INTERNAL FACTORS INFLUENCING CURRICULUM TRANSFORMATION IN HIGHER ENGINEERING EDUCATION

C. Gerwel[a], A. James[b], M. Kanyangale[c], H. Audunsson[d], V. Dagienė[e], I. Liem [f], E. Jasutė [g], R. Waldeck [h], S. Rouvrais [i], Á. Matthiasdottir[j] [1]

[a] University of KwaZulu-Natal, Durban, South Africa, 0000-0002-2330-9575
[b] University of KwaZulu-Natal, Durban, South Africa, 0000-0003-4644-1373
[c] University of KwaZulu-Natal, Durban, South Africa, 0000-0003-2259-1449
[d] Reykjavik University, Reykjavik, Iceland, 0000-0002-7730-346X
[e] Vilnius University, Lithuania, 0000-0002-3955-4751
[f] DEL Institute of Technology, Indonesia
[g] Vilnius University, Lithuania, 0000-0001-5183-9058
[h] IMT Atlantique, LEGO, Brest, France, 0000-0003-2031-9054
[I] IMT Atlantique, Lab-STICC UMR CNRS 6285, Brest, France 0000-0003-2801-3498
[j] Reykjavik University, Reykjavik, Iceland, 0000-0002-9831-5056

Conference Key Areas*: Curriculum development and emerging curriculum models in engineering; Building the capacity and strengthening the educational competences of engineering educators.*

Keywords*: Curriculum Transformation, Higher Education, Leadership, Change, Stakeholders.*

ABSTRACT

In many countries in the world, there is growing scholarly interest in higher education curriculum transformation. However, there is a lack of clarity and consensus on the factors, e.g. enablers and inhibitors, which influence curriculum transformation. The aim of this study was to explore factors influencing curriculum transformation in higher engineering education, according to the views of higher education faculty, programme leaders, and departmental heads. The study drew on the qualitative research approach, using data from an international hybrid

workshop. Data were analysed using thematic analysis. The findings revealed eight key factors identified as influencing curriculum transformation: conceptual clarity in curriculum transformation; urgency and need for rapid transformation in a changing landscape; curriculum adaptability and epistemological access; resource constraints; stakeholder engagement, diversity and inclusion; bureaucratic inefficiencies and slow decision making; higher education leadership; and professional development. By fostering an adaptive and forward-thinking approach, higher education can overcome systemic barriers and create inclusive, responsive, and future-oriented learning environments that prepare engineering students to navigate complex global challenges.

1 INTRODUCTION

Education evolves over time, as it reflects the era in which it exists, and engineering education being a good example. Nowadays, Higher Educational Institutions (HEIs) must prioritize the quality of their leadership processes to compete effectively in the internationalized education market with its disruptions. Therefore, continuous improvement of education curricula is essential to meet the growing needs of society (Supriani et al., 2022; Webb et al., 2021), as well as to be proactive in planning for an uncertain future. Enhancing the quality of curricula is a complex task that requires the dynamic and continuous effort of several stakeholders.

The curriculum has been widely analysed and interpreted by various experts, whose perspectives are shaped by their respective disciplines and experiences. Alberty (1962) for example, defined the curriculum as encompassing all activities provided to students under the school's responsibility, both inside and outside the classroom. In its chapter for the higher education sector on the meaning and content of transformation, a recent UNESCO report indicates that changes are required in the modus vivendi and modus operandi of institutions, with six possible transitions suggested, all grounded in specific contexts and local cultures (Opertti, 2023).

Curriculum development is a structured process that determines the content to be taught, the target learners, and the instructional methods used within an educational program. It is a deliberate, progressive, and comprehensive approach aimed at enhancing the education system to ensure that graduates are well-equipped for future success. This process integrates core content, engineering principles, transferable skills, and effective teaching methodologies to create a cohesive set of learning experiences that align with the intended program-level outcomes (Mitchell et al., 2024).

In recent decades there has been ongoing discussion in engineering education built on the need to follow and adapt to technological and societal changes that call for new and different competencies in students' education (Brink et al., 2024). While universities integrate advancements in scientific knowledge into their curricula, they often fail to recognize and adapt to evolving skill demands in the external world (Van Damme, 2021).

