Facilitating Curriculum Transformation in STEAM in a Volatile, Uncertain, Complex and Ambiguous World

Macdonald Kanyangale

University of KwaZulu-Natal, Durban, South Africa
ORCID: https://orcid.org/0000-0003-2259-1449
kanyangalem@ukzn.ac.za

Angela James

University of KwaZulu-Natal, Durban, South Africa
ORCID: https://orcid.org/0000-0003-4644-1373
jamesa1@ukzn.ac.za

Cecile Gerwel Proches

University of KwaZulu-Natal, Durban, South Africa
ORCID https://orcid.org/0000-0002-2330-9575
gerwel@ukzn.ac.za

Valentina Dagienė

Vilnius University, Lithuania
ORCID https://orcid.org/0000-0002-3955-4751
valentina.dagiene@mif.vu.lt

Asrun Matthiasdottir

Reykjavík University, Iceland
ORCID https://orcid.org/0000-0002-9831-5056
asrun@ru.is

Inggriani Liem

DEL Institute of Technology, Indonesia
inge@del.ac.id

Eglė Jasutė

Vilnius University, Lithuania
ORCID https://orcid.org/0000-0001-5183-9058
egle.jasute@fsf.vu.lt

Haraldur Audunsson

Reykjavík University, Iceland
ORCID https://orcid.org/0000-0002-7730-346X
haraldura@ru.is

Abstract. Curriculum transformation is critical for higher education to meet the changing needs of society and industry in a volatile, uncertain, complex and ambiguous world. However, there is little consensus among stakeholders on its definition and implementation. This qualitative research explores understandings of curriculum transformation and the processes involved in its realization. Findings highlight three key dimensions in conceptualizing curriculum transformation: dynamic and adaptive change, the transformation continuum, and regulated change. The study reveals that the process of curriculum transformation is complex, structured and evolving, and involves information gathering and structural design. While highly contextualized, curriculum transformation generally falls between two models: a top-down approach driven by government influence, or a decentralized, bottom-up change process. Academics in Higher Education Institutions may adopt the integrative meaning of curriculum transformation proposed in this study to facilitate curriculum transformation in a holistic way in a volatile, uncertain, complex and ambiguous context.
Keywords: curriculum transformation, volatility, uncertainty, complexity, ambiguity, VUCA.

Aukštojo mokslo STEAM programų transformacija nepastoviame, neapibrėžtame, sudėtingame ir dviprasmiškame pasaulyje

Santrauka. Studijų programų pertvarka yra labai svarbi, kad aukštasis mokslas atitiktų kintančius visuomenės ir pramonės poreikius nepastoviame, neapibrėžtame, sudėtingame ir dviprasmiškame pasaulyje. Tačiau suinteresuotosios šalys kol kas nesutaria dėl programos apibrėžimo ir įgyvendinimo. Šiame kokybiniame tyrime nagrinėjama studijų programų pertvarkos samprata ir su jos įgyvendinimu susiję procesai. Tyrimo rezultatai išryškina tris pagrindinius studijų programų pertvarkos konceptualizavimo aspektus: dinamiškus ir prisitaikančius pokyčius, pertvarkos tęstinumą ir reguliuojamus pokyčius. Tyrimas atskleidė, kad studijų programos pertvarkos procesas yra sudėtingas, struktūruotas ir besivystantis, apimantis informacijos rinkimą ir struktūrinį projektavimą. Nors studijų programų pertvarka labai priklauso nuo konteksto, paprastai ji priskiriama dviem modeliams: valdžios įtakos nuleidžiamam požiūriui iš viršaus žemyn arba decentralizuotam, ir iš apačios į viršų kylančiam pokyčių procesui. Šio tyrimo metu siūloma integracinė studijų programos pertvarka gali būti pritaikyta siekiant palengvinti holistinę studijų programos transformaciją nepastoviame, neapibrėžtame, sudėtingame ir dviprasmiškame kontekste.

Pagrindiniai žodžiai: mokymo programų transformacija, nepastovumas, neapibrėžtumas, sudėtingumas, dviprasmiškumas, VUCA.

Introduction

Higher Education Institutions (HEI) are challenged with complexities internal and external to their systems. The complexities are not bounded, and this makes their systems susceptible to many influences, reduces their ability to control and predict them, and renders the context in which the education takes place as crucial (Sumara & Davis, 2014). In exploring and coming to understand this context, it is apparent that it is characterised by volatility, uncertainty, complexity, and ambiguity (VUCA) in these times. Moreover, for any HEI to be effective and also prepare for the future, the need for a transformative approach to education has never been more critical. The current, traditional educational paradigms often fall short in preparing students for the dynamic challenges and opportunities of the 21st century. Therefore, this is where STEAM education – an interdisciplinary approach integrating Science, Technology, Engineering, Arts, and Mathematics (STEAM) – emerges as a pivotal solution (Barcelona, 2014).

It is argued that the concept of curriculum transformation to facilitate STEAM education in a VUCA world involves rethinking and redesigning educational frameworks to foster creativity, critical thinking, collaboration, and problem-solving skills and diverse knowledge, with appropriate incumbent attitudes (Gale et al., 2020; James et al., 2025; Roehrig et al., 2021). In HEIs, lecturers should be embracing a holistic and flexible curriculum so that to get students engaged in opportunities for them to be equipped with the competencies needed to navigate and thrive in an unpredictable and complex global landscape (El Aouri, 2024).

Globalization has significantly influenced engineering education, fostering unprecedented interconnectivity and minimizing geographical and linguistic barriers (Graham, 2018). However, these advancements have not substantially altered the traditional structures of engineering education. The qualities defining a successful engineer are becoming increasingly volatile, with the traditional skill sets losing relevance. As industries shift unpredictably, uncertainty in employment prospects grows, leaving many engineers underprepared for evolving job markets. This situation is further complicated by the com-

plexity of modern engineering challenges, which require multidisciplinary approaches and adaptability (Male et al., 2011).

