
The shift to tertiary technical and vocational education and training and the demise of South Africa's former 'technikon' system

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ABSTRACT

Post-school systems of education and training have changed dramatically across the globe, including in South Africa, over the past two decades. It is ironic, however, that as many countries chose to renew and grow 'polytechnic-type' post-school education and training subsystems, South Africa (together with other countries from the Anglo-Saxon world) chose to reduce their role, largely through institutional mergers and processes of academic drift. Much of this difference in approach is path-dependent, shaped by the specific histories of capitalist evolution in each country. However, it also has to do with the faulty policy logic which has guided these changes over the past two decades. This article investigates the rise in significance of tertiary technical and vocational education and training (TVET) through brief case studies of two countries in Central and Northern Europe where the polytechnic sector has been expanded, not reduced. The discussion then shifts to South Africa, where graduation outcomes (in percentage terms) in the universities of technology have remained flat for more than two decades. The shift from secondary to tertiary TVET requires a significant expansion of enrolments and graduations in key applied technology fields, not the stasis we are seeing in South African universities of technology.

KEYWORDS

university of technology; tertiary TVET; polytechnic education institutions

Introduction

South Africa, along with many other countries in the Anglo-Saxon world, chose to reduce the provision of ‘polytechnic-type’ post-school education over the past two decades, primarily through institutional mergers and incorporations. This decision could not have come at a worse time, as skills requirements in the global economy have changed dramatically. These changes have suggested that the need for polytechnic education has become more important now than ever before. In fact, the current period has witnessed a dramatic shift globally in the demand for technical and vocational education and training (TVET) towards tertiary (or post-school) levels rather than at the secondary (school- or college-based) level. A diverse range of countries such as Finland, Ireland, the Netherlands and Singapore have witnessed a major expansion of TVET in the past two decades, especially tertiary TVET (applied higher education) alongside a strong economic emphasis on moving up the global production value chain. The shift to tertiary TVET is a response to the demand for higher-order applied skills that only a degree-awarding polytechnic sector can provide. This shift marks an end to the prioritisation of secondary TVET at the school and college levels. Tertiary-level TVET is now the educational prerequisite for success in today’s global markets – and it takes place in polytechnics and colleges mandated to offer post-school, pre-degree qualifications alongside clear pathways into applied and technical degree programmes. In contrast to these global shifts, South Africa remains fixated on the problems of secondary TVET offered by its poorly performing TVET colleges.

The first part of this article is definitional: it describes what is meant by the term ‘tertiary TVET’ and the position it occupies in the overall national qualifications system. The second section examines the phenomenal growth of tertiary TVET globally, illustrating this through brief case studies of the Netherlands and Finland. The third section shifts the focus to South Africa’s six universities of technology (South Africa’s variant of a ‘polytechnic’ institution). It examines the background data for the six universities of technology that currently exist. The data suggest a sector that is relatively stagnant, with slow growth rates in key tertiary TVET areas. The final section provides an explanation for this stagnation and stasis – specifically the faulty policy logic of the post-1994 democratic state, which failed to align post-school education and training with these new (tertiary TVET) world realities.

The importance of polytechnic higher education

Explaining the growth of polytechnic education in certain countries of the world first requires a definition of what constitutes ‘tertiary TVET’. This is best achieved by applying a national qualifications framework template which is present in most countries and has an increasingly standardised structure. Indeed, South Africa has instituted a National Qualifications Framework (NQF) with ten levels. The first observation to be made about this structure is that the secondary school (or further education) phase ends at NQF Level 4 (or Grade 12). More interestingly, NQF Levels 5 and 6 are post-school qualifications located within the higher education band, but which are pre-bachelor’s degree programmes. The core focus of university provision begins at NQF Level 7 – the bachelor’s degree through to the PhD (NQF Level 10).

It is the intermediate band of qualifications – which are post-school, pre-degree levels (NQF Levels 5 and 6) – and their progression into applied/technical degree programmes (NQF Levels 7 and above) that are termed 'tertiary TVET' in the international literature. The qualifications offered here are the para-professional and the mid-level technician positions that are career-orientated and that are required in large numbers in an increasingly sophisticated knowledge economy. 'Ramping up' provision in this intermediate band remains one of our greatest education and training challenges.

The myth of an all-pervasive high-skills 'knowledge economy'

Such a definition of tertiary TVET clashes somewhat with the contemporary idea of a knowledge-based economy (KBE) dominated by the need for 'high skills' across all sectors (Brown, Green & Lauder, 2001). Much of the debate within this dominant idea of the knowledge economy emphasises the need for university-level graduates with bachelor's degrees in professional and high-skill areas. The grand narrative about the transition to the KBE (e.g. Castells, 1996) creates the impression that all occupations in all sectors now require high skills for a knowledge-driven economy. This is a highly problematic generalisation and exaggeration for it ignores the continued reliance on old forms of production that continue to use low- and semi-skilled workers (Kraak, 2005). In addition, it ignores the centrality of intermediate skills in most economies and societies. As Kraak argues, the transition to a knowledge economy is premised on the exponential growth in the availability of skills at the intermediate (and not only the high-end) levels. He argues that the diffusion of the new high-skills production techniques is more uneven than is acknowledged in the international literature on globalisation and the knowledge economy. These techniques do not totally displace old forms of social and economic organisation, but rather co-exist alongside them. The reality of high-skills production is that it actually occurs in relatively few sectors in the advanced and leading East Asian developing economies, namely:

- information technology (IT);
- biotechnology;
- new materials beneficiation;
- pharmaceuticals;
- aircraft manufacture;
- machine tools;
- the high-skills end of financial and business services; and
- the high-skills professions in the civil service, law and medicine.

