Widening Access and Participation in Geomatics Education: Insights from Curriculum Transformation at Tshwane University of Technology, South Africa

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Key words: geomatics education, surveying, access, equity, participation, articulation

SUMMARY

Curriculum reform in professional and technical education is increasingly shaped by the need to align regulatory requirements with widening participation and labour market relevance. In South Africa, this challenge has been particularly pronounced at universities of technology following the phase-out of legacy National Education and Training qualifications and the introduction of the Higher Education Qualifications Sub-Framework. This paper presents a longitudinal case study of curriculum reform in the Department of Geomatics at the Tshwane University of Technology between 2018 and 2025, spanning the closure of legacy programmes and the implementation of a newly articulated programme and qualification mix.

Drawing on institutional enrolment and graduation data, programme documentation, professional accreditation records, and surveys of students, graduates, and employers, the study examines how changes to qualification structure and progression pathways shaped access, participation, student progression, and graduate outcomes in geomatics education. A mixed-methods approach was used to integrate quantitative trends with qualitative evidence, allowing curriculum reform to be examined as both a structural and experiential process.

The findings indicate that the transition to an articulated, outcomes-aligned qualification framework was accompanied by a recovery in enrolments following an initial period of volatility, shifts in participation patterns, and strengthened progression across qualification levels. Student success indicators stabilised as new programmes matured, while graduate outcomes reflected diverse employment pathways, entrepreneurial activity, and mobility within and beyond South Africa. Although grounded in a single institutional context, the case offers insights relevant to higher education institutions in both developed and developing settings that are seeking to address enrolment pressures, widen participation, and sustain professional relevance in geomatics and related geospatial disciplines.

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1. INTRODUCTION

Professional and technical education in geomatics is shaped by the interaction between national qualification policy, institutional practice, and professional regulation. In South Africa, recent curriculum reform must be understood against the background of an earlier qualification system that structured surveying and geomatics education for several decades. Prior to the current framework, geomatics education at universities of technology was largely offered through qualifications developed under the National Education and Training system. These legacy programmes included the National Diploma and Bachelor of Technology, were widely recognised by employers and professional bodies, and were strongly practice-oriented, playing a central role in supplying graduates to both the public and private sectors.

Despite these strengths, the structure of the legacy system presented limitations, particularly in relation to articulation and comparability. Progression between qualification levels was often linear and institution-specific, offering limited flexibility for re-entry or movement across institutions. Credit structures and qualification types differed from internationally recognised degree models, constraining portability and broader recognition (Council on Higher Education, 2010). While professional competence was well established, opportunities for formal vertical progression and lifelong learning were uneven. These characteristics formed the context within which national qualification reform was initiated.

South Africa's reform process began with the introduction of the Higher Education Qualifications Framework in 2007, which aimed to standardise qualification types and improve coherence within higher education (Department of Education, 2007). This framework was subsequently revised and replaced by the Higher Education Qualifications Sub-Framework in 2013, which operates as the higher education sub-framework of the National Qualifications Framework and provides clearer alignment with locally and internationally comparable qualification structures (Council on Higher Education, 2013). A ministerial notice issued in 2016 required all non-aligned legacy qualifications to be closed to new entrants by the end of 2019, with institutions responsible for managing pipeline students thereafter (Department of Higher Education and Training, 2016).

Although national policy defined the parameters of reform, implementation occurred within a higher education system marked by persistent inequalities in access and participation, particularly in technical and professional fields (Council on Higher Education, 2010). Similar pressures are evident internationally, where institutions are expected to widen participation, support lifelong learning, and prepare graduates for rapidly evolving labour markets (Altbach, Reisberg and Rumbley, 2009; UNESCO, 2021). The transition from legacy qualification systems to articulated, outcomes-based frameworks, therefore, provides a lens through which curriculum reform can be examined as both a regulatory and a social intervention.

This paper examines how the Department of Geomatics at the Tshwane University of Technology (TUT) responded to the phase-out of legacy qualifications by restructuring its programme and qualification mix in line with the national framework. It asks three interrelated questions: how the redesigned programme qualification mix has affected access and participation; how it has influenced student success and progression across qualification levels; and how it has shaped employability and mobility outcomes for graduates. Drawing on institutional documentation, enrolment and graduation data, stakeholder surveys, and professional accreditation feedback, the study analyses curriculum reform as a mechanism for widening participation while strengthening professional and labour market alignment.

By situating the case within both national transformation priorities and international debates on inclusive higher education, the paper contributes insights relevant beyond the South African context. While grounded in a single institution, the findings speak to wider challenges faced by universities seeking to balance regulatory compliance, equity, and professional relevance in specialised fields such as geomatics.

2. METHODS

2.1. Research design and scope

This study adopts a single-institution case study design focused on the Department of Geomatics at TUT. A case study approach was selected to enable detailed examination of how national qualification reform was implemented within a specific disciplinary and institutional context, rather than to produce statistically generalisable findings (Yin, 2018).