Matthiasdottir et al. (2024) conclude that effective curriculum development for engineering education involves multiple key aspects, including industry relevance, active learning, interdisciplinary approaches, and the development of soft skills. A well-structured curriculum that seamlessly incorporates these elements not only provides students with technical expertise but also fosters adaptability and versatility essential for a thriving engineering career. As technology progresses and societal demands shift, engineering education must stay at the forefront of innovation to prepare graduates for future challenges.

Curriculum transformation is a challenging yet necessary process, influenced by factors such as policy reforms, technological advancements, and globalization. To equip students with the knowledge and skills required to navigate an evolving world, curricula must undergo continuous development to be resilient to the

volatile, uncertain, complex and ambiguous world (VUCA), adapt to modernization and the changing demands of society (Webb et al., 2021, Waldeck et al., 2024). Curriculum transformation involves implementing new teaching and learning guidelines, highlighting the need for stakeholders to develop clear policies and procedures to address emerging challenges effectively (Law, 2022).

Today, we need a transformative curriculum in engineering education programmes to keep up with professional development and research in higher education environments, as well as, in society and pedagogy built on fast progress of technology and changing needs of the student group (Brink et al., 2024). Engineering education research supports this, highlighting that the required skills set in engineering is diverse (Passow & Passow, 2017), role-specific (Craps et al., 2021), and continuously evolving, particularly in response to challenges such as the Sustainable Development Goals (Beagon et al., 2022). Engineering faculties are addressing these social and technological shifts in various ways. Hadgraft and Kolmos (2020) identify key trends in modern engineering programs, including the integration of theory and practice, student-centered learning, digital and online learning, and a focus on professional competencies. Similarly, in her study on the global state of engineering education, Graham (2018) distinguishes between ‘current’ and ‘emerging’ leaders in engineering. She notes that the latter are characterized by unique educational approaches such as work-based learning, multidisciplinary programs, and a dual emphasis on student self-reflection and engineering design.

Effective curriculum transformation requires meaningful stakeholder engagement, involving educators, industry professionals, policymakers, and students to ensure diverse perspectives are integrated into educational reforms. In curriculum transformation, diversity of the stakeholders is important to ensure a multi-perspective approach, which balances the needs of HEIs, society and industry. It is prudent to gain clarity on enablers and inhibitors, with respect to the power and interests of diverse stakeholders which may shape their support or resistance to curriculum transformation (Golser et al., 2025).

This study was a part of the DECART (Designing Higher Education Curricula for Agility, Resilience, and Transformation) research and innovation project. DECART is an international cooperation partnership initiative co-funded under the European Commission’s Erasmus+ programme. The project unites higher educational institutions in France, Germany, Iceland, Indonesia, Lithuania, and South Africa. The aim of the study was to explore factors influencing curriculum transformation in higher engineering education, according to the views of HEI faculty, programme leaders and departmental heads.

2 METHODOLOGY

A two-hour hybrid workshop was held in University of KwaZulu-Natal, Durban, South Africa on 28th January 2025 with 34 participants. Ten members from the DECART project attended in person, and four project members online, using the online communication platform Zoom. The rest of the participants were faculty, programme leaders, and departmental leaders mainly from the University, who were key stakeholders in curriculum transformation.

Participants worked in groups; three groups in person, and one online group. Groups were formed by allocating a number (1, 2, or 3) to each participant in the physical room. Participants identified and examined enablers and inhibitors relating to curriculum transformation and the consequences of the enabler or inhibitor on curriculum transformation. Participants engaged in discussions and used flip charts to list their responses. The workshop was recorded, onsite and online, and the transcriptions analysed, using thematic analysis. As Braun and Clarke (2006) have pointed out, thematic analysis is widely used but not well defined. They emphasize that themes should capture what is important in the data in relation to the research questions and highlight the useful meaning in links to the questions.

