

Curriculum Agility: Responsive Organization, Dynamic Content, and Flexible Education

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Abstract. This special session, within the conference theme of Incorporating Convergence into Programs, Curricula, and Continuing Education, focuses on Curriculum Agility in engineering education. It will introduce the concept of Curriculum Agility and its current trends, as well as further co-develop the concept behind it. This is done following an iterative design thinking approach, by co-creating guiding principles that engineering institutions can use to make their study programs more responsive, dynamic, and flexible. Curriculum Agility is particularly important in engineering education in order to keep pace with the rapid development of new technologies and materials. In addition, the concept aims to meet students' expectations and needs for more individualized study plans, as well as society's need for forward-thinking engineers equipped to contribute to finding solutions to current and future societal challenges. Thus, to anticipate and meet these challenges, institutions for engineering education need to have an organizational and management structure with the capacity to act within a much shorter timeframe than traditionally seen in universities. Curriculum Agility is a framework for introducing necessary changes in operations to be able to act responsibly and rapidly on change and expectations.

This work presents seven principles for Curriculum Agility that have emerged from a series of sessions at international conferences and network meetings. The seven principles currently include: Stakeholder Involvement, Organization and Governance, Decision Making, Program and Course Design, Innovation of Education, and Pedagogy and Didactics.

This special session brings educators together to discuss the 'what, how and why' with regard to Curriculum Agility. The overall aim is to further develop a shared vision on Curriculum Agility and build upon the intention of assessing it at different levels in the organization of engineering

education institutions. The expected outcome of the special session is a collection of refined, redefined, and perhaps even newly defined principles for Curriculum Agility.

Keywords— Curriculum Agility, Curriculum Innovation, Co-creation, Flexible Education, Engineering Education

I. INTRODUCTION

An agile curriculum is responsive and adaptable to changes in society and business as well as to changes in student needs and characteristics, by having the capacity to change structures, learning outcomes, and learning activities in a timely manner [1]. Curriculum Agility has become increasingly important as professional disciplines, such as engineering, are developing rapidly in order to respond adequately to environmental, technological, societal, and educational needs, developments and challenges. A survey conducted amongst the SEFI (European Society for Engineering Education) and CDIO (Conceive Design Implement Operate) networks in 2019 revealed that many engineering universities work, in addition to other aspects such as Assessment as Learning and their connection with industry, towards Curriculum Agility and flexible education while improving their education [2]. This anticipated agility and flexibility raises questions about acceptable timeframes for curricular changes, about the direction of development of student population characteristics and needs that need to be addressed, and about the necessary consistency and stable factors in teaching, when considering the VUCA (Volatile, Uncertain, Complex and Ambiguous) world that is the context of higher education nowadays [3].

The ambition to operationalize and implement the UN Sustainable Development Goals (SDG) [4], specifically target 4.7, has motivated higher education institutions to equip learners with the knowledge and skills necessary for the sustainable development of society. Considering the dynamic content of engineering education and the need for curriculum change to correspond to such societal transformations,

learning towards the SDGs is further elaborated in the UNESCO (2017) Education for Sustainable Development Goals (ESD) [5] document. To implement the ESD approach, participation from many stakeholders will be required, for example, education officials, policymakers, educators, curriculum developers, and involve students, teachers, leadership and management. As this work on the principles for an agile curriculum advances, we are convinced that this discussion is indispensable and that it needs to be taken into consideration.