The future of engineering education appears ambiguous, as traditional degree structures no longer guarantee employability. In a rapidly shifting professional landscape, individuals with diverse, adaptable skill sets may find greater opportunities than those who specialize too narrowly. Educators must therefore make a deliberate effort to enhance their competencies, ensuring that students are prepared for the demands of the 21st century. This underscores the urgent need to reform educational policies and teaching methodologies, aligning them with the realities of an ever-changing world (Fernandes & Afonso, 2021).

Understanding the distinction between change and transformation is crucial, in this context of HEIs. Change involves modifying specific aspects in response to external influences, aiming for incremental improvements. In contrast, transformation entails a profound, fundamental shift that redefines beliefs, values, and behaviours, often resulting in a complete overhaul of existing systems. While change seeks to enhance the current state, transformation aspires to create an entirely new paradigm, necessitating a comprehensive reevaluation of educational frameworks to meet the challenges posed by globalization (Webb et al., 2021).

1 Literature Review

VUCA is often used to describe unpredictable global conditions (Fernandes & Afonso, 2021). In HEI, it highlights the need for institutions to adapt to rapid changes, unpredictable futures, interconnected challenges, and unclear information. Scholars emphasise that VUCA forces demand new approaches to curriculum design, preparing students for an evolving world where traditional educational models and skills may no longer suffice (Audunsson et al., 2024; El Aouri, 2024). VUCA events can be of natural causes, like natural disasters, earthquakes, global warming and pandemic, and manmade, like sudden increase of disinformation and demand for a revised learning model in response to rapid changes in the work market.

Volatility refers to the fast pace of change that requires flexibility. Choi (2024) notes that technological and societal shifts demand frequent curriculum updates, while El Aouri (2024) emphasises adaptability in preparing students for evolving job markets. Mielkov et al. (2021) argue that volatility challenges traditional learning models, pushing for more student-driven education. Rouvrais et al. (2024) highlight that the reduction of state aid, along with new regulatory requirements, and sustainability concerns create volatile conditions that require universities to continuously adjust their goals, curricula, and business processes. It is prudent that curricula should be more modular and customizable, allowing students to acquire emerging skills without being locked into rigid educational structures.

Uncertainty describes the difficulty of predicting future trends, making traditional planning unreliable. El Aouri (2024) highlights how job roles constantly evolve, requiring broad, transferable skills. Ninela and Proches (2024) illustrate how COVID-19 forced universities to rethink crisis management and decision-making. Thabmali and Traiwichitkhun (2025) emphasise the need for teacher training in creativity, prob-

lem-solving, and human-centered learning to develop adaptable teaching methodologies. Mielkov et al. (2021) go further by arguing that curriculum design should move away from predefined competencies and instead focus on student-centered learning, where students become active participants in shaping their own knowledge pathways.

Complexity refers to interconnected challenges that demand interdisciplinary solutions. Matthiasdottir et al. (2024) stress that engineering curricula should teach real-world problem-solving, while Barcelona (2023) advocates for institutional collaboration to handle complexity. Rouvrais et al. (2024) propose enterprise architecture as a solution to structure interdisciplinary efforts, ensuring that diverse academic fields and administrative processes work cohesively rather than in isolated silos. Entrepreneurship education should integrate elements of technology, management, and social sciences so that to better equip students for complex, interconnected work environments.

Ambiguity arises from incomplete or conflicting information. Rouvrais et al. (2024) argue that engineering students must learn to work with uncertainty, while Audunsson et al. (2024) highlight Artificial Intelligence (AI) and misinformation as key sources of ambiguity. Mielkov et al. (2021) view ambiguity as an opportunity for open-ended, creative learning rather than a challenge, advocating for humanistic and student-centered learning models that prioritize adaptability and continuous knowledge creation.

In general, VUCA is a defining feature of modern higher education, requiring flexible curricula, adaptive leadership, interdisciplinary approaches, and a focus on critical thinking. To address volatility, curricula must be adaptable and continuously updated. Uncertainty calls for broad-based skills rather than rigid job training. Complexity necessitates interdisciplinary learning and real-world applications, while ambiguity requires students to develop critical thinking and independent learning (Law,2022). Collectively, these perspectives highlight a shift toward student-centered, lifelong learning models that prepare individuals to succeed in an unpredictable global landscape (Fernandes & Afonso, 2021; Matthiasdottir et al., 2024; Mielkov et al., 2021). Curriculum design and transformation occur in a VUCA world.

2 Curriculum Design and Transformation

The term 'curriculum' is traceable to the Latin word *currere*, which literally means to run a race course (Tinsae, 2016). The metaphor of a curriculum as a race course reflects the traditional and narrow view of curriculum which focuses on what will be taught (content) in a given educational program, who will teach (teacher), who will be taught (learner), with what tools and in what context (milieu), with what effect (output/outcomes), and how the learners will be assessed. In the narrow sense, curriculum is the planned sequence of instruction which outlines what students will learn, how they will learn it, and how student learning will be assessed and evaluated (El-Astal, 2023). While curriculum can be considered as 'what' is taught, instruction is the (how) process of delivering content to learners for creating meaningful learning experiences (Tinsae, 2016). Ideally, curriculum is the central guide for all educators, as to what is essential for teaching and learning, so that every student has an access to rigorous academic experiences.

The modern and broader sense of curriculum emphasises the totality of student experiences, provided that it is planned, organised and used in the educational process. The relevance of the learning experiences may take into account local, national and global needs and expectations (Dufera, 2004).

Lunenburg (2011) surmises that the expected learning outcomes, content and the student learning experiences are key aspects of the curriculum as a learning experience. The questions seeking clarity of what is being transformed in the curriculum, who drives the transformation, who is involved, how curriculum transformation unfolds, and what a transformed curriculum looks like are crucial for educators to design effective programs that meet student needs and achieve the desired outcomes (Prinsloo, 2016). Additionally, the question of what the transformed curriculum should achieve is equally important.

