

HIGHER EDUCATION RESILIENT CURRICULA: LESSONS FROM A EUROPEAN PROJECT

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Abstract

The vulnerability of Higher Education Institutions to unexpected crisis events was starkly illustrated by the Covid-19 crisis. However, certain institutions fared better than others as they were able to mobilize resilience capacities and capabilities which reinforced their ability to rapidly adapt to and cope with the crisis. The objectives of this study therefore are to picture what resilience is from the perspective of HEIs and to delineate what a resilient curriculum is. A questionnaire consisting of 23 questions, both quantitative and qualitative was sent to university members of a European project in April 2024. Several drivers of curriculum resilience deduced from the literature were tested on a numerical scale from 1 to 5 and the analysis of the 35 responses demonstrated that all drivers significantly contributed to resilience. The quantitative insights were enriched by characterizing the properties of a resilient curriculum based on textual feedback garnered from the questionnaire's open questions.

Keywords: Higher education institutions, Resilient curriculum, Curriculum design, Quantitative and qualitative analyses.

1 INTRODUCTION

Disasters, crises and extreme events are increasingly prevalent ([1], [2]). However, the characteristic complexity of globally connected sociotechnical systems in which contemporary organizations operate, creates new and unimaginable threats, which frequently render foresight and disaster prevention inoperative [3]. Therefore, preparing for the unknown is fundamental, and a resilience perspective is crucial for organizations who aim to thrive and even capitalize on crisis events as a driver of positive change, as opposed to merely surviving them [4]. In contrast to traditional risk management, resilience is based on the idea that unforeseeable events need to be anticipated and prepared for by following a proactive and not only a reactive approach [5] that confers the capacity to rapidly adapt while ensuring the continuity of essential functions and operations [6]. In the context of Higher Education Institutions (HEIs), organizational resilience is understood as the capacity to absorb, cope and adapt to both intrinsic and extrinsic challenging circumstances and to rapidly reconfigure and restore services rendered to students, academic and industrial research partners [7]. In common with the organizational resilience (OR) construct, which describes resilience in business contexts, HEI resilience is thus contingent upon the development of capacities that confer the ability to absorb, cope with and recover from both intrinsic and extrinsic shocks [7] within a cyclical process involving pre-emptive, proactive and recovery phases ([8], [9]).

As HEIs often possess highly diverse employee and student populations, transboundary type crisis events which can provoke campus closures [10] and radically disrupt international mobility for students ([11], [12]) and academic personnel [13], are particularly challenging. Such crises are often unforeseen [14] and demand rapid and radical changes to operations and the mobilization of HEIs' latent resilience capacities to rapidly deploy innovative solutions to maintain the integrity of key services and functions. However, it remains unclear how resilience and its underlying capacities should be defined and operationalized for HEIs, since they comprise heterogenous organizations ranging from specialist discipline specific entities such as Engineering or Business Schools to pluridisciplinary comprehensive universities. Moreover, the materialization of HEI resilience may occur at multiple levels, incorporating

micro-level capabilities in terms of the skills and abilities of employees [15], macro-level systemic capacities [16] both of which are likely to be linked to the individual resilience of students ([17], p.465) and employees. This conceptual richness makes it difficult to determine how to achieve HEI resilience in practice and has led to recent calls to focus on understanding how to foster resilience capabilities at a disciplinary level [17] via the design of resilient curricula [18]. The objectives of this study therefore are to picture what resilience is from the perspective of HEIs and to delineate what a resilient curriculum is. To meet these objectives, we examine the literature on resilience in curricula and conduct an online survey which was sent in April 2024 to university members of the European DECART project (www.decartproject.eu). In the remainder of this paper, we first present results deduced from the literature regarding resilient curricula. We then discuss the results of the survey and probe the properties of resilient curricula.

1.1 Resilience of higher education institutions

Education systems are the cornerstone of future prosperity and the catalyst of tomorrow's green and digital economy. However, their vulnerability to unexpected crisis events was starkly illustrated by the Covid-19 crisis. Recent research reveals a spectrum of adaptations adopted by the sector to cope with Covid-19 and how these impacted HEI's capacity to cope with and adapt to the degraded operating context.