The review period spans 2018 to 2025, covering the phase-out of legacy National Education and Training qualifications, the introduction of Higher Education Qualifications Sub-Framework–aligned programmes, and the early stabilisation of the redesigned programme and qualification mix. This timeframe captures both transitional disruption and emerging outcomes following implementation. The Department of Geomatics at TUT provides a relevant site for examining curriculum reform in professional education. During the review period, the department transitioned from legacy qualifications to a vertically articulated suite of diploma, bachelor, advanced diploma, and postgraduate diploma programmes aligned with the professional registration requirements of the South African Geomatics Council (SAGC). While the case is not intended to be representative of all institutions, it offers analytically grounded insights into curriculum reform processes that may be relevant to other professionally oriented disciplines.

2.2. Data sources

Evidence for the study was drawn from four complementary sources to capture both curriculum reform and student outcomes. Programme and qualification documentation, including Programme and Qualification Mix (PQM) records and Programme Quality Management System (PQMS) documentation, provided information on curriculum design, enrolment patterns, progression, and throughput across diploma, bachelor, advanced diploma, and postgraduate diploma programmes. This material included self-evaluation reports prepared for

professional accreditation visits and institutional responses to national quality assurance requirements.

Feedback from external regulatory and professional bodies, including the Council on Higher Education (CHE), the Department of Higher Education and Training (DHET), and the SAGC, confirmed programme alignment, compliance, and quality, and contextualised challenges encountered during initial development and early implementation. Institutional enrolment, retention, and graduation data were drawn from the Higher Education Management Information System (HEMIS) and internal university records to support longitudinal analysis of access, participation, and completion trends, including disaggregation by selected demographic indicators. Qualitative evidence from student and graduate surveys, employer feedback, and work-integrated learning (WIL) reports provided insight into the student experience, programme relevance, employability, and alignment with labour-market needs. Table 1 summarises the data sources.

Table 1. Overview of data sources used to assess curriculum reform

Data Source	Type of Evidence	Relevance to the Study
Programme and qualification documentation	Programme approval records, self-evaluation reports, enrolment and progression statistics	Provides evidence of curriculum design, implementation, and student outcomes
Accreditation and regulatory documents	Professional accreditation reports and national quality assurance documentation	Confirms compliance, quality and alignment with policy and professional requirements.
Institutional enrolment and graduation data	Institutional statistics on enrolment, retention and completion statistics	Enables longitudinal tracking and analysis of access, retention and success across demographic groups over time.
Stakeholder feedback	Student and graduate surveys, employer feedback, student experience, and WIL reports	Provides insight into programme relevance, employability and labour market alignment

2.3.Analytical approach and research phases

A mixed-methods approach was used to analyse the evidence generated across the review period. Quantitative enrolment, retention, and graduation data were analysed descriptively to identify longitudinal patterns in access, participation, and completion during the transition from legacy to Higher Education Qualifications Sub-Framework–aligned programmes. Qualitative material from programme documentation, accreditation feedback, surveys, and work-integrated learning reports was analysed thematically to examine experiences of curriculum implementation, student progression, and employability. Findings from the different data sources were integrated through triangulation to strengthen analytical coherence and to link institutional, regulatory, and stakeholder perspectives. The sequence and integration of analytical steps are illustrated in Figure 1.

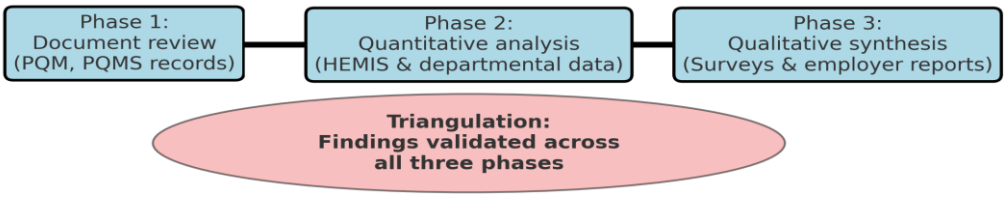

Figure 1. Phased integration of quantitative and qualitative evidence used in the study

3. RESULTS

This section presents the outcomes of the Department of Geomatics' curriculum reform at TUT between 2018 and 2025. The results are organised thematically to describe changes in programme structure, enrolment patterns, access and participation, student success, articulation across qualification levels, and graduate employability and mobility. Findings are reported descriptively, with reference to figures and tables, and focus on observed patterns and trends in the data. Interpretation of these results and their broader implications is addressed in the discussion section.