The analysis above clearly suggests that manufacturing and intermediate skilling continue to be important in advanced and developing economies across the globe (including South Africa).

The rise of tertiary-level TVET globally

The expansion of tertiary TVET has been most noticeable in a range of countries from Central and Northern Europe as well as South and East Asia – countries such as Finland, Ireland, the

Netherlands and Singapore – which have all witnessed a major growth of tertiary TVET (applied higher education) alongside a strong economic emphasis on moving up the global production value chain. One explanation for this expansion or ‘ramping up’ is that the rise of polytechnic institutions is an outcome of the democratisation of access to higher education globally, which has placed major pressures on governments to find the means of enrolling hundreds of thousands of first-generation, new higher education students. A varied clientele of differing social class strata has emerged in most national systems of higher education, which can be accommodated only through a more diversified system, ranging from the traditional elite universities through polytechnic-type institutions to post-school colleges.

The other (seemingly contradictory) pressure running alongside the forces of diversification is shifts towards the convergence of institutional type and function. Christensen (2012) makes the useful point that academic drift is not a new phenomenon: certainly not since the massive expansion of student enrolments globally from the 1970s onwards. The process of drift is much older and has been a key characteristic of the processes of professionalisation since the early beginnings of professional education. Elite pretensions and the continued striving after vertical distinctions have always acted to push educational requirements in a more genteel and theoretical direction and to make them less narrowly vocational (Christensen, 2012:146).

However, there are arguments that academic drift has intensified in the past decades. The strongest influence in this process has been the European Union (EU) and its Bologna process, which committed 30 European countries to moving towards a convergent structure of study programmes and degrees. The prime focus has been on implementing a common bachelor–master’s framework to create a convergent structure of three years for a degree and two years for a master’s degree. Teichler (2008:2) notes a growing imitative behaviour which stems from these convergent pressures.

The above discussion points to two seemingly contradictory pressures – divergence and convergence. The institutional shape and balance obtained within the higher education system after these pressures have been brought to bear are often of a hybrid nature, a mixed institutional typology of post-school provision. On the one hand, shifts towards a unitary system dominated by universities has taken place (as in Australia and the United Kingdom), but, on the other, the renewal of polytechnic-type institutions (as in Germany and its Fachhochschulen) and the creation of new polytechnics in the 1990s in countries such as Finland, Ireland, the Netherlands, Portugal and Singapore have also occurred.

Teichler (2008) argues that the idea of ‘academic drift’ – that non-university higher education institutions would assimilate themselves into universities and that this would lead eventually to the natural death of the two-type structure – is a misnomer. In reality, he argues, this upgrading took place in only a few (largely Anglo-Saxon) countries, while concurrently a significant number of other European countries saw a reverse process during the 1990s of the creation and strengthening of a two-type structure: university and polytechnic (Teichler, 2008:2). South

Africa, as a country within the 'Anglo-Saxon' path-dependent tradition, chose to go the United Kingdom route and upgrade its technikons into universities of technology.

Two central features of these new polytechnics in Europe (but also in the developmental South-East Asian states such as Singapore) are, first, the 'seamlessness' of progression through the post-school system from college to polytechnic to university. A second feature is the high level of participation by employed mature students in the polytechnic system alongside young entrants. Both of these elements are present in the brief case studies described below – the Netherlands and Finland – but these two defining elements are true for other countries such as Ireland and Singapore (for the latter two countries see Seng, 2012; Kirby, 2008).

The Netherlands TVET system

A major change was brought about in the Netherlands system at approximately the same time that changes were occurring in South Africa. New legislation in 1996 provided an entirely new institutional architecture for Dutch TVET (Visser, 2010:11). The 1996 Act devised a set of interactions between institutions which would ensure far more effective 'system alignment' and complementarity than had previously been the case (Sung, 2010:21). The new institutional elements that were introduced alongside existing institutions which were consolidated and merged included:

- A system of 17 sectoral bodies called 'knowledge centres' (*Kenniscentra*) was established along the lines of broad economic sectors. These centres play a crucial role as the 'starting point' for the design of national vocational qualifications. Employers play a key role in designing 'job profiles' of the skills needed in the economy. These occupational standards then serve as the basis for creating new qualifications that are taught by the regional training colleges (ROCs) (Cedefop, 2008:7).
- The creation of 43 ROCs formed out of the merger of hundreds of local training colleges. These colleges manage the 'school-based' learning of senior secondary vocational education. All students (in either work- or school-based pathways) follow the same qualifications that are designed by the centres. The ROCs have a strong regional development focus (Sung, 2010:21; Raddon & Sung, 2006:13).