The Covid-19 crisis revealed that HEIs possess differing resilience profiles ([18], [19]). Those who exhibited weaker performance, must now endeavor to learn from the crisis and reinforce their preparedness for future resilience demanding events [20]. If they fail to do so, they may experience severe financial sanctions such as loss of student fees and reputational damage [19]. Weaknesses in HEI systems also have the potential to propagate to the wider socio-economic landscape. For instance, differences in resilience capacity engendered inequalities in terms of access to education particularly for students from less advantaged backgrounds [19]. Looking forward in today's increasingly VUCA (Volatile, Uncertain, Complex, Ambiguous) contexts [21], achieving wide-spread HEI organizational resilience (OR) thus comprises an objective with wider ethical and democratic implications [22]. In addition, the success of industrial, entrepreneurial, corporate and government entities depend on the quality of the graduate pool of new recruits [23]. It is thus essential to improve understanding of the multi-faceted OR concept within the distinct context of HEIs.

In terms of capabilities that have been shown to confer HEI resilience, agile technology services comprise a fundamental factor. The effective provision of and access to core teaching related services via a diversity of collaborative learning platforms, synchronous (live) and asynchronous (recorded) educational technologies (EdTech), and flexible evaluation approaches, was shown to enhance HEI resilience during the Covid-19 crisis [10]. Attention to non-teaching student services is also of paramount importance [12]. For instance, HEIs that were resilient during the pandemic initiated innovative programs to transform the modalities by which services such as student library, careers, counselling, individual tutoring and sports services were delivered [11]. Students themselves may also proactively contribute to HEI resilience. During the Covid-19 crisis, certain student bodies became partners with their institutions, change-agents, collaborating to contribute to the success of new operating models and to proactively support particularly isolated international students [24].

1.2 The role of curricula in achieving HEI resilience

In the case of the Covid-19 pandemic, resilience was primarily conferred by the collective capacity of faculty, administrative personnel and students to conceive and employ innovative learning strategies [10] and novel curriculum designs [18]. If educators and students adapt to potentially significant operational transformations, HEIs may capitalize on adversity to rapidly adopt transformational changes to teaching practices and support services. Such changes ensure the continuity of operations but may also catalyze a regime shift whereby the organization attains a new, more effective post-crisis modus operandi [25].

A diversity of properties of resilient curricula have been examined in the literature ([18],[26], [10], [27]). Flexibility, in the sense of adaptability, is one such property. Its antecedents include the type of pedagogy, teaching methods adapted to a changing environment and enabled by new tools and technologies ([18], [10], [27]) or the provision for students to switch between programs ([27], [10]). Redundancy, understood as having at disposition different means for a given objective [28], is another facet of curriculum resilience. It provides the organization with a form of robustness and a capacity to adjust and react to different shocks. In the case of a curriculum, resilience is the outcome of a design

that integrates different means for motivating students [26], multiple assessment methods and omnichannel, technology enabled approach to both teaching and learning ([18], [27], [10]). Redundancy of teaching resources is also primordial for resilience and may be provided through connectivity and extra-organizational relationships such as international collaborations for joint degree programs [27]. Collaboration, connectivity and networking thus facilitate resource sharing but also enhance the capacity of students to cope with the crisis by enlarging their relational support network ([27], [10]). Intra-organizational collaboration is also a source of curriculum resilience. For instance when academics from different departments co-develop and structure the curriculum, readability and accessibility for students is improved and the enhanced coordination generates opportunities for shared teaching which fosters redundancy [18]. More generally networked interorganizational relationships procure a form of community resilience and are an important factor of OR in companies [29].