3.1. Programme reform and transition

The department renewed its programme and qualification mix in response to the national phase-out of legacy National Education and Training qualifications, which began in 2019. The National Diploma Surveying (NDSU03) and the Bachelor of Technology in Surveying (BTSU18) were progressively closed, while new qualifications aligned to the Higher Education Qualifications Sub-Framework were introduced incrementally. These included the Bachelor of Geomatics (BPGM20) in 2020, followed by the Diploma in Geomatics (DPGM23) and Advanced Diploma in Geomatics (ADGM23) in 2023, and the Postgraduate Diploma in Geomatics (PDGM24) in 2024. Together, these programmes form a vertically articulated structure that enables progression from diploma to postgraduate level, aligned with the registration requirements of the South African Geomatics Council (SAGC, 2023; 2024a; 2024b). The SAGC endorsed all new qualifications for registration at technician, technologist, and professional levels, subject to conditions linked to early implementation challenges that were addressed as the programmes matured.

In addition to programme replacement, alternative entry and progression routes were incorporated into the new qualification structure. Recognition of prior learning and articulation from Technical and Vocational Education and Training colleges were embedded in admission requirements for the new programmes. Block-mode delivery at higher qualification levels was also introduced, enabling participation by working professionals. Figure 2 presents the restructured programme and qualification mix, illustrating articulation pathways across the National Qualifications Framework.

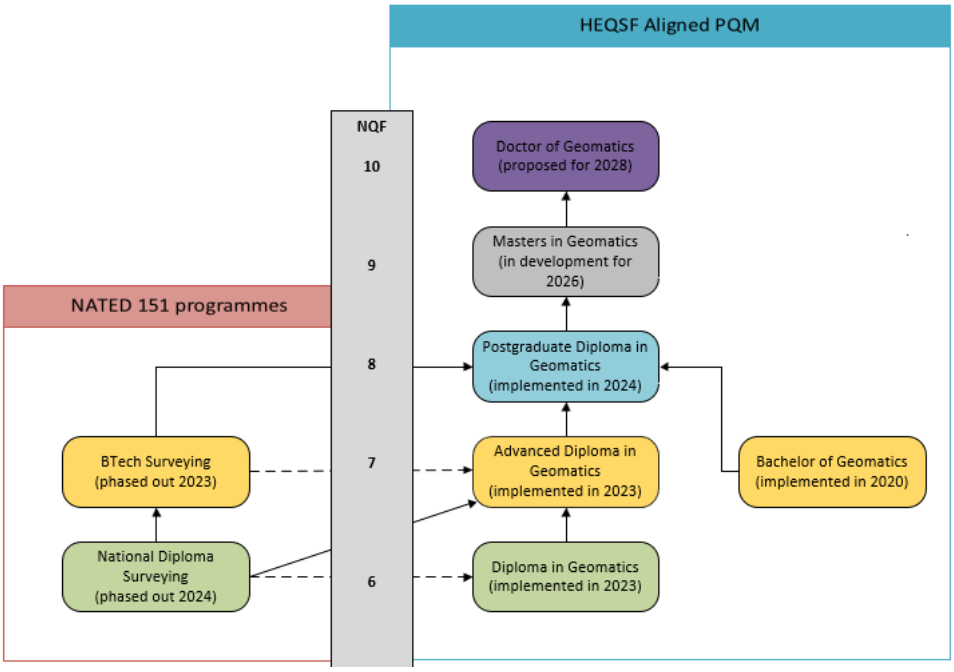

Figure 2. Restructured programme and qualification mix showing articulation pathways across National Qualifications Framework levels

3.2. Access and participation

The transition from legacy National Education and Training qualifications coincided with short-term volatility in student enrolments. Enrolments in the National Diploma Surveying increased sharply in 2019 as prospective students sought entry before programme closure, followed by a steady decline as pipeline students completed their studies. A similar tapering pattern was observed in the BTech Surveying, which closed at the end of 2023. This resulted in a temporary gap before enrolments were absorbed into the new Higher Education Qualifications Sub-Framework–aligned programmes.

The Bachelor of Geomatics, introduced in 2020, initially enrolled small cohorts and experienced disruption during the COVID-19 pandemic, before growing steadily to more than 200 students by 2025. The Diploma and Advanced Diploma in Geomatics, introduced in 2023, reached enrolments of over 250 and 80 students, respectively, within two years, while the Postgraduate Diploma in Geomatics doubled its intake in its first two years. Total enrolments reached a transitional low in 2022 before recovering strongly to nearly 600 students by 2025 (Figure 3).

