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DEVELOPMENT OF INNOVATIVE INTEGRATED ENGINEERING CURRICULA ACROSS SOUTH AFRICAN UNIVERSITIES

Lead partner: Dr Lelanie Smith, University of Pretoria, South Africa

THE CHALLENGE

Engineering education plays a critical role in providing students with the skills and competencies they need to adapt to the demands of the labour market. In South Africa, engineering programmes have traditionally been taught by academics who, while highly knowledgeable in their field, have little access to formal training and learning facilitation. Academic staff also face significant constraints, including limited time, resources, and professional development opportunities to update their curricula and teaching methods. Additionally, limited collaboration with the engineering industry reduces opportunities for graduates to develop the professional engagement skills necessary for navigating real-world workplace dynamics. As a consequence, there has been a systemic emphasis on content delivery over the development of skills, such as critical thinking, problem-solving, and teamwork. This gap in educational practice has contributed to a disconnect between engineering curricula and evolving competences required in industry, as well as the ability to address societal challenges.



THE PROJECT

The project 'Development of innovative integrated engineering curricula across South African universities' aimed to create a framework for implementing integrated curricula for engineering education tailored to the South African context. This approach combined technical skill development with holistic, authentic learning experiences, fostering technical and professional competence. By introducing project-based design throughout the courses, the curricula integrated employability skills, interdisciplinary courses, and applied mathematics, enhancing students' theoretical understanding while simultaneously building essential professional skills.

The project identified areas where it could pilot an integrated curricular approach within faculties across 16 universities in South Africa. It investigated how to improve the acceptance of the new approach and developed a training programme for staff to support the delivery of active integrated learning.

Coordinated by the University of Pretoria, the project brought together teams from different engineering schools across South Africa and was supported by UCL in the UK, with their experience in integrated curricula. UCL views this as a true partnership and shared its experiences and context with the goal of forming communities of practice to empower changes to engineering education in South Africa.

The South African partners included the University of Johannesburg, University of Cape Town, Vaal University of Technology, Nelson Mandela University, University of Kwa-Zulu Natal, Walter Sisulu University,

THE PEOPLE

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Dr Zach Simpson, University of Johannesburg
Dr Teresa Hatting, University of Johannesburg
Professor Chris von Klemperer, UCT
Dr Reuben Govender, UCT
Dr Nicky Wolmarans, UCT
Randall Patton, University of Witwatersrand
Eudes Tshitshonu, Vaal University of Technology
Professor John Mitchell, UCL
Cheryl Belford, Cape Peninsula University of Technology
Dr Bronwyn Swartz, Cape Peninsula University of Technology
Professor Anne Stark, University of KwaZulu-Natal
Professor David Lokhat, University of KwaZulu-Natal
Professor Anne Lourens – Nelson Mandela University
Dr Karin Wolff, University of Stellenbosch and SASSEE (Industry partner)

DEVELOPMENT OF INNOVATIVE INTEGRATED ENGINEERING CURRICULA ACROSS SOUTH AFRICAN UNIVERSITIES

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Cape Peninsula University of Technology, and a representative of the South African Society of Engineering Education. The work with industry was coordinated through an independent specialist, Dr Wolff, who represented industry partners and had access to real-world case studies, which were used to inform the design of the integrated curricula.¹

¹ <https://iecurricula.co.za/>

IMPACT

The project led to a significant impact, driving meaningful changes across **people, policy and practice** through the **development of a collaborative framework for an integrated curriculum**, ‘bringing life to our engineering curricula’.

The project **empowered educators** by equipping them with the skills and tools for active, integrated learning, transforming teaching practices in engineering education.

The team’s belief is that transforming engineering education requires more than just refining teaching practices—it demands a shift in how educators engage with change. Before they can implement transformative teaching, academics need the tools, mindset, and capacity to navigate the complexities of educational change. Initiatives like the project’s Change Makers in Engineering Education and Transformative Teaching in Engineering Education programmes have created spaces where educators can explore the intersection of personal identity, professional leadership, and institutional transformation. The project’s **‘systemic change facilitation approach’**² empowered participating institutions to tackle complex challenges and implement sustainable curriculum reforms. This goes beyond immediate educational outcomes, fostering a culture of innovation and resilience within higher education.

By recognising that true educational leadership

² The systemic change facilitation process has been developed in cooperation with transformation coaches as a way of introducing new teaching methods and curriculum updates with active engagement from faculty, stakeholders and leadership with the focus on addressing the unique changes of the South African landscape.

emerges from the ability to navigate complexity, manage change, and maintain personal authenticity within an institutional structure, these programmes have **equipped educators with practical strategies for leading curriculum transformation**, forming communities of practice, and influencing meaningful change. They have also emphasised personal and professional development, strengthening educators’ self-awareness, leadership presence, and resilience in balancing multiple roles.

Through this **collaborative, peer-driven approach**,³ these initiatives have provided hands-on tools for rethinking not just classroom dynamics, but also programme design, curriculum renewal, and systemic change in engineering education. By building a supportive network of teaching leaders, they ensure that educators are not only prepared to teach differently, but also to lead and sustain long-term educational transformation.

