrying theory with practice as propounded by Dewey (1986).

2.6 The Underpinning Philosophy Of Tvet

In this sub-section we give a synopsis of technology/technical/vocational education to get a better understanding of the philosophical ideologies underpinning Technical and Vocational Education and Training (TVET) in South Africa (SA).

The history of education in South Africa has been extensively documented and the works of Badroodien, (2006), Chisholm, (1997), Kallaway, (2002), Shulman, (2013) and Stevens, (2006) among others, stand out. According to Badroodien (2006), after 1920, the Union Government focused on education that would lead to the employability of white South African learners. This was done by emphasising on skills development and the teaching of work habits. However, this approach was based on segregatory policies of South Africa. Badroodien (2006) further notes that for almost 50 years before 1900, bricklaying, plastering, painting, decorating, engine cleaning, shoemaking, tailoring, carpentry and masonry were in fact widely considered only fit for coloured men and overseas workers.

It can be observed that the technical education curriculum consisted of disciplines that were considered relevant at the time, but for specific ethnic groups as outlined by the pre-1994 apartheid regime. It can therefore be argued from the above narrative that vocational and technical education was tailor made to address the employability of the white child, while at the same time restricting access of the black and coloured child from skilled work. This effectively meant that the white child got training in the skills on demand by the industry at that time, thereby ensuring that they secure employment in their relevant trade. This also served to deal with the competition for skilled work between whites and non-whites, as the latter were consigned to unskilled and menial jobs. If the trained white child could secure employment in their chosen trade, then it meant that the vocational and technical education curricula they received were aligned to the needs of industry and commerce.

A similar scenario obtains in present-day South Africa in which, although barriers to equal access to education no longer exist, many matriculants find themselves unemployed and without trade related skills (Akoojee & McGrath, 2005). Consequently, the Department of Basic Education (DBE) proposed a new three-tiered school system to be implemented in 2017 (City Press, 2016). It is envisaged that the school system will lead to about 60% of pupils completing technical qualifications. According to the Department's plan, learners would be channelled to one of the three school systems according to their strengths. The three streams would be the academic, the technical vocational and the technical occupations. Mathanzima Mweli, the director-general at the DBE, was quoted in City Press (2016) as saying

As part of the technical occupation stream, we will introduce 26 subjects, which will include spray-painting, panel-beating, hairdressing, woodwork, glasswork, glazing, welding, upholstery, husbandry (farming) and many more.

The director general highlighted that the technical vocational stream would help students to become artisans in specific trades, with electrical, mechanical and civil engineering as the major subjects. It therefore remains to be seen if the proposed vocational and technical education curriculum for 2017 will be aligned to the needs of industry, since history has shown that the skills taught at technical institutions are sometimes at variance with what industry and commerce need. The technical education curricula adopted directly influences teacher training programmes at universities. Ultimately, universities need to align their discipline-specific content and skills in their teacher training and development programmes to the current and future needs of schools and technical colleges. High unemployment rates among school leavers could be one of the results of the misalignment between what teachers are trained to teach, and the relevant skills that students need to be equipped with for the rapid changing world of work.

2.7 Threats To The Development Of Technical Eduction Curricula

Mokhothu (2015)'s findings corroborated some of Pool, Reitsma and Mentz (2013)'s arguments that Civil Technology teachers were not skilled in the practical component of the subject and thus struggled to mediate in the learners' practical assessment tasks (PATs). The teachers in Mokhothu (2015)'s study decried the lack of adequate time and training for them to be able to facilitate in the practical component of Civil Technology during their teacher training. It can be argued here that these identified constraints have a direct impact on technology student development. Therefore, it was the focus of this study to establish the nature of problems encountered by MT student teachers during teaching practice. The lack of practical skills competences was identified as one of the threats in this study.

2.8 Practical Skills Teaching Competencies In Mt

For this study, competency-based education is defined as a programme of study with clearly defined objectives in which the students are aware of what is expected of them in terms of performance and the standards to be achieved. This type of education engages learners who work at their own rate and restructure their learning styles to these objectives. Dakmara's concept paper (2013, cited in Dadi, 2014) looked at some competencies in the curricula of several European countries. Of note is the problem-solving skills competency inherent in the New Zealand curriculum. Problem solving is also a key competency in Mechanical Technology in which learners are exposed to the design process. Section 2, sub-section 2.3(f) of the CAPS of MT, (DoE, 2012: 15) document (Requirements for Mechanical Technology) clearly stipulates that:

Schools offering Mechanical Technology must have a well-equipped workshop for learners to complete the practical assessment tasks. The classroom/workshop needs to be secure with doors that lock, and burglar proof. Enough storage space should be available to store and lock all resources. Resources to offer Mechanical Technology as a subject are the responsibility of the school. The school should build up a collection of models, e.g. by asking learners, parents or mechanical, electrical and electronic repair workshops and suppliers to donate models.