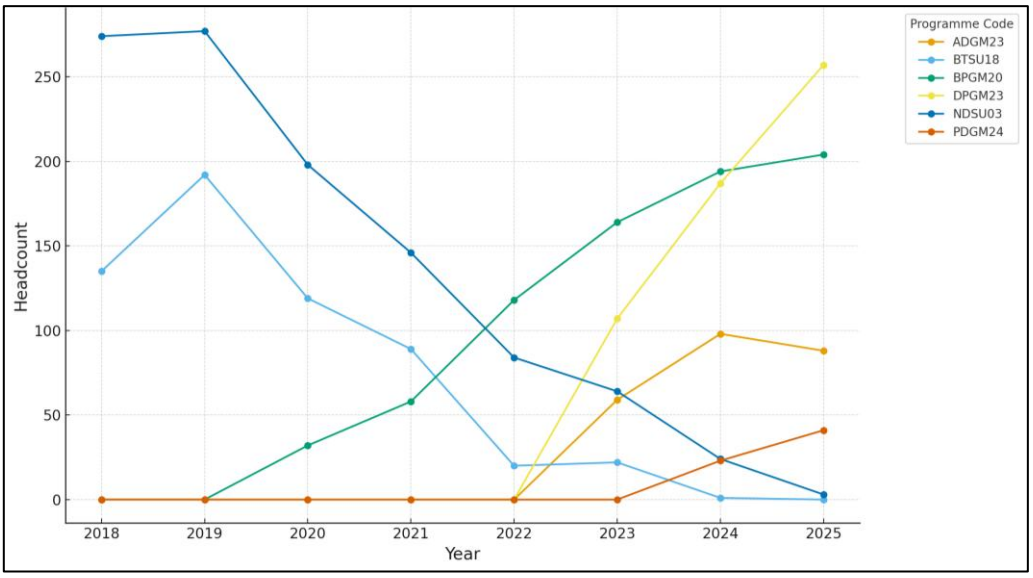

Figure 3. Total enrolments in geomatics programmes, 2018–2025

First-time entrant data further illustrate shifts in demand for entry-level qualifications. As shown in Table 2, enrolment moved from the legacy diploma to the new diploma and bachelor pathways as the restructured programme mix matured, reflecting both progression of existing cohorts and sustained new intakes.

Table 2. First-time entrants to entry-level programmes during the transition to HEQSF

Programme	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
BPGM20	-	-	37	38	75	74	74	73
DPGM23	-	-	-	-	-	113	108	105
NDSU03	83	96	0	0	0	0	0	0
Total	83	96	37	38	75	187	182	178

Participation patterns also changed demographically over the review period. Female representation increased from approximately one-quarter of enrolments in 2018 to 44 percent by 2025, while the proportion of students from Quintile 1–3 schools increased from under 10 percent to nearly 40 percent (Figure 4). In the South African schooling system, public schools are classified into quintiles from 1 to 5, with Quintile 1 representing the poorest communities and Quintile 5 the most affluent; growth in enrolments in Quintiles 1–3 therefore indicates expanded participation by students from historically disadvantaged educational backgrounds.

These shifts coincided with a range of access-related initiatives implemented during the review period, including outreach to under-resourced schools, dissemination of information on financial aid through the National Student Financial Aid Scheme, and supplementary academic support in mathematics and physical sciences for prospective students. Student-led initiatives, particularly through the TUT Geomatics Student Society, further extended outreach by enabling enrolled students to share information within their home communities. Although not presented here, geocoded analysis of student home addresses showed a widening spatial distribution of enrolments following the introduction of the redesigned programme and qualification mix. By

2025, almost 95 percent of enrolled students identified as black African, reflecting broader national demographic patterns in public higher education, with the remaining enrolments drawn from white, Indian, and coloured students. The implications of this demographic profile are considered further in the discussion section.

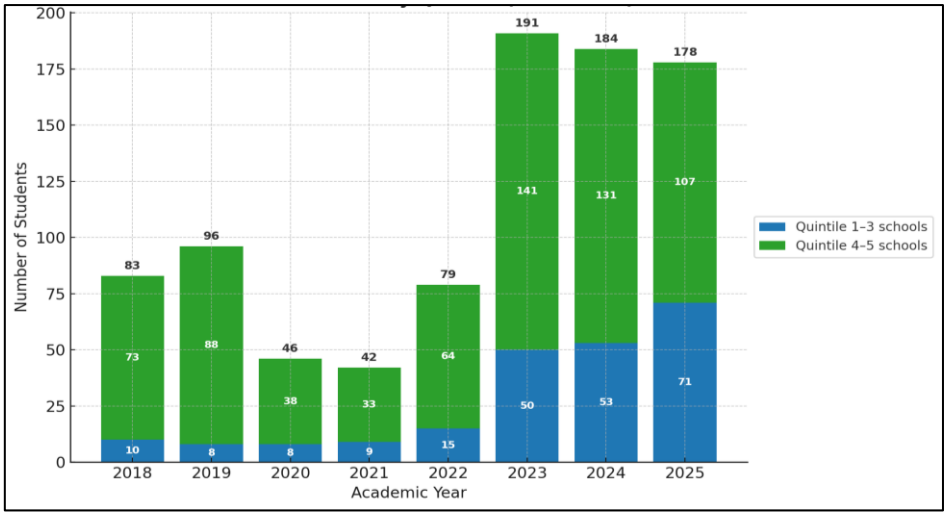

Figure 4. Quintile changes, 2018-2025, signalling expanded access for disadvantaged groups

Alternative access routes became increasingly prominent. Students entered through recognition of prior learning assessments and articulation from Technical and Vocational Education and Training colleges, pathways that were formally incorporated into admission requirements for the new programmes. As illustrated in Figure 5, these routes expanded over time and contributed to participation by non-traditional students.