The Dutch vocational education and training (VET) system has three levels. The system starts at a very early age, with Dutch children having to make their first educational choice at the age of 12: to choose a vocational track through high school. This route begins with junior secondary VET; it continues after compulsory schooling at age 16 in senior secondary school as 'secondary vocational education' (MBO); and it peaks in post-school education as 'professional higher education' – that is, applied or polytechnic higher education. Key statistics about the school VET sector indicate that:

- Vocational education comprises 16% of the total schooling system, but 35% of the secondary schooling system.

- Higher professional education – applied or polytechnic higher education – comprises 62% of all post-school tertiary training (Altinyelken et al., 2010:24).

In short, the tertiary TVET system is large in the Netherlands, larger than the academic track in higher education (Altinyelken, Du Bois-Reymond & Karsten, 2010:24, 34).

A major strength of the Netherlands model is its emphasis on growing tertiary TVET as the critical element in today's labour market (and not secondary TVET). Some of the MBO programmes extend beyond the basic school phase of 12 years of education. They start at the end of compulsory education at 16 years of age and end at an average age of 20 years. They then proceed to tertiary TVET. These trainees become highly skilled intermediate workers in the Dutch economy (Reubzaet, Romme & Geerstma, 2011:6; Cedefop, 2011:15–16).

The Netherlands also stands out for its excellent adult continuing TVET system. Social partners (employers and unions) decide through collective bargaining agreements to commit to training. A sector-based Training and Development Fund is then levied in the sector to fund such in-firm training. Currently, there are approximately 140 of these funds, which cover 85% of employees. Tax deductions are also available for firms who train their employees (Sung, 2010:20; Sung, Raddon & Ashton, 2006:64).

The case of Finland

Finland is a unique country defined by high levels of social inclusion, trust and reduced levels of inequality – all crucial ingredients in its rapid economic development since the 1980s. Castells and Himanen (2002) argue that it is precisely these qualities – a relatively equal and homogenous society – that has enabled Finland to make the dramatic leap from a resource-based economy to a knowledge society in a very short space of time. Finland's shift to the information society has been combined with retention of the main features of the welfare state and low levels of social injustice and exclusion (Dahlman, Routti & Anttila, 2006:34–36). The interventions in post-school education and training from the 1980s onwards put education, research and development (R&D) and innovation at the centre of its new industry policies, which emphasised the building up of localised economic clusters and regional economic development (Ylä-Anttila & Palmberg, 2005:2).

The central pillar of Finland's education system is that it is provided free. The quality of provision is excellent (Dahlman et al., 2006:102). The total education system consists of three levels, with a strong dual system of academic and vocational provision in both the upper secondary and the tertiary sectors. The vocational schooling system runs parallel to the general education track for the last three years of secondary schooling. Significantly, 40.1% of learners exiting the junior secondary phase choose vocational schools. This is a high participation rate in the senior secondary vocational phase, largely due to the fact that it is of equivalent status in the labour market to that of the general schooling track and it also enables access to a university education (MoE, 2008:24).

Adult education in polytechnics is also well developed in Finland. It is characterised by high participation levels by adult employees – 57% of all employed 25–64-year-olds – and high levels of public funding. The participation rates in other Organisation of Economic Co-operation and Development (OECD) countries are far lower: for example, Germany at 18% and an OECD average of 34% (MoE, 2008:37).

Higher education

Higher education is free in Finland, and, as a consequence, participation rates are very high – at 85% of the 18–24 age cohort, this is one of the highest in the world (Dahlman et al., 2006:102). There are currently 20 universities and 29 polytechnics in Finland. Ten of the universities are multidisciplinary institutions and the other ten comprise three technical universities, three schools of economics and four schools of art. They are all publicly funded. Ten of the polytechnics are privately run. There were 114 730 polytechnic students and 152 198 university students in 2007 – a total of 266 928 students in higher education (MoE, 2008:37–39).

The polytechnics are a recent institutional addition to the education system. They were introduced in the early 1990s – initially in a piloting phase (to ensure quality and standards) from 1991 onwards, and then more permanently since 1996. They were formed out of the amalgamation of former post-secondary vocational institutes. The polytechnics emphasise connections with work and practice. The research conducted in polytechnics involves cooperation with private and public enterprise. They are multidisciplinary in focus and regional in organisation so as to contribute to regional development and regional innovation systems. They offer bachelor's and master's degrees which articulate well with the university system (Schienstock & Hämäläinen, 2001:162).

The new global role of polytechnics

Transforming the role of the polytechnic – as has been illustrated above with two brief country case studies – has not simply been a case of increasing their numbers and ramping up enrolments. Nor is it only to do with the seamless progression between the secondary and tertiary vocational and academic tracks which characterise these national systems. Transformation in the polytechnic sector also has to do with a changed mode of interaction with other key stakeholders in society. This refers specifically to a new applied R&D focus allocated to polytechnics and to encouraging polytechnics' active participation in local and regional economic development – an industrial policy approach that is lacking in South Africa.

Applied R&D in regional settings

The changed role for polytechnic-type institutions – certainly in the two country case studies described above – arose as part of the new interactive dynamics driving leading national economies. Contrary to the conventional logic that globalisation involves the weakening of the boundaries of local, regional and national economies and in so doing privileging the cross-

border powers of multinational corporations, work done by economic geographers (Scott, 2006), evolutionary economists (Fagerberg, Mowery & Nelson, 2005) and innovation studies writers (Lundvall & Borrás, 1997) over the past two decades has critiqued this proposition and has proposed a new economic logic that now dominates much public policy dialogue. This logic argues that 'location' still counts and that local and regional economies are critical to national growth strategies (Richards, 2012). Understanding this shift in the dominant economic logic globally is important, as it has a number of implications for the polytechnic sector.