The School-Based Assessment (SBA) guidelines further specify the nature of practical activities that should be considered. These include tasks in Motor Mechanics, Fitting and Turning, Welding and Metalworking and Metalwork. For the learners in Mechanical Technology to successfully complete the practical assessment tasks (PATs), which are problem-solving oriented, they will need to be competent in practical skills such as welding, machining, bench-fitting and finishing. The implication is that teachers teaching Mechanical Technology must be necessarily competent in these skills. This study seeks to verify the competency levels of Mechanical Technology student teachers on some of key practical skills to determine their technological content knowledge. Table 1 shows an inventory of practical skills taught in Mechanical Technology in the FET phase.

Table 1: Inventory of applied practical skills

Section	Skills taught
Bench-fitting	Marking out
	Filing
	Drilling
	Screw-thread cutting
	Riveting
	Bending
Fitting and turning	Facing
	Parallel turning
	Chamfering
	Taper turning
	Milling
Metal fabrication	Metal arc welding
	Metal gas welding
Finishes	Painting

[Extracted from Grade 10-12 work schedules, CAPS (DoE, 2012)]

It is also worthwhile to note that at most schools where Mechanical Technology is taught in South Africa the subject is allocated six periods (three double lessons) per week. On average each period is 40 to 45 minutes. In most cases one double lesson is reserved for theory while the other four lessons are for practical work. Contrasted to teacher training time allocation at a University of Technology in Metal Technology, the same pattern obtains. For the module TAM30AS (Mechanical Technology III), three double lessons, each lesson 40 minutes long are time-tabled per week (Central University of Technology Calendar, 2016: 514). The module has 45 credits. Similarly, one double lesson is for subject content knowledge (theory) while the other two double lessons are for practical work.

The principle of lifelong education on the part of the teachers is aptly captured in The National Policy Framework for Teacher Education and Development in South Africa (DoE, 2006: 5) paragraph 6 that envisaged that the ideal teacher should be competent in all aspects of their specialist subject area. Besides, the teacher must be seen to contribute towards the development of their communities by being actively engaged in projects that seek to capacitate their communities with relevant knowledge and skills competencies. The policy makes it clear that a teacher needs to be competent both in subject content knowledge as well as pedagogical content knowledge. This presents a huge challenge to teacher trainers to ensure that they produce not only competent and effective teachers, but lifelong scholars.

In summary, it is established here that pre-service teachers could encounter challenges during teaching practice if they lack in any of these generic concepts. It is further argued that if teachers are not competent in the subject content, it affects their self-efficacy and their performance in the classroom negatively. This study used the self-efficacy theory as an evaluation tool to enable MT trainee teachers to reflect on teacher training experiences with classroom practice. This enabled the researchers to better understand the challenges pre-service teachers encounter in the teaching and learning of the subject of Mechanical Technology.

3. METHODOLOGY

This was a case study in which a total of twenty (20) Bachelor of Education pre-service student teachers specialising in Mechanical Technology education at a University of Technology were surveyed on their perceived levels of competencies in practical skills teaching. We used a questionnaire that utilised a Likert Scale on levels of practical skills competency as the main data gathering instrument. Text analysis was also used to obtain data from Examiners' Reports. Respondents were also required to indicate whether they taught the theoretical component of the concepts.

In order to explore the challenges identified by the respondents, 20 student teachers were surveyed on their practical skills competencies in Mechanical Technology. These comprised 8 (40%) female and 12 (60%) male who were all in the 20 to 29 age brackets. The 20 respondents were in their third year of study for a Bachelor of Education degree majoring in Technology Education. The survey instrument was a questionnaire which was either physically or electronically distributed or retrieved with a 100% return rate. The survey sought to establish the areas the respondents had received training in relation to what they encountered during teaching practice. The respondents were also required to rate themselves on each identified skill in Mechanical Technology and indicate the areas in which they felt they needed skills development. The results of the survey were then used to design and implement an appropriate skills development programme as an intervention.

Descriptive statistics were used to analyse and present data.