3 RESULTS

Analysis of the data through a formal process of thematic analysis, identified the following factors that influence curriculum transformation in higher engineering education: 1) conceptual clarity in curriculum transformation; 2) urgency and need for rapid transformation in a changing landscape; 3) curriculum adaptability and epistemological access; 4) resource constraints; 5) stakeholder engagement, diversity and inclusion; 6) bureaucratic inefficiencies and slow decision making; 7) higher education leadership; 8) professional development.

3.1 Conceptual clarity in curriculum transformation

Participants wanted a better understanding and definition of what curriculum transformation is. As indicated by a participant: *"And again, we know we haven't had this discussion on what do we understand by curriculum transformation? We're transforming from what? From what are we transforming?".*

Stakeholders need to understand what curriculum transformation builds on and as stated by another participant, *"If we understand from what we're transforming, then we know the direction in which we're going to move."*

3.2 Urgency and need for rapid transformation in a changing landscape

Participants repeatedly highlighted the urgent need for rapid curriculum transformation, with many emphasizing the slow pace of change, particularly within HEIs.

As stated by one participant: *“Thus with the changing times, with the diversification and massification of higher education, our student body profile has changed.”*

This urgency stems from several factors, including the rapid advancement of technology, the changing needs of students, and the evolving knowledge economy. In the context of the changing knowledge economy, the need for curricula to remain relevant, responsive to contemporary societal shifts, as well as progressive, is becoming more pertinent. The sentiment that transformation must be rapid, highlights the anxiety surrounding the potential for HEIs to fall behind in preparing students for the future.

3.3 Curriculum adaptability and epistemological access

Participants mentioned that traditional curricula, designed for the different student demographics, no longer serve the needs of diverse learners or as one participant stated: *"So with the changing times, with the diversification and massification of higher education, our student body profile has changed."*

Another participant argued: "*How then, do we teach our students so as to enable epistemological access to the curriculum? We as staff need to be able to understand the curriculum ourselves.".*

It was thus suggested that HEI leadership should focus on faculty development in terms of the curriculum and curriculum transformation, fostering a deeper engagement with evolving knowledge systems, and ensuring adaptability in teaching methods.

3.4 Resource constraints

Participants pointed to the lack of resources, whether financial, human, or technological, as a significant limiting factor in achieving curriculum transformation. HEIs must assess available resources and address gaps to ensure that transformation efforts are sustainable and impactful.

As one participant stated: *"... what is the resource? Who do we have the resources in? We don't have the resources to deal with this yet."*

A lack of financial resources can be especially inhibiting and negatively affect curriculum transformation efforts. However, the quantity and quality of HEIs also play a role. HEIs need staff who have the time to focus on curriculum transformation, and engage with diverse internal and external stakeholders, to work collaboratively to drive change. The challenge however for some faculty is their workload, whereby they have multiple key performance areas, including teaching, supervision, research, community engagement and administration.

3.5 Stakeholder engagement, diversity and inclusion

The need for stakeholder engagement and diversity was repeatedly emphasized by participants, as well as to 'motivate stakeholders' and ensure that the 'student voice' was highlighted. Participants indicated that resistance to change is a problem, and could arise from various stakeholders, including lecturers, students, and industry. The inclusion of diverse perspectives and fostering of collaboration were seen as critical enablers for successful curriculum transformation. It was noted that diversity is an enabler and is significant in creating inclusive environments that value diverse viewpoints.

Engagement was identified as a crucial factor in successful curriculum transformation and was considered to entail participative cooperation among key stakeholders, including students, faculty, leadership, and external partners. Effective engagement fosters shared vision, facilitates resource allocation, and enhances collaborative problem-solving. A participatory approach leads to stronger buy-in, curriculum relevance, and innovation in educational practices. Participants emphasized that engagement should extend beyond academia, incorporating community voices and industry insights, to ensure holistic and contextualized curriculum development.