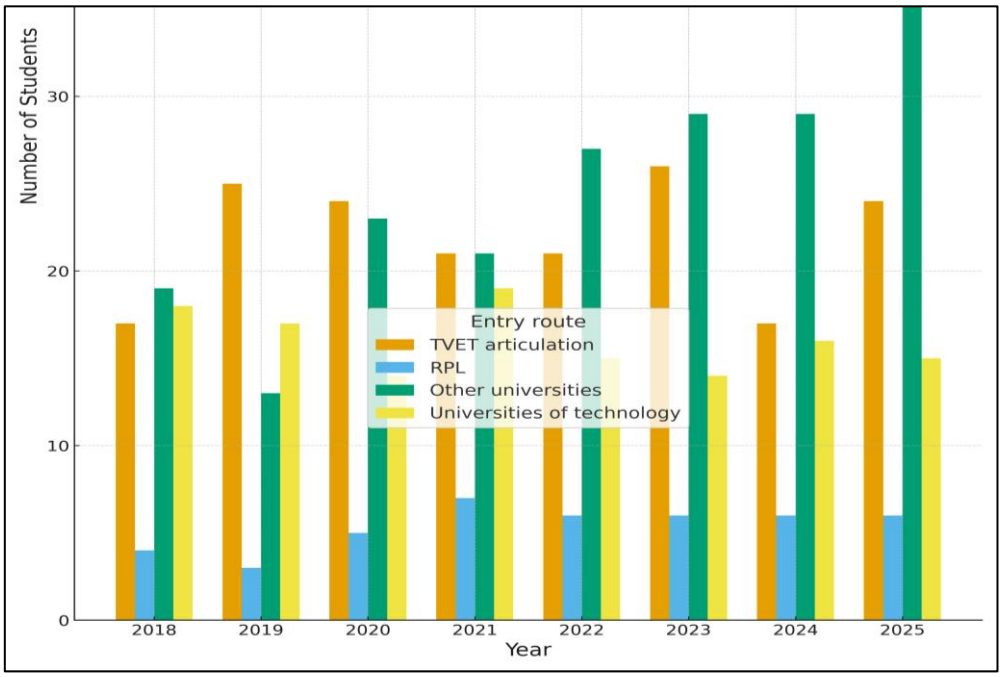

Figure 5. Alternative entry routes into geomatics programmes

3.3. Student success

Student success outcomes varied across qualifications and over time, reflecting both programme transition and system-wide disruption during the COVID-19 pandemic. Pass rates in the legacy National Diploma in Surveying were stable at around 70 percent before 2020, declined during the pandemic period, and recovered in the final years before programme closure in 2024. The Bachelor of Geomatics, introduced in 2020, recorded lower pass rates in its early cohorts, reaching the mid-50s in 2021 before stabilising at approximately 74 percent as the programme matured. The Diploma in Geomatics achieved pass rates between 70 and 75 percent in its initial years. In comparison, the Advanced Diploma in Geomatics improved from 67 percent in its first year of delivery to 74 percent in the second. The Postgraduate Diploma in Geomatics recorded an 87 percent pass rate in its inaugural 2024 cohort. These patterns are summarised in Figure 6.