4. FINDINGS

The purpose of this study was to determine the perceived levels of practical skills competencies among a group of 20 Bachelor of Education pre-service teachers specialising in Mechanical Technology at a University of Technology.

4.1 Major Challenges During Teaching Practice

4.1.1 Workshop tooling

Thirteen (13) respondents who were deployed to township schools reported that their school workshops did not have adequate hand tools such as scribers, centre punches, files and hacksaws commensurate with the number of learners in their classes. Eleven (11) respondents highlighted that their workshops had only one drilling machine for all their classes. The net effect on these challenges was to afford the learners the opportunity to do practical work only rarely. If the pillar drill broke down, it took a considerable amount of time before it could be repaired, resulting in the teachers only focusing on teaching theory lessons.

Eighteen (18) respondents observed that the equipment in their school workshops were very old and in a state of disrepair. They could not maintain the equipment themselves, as they lacked the expertise and time. Only four respondents said their workshops had welding bays that were partitioned. Most of the respondents only taught the theoretical content of the subject as per syllabus guidelines and only concerned themselves with the PAT as and when it was required. In most cases the PAT was done when the respondents would have completed their six months teaching practice attachment and were back at university. It would appear as though the shortage of tools and equipment in the school workshops was one of the excuses used to focus on not respondents not doing practical lessons during teaching practice.

Re-tooling the workshop was an area beyond the respondents' scope as it was the responsibility of the Head of Department (HOD). Most respondents reported that each time they enquired about tools and equipment from their respective HODs, they would be informed of budgetary constraints and advised to use whatever was there. Some respondents asked their learners to either bring their own tools from home or complete the projects outside school and only submit the final project for assessment. This would be a breach of learning guidelines for the subject, especially on the production of learners' own work. The teacher is required by policy to ensure that the project submitted is the learner's authentic work, while the learner is required to complete a declaration form affirming that they did not get assistance in producing the PAT. The only way a teacher can verify that it is the learner's own work is if the project is done in the workshop under the teacher's supervision from beginning to the end.

4.1.2 Workshop overcrowding

The official teacher-learner ratio for technology subjects such as Mechanical Technology is 1:20, while that of tertiary institutions is 1:15. The table below shows the class sizes taught by the participants during teaching practice from Grade 1 to Grade 12.

Table 2: Class sizes per grade per respondent

		Respondent																			
Grade		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
10	Number of	38	0	47	31	19	45	52	28	33	19	39	44	40	26	33	40	30	27	39	23
11		0	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	19	9
12		0	0	0	0	0	0	0	0	0	0	7	0	0	0	12	0	6	0	0	0

The statistics show that on average the teacher learner ratio was twice above the official ratio of 1:20. Overcrowding in Grade 10 went hand in hand with inadequate hand tools, few workbenches and inadequate machinery. Most of the participants had no Grade 11 and 12 classes. This could be an indication of lack of confidence in the abilities of student teachers to teach those grades. Student teachers were only teaching in four cases at Grade 11 and three cases at Grade 12 level. The class sizes at Grades 11 and 12 were well below the official ratio. In most cases the matric classes were taught by the mentor teachers. It could be concluded that the argument by student teachers that they were overloaded with work could be valid. This workload also compromised the teaching of practical skills at Grade 10, which is a critical grade, as learners are coming from Grade 9 where practical skills teaching were not intense. In Grade 10 the learners now specialise in Mechanical Technology and are expected to do focused practical assessment tasks involving specific skills in welding, machining and fitting as well as in automotive, depending on their electives. The overcrowding could also be a contributory factor to the teacher's focus on teaching theory exclusively, to the detriment of practical lessons.

The few hand tools and workbenches meant that most learners would not be engaged meaningfully during the practical lessons as they would be waiting for their chance to use the tool or workbench. At the end of the lesson not much is achieved because of the idle time at the learner's disposal. The large classes at Grade 10 level presented class management challenges. The respondents reported that noise levels were high as learners constantly squabbled over learning resources such as textbooks and tools, which were in short supply. The respondents decried that 40% of their teaching time was spent on trying to settle down the learners. At the end of the day they were exhausted and stressed, leaving no room for preparing teaching materials for subsequent lessons.

4.1.3 Practical skills content knowledge

Respondents who were deployed at three well-equipped technical schools reported that most of the machinery in their workshops was not familiar to them, as they had never seen, let alone used them during their training. They argued that they had only done the theory component of the machine, which included labelling of machine parts and safety precautions related to the use of the machines. Most respondents said that they would remain behind after school hours to study how the equipment worked or enlisted the assistance of the mentor teacher. One respondents at a technical school in the Motheo District said she had to attend her mentor teacher's practical lessons so that she could learn how to weld.