As stated by one participant: *“We can resolve problems together as well. So, resolving problems and ability to work as a team to come up with a solution is what also comes out of engagement. And the discussions that arise out of it because we've got more participants, there's more buy-in, there's support”.*

Engagement is seen as a means of resolving differences, building consensus, and ensuring that the curriculum is relevant to the needs of all stakeholders. The concept of "participative cooperation" highlights the importance of creating inclusive and participatory environments, where diverse perspectives are shared and valued. The benefits of engagement include the development of a "shared vision," the ability to "resolve problems together," and increased "buy-in" and support for curriculum initiatives. The emphasis on "joint engagement" underscores the need to move away from top-down approaches to curriculum development and embrace more collaborative, participatory, and democratic approaches.

3.6 Bureaucratic inefficiencies and slow decision making

Bureaucracy and slow decision-making were considered by participants to be serious barriers to curriculum transformation. Ideas for curriculum transformation may occur more easily from those at the coalface, given their proximity to students, and the VUCA context within which HEIs operate. The challenge however arises in that those who are closest cannot just bring about significant changes as approvals need to be sought from various stakeholders and leaders (e.g. teaching and learning committees and the leadership, quality assurance, and other committees within HEIs). The process can be quite bureaucratic, given the paperwork and motivations which need to accompany requests to make changes.

Decision-making processes within universities are often prolonged, causing the curriculum to lag behind real-time changes in the academic and societal landscape. Leadership styles contribute to this issue, as some leaders hesitate to make rapid decisions and present negating factors, while others adopt a more bureaucratic, hierarchical style. The complex leadership structure in universities, where responsibilities are dispersed among multiple leaders, further exacerbates delays. Further delays may also be experienced outside the HEIs, e.g. relevant national bodies involved in programme accreditation and quality assistance.

3.7 Higher education leadership

Participants noted that effective leaders are the key to successful curriculum transformation and that they should enable institutional growth, align with a shared vision and ensure that transformation efforts are interconnected rather than fragmented. The challenge according to participants was to ensure that leadership is not just symbolic but actively fosters participatory and collaborative actions and systemic understanding.

It was noted that leaders themselves may require development when they assume formal leadership roles in HEIs, given the responsibility. It is thus critical to ensure that HEI leaders receive the necessary support to thrive and be able to take their HEIs forward, and not just maintain the status quo. A participant said: “*To be a leader is an intense position to be in. But how are leaders enabled to be in those leadership positions as well? Or is it just about promotion?”*

Leadership entails an influence on relationships to achieve shared goals and objectives, and not just being in a position of authority. In the context of curriculum transformation, HEI leaders need to be able to influence the diverse stakeholders, by drawing on conducive leadership styles to facilitate change and foster collaboration. Leaders must navigate diverse interests, manage complex academic structures, and align multiple components to drive transformation. Systems thinking is a crucial competency, as leaders must conceptualize and implement changes across multiple levels of the institution.

Leadership in curriculum transformation is not centralized, it operates across multiple levels, from policymakers to faculty members designing for and implementing changes. The gap between policy formulation and actual implementation remains a core issue, often due to lack of oversight, resistance from stakeholders or misalignment with institutional realities. Leaders must not only create policies and focus on enforcement, but should create a conducive environment, where HEI staff are willing to focus on creative processes to conceive, design, redefine, and implement, within a spirit whereby there is a culture that appreciates such values and approaches to teaching and learning.

Participants noted that the role of leadership in curriculum transformation was considered a major factor in enabling or inhibiting curriculum transformation. *"So I think there needs to be far deeper conversations around the notion of leadership and especially for curriculum transformation."*

3.8 Professional development

Participants indicated professional staff development as a critical enabler for effective curriculum transformation. It was noted that HEI leadership should prioritize continuous professional development (CPD) initiatives. Without a strong understanding of curriculum dynamics, including formal, informal, hidden, and actual curricula, academic staff may struggle to implement meaningful transformation.

Participants noted the role that HEI leaders need to play in understanding the need for meaningful and relevant professional development for faculty but also ensuring that they support their staff in such initiatives.

A participant indicated: *“... it is incumbent on the leadership to recognize this important aspect of our professional development as academics and to support that. So how do the leaders then support that?”*

This is where the concept of the profession comes in and how critical it is to stay updated, relevant, learn about new trends and acquire the necessary skills and abilities to adapt to the demands of the VUCA world. This was considered especially pertinent with respect to technology and the learners and their unique generational characteristics.