When designing a curriculum, it can be considered as composed of several components (e.g., the learning outcomes, content, teaching methods, assessment, evaluation), with each of those describing different aspects of the curriculum, whereas transformation can affect one or more components. The components in a curriculum are interrelated to each other, and an event can impact more than one component, in different ways, thereby making transformation complex. Curriculum transformation is needed when the HE needs to maintain curriculum resilience (Bennett & Lemoine, 2014; Hollnagel, 2010). In the VUCA world, we have to handle the transformation effectively and efficiently, not simply because it can impact many and interrelated aspects, but also because it can have a lasting impact on learning and different stakeholders. Transformations need a good curriculum design or process of organizing educational content, activities, and assessments for a course or a class (McManus et al., 2008).

The curriculum, in a broad sense, describes the totality of student learning experiences provided, whereas, in practice, the curriculum of a program defines the content that will be taught, including the skills that are to be developed, the learning outcomes, the methods used in delivering the program, including the instructional methods and assessments, and the targeted students. Several examples of the curriculum structure and design have already been discussed in literature (e.g., Alberty, 1962; Van den Akker, 2004; Mitchell et al., 2024), and the description of the curriculum reflects the context of the program, i.e., requirements from various stakeholders like society, the educational institution, students, and the relevant industry. In addition, Webb et al. (2021) emphasised that educational institutions must strive to continuously upgrade the curricula to respond to today's environment and modernization, and the changing demands of society. This may include policy reforms, adaptation of advancing technology, and ensuing globalization.

3 Curriculum Structure and Components

In curriculum transformation, it is prudent to have an outline of the structure and components of a curriculum to effectively guide educators in understanding the alignment of curriculum with national and global standards and the holistic impact of VUCA on a curriculum. In this paper, the context and focus are on higher education, and the curriculum

outline provided in Table 1 is based on analysis of several current examples from higher education in STEM and management education (as presented by the *DECART* project participants) (Audunsson et al., 2024; Matthiasdottir et al., 2024). The analysis resulted in a practical outline of a curriculum that is composed of nine components and is meant to reflect the current issues that educational institutions are facing today and that should be addressed.

The curriculum framework in Table 1 offers a realistic reflection of the current state of higher education programs and accounts for both structural and pedagogical elements while integrating broader societal and institutional concerns. By incorporating these components, the curriculum model not only aligns with the conventional educational frameworks but also addresses the evolving challenges and expectations of modern higher education. It provides a structured yet adaptable foundation for designing curricula that prepare students for dynamic and globally interconnected professional environments.

Table 1. *Curriculum components with short description (Audunsson et al., 2024; Matthiasdottir et al., 2024)*

Program Curriculum Components	Description and content. *The component may include ...*
1. Main goals and learning outcomes	… the program's main goals and the learning outcomes.
2. Entry requirements	… entry requirements for students entering the program.
3. Structure and content of the program	… a sequence of courses or modules, study paths, content and learning activities, and a timeline.
4. Teaching and learning methods	… the role of the teacher, teaching and learning material and activities.
5. Location of teaching and learning	… onsite, online, internship, expeditions and study abroad.
6. Transversal and personal attributes	… interpersonal abilities, communication, teamwork, intercultural understanding, personal traits and ethics, and critical thinking.
7. Assessment methods	… a range of assessment methods, from traditional exams and written assignments to project-based evaluations, peer assessments, and competency-based approaches.
8. Language	… the language of instruction and communication, potentially involving multiple languages or modes of expression.
9. Social and ethnic diversity	… students from diverse social backgrounds and those with disabilities, while also integrating a broad spectrum of ethnic, local, and international competencies.

When the curriculum framework and the relationships between its components are thoughtfully designed, higher education institutions can enhance the flexibility and interdependence of these elements, enabling them to respond effectively to VUCA situations. This adaptability became particularly evident during the COVID-19 pandemic, which underscored the necessity for educational structures to accommodate rapid changes. For

instance, providing students with options regarding the format (in-person, online, or hybrid), location, and duration of their courses, as well as opportunities for internships or study abroad programs, allows institutions to better meet diverse student needs and external challenges. Such flexible approaches not only support personalized learning pathways but also ensure continuity and resilience in the face of unforeseen disruptions.

4 Aim and Research Questions

The aim of the research is to explore the understandings of curriculum transformation and the processes involved in its realization. The exploration of the participants' understanding(s) is essential to the unpacking of the processes required for the curriculum outcomes to be achieved.

We formulate this problem into Research Question 1 and 2:

1. What are the understandings of the DECART project members and staff from the partner institutions of curriculum transformation in the context of a VUCA world?
2. How do the DECART project members and staff from the partner institutions describe the key processes and factors in curriculum transformation?

This study seeks to capture the diverse perspectives on curriculum transformation, highlighting the challenges and opportunities within its implementation. By identifying, summarising, and interpreting these insights, it contributes to a deeper understanding of how higher education institutions can effectively navigate and implement curriculum transformation in a VUCA.

5 Methodology

The study drew on the interpretivist paradigm, with the qualitative research approach being employed to obtain in-depth views and opinions of the DECART project participants. A case study strategy was employed, as the case focused on the participants' conceptualisation of STEAM education in the context of VUCA. Purposive sampling was employed, drawing on project partners and staff from the various HEIs (France, Germany, Iceland, Indonesia, Lithuania, and South Africa).

The findings in this paper are drawn from data gathered in three workshops (a virtual workshop on 13 May 2024, a hybrid one on 27 June 2024, and a virtual one on 27 August 2024, see below for descriptions) with the DECART project members. Data gathering methods were verbal questions presented by using digital tools, such as Mentimeter, Rich pictures, Jamboard, and Google forms, serving to gather real-time data, and to stimulate rich discussions with the participants about the various objectives for each workshop. The participants were organised into groups and engaged in discussions in Zoom breakout rooms, and thereafter shared with everyone, upon returning to the main room. Group allocation for the two virtual workshops was implemented by using the Zoom breakout room allocations to assign the participants automatically. The hybrid workshop had one breakout room in Zoom, and breakout rooms in the room, whereby participants were assigned to a group by using numbers (e.g., 1, 2, 3).