The School-Based Assessment (SBA) guidelines (DoE, 2012) further specify the nature of practical activities that should be considered. These include tasks in Motor Mechanics, Fitting and Turning, Welding and Metalworking and Metalwork. All the respondents said they were competent in bench-fitting processes such as measuring and marking out, filing, drilling, riveting and bending. However, they felt that they were inadequately prepared to teach practical lessons in fitting and turning as well as in welding. Those respondents teaching Grade 11 and 12 had had to rely on their mentors to teach skills in machining and fitting as the practical assessment tasks needed those skills. The respondents felt strongly that their inability to teach certain skills resulted in learners losing trust and respect, as they were viewed as incompetent to teach at that level. This resulted in the respondents losing confidence in their own teaching abilities. The result was frustration and loss of self-esteem among the student teachers. One female respondent said she was disheartened when she overhead her Grade 11 learners say, "M'am cannot teach us to cut threads, don't you know that she is not yet qualified …" Taylor and Vinjevold (1999) and Muller (2000) observe that a learner's perception of the instructor's abilities has a direct link to the learner's mental preparedness to listen and learn from the instructor. In this case, learners could have lost confidence in the teacher's abilities to teach them new skills in threading.

To compensate for the lack of practical skills, the respondents reported that they focused on covering the syllabus content, which only required a textbook and simple teaching/learning media. The teachers were only concerned with meeting the assessment requirements for each term. Two respondents who were teaching Grade 12 classes reported that they gave their learners free reign on the PATs, implying that learners could improvise by coming up with a completed practical assessment task.

The lack of practical skills acquisition by learners in Mechanical Technology is captured in The Examiner's Report (DoE, 2012) in which Technology showed that there was a tendency by educators to inflate marks on mediocre PATs superficially to mask the lack of quality and then subsequently proclaimed high pass rates in the subject. Failure to provide learners with the right resources and equipment has led to the presentation of fake projects by learners who go into the community and buy or have the projects made for them outside the school. These projects are then presented to the educator as the learner's original work. While it is a requirement that PATs be done in the school workshop under the supervision of the educator, there is no one to verify compliance by the educator. Although checks and balances are there whereupon learner projects are moderated internally by the HOD and externally at cluster and district levels, there is no mechanism to physically verify that the projects were made in the school workshop. The educator is primarily concerned with meeting the deadline and having evidence of the learner's work, which ultimately translates into results. If the learner can improvise, then the educator is satisfied. The sad thing is that the learner has not acquired the process skill of welding, turning, milling, painting, etc. It is a plain demonstration of the effect of mis-alignment between the educational objectives of the subject as outlined in CAPS and the implementation of the curriculum and the consequential educational effect. This approach is in direct contrast with Bransford et al. (1999)'s view that for learners to gain insight into their learning and their understanding, frequent feedback is critical. The feedback should be on the learner's authentic work. Learners need to monitor their learning and actively evaluate their strategies and their current levels of understanding. This view is supported by Pellegrino et al. (2001), who observe that individuals acquire a skill much more rapidly if they receive feedback about the correctness of what they had done. It can therefore be argued that in the absence of skills competencies among the student teachers, as in this case, invalidated any feedback given to the learners.

4.1.4 Teaching media and resources

All the respondents reported that their workload made it impossible for them to prepare teaching aids such as charts, posters and models. They relied on the media made available by the Department of Education. Priority was on covering the syllabus

as per work schedules by improvising on the available teaching/learning resources. The respondents wanted a situation whereby they can take the teaching/learning media they produce for their micro-lessons on campus with them to teaching practice. This, they argued would go a long way in saving time and improving on lesson delivery. A poignant fact made by the respondents was that even though they understood the importance of using a variety of media in their lessons, they neither had the skills nor the time available to prepare the relevant media for their lessons. This view was also reinforced by several respondents, who observed their mentor teachers teaching from the textbook without any media. It would appear as if the student teachers had the impression that it was the norm to deliver lessons without teaching media, even when the lesson topic made it imperative for teaching/learning media to be availed. It could be that the teaching in this case was focused on producing good results in examinations.
Njabili (2004:37) maintains that in such a situation the content of the curriculum and emphasis in teaching are determined by examination demands. On the other hand, research has shown that curricular objectives can best be achieved if examinations and assessment serve the curriculum. The fact that mentor teachers were teaching from the textbook without teaching/learning media did not mean that their teaching was effective, nor did it downplay the role of media in teaching/learning. Suffice it to say, it sent the wrong message to the observant student teachers.