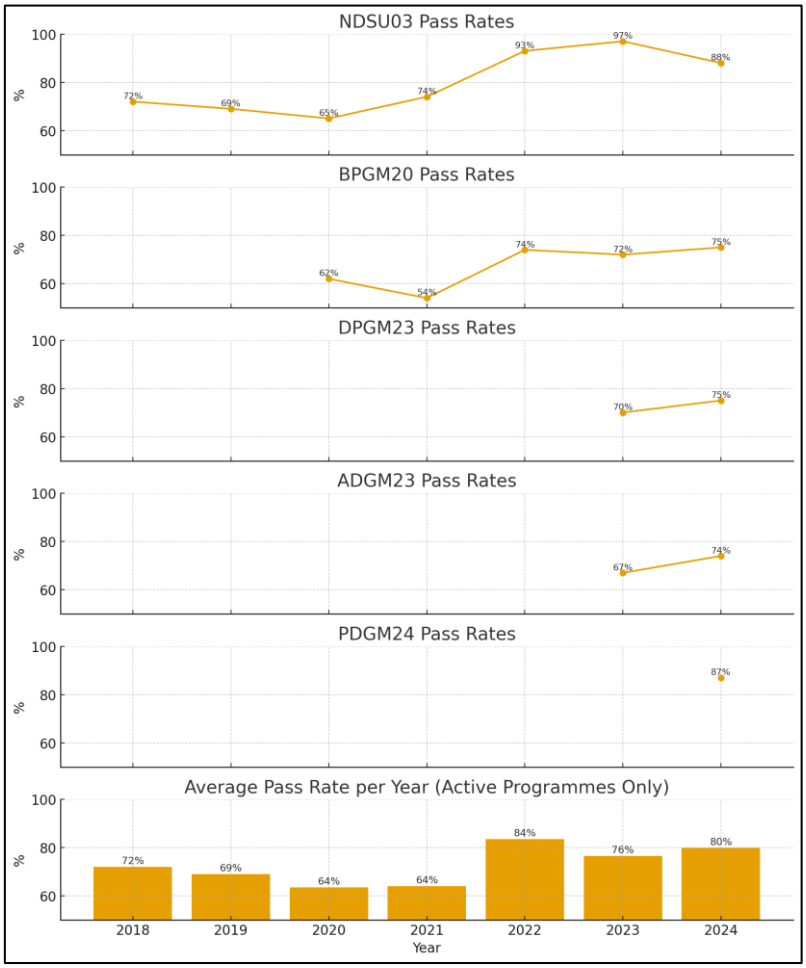

Figure 6. Pass rates by qualification, 2018–2025

Retention rates remained relatively high across the review period, generally ranging between 80 and 90 percent, with temporary declines during the pandemic and recovery from 2022 onwards. Graduation patterns reflected both extended time to completion and the phased closure of legacy qualifications, with many students in undergraduate 3-year programmes requiring four years to complete qualifications. As illustrated in Figure 7, graduation numbers

declined during the transition period and increased from 2023 as cohorts from the new Higher Education Qualifications Sub-Framework–aligned programmes reached completion. Peaks in graduation in 2019 and 2021 corresponded with accelerated module offerings to support completion of legacy programmes prior to closure.

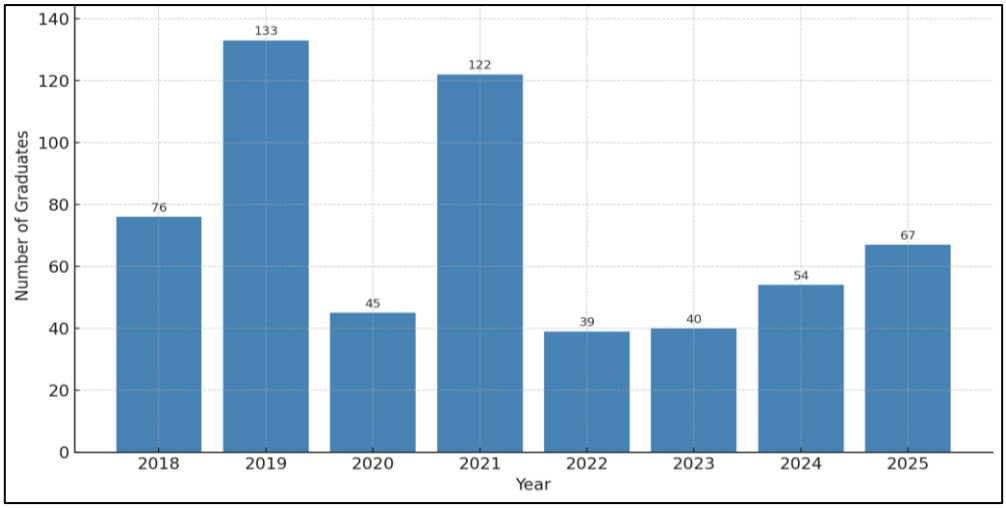

Figure 7. Graduation counts by qualification during programme transition, 2018–2025.

3.4. Articulation

Patterns of student progression across qualifications show that articulation occurred across the programme suite during the review period. Recorded flows include progression within the legacy programmes prior to their phase-out from 2019, as well as movement into newly introduced Higher Education Qualifications Sub-Framework–aligned programmes, particularly the Advanced Diploma in Geomatics. Progression from the Bachelor of Geomatics into the Postgraduate Diploma in Geomatics was also observed (Figure 8). The data further show instances of students re-entering formal study after breaks in enrolment and moving between qualification levels at different points in time. Such movements occurred across both legacy and new programmes, indicating multiple entry and exit points and reflecting vertical progression from entry-level to postgraduate qualifications alongside re-entry following interrupted study trajectories

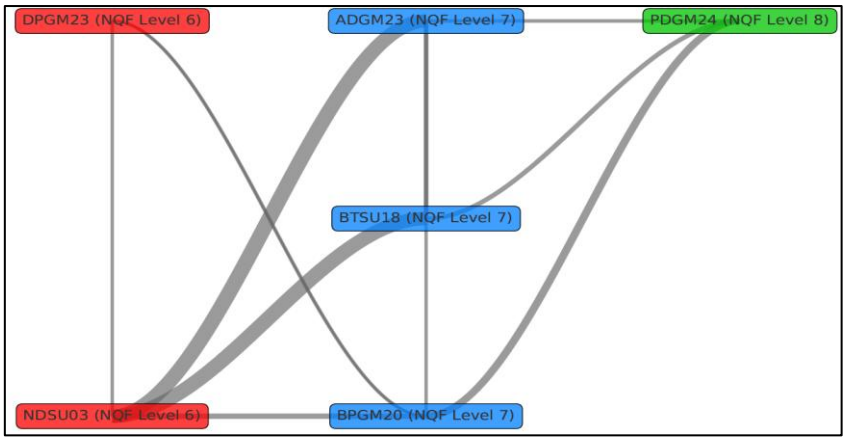

Figure 8. Sankey Chart showing articulation flows across geomatics qualifications