The first virtual workshop was held on 13 May 2024. All participating HEIs were represented, with 13 participants who joined for the 3-hour interactive virtual workshop. The objective of the workshop was to unpack the curriculum transformation with respect to: identifying the disruptions experienced by HEIs with respect to curriculum; exploring understandings of curriculum transformation; exploring the main challenges experienced with curriculum transformation that should be addressed; and unpacking the multiple dimensions of curriculum transformation. In this regard, dimension meant a part, feature, way of considering and thinking about curriculum transformation.

The second workshop was held in the hybrid mode on 27 June 2024. Twenty-seven participants, comprising DECART project partners and staff from the partner institutions, took part in the three-hour workshop. The objectives of the workshop were to: identify the stakeholders involved in curriculum transformation; examine the role that the stakeholders play in curriculum transformation; and test the curriculum transformation framework.

The third virtual workshop was held on 27 August 2024. The three-hour workshop was attended by 19 participants, including DECART project partners, as well as other academics from University of KwaZulu-Natal (UKZN) and two universities in Indonesia. The objectives of the workshop were to: explore curriculum transformation, and its complexities and challenges; and examine the curriculum as an intervention that redefines and shapes individuals through ideology and social norms, and exploring whose interests are served in this process.

Data were analysed by using thematic analysis to develop the relevant themes depicting the participants' understanding(s) of curriculum transformation and the key processes and factors in curriculum transformation in the context of a VUCA.

6 Results and Discussion

The results are presented in two sections: the dimensions of curriculum transformation and the process of curriculum transformation. This study sought to capture diverse perspectives on curriculum transformation, highlighting both the challenges and opportunities in its implementation. By identifying, summarising, and interpreting these insights, it contributes to a deeper understanding of how higher education institutions can effectively navigate and implement curriculum transformation. The findings are structured into two key sections: the dimensions of curriculum transformation, which examine its conceptual foundations, and the process of curriculum transformation, which explores the practical steps and factors influencing its realization. This approach offers a comprehensive perspective on both the theoretical and practical aspects of curriculum transformation in higher education.

6.1 Dimensions of curriculum transformation

The dimensions of curriculum transformation reveal three key interdependent dimensions of dynamic process of change and adaptation, transformation continuum, and a regulated process of change.

6.1.1 Dynamic process of change and adaptation

First, this focuses on the forward-looking nature of curriculum design, where the aim is to equip students with the skills and knowledge needed for future challenges. It emphasises the need for curricula to anticipate and address future societal and industry demands. This is echoed by El Aouri (2024) in emphasising the importance of a holistic and flexible curriculum. The participants noted the importance of curriculum transformation.

"The world is changing, so we need transformation."

Adapting the current curriculum to meet the future needs, curriculum resilience and transformation as a dynamic process all speak to change focusing on future adaptation, and the continuous nature of change.

"And, for us, it's a future-oriented process. Yeah, in which we do a view into the future and to look what is important in the future, what students have to learn to work in the future, to deal with future problems."

Second, this theme also encapsulates the idea that curriculum transformation is not a one-off static event but frequent and ongoing adaptation of the curriculum to the changing educational landscape. This finding is aligned with the research of Fernandes and Afonso (2021).

"... Curriculum transformation is adaptation and, yeah, education for positive change and future orientation."

"So adapt to new, changing conditions, new social, societal conditions and so having new views integrated into your curriculum. I think when you make a curriculum transformation, [it] is for better preparing our students [for] the future."

Third, the intensity of changes and the constant review of various constitutive components of curriculum and instruction in response to societal, technological, and economic shifts is a key aspect of the dynamic nature of the curriculum transformation.

"You know it's about re-evaluating, redesigning, enhancing relevance and responding to societal and global needs changes and so on. So it must somehow adapt for a new educational landscape."

"You may want to become in some sense more robust..."

6.1.2 Transformation continuum

This theme explores the difference between incremental changes (small updates) and transformation (significant shifts), recognising that both of them play a role in curriculum evolution.

"And there are two views… which say that you may transform something. You may have an innovation because you want to adapt. There is adaptation going on, and you may adapt…"

The participants debated the triggers for each of those, and how they impact educational outcomes.

Two key aspects that emerge are fine-tuning versus re-creation and innovative thinking and change in the educational design. The two ideas capture change as a radical process with pervasive transformation or incremental changes are both induced by innovative thinking and design in education. In terms of a continuum, transformation can be brought about incrementally over time through smaller changes or radically in larger transformations, both resulting in curriculum transformation. This second conceptualisation of curriculum transformation captures the nature of the continuum and variety of transformation in curriculum transformation.

"Why we should make a distinction between change and transformation may be an important matter. I was talking about incremental innovation before. It's like a change but it's a small change and even though you may not pursue it, it's a change."

"And I was speaking about disruptive innovation. This is a transformation. It's a matter of definition, of course, but it may say something about triggers…"

"But there are many kinds of innovation, out there. There is incremental innovation, meaning [that] you change a little bit each time, each time, each time. But it's the same. [With] sub-transformation going on. So it's a process but they are also disruptive in innovation, meaning at once."

"… a complete reimagination of the curriculum context, the content in terms like that. Transformation should result in an educational approach that's different from its original form."

"So disruption in education is about challenging the status quo, the established norms, practices, and assumptions that have become so ingrained [that] we rarely question them. It's about recognizing that our current educational systems may no longer be serving our students or society effectively."

The different forms of change that have been described emphasise the importance of faculty and leaders being able to manage change, given the complexity (Law, 2022).

6.1.3 Regulated process of change

This third theme discusses how external factors such as government regulations, societal events, or global crises (e.g., pandemics) can impose changes on curricula, often necessitating quick adaptations or transformations.

"You may want to become in some sense more robust, so preventing bad things from happening, being able, for example, to adapt to a pandemic or something like that."

"So you are imposed to do some changes because it comes, it's just imposed on you, an external event like a pandemic had some change to be down. It was a small change, but it changed the curriculum in some sense, because we all adapted to this new way of teaching…"

Some participants noted how a crisis presented an opportunity for curriculum transformation. Crises are seen as opportunities for growth and transformation within educational systems. The findings emphasise that disruptions like pandemics, technological changes, and external crises challenge the status quo and prompt institutions to adopt new learning methods.