4.2 Findings From The Practical Skills Competency Survey
4.2.1 Mentored in the practical skill
Question 7: The following question seeks to find out if you received training or mentorship in the listed Mechanical Technology practical skills during your teacher training course.

Table 3: Results for question 7

		Yes	No	N/A
Q7: Trained in the skill	Marking out	16	4	
	Cutting with a hacksaw	15	4	1
	Chiselling	12	8	
	Filing	15	5	
	Screw-thread cutting	10	9	1
	Riveting	15	5	
	Bending/Folding	17	3	
	Drilling	18	2	
	Facing	2	16	2
	Parallel turning	2	16	2
	Chamfering	3	15	2
	Taper turning	3	15	2
	Milling	4	12	2
	Metal-arc welding	11	8	1
	Metal-gas welding	7	12	1
	Painting	12	8	
	Bluing (Surface hardening	7	12	1

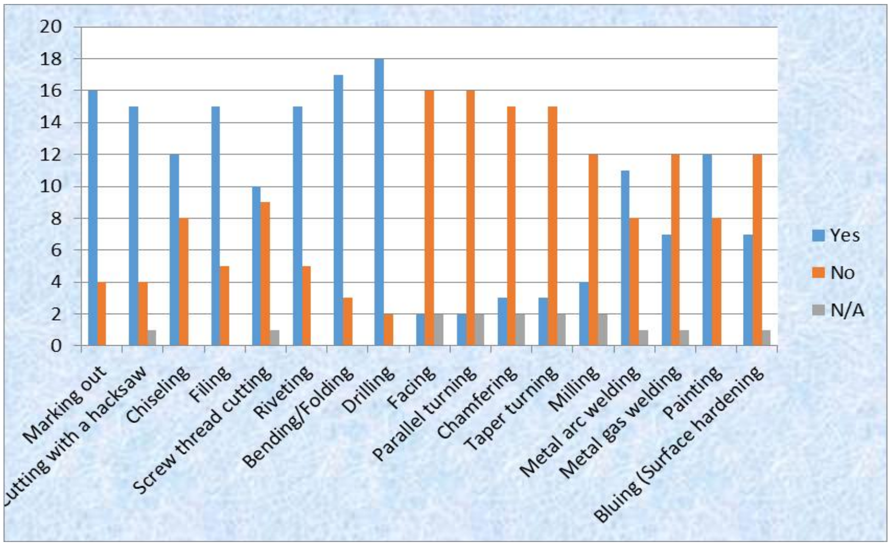

Chart 1: Results of skill training

The results to the question of whether the respondents were mentored in specific practical skills during training are shown in Chart 1 above. These skills are in the subject content knowledge of Mechanical Technology. After probing why some respondents indicated that they had not received training on the specific skills, it emerged that they had not done the subject at FET phase (Grade 10 to 12), but had only opted to major in the subject at university. The respondents who said they had received some training on specific skills explained that they acquired the skills at high school as Mechanical Technology was one of their matric subjects. On the other hand, 7 respondents indicated that they had not done the subject at the FET phase but learnt some basic skills from their peers during project work at university. Skills transfer took place through collaborative learning between those students who had done Mechanical Technology at high school and those who had not. This is in line with Felder, Felder and Dietz (1998), Michaelsen, Knight and Fink (2004) and Davis (2009), who observe that students can also teach one another by addressing misunderstandings and clarifying misconceptions. This, they argue, promotes student-faculty interaction and increases student retention, self-esteem and responsibility and prepares students for real life, social and employment situations.

Of note on the results shown in Table 4 is the fact that many respondents indicated that they had never done any machining and fitting skills either at high school or at university. Barkely, Cross and Major (2014), who see knowledge as a social construct argue that gaps in knowledge in a discipline can cause an individual to lose confidence in themselves, leading to poor performance. It can therefore be inferred that if teachers feel incompetent in a skill, they could end up being frustrated and may not discharge their duties confidently and effectively.

4.2.2 Classroom theory/practical application of skill

Question 8: This question seeks to find out from you if you have taught the skill to your Mechanical Technology classes (Grades 10, 11 & 12). Responses to this question are shown in Table 4 and Chart 2, respectively.