2 METHODOLOGY AND SAMPLE - BASIC FIGURES

A questionnaire was sent to members of the DECART consortium in April 2024 to collect data pertaining to the properties of a resilient curriculum. The questionnaire consisted of 23 questions of which 13 employed a 5-point Likert scale, 4 a 3-point ordinal scale while 6 comprised open questions (see annex 1) The questions were formulated based on the drivers of a resilient curriculum deduced from the literature (section 2). We analyzed the quantitative survey data in R and given the small, non-parametric sample we used the Wilcoxon-signed rank test to evaluate whether the population mean ranks for each resilience driver differed significantly. Qualitative data, which comprised text responses to questions 3, 10, 12, 19, 23 (see Annex 1), were extracted to MS Excel and all responses for each question were consolidated in distinct tabs and were then analyzed using a thematic analysis approach [30] to identify underlying patterns or themes.

35 respondents answered the survey with a repartition per country given in the first column of Table 1. Concerning the types of HEI, STEM (Science, Technology, Engineering and Math) institutions represented 2/3 of the institutions (column 2) and among the respondents half of them (18) had a good understanding of curriculum design (leaders or participated more than once) (column 3). Twenty respondents had some expertise with resilience concepts (column 4). Twelve respondents had both participated in curriculum design and had a good expertise in resilience (Table 2)

Table 1. Summary statistics (independent columns, no correspondence between figures in a line)

| Participants | HEI Institutions | Curricula design expertise | Resilience expertise |
|---------------------|-------------------------|--|---|
| France: 6 | HSS 2 | never participated: 1 | No or vague knowledge: 4 |
| Germany: 3 | Management 9 | Participated as external observer: 4 | Knowledge from social conversation: 11 |
| Iceland :2 | STEM 23 | Participated once as an active member: 12 | Knowledge from science or through professional activities: 10 |
| Indonesia: 15 | STEM-Man-HSS 1 | Participated more than once as an active member 13 | Knowledge and some practice with the concept: 8 |
| Lithuania: 5 | | Participated as a leader 5 | Expert 2 |
| South Africa: 4 | | | |

Table 2: Respondents' expertise: curriculum design (column) versus resilience (row)

| <i>Expertise in Resilience</i> <i>Expertise in Curriculum design</i> | <i>No or vague knowledge</i> | <i>Common wisdom</i> | <i>Scientific or professional knowledge</i> | <i>Knowledge and practice</i> | <i>Expert</i> |
|---|------------------------------|----------------------|---|-------------------------------|---------------|
| <i>Never participated</i> | 0 | 0 | 0 | 0 | 1 |
| <i>Only observer</i> | 0 | 1 | 1 | 1 | 1 |
| <i>Active member once</i> | 1 | 5 | 4 | 2 | 0 |
| <i>Active member >1</i> | 3 | 4 | 3 | 3 | 0 |
| <i>Leader</i> | 0 | 1 | 2 | 2 | 0 |

3 RESULTS

3.1 Quantitative results

3.1.1 Drivers of resilience

Table 3 shows the principal results for the drivers of resilience. The reader may see the corresponding questions to the different codes (like Red-Media) in the annex and a shorter definition in table 3. All drivers were found to contribute significantly to resilience (all p-values $\ll 0.001$). Redundancy in transmission channels (Red_Media) had the lowest mean rank (3,51 i.e. between 3 = a bit useful and 4 = very useful for curricula resilience) but was still significant for resilience (p-value $\ll 0.001$). The factors Red_SciFields, Red_assesM and Cur_Struct were not significantly greater than the factor Red_Media (all bilateral one-sided paired Wilcoxon tests with p-values > 0.1). A significant split with Red_Media arose with Eco_Intelli (one-sided paired Wilcoxon test with p-value 0.017) including all subsequent factors in table 3, up to (Cont_Adap) (all bilateral paired Wilcoxon tests with Red_Media had p-values $< 0,01$), the latter therefore suggested a greater importance for curricula resilience. For the 3 last items of table 3 the factors Flex and Red_TeachM were not significantly lower than Cont_Adapt (all p-values > 0.1 , one-sided paired Wilcoxon tests). The split was with the factor Tech_Inno and the preceding items in table 3; Red_LearnM, Flex_Course and Eco_Intelli (one-sided Wilcoxon tests with Cont_Adapt have p-values < 0.05). The three groups color coded from white to green for increasing significance for resilience are shown in table 3.