In higher education, the more commonly known Curriculum Flexibility focuses on adaptation to the changing needs and characteristic of students by customization. Flexibility has become a general approach to addressing varying factors such as learning time, learning environment, and learning pace, entry level, learning preferences to increase accessibility to higher education [6]. Partial individual freedom of choice in learning content is offered regularly as well for this purpose, for instance choice elements in the program (minors, exchanges) or choices within project education. This Curriculum Flexibility is a part of Curriculum Agility, which proposes a more holistic measure of how quickly and adequately higher education institutions can react to their rapidly changing context, and which is the focus of this paper and workshop. Next to customization, Curriculum Agility also takes different administrative, organizational, and pedagogical aspects into account in order to achieve the desired adaptability of a curriculum. Therefore, it considers the structure and design of a study program on three levels: responsiveness of the educational organization, the dynamic potential of the learning contents offered, as well as the degrees of flexibility of how the education is offered [1]. Moreover, Curriculum Agility focuses not only on the ability to respond to change, but also on *anticipating* change, which requires the further ability to implement (disruptive) innovations, curricular change and institutional transformation [7].

Case studies have shown the need for an institutional organization that truly allows for innovation and adaptation [8]. Therefore, Curriculum Agility is not just limited to considering the learning vision, learning goals, learning content, materials and resources, teacher roles, learning groups, learning spaces, learning time, and assessment, which are defined as the building blocks of a curriculum [9], but also involves the processes for decision making, administration, policies, and legislations.

II. THE 7 PRINCIPLES OF CURRICULUM AGILITY

The development of the Curriculum Agility concept described in this paper, and to be presented at the special session, has been an ongoing effort since 2018, when the first workshop on Curriculum Agility was led by some of the authors of this work at the 14th International CDIO Conference at Kanazawa Institute of Technology in July 2018, Kanazawa, Japan. Since then, a total of five workshops have been held at different international engineering education conferences, where different aspects and topics relevant to Curriculum Agility have been discussed, such as defining its scope, discussing perceived barriers for change, generating principles for good practice, and discussing Curriculum Agility in Covid-19 times. Table 1 illustrates the seven principles of Curriculum Agility, as formulated in 2020 after summarizing, discussing and analyzing the outcomes of the sessions so far [1].

TABLE I. THE SEVEN PRINCIPLES FOR CURRICULUM AGILITY [1]

Principle	
<i>Stakeholder Involvement</i>	Structures and procedures at the institution for identifying and prioritizing new needs, inviting stakeholder involvement in change processes to ensure an effective process for carrying out changes.
<i>Organization and Governance</i>	Ensuring an organizational structure that can effectively address the administrative system and institutional and national regulations in order to implement and maintain curriculum changes.
<i>Decision Making</i>	Having an effective curriculum and course approval process: timeframes, steps required, number of persons involved, communication channels.
<i>Entrepreneurial Management</i>	Establishing and maintaining a <i>change culture</i> . Ensuring a culture rather than a "one-person engagement". Establishing how change can be achieved initiative-driven: proactive rather than reactive.
<i>Program and Course Design</i>	Allowing flexibility in program and course design: adjustable projects, designing learning outcomes for change and flexibility. Also providing opportunities for students to build their own profiles.
<i>Educational Innovation</i>	Encouraging initiatives and innovation that promote education that is responsive and adaptive to change.
<i>Pedagogy and Didactics</i>	Promoting scholarship of teaching and learning among both teachers and students. Encouraging collegial teaching teams.

The first four principles and their descriptions in table 1 are to be considered from an institutional perspective. 'Stakeholder Involvement' highlights the value, and even necessity, of involving a wider range of stakeholders in the process of changing curricula. The principle 'Organization and Governance' relates to the underlying framework of regulations and traditions that dictate how a study program is structured, and outlines which support structures need to be addressed when changes are made. The principle 'Decision Making' is directly related to the people, or specifically the positions they are in, involved in the change process. It is therefore closely associated to the principle 'Organization and Governance'. 'Entrepreneurial Management' relates to the responsibility of the leadership of an institution to encourage continuous curriculum development.