Table 4: Taught theory and practice of skill

		Taught theory			Taught practical		
		Yes	No	N/A	Yes	No	N/A
Q8: Taught theory & practical	Marking out	11	7	1	5	10	1
	Cutting with a hacksaw	11	7	1	3	12	1
	Chiselling	10	8	1	4	11	1
	Filing	11	7	1	4	11	1
	Screw-thread cutting	9	9	1	4	11	1
	Riveting	11	7	1	4	11	1
	Bending/Folding	10	8	1	4	11	1
	Drilling	10	7	1	4	11	1
	Facing	4	13	2	1	14	1
	Parallel turning	4	13	2	1	14	1
	Chamfering	3	14	2		15	1

	Taper turning	5	12	2		15	1
	Milling	6	11	2	2	13	1
	Metal arc welding	9	9	1	4	11	1
	Metal gas welding	8	10	1	2	13	1
	Painting	8	10	1	2	13	1
	Bluing (Surface hardening	5	12	2		14	2

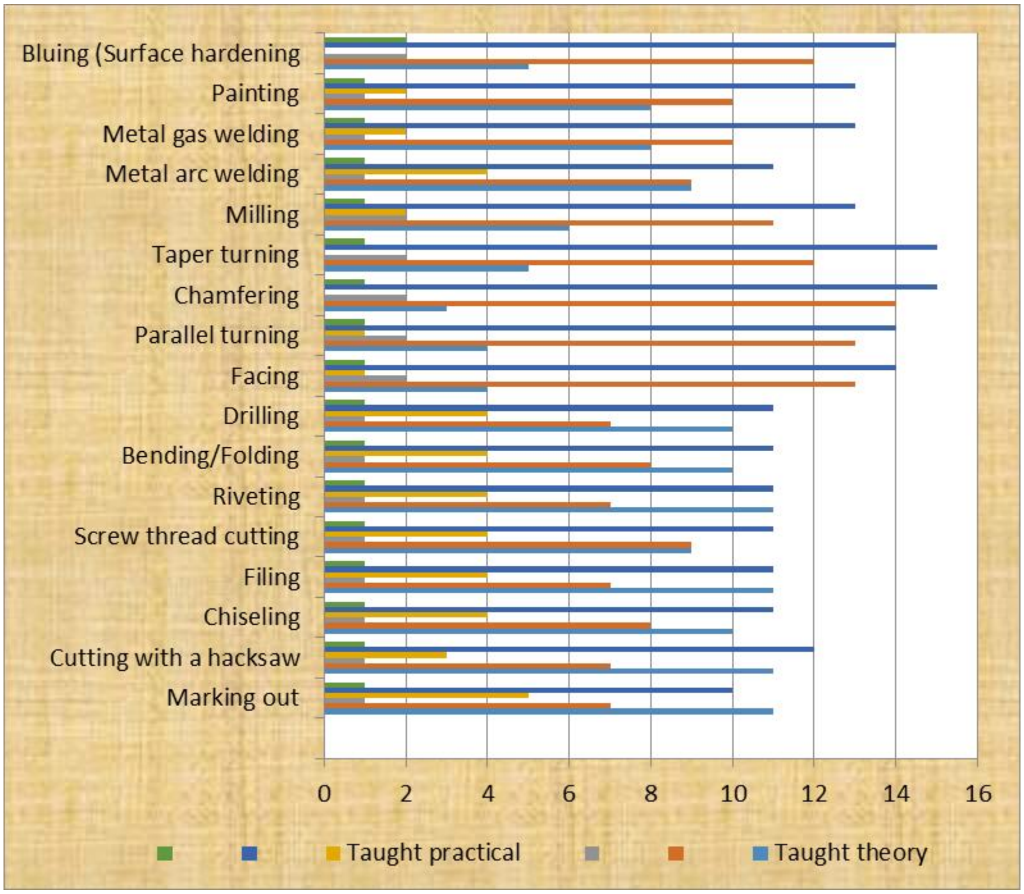

Chart 2: Taught theory and practice of skill

The results show that almost 50% of the respondents indicated that they taught the theoretical application of knowledge of basic bench-fitting skills of marking out, cutting with a hacksaw, chiselling, filing, screw-thread cutting, riveting, bending/folding and drilling. This was in sharp contrast to machining and fitting, as well as welding skills. Those who did not teach the theory revealed that the topics that were given to them by their mentors did not involve those on the questionnaire checklist. Between 55% and 75% of the respondents indicated that they never taught the practical aspects of the skills on the checklist. Upon probing as to why they did not teach the practical content knowledge, reasons such as ‘I don’t know how to do the skill’, ‘No infrastructure nor equipment’, to ‘My mentor was the one teaching the practical lessons’, were proffered. The practice of selectively teaching the theory of some concepts in Technology education and omitting the practical application of the concepts goes against the philosophy of praxis, which is the hallmark of Technology education, as advocated for by John Dewey and Karl Marx, who emphasise the need to marry theory with practice. This means that for learning to be effective, the theory taught is operationalised through