4 CONCLUSION

“The last few years have seen significant global crises, including a rise in armed conflict, and mounting geopolitical tensions, which have implications for public spending, international migration, global health, and national policy priorities. Their

implications for education play out in various ways, [...] also the necessity of resilience and adaptability in our education systems" (OECD, 2025). Curriculum transformation in HEIs has become an imperative that demands proactive preparation.

The study has identified internal factors that influence curriculum transformation. It is critical to first gain conceptual clarity in curriculum transformation. Given the urgency and need for rapid transformation in a changing landscape, there must be curriculum adaptability and epistemological access. However, this is a process that requires the inclusive engagement of diverse stakeholders, where effective curriculum transformation necessitates a systemic effort to overcome barriers, including resource constraints and bureaucratic inefficiencies and slow decision-making. Leadership in HEIs and the professional development of staff play a crucial role in enhancing curriculum adaptability and ensuring epistemological access. The results of this study resonate on several key aspects with another study (Waldeck et al, 2024, Waldeck et al. 2025) where the authors found that curriculum resilience involves adaptation to a changing world with curriculum aligning with real-world VUCA challenges and problems. It relies on a quality culture of the different stakeholders sustained by the diversity of perspectives and shared responsibility, fostering an adaptive mindset and a commitment to continuous improvement.

Curriculum transformation is essential for HEIs to prepare future engineering graduates capable of addressing complex global challenges and thriving in an increasingly VUCA world. There must however be opportunities for the diverse stakeholders in HEIs, and those external to the HEIs, to come together to critically engage with the challenges impacting the curriculum and HEIs and to consider what is required to develop students for the workplace in a timely manner. Stakeholder engagement and an understanding of their roles in driving curriculum transformation, are key to ensuring relevance, adaptability, proactivity and responsiveness of higher engineering education in disruptive contexts.

The study drew on the perspectives of participants in a specific context as outlined in the methodological section, relating to curriculum transformation in HEIs. Valuable insights were obtained, but the study findings cannot be generalized as the limitation is the small sample size, and the method. Future studies can draw on mixed methods approaches with larger samples from the participating HEIs. The study can also be extended beyond the project. The role of leadership in facilitating curriculum transformation also featured quite prominently in this study, thus future research should explore this further.

Despite the limitations, it is nonetheless interesting to see how the perspectives of international participants from diverse HEIs, and several South African participants, converged. The South African participants may have had far more experience of curriculum transformation for many years, given the historical context (Lange, 2017; Kloot & Rouvrais 2017). While for the international participants, curriculum transformation and transition may be more topical in recent years, due to various crises which have and are impacting HEIs, e.g. in the European Union. It is evident though that HEIs worldwide are affected by the multiple crises occurring in the VUCA world, which challenges the status quo,

thereby necessitating rapid curriculum transformation, to ensure relevance, sustainability, and purpose.

REFERENCES

Alberty, H. (1962). *Reorganizing The High School Curriculum*. New York: The Macmillan Company. CRID 1130282269736941056

Beagon, U., Kövesi, K., Tabas, B., Nørgaard, B., Lehtinen, R., Bowe, B., … Spliid, C. M. (2022). Preparing engineering students for the challenges of the SDGs: what competences are required? *European Journal of Engineering Education,* 48(1), 1–23. https://doi.org/10.1080/03043797.2022.2033955

Braun, V. & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77-101, DOI: 10.1191/1478088706qp063oa

Brink, S. C., de Hei, M., Sjoer, E., Carlsson, C. J., Georgsson, F., Keller, E., Admiraal, W. (2024). Curriculum Agility principles for transformative innovation in engineering education. *European Journal of Engineering Education*, 1–17. https://doi.org/10.1080/03043797.2024.2398165

Craps, S., Pinxten, M., Knipprath, H., & Langie, G. (2021). Different roles, different demands. A competency-based professional roles model for early career engineers, validated in industry and higher education. *European Journal of Engineering Education*, *47*(1), 144-163. https://doi.org/10.1080/03043797.2021.1889468