Principles five to seven involve the innovative, flexible pedagogics perspectives, including the professional and societal demands perspectives that are added in an integrated way to the institutional standpoint. 'Program and Course Design' characterizes the degree of flexibility necessary for keeping the curriculum content of study programs purposeful, while ensuring quality. The principle 'Educational Innovation' emphasizes the openness for transformation, where both bottom-up initiatives and top-down initiatives are welcome. and are discussed and implemented in line with the principle of 'Entrepreneurial Management'. Finally, the principle 'Pedagogy and Didactics' draws attention to the significance of making evidence-based, systematic and systemic decisions when changing curricula, where collaboration is welcomed and encouraged.

In January 2019, during the EU & UK-NI CDIO Regional meeting at CESI Graduate School of Engineering in La Rochelle, France, advantages of Curriculum Agility were highlighted by the participants of the second workshop. From an educational point of view, Curriculum Agility was said to give room for teaching to be customized to the current and future student generations. It was also mentioned that Curriculum Agility opens the possibility to offer interdisciplinary experiences to students, allowing them to prepare for working in an interdisciplinary work field during their studies. Another advantage mentioned was a swift change of direction in content when needed because of new technological developments. From the students' individual perspective, Curriculum Agility could offer more possibilities for exploration of elective courses, help students to find their strengths, talents, and passions, and provide them with the opportunity to make choices and thus find more meaning in what they do. Overall, this was deemed to increase student motivation to learn.

Key barriers and challenges were identified in several of the previous sessions, including the full day working group session at the 15th International CDIO conference in June 2019 at Aarhus University, Aarhus, Denmark. The most important challenges and barriers can be summarized as “making changes stick”, “a lack of careful planning and effective leadership”, “the disruptiveness of transformational innovation”, “initiative fatigue”, “staff competence and engagement”, “a shortage of staff” and “regulatory or process inertia and blocks”.

The fourth session was held online during the EU & UK-NI CDIO Regional Meeting in January 2021 at NTNU Norwegian University of Science and Technology, Trondheim, Norway. This time, the work focused on the need for Curriculum Agility in the event of extraordinary events such as a pandemic. Participants indicated there had been many online teaching developments within the Pedagogics and Didactics principle, as well as shifts in assessment practices, either from centralized to decentralized, or decentralized to centralized in within the Program and Course Design principle. The problems and bottlenecks that resulted from the non-agile (or the not optimally agile yet) Organization and Governance, and necessary impromptu shortcuts in Decision Making demonstrated where more curriculum agility was essentially needed. Despite the acceleration in pedagogic developments towards blended and online teaching, some pre-Covid-19 efforts in the Educational Innovation and Stakeholder Involvement principles were disrupted and halted due to the attention needed for short-term organizational priorities. The entrepreneurial spirit of teaching staff to test new things and experiment mainly turned to already present online teaching tools, and the pressing stimulation by management to deliver alternated with fatigue of the suboptimal solutions, which had no clear timeline beforehand of their temporality, ended up challenging strategic Entrepreneurial Management.

In addition to the Organizational and Governance actions, common issues regarding Program and Course Design agility, because of the pandemic, were highlighted at the authors' institutions. Certain aspects of the quality assurance (QA) process for program management had to be identified and fast-tracked to cope with the essential changes to courses. The QA processes themselves did not change, but specific aspects were exposed and required careful management to ensure that

quality could be maintained within a forced, quicker timeframe, where major changes were required and could not be applied within the normal, rigid QA timescales. In general, a major change to a program can be described as a change that has a substantial impact on the entire program in terms of delivery, content and/or learning outcomes. Such changes usually require consultation with all stakeholders and must be scrutinized and rectified under a tiered system, consisting of at least two tiers in most educational organization and governance structures.

III. SPECIAL SESSION GOALS

Recent experiences in higher education globally illustrate the usefulness of Curriculum Agility. The pandemic has revealed what needs to be changed in the structures around and within a curriculum, both from an organizational and pedagogic point of view, in order to reach a more adequate system that can move with, respond to, and perhaps even anticipate constant changes and challenges. It was possible to observe that adjustments to the content of the curriculum to the constantly fast-changing professional and social context was overshadowed by the organizational and didactic measures that had to be taken.