Uhl-Bien (2021, 159) argues that "Things are not and never will be exactly the same. And in this highly dynamic and complex world, what we must do as leadership scholars and practitioners, [is to] equip leaders and followers with adaptive and emergence mindsets that prepare them to embrace, rather than resist, complexity as it happens around them so that they can pivot as needed to enable generative emergence for their own and for society's greater good."

Viewing crises as opportunities for an educational reform is an optimistic approach, but it also requires careful consideration of the consequences. While crises often spur innovation, they can also exacerbate existing inequalities, as institutions with more resources are better positioned to adapt. Furthermore, crisis-driven changes may lack thoughtful implementation and evaluation, leading to hasty decisions that do not consider the long-term impact on students and the faculty. For example, the shift to remote learning during COVID-19 highlighted the potential of online education but also exposed its limitations, particularly in terms of accessibility, student engagement, and learning outcomes.

"So for me, crisis is opportunity. It's not. It's not a problem."

The theme captures that, in terms of ideas, due to multidisciplinary and multi-stakeholder influence, there will be inducements to change which may induce disruptions to the existing curriculum. The existence of multi-perspectives and forces inducing change and ensuing disruption implies the need for regulation to ensure a well-structured and managed process of transformation.

"[…] Transformation is a process, there's regulation which says: at specific intervals you have to do that. So what came to my mind was, it is a process that you do in-between regulations, or only you stay idle, and when the regulation says 'transform', you do that transformation, it would still be a process."

"Give the regulation and the framework. But, even in the framework, we, [and] also the government expects us also to involve the industry, the alumni and so on, so [there is] still involvement of stakeholders there."

"Control is good also, so the government will make sure whether we follow. Otherwise, we will be in trouble in the accreditation, because the accreditation [is due]. Also, the board will check whether we follow the regulation or not… So I think most of the university follow the guidelines."

6.2 The process of curriculum transformation

In exploring the curriculum transformation process, the participants identified: a structured dynamic process (a dynamic and continuous process, information gathering and

structural design, verification, implementation and design); multi-stakeholder approach (engendered by student calls, multi-stakeholder approach, role of stakeholders), government-influenced and somewhat similar processes across countries.

6.2.1 Structured dynamic process

Curriculum transformation is dynamic and continuous, characterised by its iterative nature, in this context, the engagement and collaboration between multiple groups of stakeholders. The curriculum evolves constantly, incorporating input from various stakeholders (students, industry, alumni) so that to ensure that it remains relevant and aligned with contemporary needs (Vreuls et al., 2023). The reference to curriculum design as 'bubbling' underscores its non-linear nature – always in motion, adapting to external influences. The theme highlights how curriculum transformation is not a one-time event but rather an ongoing process involving structural design, verification, and evaluation. The cyclical process helps to ensure that changes are not only implemented but regularly assessed and adjusted by academics based on feedback from various sources.

> *"...it [curriculum transformation] refers to a certain kind of process that includes amending, revising, reviewing. Reviewing is also part of a change process of a curriculum into modifying or updating the content, also updating the structure, and also in the delivery of the curriculum or the curricula."*

The transformed curriculum as a framework continuously gives cues and feedback to further change or reinforce necessary dimensions and process of delivering content, assessment of learning and evaluation to be in tune with changing stakeholder needs. The dynamism in terms of the intensity and frequency of the change in curriculum also aligns with the need for curricula to keep pace with societal, technological, and industry changes.

> *"[...] another aspect that was very interesting to me was the industry 4.0 [...] which speaks more to the direction of where the curriculum needs to go to meet the society requirements because the curriculum are not being done for the sake of the university. That curriculum, when transforming, needs to [be] taken into account."*

While this dynamic approach allows flexibility and responsiveness to change, it may also lead to challenges in maintaining a coherent and stable curriculum. Constant revisions could result in a lack of continuity, which would potentially be confusing for both educators and students. Moreover, balancing the input from multiple stakeholders requires clear mechanisms for prioritising certain changes over others.

6.2.2 Information gathering

The importance of gathering input from various sources, such as advancements in technology, industry needs, and alumni feedback, to inform curriculum updates, is essential in facilitating curriculum transformation. In countries where government regulations dictate curriculum changes, the process can be rigid and top-down, but the inclusion of

other stakeholders ensures that the curriculum reflects real-world requirements. Knowledge sharing is critical to curriculum renewal (Sullanmaa et al., 2021). There is a need for curricula to remain relevant to job market demands.

> *"You just have to speak to parents on a daily basis to hear their concerns about social media, and where their children are learning from, they're concerned that they're [i.e., children] not learning things at school or at university but in spaces that that we have no control over. So how are we going to cope with the onslaught of AI, generative AI, and all the technology that's coming, will we have a hold?"*

By involving industry experts and alumni, institutions can bridge the gap between academic learning and professional practice. However, the emphasis on market needs may sometimes overshadow other educational goals, such as critical thinking, ethical education, or cultural sensitivity. It must be noted that the rigid regulatory frameworks mentioned might stifle innovation, thereby limiting the curriculum's ability to evolve in response to emergent trends in education. It is important to balance planned and emergent approaches (Kristensen et al., 2019).

6.2.3 Multi-stakeholder approach

Curriculum transformation is not the responsibility of a single entity but a collaborative effort involving multiple stakeholders, including faculty, students, industry representatives, and government regulators.

> *"Also, it's important that curriculum transformation involves a lot of stakeholders or a lot of parties. So it's good to discuss about the involvement component when we are doing curriculum transformation such as stakeholders and students, or maybe industry leaders, alumni and all other parties."*

> *"Changing societal needs... and market demands."*

The theme stresses that power dynamics play a significant role in determining whose voices are heard and whose opinions shape the process. For example, students and alumni may express demands for more flexible or online learning, while industry stakeholders may prioritise technical skills. A multi-stakeholder approach is essential for creating a well-rounded and relevant curriculum. However, power imbalances among stakeholders can affect the outcome, as some groups (for example, government regulators or industry leaders) may hold more influence than others (for example, students or the faculty).