practical work when learners solve practical problems through the design process, for instance. If the teacher is not competent in a skill, then the link between theory and practice is broken. It can be argued therefore that student teachers under the circumstances as in this study may require some form of reskilling in specific practical skills in Mechanical Technology. Mechanical Technology teachers (mentors in WIL) as well as the WIL environments in which the pre-service teachers were placed to apply acquired knowledge and skills did serve the intended purpose of developing the teaching skills of the student teachers.

4.2.3 Practical skills competency self-rating

The 20 respondents were asked to rate themselves on how well they thought they could execute a specific practical skill in Mechanical Technology. This was to enable the researcher to carry out a needs analysis of the student teachers on teaching practice.

Question 9: This question seeks to find out from you how you rate your competency level in each practical skill.

Level	Descriptor
1	Not yet competent
2	Slightly competent
3	Average
4	Competent
5	Very competent

The results to question 9 are shown in Table 5 and Chart 3, respectively.

Table 5: Results of skills competency self-rating

Q9: Competency self-rating	Level	1	2	3	4	5
	Marking out	0	1	5	9	5
	Cutting with a hacksaw	1	2	10	4	3
	Chiselling	2	2	9	6	2
	Filing	2	1	4	7	6
	Screw-thread cutting	7	4	4	4	1
	Riveting	0	4	6	7	3
	Bending/Folding	1	2	4	9	4
	Drilling	0	0	5	8	7
	Facing	13	4	1	2	0
	Parallel turning	13	5	1	1	0
	Chamfering	13	4	3	0	0
	Taper turning	14	3	2	1	0
	Milling	14	1	4	0	1
	Metal arc welding	6	4	4	3	3
	Metal gas welding	9	2	4	1	4
	Painting	4	3	2	6	5
	Bluing (Surface hardening	14	0	3	1	2

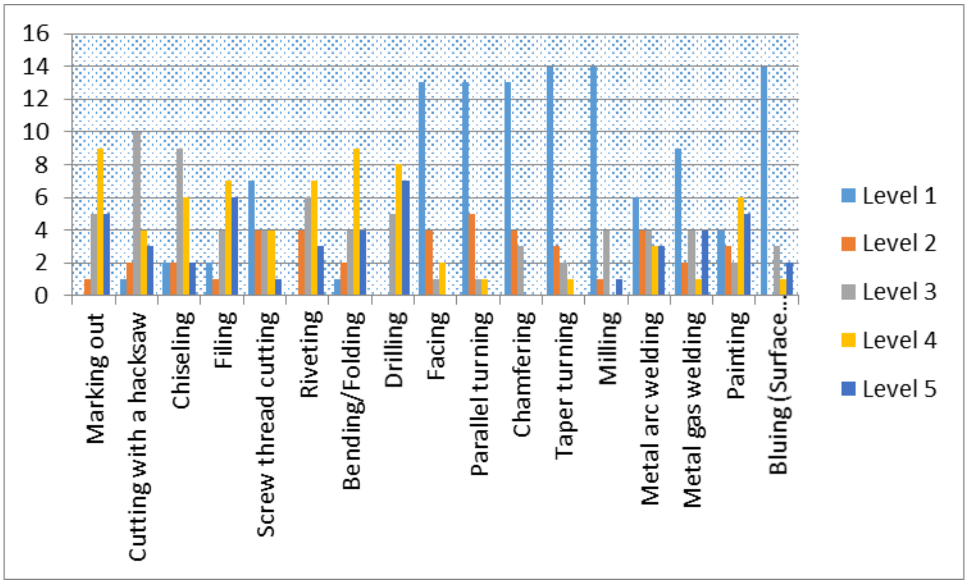

Chart 3: Visual representation of skills competency self-rating

Table 6 below puts the results of the self-rating into perspective by showing the cumulative percentages for each identified practical skill.