3.5. Employability and mobility

A graduate survey conducted with all graduates since 2018 received 272 responses from a total of 576 graduates, noting that many respondents had articulated through more than one qualification. Employment outcomes were reported across a wide range of sectors, including construction, mining, geospatial services, the public sector, education, energy, and water management. Nearly 30 percent of respondents reported employment in emerging fields such as software development, defence, and design.

Entrepreneurial activity was also reported. Seventeen percent of respondents indicated that they had established single or joint practices within three years of graduation, in some cases employing other graduates from the department. In addition, a proportion of graduates reported pursuing further study, either within the institution or at other higher education institutions. Graduate mobility extended beyond the national labour market. Respondents reported using their qualifications to secure employment elsewhere in Africa and internationally, including in the Middle East, Australia, New Zealand, the United Kingdom, North America, and the Nordic region. The sectoral distribution is summarised in Figure 9.

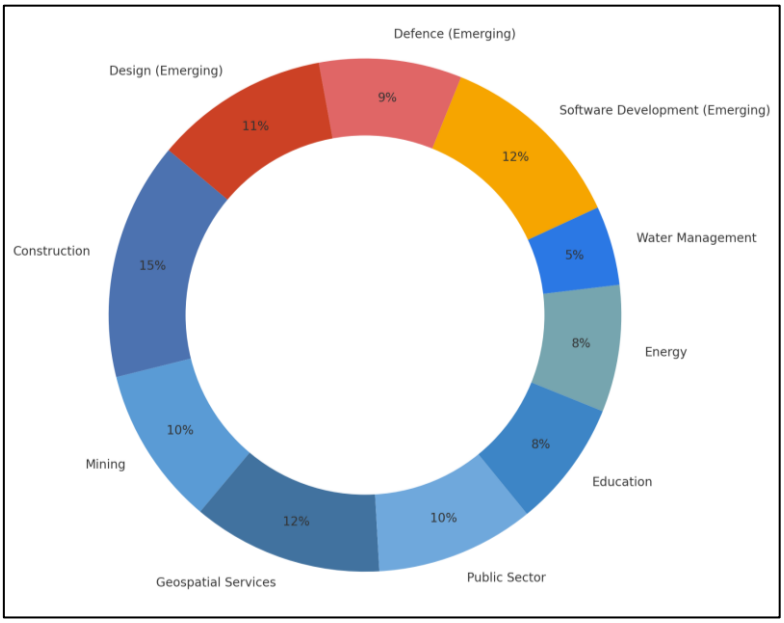

Figure 9. Existing and emerging sectoral distribution of graduates

3.6. Summary of results

The results indicate that the transition from legacy qualifications to a restructured, Higher Education Qualifications Sub-Framework–aligned programme and qualification mix gradually coincided with changes in enrolment patterns, participation, student success, and graduate outcomes over the review period. Following an initial phase of volatility during the transition period, enrolments recovered as new programmes became established. Participation broadened demographically, while articulation and progression across qualification levels were observed, including re-entry following interrupted study. Student success indicators stabilised as programmes matured, and graduate outcomes reflected a range of employment pathways, entrepreneurial activity, and mobility within and beyond South Africa.

4. DISCUSSION

The findings presented in the preceding section are considered here in relation to curriculum reform and professional education in geomatics. The discussion situates the case of the Tshwane University of Technology within broader national and international debates on widening access, articulated learning pathways, and workforce development in technically specialised fields. The transition to Higher Education Qualifications Sub-Framework–aligned programmes is examined not only as a regulatory response, but also as a process that reshaped access routes, progression opportunities, and graduate trajectories over time. In doing so, the discussion engages with international priorities around inclusive and equitable higher education, including Sustainable Development Goal 4 (quality education) and Sustainable Development Goal 10 (reduced inequalities), while remaining attentive to the institutional and policy context in which the reform occurred.

4.1. Curriculum reform and widening access

The findings indicate curriculum reform in geomatics education was associated with measurable shifts in access and participation during the review period, particularly in relation to gender and socio-economic background. Increases in female enrolment and participation by students from Quintile 1–3 schools suggest that the restructured programme and qualification mix coincided with broader entry into a field that has historically shown limited demographic diversity. In the South African context, where school quintiles serve as a proxy for socio-economic disadvantage, these patterns align with national transformation priorities as well as international commitments under Sustainable Development Goals 4 and 10, which emphasise inclusive and equitable access to education. While the results do not support causal attribution, the consistency of these trends points to the role of qualification structure, formal articulation pathways, and alternative access routes in shaping participation. Flexible modes of delivery also appear to have played a role, particularly through the introduction of block-mode provision in advanced and postgraduate programmes, which expanded access for working professionals seeking to continue their studies beyond undergraduate level and to register at higher registration categories of the South African Geomatics Council. At the same time, the findings suggest that curriculum reform alone is insufficient to widen participation, and that sustained gains depend on complementary institutional measures identified in the results, including targeted outreach, financial aid awareness, and academic support in professional fields with high entry thresholds.