> *"Curriculum transformation is hindered by ideology and power structures."*

This can lead to curricula that prioritise certain interests – such as employability – over others, potentially marginalising important but less commercially viable areas of knowledge. In addition, the challenge lies in managing diverse inputs to create a coherent and balanced curriculum that meets both educational and professional standards. Curriculum transformation is sensitive to voices missing and stakeholders silent in the curricula but also the implications of these on the curriculum.

"Different stakeholders have differences, have different opinions, have different interests…"

"And the other thing is not only about involvement, but also about integration, how we can integrate from different views of perspective. So this is not only one person's view, but we need to consider a lot of different perspectives, yeah, related with the involvement. So when we get involved, also, to integrate the feedback or opinions from all parties that are involved."

Brink et al. (2025) assert that widespread stakeholder engagement inevitably results in emergent needs and directions, making it harder to run effective change management projects along with rigid, tightly controlled lines, leading to the sixth conclusion that it is important to be able to embrace fluidity and adaptability.

6.2.4 Government influenced/informed or planned approach

Government's role in curriculum transformation varies a lot across countries. In highly centralised systems, the government exerts a significant control over curriculum design, leaving little room for flexibility.

"[…] it's very different with, are you like bottom up, bottom top approach. But we are very top… So we are really very dictated by the government, even all the guidelines, everything. The frameworks have already been decided by the government. So we need to follow…"

In contrast, other countries might have slightly more decentralised approaches, allowing institutions more autonomy. Government involvement ensures that national priorities – such as economic growth, societal values, or political stability – are reflected in education. However, heavy regulation can limit innovation and responsiveness, as institutions may be bound by outdated frameworks that do not reflect the current educational needs. The tension between freedom and control is a key issue, as educators and institutions may struggle to balance compliance with regulatory demands against the need for innovative, flexible curricula that cater to local and global contexts (Brown, 2014).

"[…] they [partner HEI] have a rigid regulatory top-down clearly defined approach to the curriculum change, and they do that periodically, sometimes every five years or every two years, depending on a particular programme. But it's so detailed, and there's no room for flexibility because it is directed by the government."

6.2.5 Role of stakeholders

Stakeholders play varied roles in curriculum transformation, from providing feedback and suggestions to decision-making. Their involvement ranges from giving policy guidance and conducting needs analysis to influencing the design and implementation of curriculum changes.

"[…] yeah, include… how we can create a process where teachers, students, maybe stakeholders from the industry can take part? And then, the question, How important [are the] stakeholders in this process? And maybe it's it depends on the study programmes, the university and so on.."

The diverse roles ensure that the curriculum is aligned with both academic and market needs. While stakeholder involvement is crucial, not all stakeholders have equal power or influence, which can lead to disparities in whose needs are prioritised. For example, industry input may drive the curriculum toward a more skills-based approach, while academic experts may push for theoretical depth.

"And we talk about different points, for example, about industry that is important to prepare the students and future employees for the requirements of future industry about new technologies and new innovations. It is important to consider a sustainable society and to yeah, to look into the future and to integrate into cultural competences. Yes, justice and equity. It's important that all the stakeholders… Where we talk before, to engage them in the process, and to entice the faculty to engage in curriculum transformation, and also engage not only the faculty, also the quality assurance, relevant associations and external accreditation."

"[…] in terms of transformation, the whole aspect of power and the role that the different stakeholders play is something very significant."

Balancing these roles (Wised & Inthanon, 2024) is critical to ensuring that the curriculum remains holistic, addressing both practical job market requirements and broader educational goals like critical thinking, creativity, and citizenship. It is also critical to integrate change management processes when engaging curriculum transformation activities.

"And, if possible, we should have a good change management system to handle the transformation because the only thing that does not change is the tense itself…"

Given the results on dimensions and process of curriculum transformation, the below-presented Figure 1 depicts the integration of the dimensional and processual elements to conceptualize curriculum transformation.
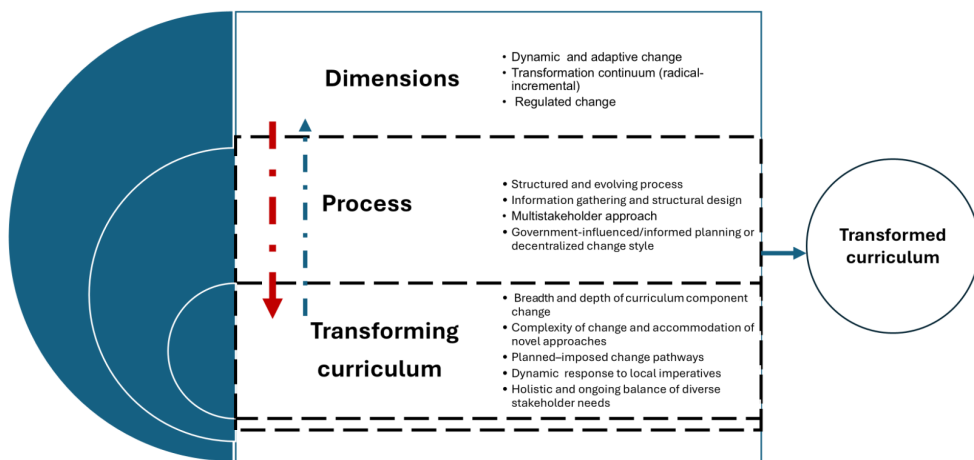

Figure 1. Integrative meaning of curriculum transformation

Figure 1 shows that the integrative meaning of curriculum transformation embraces the iterative and flexible interaction of the understanding of the dimensions of curriculum shaping (the red arrow going down), and that it is not only the structured and evolving process but also the planned or imposed pathways, dynamic responses to global changes and local imperative in transforming the curriculum and vice versa (the blue arrow going up). These two iterative interactions are critical in contributing to a transformed curriculum.

6.2.6 Similar processes across countries

"Similar processes across countries" indicates that curriculum transformation processes often follow comparable structures globally. The participants noted similar timelines, stakeholder involvement, and structural approaches to curriculum revision. While the structural similarities suggest a shared understanding of the importance of periodic curriculum revision, these processes may also reflect some kind of uniformity that does not account for local or cultural differences. Global standardisation could risk homogenising curricula, which may not be suitable for diverse educational contexts. Beyond this, the "one-size-fits-all" approach may not accommodate specific local needs or innovative approaches that could emerge in different educational settings with specific institutional and societal imperatives for transformation.