Table 3 Main statistics about drivers of curriculum resilience (scale 1:5). All drivers are significant for resilience (***) = p-values $< 0,001$). The colors represent a partition with increasing significance for curricula resilience: the factors of the middle group are significantly greater than "Red_Media" and significantly lower than Cont_Adap

| <i>Drivers of resilience</i> | <i>Code</i> | <i>min</i> | <i>max</i> | <i>median</i> | <i>mean</i> | <i>question</i> |
|--|---------------|------------|------------|---------------|-------------|-----------------|
| Redundancy in media or transmission channels | Red_Media | 1 | 5 | 4 | 3,51*** | number: 7 |
| Redundancy in scientific fields for a given topic | Red_SciFields | 1 | 5 | 4 | 3,71*** | 9 |
| Different ways for teachers to evaluate a given skill | Red_AssesM | 1 | 5 | 4 | 3,74*** | 6 |
| Standardizing and simplifying the curriculum structure | Cur_Struct | 1 | 5 | 4 | 3,77*** | 11 |
| Adjusting educational methods and content based on economic intelligence | Eco_Intelli | 2 | 5 | 4 | 4,03*** | 21 |
| Flexible course formats | Flex_Course | 2 | 5 | 4 | 4,14*** | 18 |

| | | | | | | |
|---|------------|---|---|---|---------|----|
| Redundancy in learning methods: different means for students to engage with a given topic | Red_LearnM | 3 | 5 | 4 | 4,14*** | 5 |
| Adjusting educational methods and content based on technological innovations | Tech_Inno | 3 | 5 | 4 | 4,29*** | 22 |
| Flexibility as having a means, resource or approach that can be adapted to alternative uses / ends or objectives | Flex | 3 | 5 | 5 | 4,40*** | 17 |
| Redundancy in teaching methods | Red_TeachM | 4 | 5 | 4 | 4,43*** | 8 |
| Continuous adaptation i.e. teachers cultivating a mindset of continuous learning and adjustments of educational methods, content and strategies based on external changes | Cont_Adap | 4 | 5 | 5 | 4,51*** | 20 |

3.1.2 Digital technologies and resilience

We also evaluated the risk and opportunity associated with two types of digital technologies for curriculum resilience: those based on artificial intelligence (AI), such as ChatGPT, called AI_Risk and AI_Opp and digital technologies NOT based on AI (Digit_Risk and Digit_Opp) e.g. technologies that support the digitalization of the learning experience or facilitate online teaching such as Moodle or on-line learning technologies, Woodclap, etc. The results (table 4) suggest that AI is seen as both a risk and opportunity for resilience (significantly different from zero) and as much a risk as opportunity (p-value = 0.09). Non-AI based digital technologies were seen as both a risk and opportunity for resilience but overall, more an opportunity than a risk (p-value < 0.001), two-sided, paired).

Table 4. Digital technologies: risk and opportunities for resilience

| Variable | min | max | median | Mean | Question nb |
|------------|-----|-----|--------|------|-------------|
| Digit_Risk | 0 | 2 | 1 | 0,80 | 15 |
| AI_Risk | 0 | 2 | 1 | 1,29 | 13 |
| Digit_Opp | 0 | 2 | 1 | 1,46 | 16 |
| Digit_Opp | 1 | 2 | 1 | 1,49 | 14 |

3.2 Qualitative results

Textual analysis of the qualitative data resp. i) cite one or more properties of a curriculum that makes a curriculum resilient, ii) can you think of any other redundancy factor, iii) by which properties would you define a resilient curriculum structure, iv) indicate what a flexible curriculum could be or mean for you OR state any other contributor of flexibility, v) is there any remark about the design of a resilient curricula that you would like to share? led us to develop a resilient curriculum model comprising 4 dimensions: teaching and learning strategies, structure of curriculum, content of curriculum and network/ collaboration as shown in table 5.