The introduction of integrated curricula in engineering ensures that engineering graduates are **well-equipped to navigate the complexities of the modern workforce** and address **pressing societal challenges**. By aligning graduate attributes with the Sustainable Development Goals (SDGs), students are prepared to make meaningful contributions to societal and environmental sustainability while tackling the challenges of today and the future. Through **active and interdisciplinary learning approaches**, students develop important skills,

³ This initiative was further enriched by project team visits to international centres of excellence, namely the Aalborg University project-based learning centre (Denmark) and KTH, Royal Institute of Technology in Stockholm (Sweden).

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such as critical thinking, problem-solving, and collaboration. These competencies enhance their employability and adaptability, enabling them to thrive in an ever evolving and dynamic workforce.

Building a sustainable, **engaged network of engineering educators** has been central to advancing curriculum transformation and professional development. This initiative has fostered ongoing national and regional collaboration through structured, multi-level engagement.

At a national level, consistent engagement with ECSA (Engineering Council of South Africa), along with Deans and Heads of Departments across Engineering Schools, has ensured alignment with accreditation requirements and institutional priorities. Monthly online sessions have provided a platform for engineering academics to discuss common challenges in teaching and curriculum development, creating a shared knowledge base across institutions.



Beyond virtual collaboration, the network has been strengthened through in-person and hybrid engagements. The Change Makers in Engineering Education programme, along with other national events, have served as key moments for deepening peer learning, leadership development, and strategic alignment. Additionally, regional hybrid events (in provinces including Western Cape, Kwa-Zulu Natal, Eastern Cape and Gauteng) have expanded participation, ensuring that educators from different contexts can contribute to and benefit from a growing, decentralised community of practice. Engineering academics across South Africa and the African continent now participate in the informal Engineering Education Research Network Africa (EERN - Africa).⁴ A research paper on EERN's community of practice highlighted six key themes of value: networking, capacity development, emotional support, professional identity, social and environmental impact, and breaking borders.⁵

This sustained networking and engagement has **bridged institutional silos**, facilitated cross-regional knowledge exchange, and laid the foundation for long-term collaboration in engineering education reform.

By supporting all **16 engineering schools in South Africa**, the project is strengthening South Africa's capacity to produce high-quality engineers. This contributes to national development by addressing critical infrastructure and technological needs. The project has generated national momentum around

⁴ <https://reen.co/>

⁵ Australasian Journal of Engineering Education: Reflecting on a community of practice for engineering education research capacity in Africa: who are we and where are we going? Esther Matemba, Lelanie Smith, Karin Wolff, Helen Inglis, Disapele Mogashana, Lauren Jansen: Published online: 07 Jul 2023

Question: How can an integrated curriculum lens address some of our assessment challenges?

Lecturers can adopt new approaches to assessment, keeping three guiding principles in mind:

1. Assessment serves a variety of purposes and is a **POWERFUL** instrument of learning.
2. Assessment should empower learners to meet their **FUTURE** learning needs.
3. Assessment is **INTEGRAL** to a curriculum and should be seen as part of the teaching and learning process

Extracted from engineering curricula one pager 'assessment strategies for an integrated curriculum', project documentation

curriculum renewal, setting a precedent for policy-driven reforms in how engineering education is structured and delivered. This creates a foundation for broader reforms in other academic disciplines as well.

Events like an Indaba (conference) hosted with ECSA brought together academic leaders and policymakers and provided a platform to align institutional goals with national accreditation policies. These types of discussions are essential for creating policies that reflect the needs of both education providers and industry. The project has opened up discussion and debate about the critical role of engineers, technologists and technicians in driving societal impact. The discourse extends beyond engineering within higher education, to explore broader connections between education and industry.

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THE FUTURE

The project's long-term vision is to establish a student-centred, contextually relevant and integrated engineering curriculum across all South African universities. The development of the regional hubs to support curriculum development, teacher training, and a community of practice will further support this ambition.



The funds from, and the reputation of the Royal Academy of Engineering have provided a platform to leverage additional funding. This includes from the South African University Capacity Development Programme fund (UCDP) which supported further curriculum implementation across participating institutions as well as the development and wider roll out of the teacher training programme.

In 2024, a consortium led by project lead Lelanie Smith through EERN-Africa, secured European Commission funding through the Intra-Africa Mobility Scheme.⁶ The capacity-building for Engineering Education (CB4EE) project⁷ is focusing on transformative research to support systemic change in engineering education in Africa to tackle global challenges.

While ECSA has been a vital partner, engaging other industry stakeholders remains a challenge due to competing priorities. Engagement with ECSA is planned to continue and future efforts will focus on incentivising stronger industry participation to deepen the curriculum's relevance and impact. There are also plans to engage more with the accreditation process, with ECSA, which will be a key driver for change.

⁶ https://www.eacea.ec.europa.eu/grants/2021-2027/intra-africa-academic-mobility-scheme_en

⁷ https://www.up.ac.za/faculty-of-engineering-built-environment-it/news/post_3239414-international-support-for-engineering-education-in-africa



SOURCES

This impact case study was prepared using information from interviews with the project team, online resources and progress reports supplied by the Academy..

- Progress report 1: 1 December 2021
- Progress report 2: 30 June 2022
- Interim report 2024
- TSP application for development of innovative integrated engineering curricula across partner SA HE institutions
- Interview with Helen Inglis, University of Pretoria
- Correspondence with Lelanie Smith, University of Pretoria
- Website: Innovative engineering curriculum: Bringing life to our engineering curricula: <https://iecurricula.co.za/> (accessed December 2024)
- Video footage – Case study interviews of the project team, filmed by Kit Oates, October 2024



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