The new economic logic points, first, to the shift in production systems towards greater knowledge intensity. The basis for new economic rents is not so much found in the materials production sphere as it is in value-adding activities such as design, branding and marketing. Tangible resources such as land, technology and capital have become increasingly widespread. Because of this, the new competitive advantage lies in the intangible resources of firms (Kaplinsky & Morris, 2001:101). Secondly, these intangible resources are often best captured locally, largely because they are 'tacit' knowledge resources embedded in the firm and its workers. Today, tacit knowledge is the primary competitive asset of firms. It is practical, experiential knowledge which all employees in work contexts acquire – including managers, R&D specialists and shop-floor production workers. It is the opposite of codified knowledge, which is formal and procedural, organised in a range of academically based disciplines and publicly available through academic study and research.

Clearly, 'localisation' is now key. Even in the age of IT, with the death of distance as an obstacle to economic advance, some knowledge still remains 'sticky' – it can be harnessed only in local production settings, and is intelligible only to those closed groups who work with it daily (Coenen, Asheim, Bugge & Herstad, 2017). But there are other benefits to localisation. The most important is that of knowledge spillovers by which firms derive advantage from locating themselves close to one another, because this provides privileged access to diverse knowledge and networks within and across firms and related industries (Coenen et al., 2017:6). A third factor is a new emphasis on decentralising the governance of economic development to local and regional settings. For example, Richards (2012:121) argues that economic development is best advanced by a decentralised, local governance approach. Economic development occurs as a complex interlocking of a set of social, economic and political factors which are best dealt with by state policy at regional and local levels.

It is in this new economic context that polytechnic education institutions have a critical role to play. The polytechnic is a key institution in the wider cluster or city-region that plays a critical and distinctive role in processes of localised knowledge formation and sharing, working alongside firms and other co-located players such as intermediaries and private training academies to promote the locality or region's economic wellbeing. These economic changes have resulted in a very important redefinition of the role of polytechnic-type institutions. Whereas previously, polytechnics were not involved in research activities, in today's conception of a polytechnic, applied R&D is a critical function, often defined in regional settings and in partnership with industry and government (Scheinstock & Hämäläinen, 2001:162). James, Guile and Unwin

(2011) note that the local and regional economic development literature (including cluster studies) suggests that, although skilled labour is important, it is the way in which production processes are organised and institutionally supported within localised networks that is crucial. They suggest that 'learning' in this literature is interactive and context-dependent. Therefore, successful learning is the outcome of interactions and relationships between firms and other institutions such as polytechnics within favoured regions (James et al., 2011:4).

Firm–polytechnic interaction

The primary focus of the wider evolutionary innovation and economic geography school as discussed above has been the study of 'the firm' as a social as well as an economic organisation and, in particular, the role played by 'learning' within the firm as the main basis for competitiveness in the global economy. Competitiveness here is seen as an endogenous activity, built from within the firm, primarily through the effective harnessing of the tacit knowledge capabilities of the firm. The tacit is situated expertise; it resides in the organisational routines of the firm and it is also 'embedded' in its skilled labour and a localised or regional economy. Firms maximise their tacit capabilities internally by cooperating with other firms co-located in the same neighbourhood or region. They do so externally through working with organisations such as colleges, polytechnics and state regional development agencies which provide incubation and business development support along with various financial incentives. Through all of these activities, firms are able to share and expand their stock of tacit knowledge and, in so doing, build on their market competitiveness (Boschma & Martin, 2010:5).

Esser, Hillebrand, Messner and De Meyer-Stamer (1996:3) argue that institutions such as universities, polytechnics, vocational colleges, R&D institutions, technology transfer offices and small-business development agencies become key locational assets for the regeneration of a locality or a region. Interactional dynamics between firms and these locational assets help to build up the industrial site by strengthening locational factors such as education and R&D. These network relations have become a new form of capitalist organisation – a 'third arena of allocation between markets and hierarchies' (Esser et al., 1996:63). In short, the key unit of competition in the global economy now is not the solitary firm acting competitively but the clusters or groups of firms organised in networks and the efficiency of the interactions between these firms and key locational assets such as polytechnics, R&D facilities and the like.

Interactive dynamics in Finland

A regional focus is evident in the way polytechnics were launched in Finland in 1993 – they are multidisciplinary and applied in focus and regional in organisation so as to contribute to regional economic development. The new polytechnic role is evident in the emphasis on cluster economic policy since the early 1990s. Such a policy emphasises the importance of locational competition and knowledge spillovers (Ylä-Anttila & Palmberg, 2005:12–18; Dahlman et al., 2006:77–78). Cluster policies, by their very nature, have a strong local and regional focus. Centres of expertise have been established in peripheral regions as multi-organisational constellations incorporating

polytechnics, hospitals, firms and science parks – for instance, those in the biotechnology area. In addition, the ‘employment and economic development centres’ (T&E centres) are development agencies that work with small and micro-enterprises (SMEs) and fall under the Department of Trade and Industry. They comprise a network of 15 regional offices across Finland. The remit of these agencies is to serve the needs of SMEs by providing business support services, consultation and advice, as well as financing. They use the services of the polytechnics to develop SME support services (Ylä-Anttila & Palmberg, 2005:11).