Table 5: qualitative results

| Dimensions | Properties along the dimensions from the survey |
|----------------------------------|---|
| Teaching and learning strategies | <p>Adaptable modes of teaching and assessments with the ability to 'immediately' switch to alternative delivery formats/ teaching modes</p> <p>Flexibility in learning formats: Hybrid learning models, competency-based learning, ...</p> <p>Diverse expertise and backgrounds of instructors</p> |

| | |
|-------------------------|--|
| Structure of curriculum | <p>General properties: Adaptability, scalability, modularity, accessibility, interdisciplinarity, technology integration, feedback mechanisms, sustainability, agility</p> <p>Flexibility:</p> <ul style="list-style-type: none"> - of course opening in different semesters, of the curriculum structure e.g. with at least 30% of the curriculum made up of blocks of electives chosen by students - Curriculum structure that can be adapted to various scientific changes and society needs. - Different pre designed learning paths to achieve the same learning outcomes <p>Structure :</p> <ul style="list-style-type: none"> - clear building blocks, clear interrelation between building blocks, comprehensive overview with the component sections, the content, strategies, resources, assessments, community inputs. - Readability by students (of many different academic expectations) <p>Agility of the structure: dynamic content update mechanisms; feedback and iteration loops, push and pull content .</p> <ul style="list-style-type: none"> - towards student interests ; availability of on-demand learning resources. - for students to gain knowledge and experiences in industry or research institution; <p>Simplification of procedures for program renewal</p> |
| Content of curriculum | <p>Teaching of fundamentals and up-to-date knowledge avoiding obsolescence of tools/methods and approaches. Minimum prerequisite courses</p> <p>Pedagogy alignment</p> <ul style="list-style-type: none"> - emphasis on soft skills and creativity - Integration of real-world experiences, inclusion of contemporary issues and hands-on experience - aligned with the goal of the learning outcome on individual level and within the curriculum |
| Network / collaboration | <p>Redundancy of available teachers/ in each topic ;</p> <p>Collaborative elaboration of curriculum structure: Common educational goals and means of the participating institutes. Links with practical projects and local territories</p> <p>Environment that encourages, between all school stakeholders, experimentation, adaptability, collaboration, multi-directional relationships & communications among educators, students, and stakeholders faculty and administrative staff,....</p> |

4 CONCLUDING REMARKS

The quantitative findings extend the current research concerning how curriculum design may contribute to HEI resilience suggesting that curricula exert an ongoing influence on resilience via the provision of a structure that facilitates the emergence of a resilience process. This resilience dynamic is thought to be fueled by the continuous development of resilience capabilities such as redundancy (both in teaching and learning approaches and pedagogical resources), flexibility and ongoing intelligence (technology/ economic) monitoring and acquisition. The qualitative findings echo this interpretation of how curricula may contribute to HEI resilience but respondents focused mostly on intra-organizational aspects of the relationship with resilience being conceived as the outcome an ongoing commitment to developing resilience capabilities such as flexibility (learning formats/ curriculum structure), adaptability (teaching modes/ delivery formats) and agility via the mobilization of four properties of resilient curricula namely, teaching and learning strategies, the structure and the content of the curriculum and network/ collaboration. Our study is subject to several limitations mostly linked to the small (n=35) sample size. First, 14% of respondents possessed limited curriculum design expertise while 11% possessed limited resilience knowledge. In light of this, we included definitions of the main concepts in the questionnaire however, the results for these and other respondents, may be biased or ill-founded. Further research might build on these findings by conducting in-depth interviews with relevant curriculum stakeholders to

refine our four-dimensional resilient curricula model and to lay the foundations for the subsequent quantitative research to develop a resilient curricula scale.