4.2. Articulation, progression and lifelong learning

The results demonstrate that the restructured programme and qualification mix enabled more flexible patterns of articulation and progression than were possible under the legacy qualification system. Observed movement across qualification levels, including progression from entry-level to postgraduate study and re-entry following interrupted enrolment, indicates that formal articulation pathways functioned in practice rather than existing only as structural design features. These patterns align with broader shifts in professional higher education towards supporting lifelong learning, where study trajectories are increasingly shaped by employment, financial constraints, and changing skills requirements. In the South African context, where historical inequalities have constrained upward mobility, the availability of multiple entry and exit points represents an important mechanism for extending educational opportunity over time. More broadly, the findings suggest that articulation within a coherent

qualification framework can support progression for both traditional and non-traditional students, while maintaining alignment with professional registration requirements in a regulated field such as geomatics.

4.3. Student success and progression

Patterns of student success observed during the review period reflect the combined effects of curriculum reform, programme maturation, and system-level disruption. Variability in pass rates across qualifications, particularly during early implementation and the COVID-19 pandemic, highlights the sensitivity of student performance to periods of structural change. The subsequent stabilisation of pass rates as programmes became established suggests that student success is closely linked to the consolidation of curriculum design, assessment practices, and academic support. Extended time to completion and staggered graduation patterns further indicate that success in professional education cannot be assessed solely against nominal programme durations. Instead, continuity of study and eventual completion emerge as meaningful indicators of success within an articulated qualification framework that accommodates non-linear progression and diverse student trajectories.

4.4. Graduate outcomes, mobility and labour market alignment

Graduate outcomes reported in this study indicate that the restructured qualification framework supported employability across a diverse and evolving labour market. Employment across both traditional geomatics sectors and emerging geospatial fields suggests that curriculum reform facilitated the development of adaptable and transferable skills rather than narrowly defined occupational preparation. Entrepreneurial activity among graduates further reflects forms of professional formation that extend beyond salaried employment. Graduate mobility within and beyond South Africa points to improved comparability and recognition of qualifications aligned to the Higher Education Qualifications Sub-Framework, while also highlighting ongoing tensions between global employability and local skills needs. Within this context, the findings underscore the role of curriculum reform in supporting professional formation that is responsive to both national development priorities and participation in international labour markets.

4.5. Remaining challenges and opportunities

While the findings point to positive outcomes associated with curriculum reform, several challenges remain. Sustaining growth in access and participation will require continued investment in academic staffing and administrative capacity, alongside targeted academic support to consolidate gains. Representation of smaller population groups remains limited, indicating the need for more nuanced inclusion strategies beyond initial access. In addition, stronger and more systematic partnerships with industry will be important to sustain graduate opportunities across both established and emerging sectors, particularly in an evolving geospatial labour market. These challenges highlight that curriculum reform is not a one-off intervention but an ongoing process that depends on institutional capacity, external engagement, and responsiveness to changing professional contexts.

5. CONCLUDING REMARKS AND RECOMMENDATIONS

This paper examined curriculum reform in geomatics education through a longitudinal case study of the Department of Geomatics at the Tshwane University of Technology during the

transition from legacy National Education and Training qualifications to Higher Education Qualifications Sub-Framework–aligned programmes. The findings show that restructuring the programme and qualification mix was accompanied by changes in enrolment patterns, participation, student progression, and graduate outcomes over time. Following an initial period of volatility associated with programme closure and system-level disruption, enrolments recovered as new programmes became established, participation broadened demographically, and articulation across qualification levels was observed in practice. Student success indicators stabilised as programmes matured, while graduate outcomes reflected diverse employment pathways, entrepreneurial activity, and mobility within and beyond South Africa.

While grounded in a single institutional context, the case offers insights relevant to higher education institutions in both developing and developed settings where geomatics and related geospatial fields compete with other STEM disciplines for student enrolment and visibility, despite their foundational role in infrastructure development, environmental management, digital transformation, and spatial decision-making. Across contexts, the findings suggest that clearly articulated qualification pathways, flexible entry and exit points, and delivery modes that accommodate working professionals can support participation and progression across diverse student populations. At the same time, curriculum reform alone is insufficient to sustain these outcomes without complementary institutional measures, including adequate staffing, targeted academic support, and sustained engagement with industry and professional bodies. In this way, curriculum reform can contribute not only to widening participation and professional formation, but also to strengthening the visibility and long-term sustainability of geomatics education within increasingly competitive higher education environments.

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7. BIOGRAPHICAL NOTES

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