The South African universities of technology

The discussion now shifts to South Africa. The central question is to what extent South Africa’s universities of technology have prospered and grown in the way that the Dutch and Finnish polytechnic systems have over the past three decades.

A first observation is that the South African higher education system did grow significantly in the immediate post-apartheid period. Subotzky (2003) provides a statistical picture of this growth, distinguishing between technikon and university growth in terms of the production of graduates. A key trend visible in Table 1 is the rapid growth of technikon graduates in the immediate aftermath of the collapse of the apartheid restrictions on black students entering formerly whites-only institutions. Graduation numbers shot up by 126% in the technikons between 1988 and 1996.

TABLE 1: Percentage distribution of graduates between universities and technikons, 1988–2000

Year	University graduate numbers	University graduations as a percentage of total higher education graduations (%)	Technikon graduate numbers	Technikon graduations as a percentage of total higher education graduations (%)
1988	42 193	83	8 580	17
1996	66 426	77	19 388	23
1998	64 701	76	20 558	24
2000	67 028	76	21 221	24

Source: Subotzky, 2003:352

Unfortunately, the growth boost triggered by the advent of democracy in 1994 did not last, and the percentage of graduations from technikon institutions settled at around 24% of total graduations in higher education. Factors behind this slowdown in growth included efforts by the Department of Education (DoE) to slow growth, as well as the cost of higher education proving to be a major obstacle to many working and lower middle-class families. The DoE indicated in July 2004 that it intended to cap headcount enrolment in higher education from 2005 onwards – because of funding constraints, poor throughput rates and high dropout levels. The effect of this decision was a slight drop in total enrolments in 2005 and flattened growth

for a few years after that – all within a range of 720 000 to 740 000 students in the higher education system (DoE, 2005; Taylor, Fleisch & Shindler, 2008:60).

These problems were exacerbated in the period 2004–2005, when the technikon landscape was dramatically restructured through mergers and incorporations: 15 technikons were restructured and reduced to 6 universities of technology and 3 comprehensive universities. The latter change entailed the merger of a technikon and a university to form a comprehensive university. The three comprehensives – Nelson Mandela Metropolitan University, the University of Johannesburg and Walter Sisulu University of Science and Technology – are being excluded from this analysis of polytechnic capabilities because it is difficult to determine the extent of the applied or technical qualifications being offered at these institutions. This dilemma has emerged as a consequence of the process of academic drift that is occurring in these institutions as they try to enhance their 'university' status in terms of new priorities such as improving research output and increasing the number of postgraduate students, the publication rate in accredited journals and the number of staff with PhDs.

Notwithstanding these important institutional changes, Table 2 reflects strong continuities in the production of polytechnic capabilities prior to and after the mergers and incorporations. The number of graduates (in percentage terms) emanating from the universities of technology in 2015 is precisely the same as it was in 2000 – at 24% of all higher education graduates.

TABLE 2: Total graduations in the university of technology sector, 2015

University of technology	Graduations
Cape Peninsula University of Technology (CPUT)	8 342
Central University of Technology (CUT)	3 388
Durban University of Technology (DUT)	6 548
Tshwane University of Technology (TUT)	12 696
Vaal University of Technology (VUT)	3 976
Mangosuthu University of Technology (MUT)	2 491
Total number of graduates in the university of technology sector in 2015	37 441
University of technology graduates as a percentage of the total number of higher education graduates in 2015 (which was 191 524)	24%

Source: The Higher Education Management Information System (HEMIS) does not produce detailed university of technology data. Hence, Tables 2–5 have been produced by the author from data extracted from the online HEMIS database of the department of Higher Education and Training (DHET).

This flattening out of the number of graduates emanating from the universities of technology since 2000 (at 24%) is the central problem addressed in this article. The phenomenon of no growth (in percentage terms) in applied tertiary-level capabilities runs counter to developments

elsewhere in the world, where polytechnic graduations have grown rapidly over the past two decades – in both aggregate and percentage terms.

Three-year diplomas and the BTech

A significant component of the total university of technology graduations in 2015 was the three-year National Diploma and the four-year Bachelor of Technology (BTech) qualifications. Table 3 provides the core graduation data for 2010–2015:

The National Diploma is the primary qualification offered by the university of technology sector. Graduations in Business, Economics and Management Studies are by far the largest category (36.8%), followed by Engineering Studies (21.2%), Public Management (9.1%) and ICT Studies (6.7%). The fact that Applied Engineering Studies represents only 21.2% of all graduates emanating from the university of technology sector is problematic for a polytechnic-type institution.

Table 4 traces the extent of progression by three-year National Diploma graduates into the degree-level programmes at universities of technology: the BTech degree. This is one of the only pathways for tertiary TVET graduates into the degree-awarding component of higher education. There is a highly divergent growth pattern here, varying between 20% and 64% for five of the universities of technology, and 275% growth for MUT, which grew from an extremely low base in 2010.