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ANNEX: the survey

Table: questions and scales All quantitative variables in a scale 1: 5 with 1= impedes resilience , 2 = neutral, 3 = a bit useful, 4 = very useful, 5 = essential ; AI_Risk and Digit_Risk are on a scale 1:3 , 0= no risk , with 1 = small risk , 2 = high risk) ; AI_Opp and Digit_Opp on a scale 1:3 with 0= no impact, 1 = small opportunity, 2 = big opportunity

| Questions with question numbers | name | Scales |
|--|-----------------|---------------|
| 1. How would you rate your expertise of program curriculum design like building a new master program or amending a first year bachelor program? | Exp_Curri | 1:5 |
| 2. How would you rate your expertise with resilience concepts or theory? | Exp_Resi | 1:5 |
| 3. Please state at least one or more properties of a curriculum that makes it resilient. To answer this question, you may wish to refer to a curriculum that you are aware of. | Prop_Res | Textual |
| 4. Please state at least one or more properties of a curriculum that makes it not resilient. | Prop_NoRes | Textual |
| 5. Redundancy in learning methods : different means for students to engage with a given the topic such as visual, auditory, written, kinesthetic, MOOCs, storytelling, games, project-based learning, etc. | Red_LearnM | 1:5 |
| 6. Redundancy in the assessment methods for a given topic: different ways for teachers to evaluate a given skill or knowledge e.g. Multiple Choice Questions, homework, distance orals, reports, etc. | Red_AssesM | 1:5 |
| 7. Redundancy of channels or media for transmitting a given course content e.g. Zoom, discord, Microsoft Teams, kahoot, etc. | Red_Media | 1:5 |
| 8. Redundancy of teaching methods : different ways for the instructor to interact with students to achieve a given learning objective e.g. lecturing, inquiry-based learning, game-based learning, group project learning, inverse classes ... | Red_TeachM | 1:5 |
| 9. Different scientific fields in addressing a given topic | Red_SciFields | 1:5 |
| 10. Can you think of any other redundancy factor that could be essential or very useful to the resilience of a curriculum ? | Red_Other | Textual |
| 11. Standardizing and simplifying the curriculum structure allows: i) a better planning of formative and summative assessment, ii) a better readability by students, iii) a better coordination of the many units provided by academics in several departments. Please rate the usefulness of standardizing and simplifying the curriculum structure for curriculum resilience ? | Cur_Struct | 1:5 |
| 12. By which properties would you define a resilient curriculum structure | Cur_Struct_Prop | Textual |
| 13. Generative artificial intelligence (AI) is an AI technology enabling to continuously and automatically improve its performance from data (Unesco, 2023) , e.g. chatGPT. How would you rate the degree of risk represented by generative AI for curricula resilience? | AI_Risk | 1:3 |
| 14. How would you rate the opportunity represented by generative AI for curricula resilience? ? (A technology can both be a risk and an opportunity) | AI_Opp | 1:3 |

| | | |
|--|-------------|---------|
| 15. How would you rate the degree of risk represented by digital technologies NOT based on AI for curricula resilience (e.g. technologies that support the digitalisation of the learning experience or facilitate online teaching like moodle, on-line learning technologies, woodclap, ...)? | Digit_Risk | 1:3 |
| 16. How would you rate the opportunity represented by digital technologies NOT based on AI for curricula resilience? | Digit_Opp | 1:3 |
| 17. Please rate the usefulness of flexibility for a resilient curriculum | Flex | 1:5 |
| 18. In particular, please rate the usefulness for a resilient curriculum of flexible course formats (e.g. a course that can easily be instantiated into different teaching modes such as face-to-face, online, hybrid) ? | Flex_Course | 1:5 |
| 19. Please indicate what a flexible curriculum could be or mean for you OR state any other contributor of flexibility you can think of for curriculum resilience ? | Flex_Other | Textual |
| 20. Please rate the usefulness of continuous adaptation for a curriculum resilience? | Cont_Adap | 1:5 |
| 21. Adjusting educational methods and content based on economic intelligence (links with industries, market probing, social network analysis, news and social medias...): | Eco_Intelli | 1:5 |
| 22. Adjusting educational methods and content based on technological innovations: | Tech_Inno | 1:5 |
| 23. Before submitting this questionnaire, is there any remark about the design of a resilient curricula that you would like to share, e.g. on action levers or properties not already stated in the above questions? | Miscan | Textual |