7 Conclusion

Curriculum transformation is interdependent, dynamic, complex and regulated change according to the opinion(s) of the *DECART* project members and staff from the partner institutions who participated in this study. Curriculum transformation as dynamic and adaptive change is characterised by a forward-looking stance of curriculum design, emphasising curricula to anticipate and address future societal and industry demands.

Additionally, this study is explicit that the understanding of curriculum transformation of the participants also focused on the transformation continuum. In this regard, curriculum transformation involves incremental changes (minor updates) and transformation (significant shifts). In pursuit of curriculum transformation, it is prudent for STEAM educators in HEI to be fully aware of how curriculum transformation captures the nature of the continuum and variety of transformations. While understanding curriculum transformation in terms of a dynamic process of change and adaptation and transformational continuum is insightful, it is inadequate without understanding how external factors (e.g., government regulations, societal events, or global crises) impose or influence adaptations or transformations. The external factors bring to the fore that curriculum transformation as a regulated change sometimes arises from external factors. Curriculum changes may be planned, while other changes (e.g., crises) are unplanned and imposed on the curriculum by external influence. Educators must be cautious that curriculum changes driven by the government are often centralised, and that they may limit the flexibility and innovation of academics in curriculum transformation. Alterna-

tively, crisis-driven changes are paradoxical as they may create opportunities for academics to do things differently, or lead to hasty decisions that may be oblivious to the long-term impact on students and the faculty. This paper is valuable as it illuminates a comprehensive and holistic view of curriculum transformation typified by dynamic and adaptive aspects, the transformation continuum, and regulated change.

It is decipherable in this study that the DECART project members and staff described the transformation process in four distinct ways. The study proposes that academics should facilitate curriculum transformation by being mindful that it is not only a structured dynamic process, but also a multi-stakeholder approach involving multiple stakeholders (Gerwel Proches et al., 2025), and a government-influenced or planned approach. These aspects reveal that conceptualising the curriculum transformation process is a challenging task. As such, it is cardinal for academics to emphasise the dynamic and ongoing change along the transformation continuum, which can induce innovative thinking of curriculum transformation in a VUCA context. More importantly, curriculum transformation may be more effective if conceived as a multi-stakeholder approach, which depicts specific change styles to meet the needs of diverse stakeholders such as students, academics, industry, institutional and societal needs. Lastly, the paper calls educators to adopt a holistic and integrative understanding of the interdependent facets that constitute curriculum transformation and the nature of the process, which embraces the breadth and depth of change required in the curriculum to respond to global change and the necessity of a dynamic response to the local imperatives.

The limitation of this study is that the results are based on the views of academics only, and that it only involves a small sample. As such, the results cannot be generalised, but can be transferred to a similar context. Future studies can draw on a larger sample and use mixed methods to operationalise, validate, or modify the integrative meaning of curriculum transformation proposed in this qualitative study and enhance its explanatory power. It is crucial that future research integrates the perspectives of external stakeholders, such as industry and regulatory authorities, to unravel the meaning of curriculum transformation from diverse perspectives and how it can be facilitated in STEAM in a VUCA world.

References

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

Audunsson H., Matthiasdottir A., Barus A., Rouvrais S., Waldeck, R. et al. (2024). Factors that may impact curriculum design in higher education in a VUCA world. *20th International CDIO Conference*, Tunis, Tunisia. https://cdio.org/sites/default/files/documents/78_CDIO 2024 Proceedings.pdf

Barcelona, K. (2014). 21st century curriculum change initiative: A focus on STEM education as an integrated approach to teaching and learning. *American Journal of Educational Research*, *2*(10), 862–875.

Barcelona, V. (2023). From VUCA to Institutional Synergy. *UNIVERSITAS - The Official Journal of University of Makati, 11*(1), 143–149. https://journals.umak.edu.ph/universitas/article/view/240

Bennett, N., & Lemoine, G. J. (2014). What a Difference a Word Makes Understanding Threats to Performance in a VUCA World. *Business Horizons*, 57, 311–317.

Brink, S.C., de Hei, M., Sjoerc, E., Carlsson, C. J, Georgsson, F., Keller, E., McCartan, C., Enelundh, M., Lyng, R., & Admiraal. (2025). Curriculum Agility principles for transformative innovation in engineering education. *European Journal of Engineering Education*, *50*(3), 455–471.

Brown, S. (2014). You can't always get what you want: Change management in higher education. *Campus-Wide Information Systems, 31*(4), 208–216.

Choi, D. P. (2024). Preparing Students for the VUCA World: The autocatalytic process of learning, engagement, and character formation in christian higher education. *Journal of Research for International Educators*, *3*(1). https://www.jorie.org/index.php/journal/article/view/23

Dufera, D. (2004). The Status of research undertaking in the Ethiopian higher institutions of learning with special emphasis on AAU. *The Ethiopian Journal of Higher Education*, *1*(1), 83–104.

El Aouri, M. (2024). Higher education in a VUCA-driven world: The need for 21st century skills. *Proceedings of the International Conference on 21st Century Skills in Higher Education*, *5*(1). DOI : https://doi.org/10.34874/IMIST.PRSM/liri-v5i1.49975

El-Astal, M. (2023). What is Curriculum? Building a Broader Understanding of the Term, *Journal of Curriculum and Teaching*, *12*(6),188–196. https://doi.org/10.5430/jct.v12n6p188

Fernandes, J. M., & Afonso, P. (2021). Engineering education in a context of VUCA. In *4th International Conference of the Portuguese Society for Engineering Education (CISPEE)* (pp. 1–8). IEEE. DOI: 10.1109/CISPEE47794.2021.9507229

Gale, J., Alemdar, M., Lingle, J., & Newton, S. (2020). Exploring critical components of an integrated STEM curriculum: an application of the innovation implementation framework. *International Journal of STEM Education*, 7, 1–17.