Taking these experiences and observations gathered through the process, this sixth session aims to further develop a shared vision of what constitutes Curriculum Agility, and to find ways to assess it at different institutional levels, including both faculty and management as agents. The goal is to collect validated, refined, redefined, and perhaps even newly defined principles for Curriculum Agility. To achieve this objective, the participants of the special session during the Frontiers in Education 2021 conference, both educators and management, are invited to reflect on and discuss the principles by following a guided group session method, in order to refine and enhance, validate and expand the concept.

IV. AGENDA

The special session has been designed to promote active participation through discussion and negotiation of the concept of an agile curriculum and how it relates to different engineering educational settings. After a brief introduction of Curriculum agility and the pre-formulated principles (see Table 1), the discussion will be divided in two main sections; first a discussion to negotiate a framework for a joint conceptual interpretation, and then a guided discussion, where participants can choose to focus on either didactic, content or organizational issues.

Overview of the session agenda:

- (1) Introduction to Curriculum Agility (10 min).
- (2) Reflections on why and when we need curriculum agility – fishbowl discussion (20 min). This exercise with the whole audience will stimulate individual reflections on why and when curriculum agility is needed and is geared towards creating a common understanding of what, how and why Curriculum Agility is being discussed.
- (3) “Dynamic Content, Flexible Education and Organizational Responsiveness and its principles” – guided group discussions (40 min). In this part, participants choose a principle or a set of principles

from within the flexible pedagogics, dynamic (engineering) content, or organizational responsiveness perspectives to dive deeper into. By using techniques such as The 5 Why's, Reverse Brainstorming, or the KISS-factors [10] the principles are turned inside out and refined or perhaps even alternate versions will be generated by each groups. The results will be elevator-pitched to the whole audience during the wrap-up.

- (4) Wrap-up by short principle-elevator-pitches by the participant groups (10 min).

V. EXPECTED OUTCOME AND FOLLOW UP

The workshop on Curriculum Agility provides an opportunity to reflect on how higher education institutions can improve, develop, or anticipate their responses to rapidly changing conditions in the 21st century and beyond. By sharing experiences and ideas from different roles, disciplinary contexts, and educational frameworks, the participants will be able to identify and distinguish which factors should be prioritized. Participants are expected to leave the session with emerging insights and questions about how agile their curricula are and could be within their own specific context. They may also become aware of national, regional and institutional differences.

The principles pitch, along with the generated output in the discussion groups, will serve to further refine the Curriculum Agility model. It will be source material for a refined set of principles that propose an adequate agility of a curriculum in engineering education.

A long-term goal within the work on Curriculum Agility is to develop a self-evaluation tool useful for assessing the level of Curriculum Agility within an educational organization. The tool will encompass a rubric-based self-evaluation similar to that used within the CDIO-framework [11]. The rubric has six levels of assertions for each of the principles (or standards for the case of CDIO) and suggested evidence for each level [12]. The generic form of the assertions associated with each principle is on the form of a maturity scale ranging from level "0: we have not considered that" to "5: we have a full implementation of that, which we continuously monitor and improve".

VI. NOVELTY

The seven principles of Curriculum Agility offer a holistic view on futureproof curriculum design and quality development, which widens and operationalizes the scope of Curriculum Flexibility. For any university to be able to respond to the needs of the emerging VUCA world, it is necessary to identify the relevant factors governing the implementation of Curriculum Agility.

As defined, Curriculum Agility describes not only the ability of an institution to set up new study programs or specializations in response to changes, but also the ability to close down study programs. It presently outlines seven major principles to re-purpose existing study programs, relevant to navigating a number of administrative, legislative, organizational, pedagogical, and cultural frameworks. Identifying and developing an understanding of the relevant principles is necessary if the desired response times for meeting the demands of the VUCA world of the 21st century and beyond is to be adequately met.

BIOGRAPHY

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