Although the growth patterns of the BTech in South Africa over the past five years may appear reasonable, the percentage of degree graduates in the higher education system that have a specifically vocational or applied degree is still very small. Taking the BTech as the core ‘applied’ degree programme in the South African higher education system, Table 4 suggests it was only 6.6% of all graduates in the higher education system in 2015.

Similarly, the specifically Engineering component of the overall BTech programme is small. Table 5 indicates that only 2 239 graduates in 2015 out of a total of 12 650 BTech graduates across the six universities of technology studied Engineering – amounting to 18% of all BTech graduates. This is an extremely low progression pathway for Engineering into degreed tertiary TVET. It suggests a very weak engineering or applied/technical ‘character’ associated with these universities of technology.

TABLE 3: Post-school, non-degree university of technology graduates with three-year diplomas, 2010–2015

CESM category	Graduates with three-year diplomas						Percentage distribution
2nd-order CESM category	2010	2011	2012	2013	2014	2015	2015
01: Agriculture, Agricultural Operations and Related Sciences	660	749	816	804	802	934	4.3
02: Architecture and the Built Environment	523	627	569	636	649	601	2.8
03: Visual and Performing Arts	700	737	833	734	730	833	3.8
04: Business, Economics and Management Studies	7 345	7 830	8 296	7 919	7 865	7 983	36.8
05: Communication, Journalism and Related Studies	470	547	533	571	513	569	2.6
06: Computer and Information Sciences	1 373	1 481	1 727	1 704	1 621	1 442	6.7
07: Education	81	23	33	23	29	32	0.1
08: Engineering	3 456	3 609	3 759	4 495	4 916	4 592	21.2
09: Health Professions and Related Clinical Sciences	843	920	942	895	905	923	4.3
10: Family Ecology and Consumer Sciences	89	161	96	113	111	107	0.5
11: Languages, Linguistics and Literature	116	125	218	235	286	315	1.5
12: Law	104	144	249	221	225	310	1.4
13: Life Sciences	284	290	336	353	367	381	1.8
14: Physical Sciences	539	591	512	495	526	550	2.5
15: Mathematics and Statistics	4	11	8	17	24	17	0.1
16: Military Sciences	0	0	0	0	0	0	0.0
17: Philosophy, Religion and Theology	0		0	0	0	0	0.0
18: Psychology	0	0	1	0	0	0	0.0
19: Public Management and Services	1 550	1 670	1 761	1 869	1 799	1 965	9.1
20: Social Sciences	62	71	80	89	71	75	0.3
Total graduations	18 200	19 588	20 771	21 176	21 439	21 678	100

Source: Data extracted from the online HEMIS database of the DHET

TABLE 4: University of technology graduates with a four-year BTech degree, 2010–2015, per university

Year	CPUT	CUT	DUT	TUT	VUT	MUT	Total university of technology graduations	Total graduations in higher education	Share of BTech graduates as a percentage of total higher education graduations (%)
2010	2 663	780	1 873	2 804	830	59	9 009	153 325	5.9
2011	2 798	916	1 790	3 035	895	164	9 598	160 625	6.0
2012	2 923	1 122	1 834	2 989	1 006	93	9 967	165 995	6.0
2013	3 119	1 175	2 162	3 176	1 268	164	11 064	180 823	6.1
2014	3 293	1 269	2 258	3 540	1 100	242	11 702	185 373	6.3
2015	3 299	1 283	2 469	4 384	994	221	12 650	191 524	6.6
Percentage change between 2010 and 2015	24	64	32	56	20	275	40	25	0.7

Source: Data extracted from the online HEMIS database of the DHET

TABLE 5: University of technology graduates with a four-year BTech degree in Engineering, 2010–2015, per university

Year	CPUT	CUT	DUT	VUT	MUT	TUT	Total number of Engineering BTech graduates	Total BTech graduates in all fields per year	Engineering BTech graduates as a percentage of total BTech graduates in all fields (%)
2010	381	185	243	202	8	434	1 453	9 009	16
2011	381	111	283	253	11	391	1 430	9 598	15
2012	377	217	303	289	4	452	1 642	9 967	17
2013	442	200	329	325	8	484	1 788	11 064	16
2014	462	260	343	290	16	596	1 967	11 702	17
2015	423	350	456	324	15	671	2 239	12 650	18

Source: Data extracted from the online HEMIS database of the DHET

The data presented above are highly problematic because they indicate the slow growth in the university of technology sector and because they indicate the small proportion of graduates with applied or technical qualifications in the overall higher education system. Because of this,

South Africa is falling far behind developments in the TVET sector globally. For example, in the Dutch system almost 62% of those in higher education are in an applied vocational field at a university of professional education (polytechnic), with a high proportion acquiring applied degree qualifications (Altinyelken et al., 2010:24). In South Africa, the figure for graduates with applied or technical qualifications from polytechnic-type institutions is 24%, with the critical field of Engineering Studies only a small component.

The demise of South Africa's universities of technology

A number of problems with South Africa's universities of technology have already been raised. These include: the dramatic reduction in the number of polytechnic-type institutions; academic drift; poor progression in the post-school system, especially from the universities of technology into the university sector; the lack of growth in engineering and technology graduations; and the lack of interactive capabilities ('articulation') with industry.