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

Gerwel Proches, C., Kanyangale, M., James, A., Barus, A., Rouvrais, S., Waldeck, R., Audunsson, H., Matthiasdottir, A., Dagiene, V., & Lemke, C. (2025, June). Stakeholder analysis for curriculum transformation in higher engineering education. *Proceedings of the CDIO 2025: 21st International CDIO Conference: Forging connections: synergies for a sustainable future*, Melbourne, Australia.

Hollnagel, E. (2010). How resilient is your organisation? An introduction to the resilience analysis grid (RAG).https://www.researchgate.net/publication/281803346_How_Resilient_Is_Your_Organisation_An_Introduction_to_the_Resilience_Analysis_Grid_RAG

James, A., Gerwel Proches, C., Kanyangale, M., Dagiene, V., Jasute, E., & Waldeck, R. (2025). The Role of Leadership in Curriculum Transformation: Implications for Science, Technology, Engineering, Arts and Mathematics in Higher Education. *Proceedings of the* 6th *International Baltic Symposium on Science and Technology Education Conference,* Siauliai, Lithuania.

Kristensen, N. S., Andreasen, L. B., Kofoed, L. B., & Bruun-Pedersen, J. R. (2019). Balancing a change management process: A case study of how to approach curriculum change in higher education. In SEFI annual conference 2019: Varietas delectat: Complexity is the new normality (pp. 1926–1936). SEFI: European Association for Engineering Education.

Law, M. Y (2022). A Review of Curriculum Change and Innovation for Higher Education. *Journal of Education and Training Studies*, *10*(2), 16–23.

Lunenburg, F. C. (2011). Theorizing about Curriculum: Conceptions and Definitions, *International Journal of Scholarly Academic Intellectual Diversity*, *13*(1), 1–6.

Male, S. A., Bush, M. B., & Chapman, E. S. (2011). Understanding generic engineering competencies. Australasian Journal of Engineering Education, *17*(3), 147–156. https://doi.org/10.1080/22054952.2011.11464064

Matthiasdottir, A., Audunsson, H., Dagienė, V., Rouvrais, S. & Gerwel, C. (2024). Examining best practices in curriculum design: Insights for engineering education. *Proceedings of the 42nd Annual Conference of*

the European Society for Engineering Education (SEFI), Lausanne, Switzerland. https://doi.org/10.5281/zenodo.14254854

McManus, S. Seville. E., Vargo, J. & Brunsdon, D. (2008). Facilitated Process for Improving Organizational Resilience. *Natural Hazards Review*. *9*(2), 81–90. https://doi.org/10.1061/(ASCE)1527-6988(2008)9:2(81

Mielkov, Y., Bakhov, I., Bilyakovska, O., Kostenko, L., & Nych, T. (2021). Higher education strategies for the 21st century: philosophical foundations and the humanist approach. *Revista Tempos E Espaços Em Educação*, *14*(33). https://doi.org/10.20952/revtee.v14i33.15524

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

Ninela, S., & Proches, C. N. (2024). Exploring Leadership Challenges in VUCA Times in a Higher Educational Institution During the COVID-19 Pandemic in South Africa. *Journal of Contemporary Management*, *20*(si1), 196–217. https://doi.org/10.35683/jcm23.033.258

Prinsloo, P. (2016). Curricula as contested and contesting spaces: Geographies of identity, resistance, and desire. Unpublished paper, presented at the *Conference on Transforming the Curriculum: South African Imperatives and 21st Century Possibilities*, University of Pretoria, 1 February 2016.

Roehrig, G. H., Dare, E. A., Ring-Whalen, E., & Wieselmann, J. R. (2021). Understanding coherence and integration in integrated STEM curriculum. *International Journal of STEM Education*, 8, 1–21.

Rouvrais, S., Audunsson, H., Chelin, N., Jacovetti, G., Waldeck, R., Puren, C., ... & Proches, C. G. et al. (2024). Learning Material on Curriculum Design. *Report R13*. University of KwaZulu-Natal - Afrique du Sud; Institut teknologi Bandung; IMT Atlantique; Reykjavik University; Vilnius University; Rheinisch-Westfälischen Technischen Hochschule Aachen. https://archivesic.ccsd.cnrs.fr/LAB-STICC_SHARP/hal-04591106v1

Sullanmaa, J., Pyhältö, K., Pietarinen, J., & Soini, T. (2021). Relationships between change management, knowledge sharing, curriculum coherence and school impact in national curriculum reform: a longitudinal approach. *International Journal of Leadership in Education, 27*(6), 1395–1419.

Sumara, D. J., & Davis, B. (2014). Unskinning curriculum. In W. F. Pinar (Ed.) *Curriculum* (pp. 75–92). Routledge.

Thabmali, P., & Traiwichitkhun, D.. (2025). Guidelines for Enhancing Design Thinking for Student Teachers. *Journal of Education and Innovation*, *27*(1), 27–50. retrieved from https://so06.tci-thaijo.org/index.php/edujournal_nu/article/view/279160

Tinsae, E.W. (2016). A critical review and analysis of the definitions of curriculum and the relationship between curriculum and instruction. *International Journal of Research in Engineering and Social Sciences*, *6*(4), 8–12.

Uhl-Bien, M. (2021). Complexity leadership and followership: Changed leadership in a changed world. *Journal of Change Management*, *21*(2), 144–162.

Van den Akker, J. (2004). Curriculum Perspectives: An Introduction. In *Curriculum Landscapes and Trends*, Springer, Dordrecht: 1-10. https://doi.org/10.1007/978-94-017-1205-7_1

Vreuls, J., van der Klink, M., Koeslag-Kreunen, M., Stoyanov, Boshuizen, H., & Nieuwenhuis, L. (2023). Responsive curriculum development: Which factors support breaking through institutional barriers? *Journal of Vocational Education & Training*, *77*(3), 582–610.

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

Wised, S., & Inthanon, W. (2024). The Evolution of STEAM-Based Programs: Fostering Critical Thinking, Collaboration, and Real-World Application. *Journal of Education and Learning Reviews*, *1*(4),13–22.