Table 6: Total percentages per level per skill

Total percentages per Level					Skill
Level 1	Level 2	Level 3	Level 4	Level 5	
0	5	25	45	25	Marking out
5	10	50	20	15	Cutting with a hacksaw
10	10	45	30	10	Chiselling
10	5	20	35	30	Filing
35	20	20	20	5	Screw thread cutting
0	20	30	35	15	Riveting
5	10	20	45	20	Bending/Folding
0	0	25	40	35	Drilling
65	20	5	10	0	Facing
65	25	5	5	0	Parallel turning
65	20	15	0	0	Chamfering
70	15	10	5	0	Taper turning
70	5	20	0	5	Milling
30	20	20	15	15	Metal arc welding
45	10	20	5	20	Metal gas welding
20	15	10	30	25	Painting
70	0	15	5	10	Bluing (Surface hardening

The skills competency self-rating results indicate that a large proportion of the respondents felt that they were not competent in machining and fitting processes, compared to bench-fitting processes. All these skills are in the Mechanical Technology syllabus for the FET phase. The implication of this self-appraisal by the respondents is that the learners that are taught by the respondents may not be getting value for money from their teachers. A heat treatment skill of surface hardening (bluing), which is applied to steel products as a corrosion-resistant finish enables learners to produce high-quality steel products. If 70% of the respondents said they were not competent at all in the skill of surface hardening, then it could safely be concluded that the learners would not learn the practical application of the concept that they have been exposed to the theory of under the topic of ‘Heat treatment of plain carbon steels’ in Grades 10 and 11. The data shows that the pre-service teachers are not competent in the key skill areas required for MT teaching. The data further suggests that the pre-service teachers enrolled in the programme do not have the required entry (NQF Level 4) discipline-specific content knowledge to teach the subject.

Suppose a learner who has gone through matric without being taught the skills opts to go to university to study for a B.Ed. degree in Technology Education and the student is also not taught the skills up to getting their qualification and joins the profession of teaching. This would mean that a cycle of practical skills deficiency is perpetuated in the subject. While it may not be practically feasible for one to be 100% competent in any area, assessment guidelines and standards to be achieved for one to be deemed competent after performance measurement make it possible to identify areas of improvement by the student. Gonzalez-Bravo (2015) argues that competency-based education is characterised by a programme of study with clearly defined, concrete, measurable objectives of which every student participating in the programme must have demonstrated mastery upon programme completion.

For example, in Ontario, Canada, in 1998 the provincial government introduced a new curriculum for elementary school students. This curriculum focuses on measurable competencies that are evaluated for each student in the language arts, mathematics, and science and technology and are consistent at every school throughout the province (Ontario Ministry of Education and Training, 1998). It is therefore imperative that student teachers be exposed to both theory and practice of the concepts making the body of knowledge of a practical subject such as Mechanical Technology. Literature in support of the need to teach skills to students to a point where they are certified as being competent has been highlighted in this study.

5. DISCUSSION OF FINDINGS AND CONCLUSION

The pre-service teachers who participated in the research were drawn from diverse educational backgrounds as they engaged in teacher training and WIL in particular. These student teacher perspectives demonstrate the diversity of the teaching contexts from which student teachers draw subject content knowledge and skills. The study provide further insight into the professional development requirements of newly appointed MT teachers.

The study revealed that the student teachers enrolled in the B.Ed. in MT programme at a University of Technology were not sufficiently exposed to the key discipline-specific skills development programmes during teacher training, WIL and prior to enrolment in the programme. The data in Table 1 and Table 4 suggest that the student teachers primarily teach the basic bench fitting skills during teaching practice and do not engage the learners in the key discipline-specific skills (Taper turning, milling and welding) during teaching practice. The data in Table 3 further suggest that the mentor teachers at schools where these students were placed did not engage the student teachers during WIL in teaching of key skills development even though they are aware it forms part of the key curriculum content spelt under CAPS.

The pre-service student teachers in this enquiry expressed the willingness for in-service in the practical skills they felt they were not competent in. Some of the challenges the student teachers encountered during teaching practice included under-resourced school workshops, over-crowded classrooms and the lack of practical skills content knowledge. The net effect of these challenges on the pre-service teachers was the loss of self-confidence by the student teachers and the emphasis on theoretical teaching to the detriment of the practical application of concepts.

There could be need to further investigate the background of students admitted into technical subject courses and the nature of work-based learning that these students would need to develop the requisite skills needed for the effective implementation of a technical teacher training curriculum. The practical skills training environment at tertiary level also needs to be explored for compliance with the desired graduate attributes as there seems to be a mis-alignment between the training given to pre-service teachers and the skills they are required to teach in schools.

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