The demise of South Africa's former technikons – as has been outlined above – clearly arises from a series of policy errors which are outlined below. The discussion will cover two causal factors which have significantly weakened the technikon sector in South Africa. The first is a flawed higher education policy process regarding the former technikons. The second is a flawed industrial and innovation policy which has underemphasised tertiary TVET and has failed to recognise the important contribution universities of technology could play in regional and local economic development.

Flawed higher education policy process regarding the former technikons

The higher education policy process from the mid-1990s to the mid-2000s was characterised by significant turmoil and conflict. It was also hamstrung by major infrastructural and financial resource constraints. As a result, non-optimal policy outcomes have emerged with regard to institutional mission and differentiation. These include a tendency towards academic drift, which is strong across the system (see DoE, 2005; Badsha & Cloete, 2011:16), and the weakening of the distinctive applied role that universities of technology should play.

The higher education policy formulation process from the mid-1990s to the mid-2000s vacillated between two opposing positions: support for a single or unified system of higher education, versus support for the continuation of the binary divide between universities and technikons. The official position adopted in the White and Green Papers of 1996 and 1997, and enshrined in the Higher Education Act of 1997, was that of a single system regulated as a coherent whole, applying uniform norms and procedures with sufficient flexibility to allow for diversity in responding to the multiple needs of highly differentiated learner constituencies.

The second position evolved as a result of the considerable opposition to the idea of a unified system during the deliberations of the National Commission on Higher Education (NCHE), which sat in 1996. This opposition arose from two sources: from the technikons themselves,

and from the heads of the historically disadvantaged institutions (HDIs), which believed the new approach would yet again put them at a disadvantage because of their lack of capacity to respond creatively to new programme offerings. The interim discussion document of the NCHE reported that elements in the technikon sector had made submissions that argued strongly for retaining and reinforcing the technikons as a distinct sector with a unique mission in higher education (NCHE, 1996:55).

The evolution of the idea of a single system, termed ‘flexible differentiation’ in the NCHE documents, would occur according to institutional missions and programme mixes. Institutional differentiation in this context would evolve in line with a planned process based on emerging national and regional needs and not the inherited sectoral location of the institution (NCHE, 1996:56–57). The government’s twofold position on institutional differentiation – retaining functional differentiation in the short to medium term while moving towards flexible differentiation (a single system) in the longer term – was sustained throughout several iterative policy rounds during the period under review. The government’s primary concern throughout this period was that, in moving towards a single system regulated by uniform norms and standards, the programme distinctions between technikons and universities should not be eroded (Kraak, 2006).

Resource constraints and rationalisation

Running alongside this policy discourse on differentiation was a related yet distinct policy problem: resource constraints and the need to rationalise and merge South Africa’s 36 institutions of higher education. The National Working Group (NWG) – the final policy initiative appointed by the Minister of Education to reform higher education in 2001 – proposed an entirely new institutional landscape comprising four differing types (DoE, 2001). The government accepted most of the recommendations of the NWG, committing itself to maintaining, in a flexible manner, the existing mission and programme differentiation between technikons and universities for at least the next five years (DoE, 2002:7).

Most of the institutional mergers occurred during the period 2004–2005. The new landscape shaped by this process of merger and incorporation created a new basis for institutional differentiation. The result was 25 institutions representing four diverse types: 11 universities, 6 universities of technology (the former technikons), 6 comprehensive universities and 2 national institutes of higher education. Significantly, these four institutional typologies emerged not because of a comprehensive policy or research process focused on developing a new basis for differentiation, but rather as a by-product of the merger and incorporation process. In particular, they were the outcome of the politics of negotiation which accompanied the decisions about which institutions would be merged or not and which would become comprehensives or universities of technology. Very little research or policy work was done by the state on what the roles of the new institutions would be.

Emergence of the universities of technology

The higher education policy process from 1996 to 2006 was not commissioned specifically to study the manner in which technikons execute their applied or polytechnic functions; nor did it concern itself with making an appropriate distinction between the research functions of universities and polytechnics. Policy and the subsequent legislation distinguished these two institutional entities purely on the basis of their differing teaching programmes – the one primarily offering national diplomas (with some BTech degrees), the other offering degree and postgraduate qualifications across the board. Universities of technology were formally instituted by the Minister of Education in October 2003 under duress resulting from pressure exerted by the Committee of Technikon Principals, which sought the name change from 'technikon' to 'university of technology'. In so doing, this decision was not informed by a rational process of policy development, but rather by administrative fiat that had its origin in political lobbying. No government policy documentation has evolved to explain the new category 'university of technology' and its institutional functions (Kraak, 2006). The outcomes of this flawed process have resulted in the diminution of the polytechnic function in South Africa, with only six universities of technology remaining.

Flawed innovation and industrial policy

Another sphere of South African public policy which ignores the unique role of the universities of technology is that of innovation policy. Innovation policy falls within the purview and under the control of the Department of Science and Technology (DST) and not the department that regulates higher education institutions – which is currently the DHET. There are significant differences between the ways these two departments deal with universities.