Graham, R. H. (2018). *The global state of the art in engineering education.* Cambridge, MA: Massachusetts Institute of Technology, USA. ISBN 13: 9780692089200

Golser, M., Hofer, A., Kargruber, J., & Rauch, E. (2025). *Integrating Stakeholder Engagement: Refining Engineering Education for the Mobility Value Chain in Industry 5.0.* Procedia Computer Science, 253, 964-973. https://doi.org/10.1016/j.procs.2025.01.158

Hadgraft, R.G. & Kolmos, A. (2020). Emerging learning environments in engineering education, *Australasian Journal of Engineering Education*, 25(1), 3-16. https://doi.org/10.1080/22054952.2020.1713522

Kloot, B. and Rouvrais, S. (2017). The South African engineering education model with a European perspective: History, analogies, transformations and challenges. *European Journal of Engineering Education*, 42(2), 188-202. Taylor & Francis.

Lange, L. (2017). 20 Years of higher education curriculum policy in South Africa. *Journal of Education, Durban*, (68), 31-57.

Law, M. Y. (2022). A Review of Curriculum Change and Innovation for Higher Education. *Journal of Education and Training Studies*, 10(2), 16-23. https://doi.org/o10.11114/jets.v10i2.5448

Matthiasdottir, Á, Proches, C. G., Audunsson, H., Rouvrais, S., Dagienė, V. & Barus, A. (2024). *Examining best practices in curriculum design: Insights for*

Engineering education. Proceedings of the 52nd Annual SEFI conference, Switzerland.

Mitchell, J. E., Capdevila, I., Economides, S., Gwynne-Evans, A., Laperrouza, M., Tilley, E., Thomson, G., & Wint, N. (2024). Curriculum development and emerging curriculum models in engineering. Proceedings of the *52nd Annual Conference of SEFI*, Lausanne, Switzerland. https://doi.org/10.5281/zenodo.14260987

OECD (2025), *Trends Shaping Education 2025*, OECD Publishing, Paris. https://doi.org/10.1787/ee6587fd-en.

Opertti, R. (2023). Curriculum in transformation mode: rethinking curriculum for the transformation of education and education systems. UNESCO International Bureau of Education. IBE/2023/P1/01. https://unesdoc.unesco.org/ark:/48223/pf0000387188

Passow, H.J. & Passow, C.H. (2017). What competencies should undergraduate engineering programs emphasize? A systematic review. *Journal of Engineering Education*, 106, 475-526. https://doi.org/10.1002/jee.20171

Supriani, Y., Meliani, F., Supriyadi, A., Supiana, S., & Zaqiah, Q. (2022). The Process of Curriculum Innovation: Dimensions, Models, Stages, and Affecting Factors. *Nazhruna: Jurnal Pendidikan Islam,* 5(2), 485-500. https://doi.org/10.31538/nzh.v5i2.2235

Van Damme, D. (2021). *Transforming Universities for a Sustainable Future*. In Van't Land, H., Corcoran, A. & Lancu, D., The Promise of Higher Education, *Springer*, Switzerland, 431-438, https://doi.org/10.1007/978-3-030-67245-4

Waldeck, R., Garner le Gars, R., Audunsson, H., Barus, A., Liem, I. , Kanyangale, M., Gerwel Proches, C., Rouvrais, S., Winkens, A-K. (2024) Higher education resilient curricula: lessons from a European project, ICERI2024 Proceedings, 3592-3600. https://doi.org/10.21125/iceri.2024.0915

Waldeck, R., Gardner le Gars, Winkens, A-K., R., Audunsson, Rouvrais, S., H., Barus, A., Dagiene, V., Gerwel Proches, C., et al. Curriculum Resilience, the DECART project (Designing higher Education Curricula for Agility, Resilience & Transformation), Report, Version 2.0, March 2025. www.decartproject.eu

Webb, A. S., Hubball, H. T., & McKenzie, M. (2021). Strategic approaches to globalisation curriculum practice: Responding to faculty development needs and circumstances in diverse university contexts: *International Journal of Curriculum and Instruction*, *13*(2), 1209-1225.