In pursuing its innovation policy premised strongly on high-end R&D, the DST's website unashamedly lists only 7 universities out of the current 25 higher education institutions as being part of the national system of innovation. Furthermore, many of its research levers, such as the Innovation Fund and the Technology and Human Resource for Industry Programme (THRIP), are designed to promote innovation-aligned research at these institutions. In contrast, the DHET does not formally recognise the label 'research university' and attempts to regulate the system of 25 institutions as a single system. In neither department, therefore, is the potential role of polytechnic-type institutions – and their applied R&D – given explicit consideration.

Dalitz and Toner (2016) raise a similar point with regard to Australian innovation policy. They examined the exclusion of the TVET sector in major government reports on Australia's innovation system. They found that almost all of these reports present skills development as a principal driver of the Australian national innovation system (NIS). Notwithstanding this, they found that both the secondary and the tertiary TVET systems were excluded from government policies on NIS (Dalitz & Toner, 2016:55). These authors find this observation highly contradictory of much of the economic analysis undertaken within Australian and global innovation studies, which recognises that skills generated by tertiary TVET systems and the

learning processes they promote through interactions with firms are central to the incremental innovation that occurs in many industries (Dalitz & Toner, 2016:55). Dalitz and Toner (2016:58) conclude their analysis by noting that it is the problem of ‘departmentalism’ in Australia which leads to innovation and education policy being treated as ‘only loosely connected in the actual process of policy formation and implementation as compared to the rhetoric of politicians and reports’.

Neglect of the economics of ‘localisation’

The South African government, through its science and economic departments (the DST and the Department of Trade and Industry (dti)), has neglected the ‘economics of localisation’ and endogenous firm development, as discussed earlier, with more resources and energy going to high-end R&D. The government has not fully understood this second mode of innovation based on incremental improvement in productive capabilities developed internally within firms. This has meant that university R&D has been prioritised and applied forms of research and development in universities of technology have received less attention.

This neglect of the interactive, incremental mode of innovation has strong parallels with the neglect of secondary and tertiary TVET in innovation policy in South Africa. One of the clearest indications of the neglect of the applied research role of polytechnic-type institutions in South Africa emerged from a 2007 OECD study of South Africa’s NIS. The OECD authors outline their key concept of ‘DEEM’ (Design, Engineering, Entrepreneurship and Management), which signifies a set of intermediate to high-level competencies needed in the workplace by the middle-to-senior workforce that only a ‘polytechnic’ mode can develop in any higher education system. In their notion of production, DEEM plays a crucial adjunct role to the more formalised and higher-order R&D function. The report argues that DEEM capabilities are best produced through high levels of institutional interaction between firms and external agencies such as polytechnics in localised and/or regional settings. It is these internal DEEM capabilities that define a firm’s dynamism – its ability to overcome uncertainty by changing and doing things differently and operating more effectively.

Polytechnic entities such as the former technikons and the specialist industrial subdivisions of the Council for Scientific and Industrial Research (CSIR) were crucial in providing DEEM support activities to firms in the past. They provided R&D and technology transfer services that had more direct industrial application, typically helping companies to move a little beyond what their internal capabilities would otherwise permit, reducing the risks and increasing the rate of incremental innovation. The traditional university system is not a good tool for providing this kind of support. The OECD report argues that South African industrial policies ignore these important DEEM capabilities and the potential contribution of universities of technology to economic growth (OECD, 2007:112).

Such a conception of DEEM – as a specific non-R&D capability crucial to industrial renewal and yet distinct from formalised R&D activities promoted by the innovation policy of the

DST – was not present in the higher education or innovation policy formulation processes of the late 1990s and early 2000s. The reasons for the neglect of these DEEM activities are complex, but a number of causal factors can be identified. First, the phenomenal growth of the services sector in South Africa and globally over the past two decades has shaped perceptions that this structural shift has coincided with a diminution of the contribution of manufacturing. This perception is, of course, erroneous, but it has contributed, secondly, to a dramatic change within the universities of technology away from the hard engineering and applied sciences towards courses in the soft sciences such as commerce and management, the humanities and the social sciences. Indeed, these processes of 'academic drift' have led the universities of technology to abandon their traditional DEEM role. Thirdly, in recent years, the universities of technology have concerned themselves largely with the processes of certifying graduates in qualifications across the whole gamut of academic fields. There has not been an equivalent focus on their distinctive applied research role or with their interaction with firms in local or regional settings, in order to apply considerable engineering and technical expertise, particularly in DEEM fields.

Conclusion

The political and economic restructuring that accompanied the demise of apartheid and ushered in the new democratic dispensation brought with it severe costs for the DEEM function, the most punitive of which was the rightsizing and/or privatising of the state-owned enterprises. In so doing, the strong cooperative relationships previously built up between the state-owned enterprises, the technical colleges and the technikons to train and skill artisans, technicians and technologists were scaled down and, in many instances, permanently lost (Kraak, 2008).

These changes have coalesced over the past two decades in such a way that the universities of technology have become concerned primarily with teaching and instruction at the considerable expense of the applied design, engineering and related management and technical functions of private firms. Although references are made within the university of technology sector to its having an applied role, it would appear that no distinctive official philosophy has emerged that distinguishes these universities from the academic universities with respect to intermediate skilling and applied research work. Accordingly, the risk of further academic drift continuing unabated is high.

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