Education 4.0 as a Driver for Institutional Change in Higher Education: A Qualitative Study of Educational Transformation in a Danish HEI

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Abstract: In recent years, the concept of "Education 4.0" has emerged as a response to the technological, social, and economic transformations that have accompanied the rise of Industry 4.0 (Rienties, 2023; Miranda et al., 2021; Salmon, 2019). As industries increasingly integrate advanced technologies such as AI, big data, and the Internet of Things, institutions of higher education (HE) are similarly compelled to rethink their structures, methods, and objectives. Education 4.0 aims to equip learners with the skills needed in an evolving digital economy, promoting critical thinking, adaptability, and digital literacy (Oliveira & Souza, 2022; Alenezi, 2021). This paper presents a study of a program aimed at building capacity for Education 4.0 through a targeted and strategic organizational program in a higher education institution in Denmark. For two years, researchers applied a formative dialogue research-approach, where the activities were studied in real time without direct involvement of the researchers in the activities. Through interviews with stakeholders across three organisational tiers (the strategic, the tactical, and the operational level), our study explores to which extent, and by which means, the targeted program enhanced institutional capacity, contributing to the broader goal of integrating Education 4.0. The main research question was: "How can a targeted organizational change program enhance capacity building at strategic, tactical, and operational levels to support the implementation of Education 4.0 in higher education?" Through analysis of a series of in-depth interviews, we find that the program takes a technology-driven approach despite intentions of the opposite; that management of the institution sees great potential for change in the program; and that participants in the program's experimental activities can get caught between innovation, everyday practices, and educational culture.

Keywords: Educational Transformation, Education 4.0, Emerging Technologies, Learning Design, Formative Dialogue Research

1. Introduction

Across the globe, digital transformation is reshaping the way societies work, communicate, and learn. In higher education, this transformation is not merely about adopting new technologies - it is about rethinking educational practices, structures, and cultures to align with the rapidly evolving demands of the digital age (Rienties et al., 2023; Miranda et al., 2021). In this context, "Education 4.0" has emerged as a strategic framework that responds to these shifts by promoting digitally enriched, learner-centred, and innovation-driven educational models (Oliveira & Souza, 2022; Alenezi, 2021). Education 4.0 extends beyond e-learning platforms or digital tools. It encompasses the development of new pedagogical formats, integration of emerging technologies such as AI, and greater alignment with workplace competencies and lifelong learning (Salmon, 2019). However, achieving this vision is not simply a matter of implementing new technologies or policies. It requires deep organizational change - particularly in how institutions build capacity among staff, create enabling structures, and foster cultures that support experimentation and collaboration.

This paper examines how a targeted and strategic organisational change program, labelled "Education 4.0.", can enhance institutional capacity to support the implementation of Education 4.0 at a University College in Denmark. In the paper, we present findings from a study of an initiative that aims to create educational change as well as a changed mindset of teachers, management, learning designers, and support staff towards the process of experimenting with new and emerging technologies to change the organization. The institutional program in question involved a multi-level approach, engaging key stakeholders at the strategic, tactical, and operational levels of the institution. Each level was assigned a crucial role in steering the organisation toward an adaptive, future-oriented educational model that aligns with the local assumption of the Education 4.0 phenomenon.

The paper contributes to ongoing debates about digital transformation, organisational learning, and educational innovation by addressing the research question: How can a targeted organisational change program enhance capacity building to support the implementation of Education 4.0 in higher education?

The program in question is an attempt to develop a new path to educational and teaching development – a design-oriented and experimental approach to educational development, inspired by the phenomenon of Education 4.0. The basic assumption behind the program was that many digital innovations that are changing society will also change how institutions will offer education in the future. Over a three-year period, the program has engaged educators, consultants, and managers in an institutional program that aimed to gain experience with the opportunities and barriers that current digital innovations offer in relation to education and learning. The article brings forward the perspectives of both steering committee members and program leaders. Their experiences give insight into how higher education institutions can navigate the complex interplay of strategic intent, operational realities, and pedagogical innovation.

2. Background and Context of the Study

The study was conducted at a Danish University College from 2022 to 2024. In 2022, the Institution's board of management decided to launch a targeted organisational program called "Education 4.0", and the authors were invited to study the implementation of the program. The program was highly inspired by a paper by Christiansen et al. (2018) discussing the relationship between Industry 4.0 and educational design in the future. Based on this, two fundamental assumptions shaped the program from its inception: 1. The assumption that the influence of digital technologies on society will change how education will look in the future, and 2. That the path to developing the education of the future involves challenging and disrupting the current logic and rationale of educational practices.

From the onset, a principal value in the Education 4.0 program was co-creation, meaning that initiatives in the program are conceived and implemented by users, i.e., teachers and other staff at the Institution. The program aims to give this co-creation process a common direction by introducing two things: 1. Thematic tracks, into which ideas must fit, and 2. Design principles, on which ideas must be based. To encourage a user-driven approach, twice a year, staff at the institution could submit their ideas for educational experiments or development activities which they believed was within the scope of the Education 4.0 themes. The term "idea" was carefully chosen to give emphasis to the exploration and experiments. Ideas were selected by the leaders and the steering committee of the program, and resources were allocated in terms of time and technical and pedagogical support for the owner of the idea. As illustrated in figure 1 below, participants in the program were expected to carry their idea through as many of the phases as possible. However, implementation was not always the goal, as a possible consequence of the explorative approach was that some ideas turned out to be immature, too difficult to implement into existing study programs, or simply to not give sufficient additional value to teaching or learning. To support staff in developing their ideas, the program offered guidance from pedagogical or technological consultants, which were at first named "track leaders". As the significance of the initial thematic tracks diminished over time, the name of this role was changed. Not all ideas were formulated by teachers, also administrative departments had ideas on how to integrate digital technology in their ways of working.

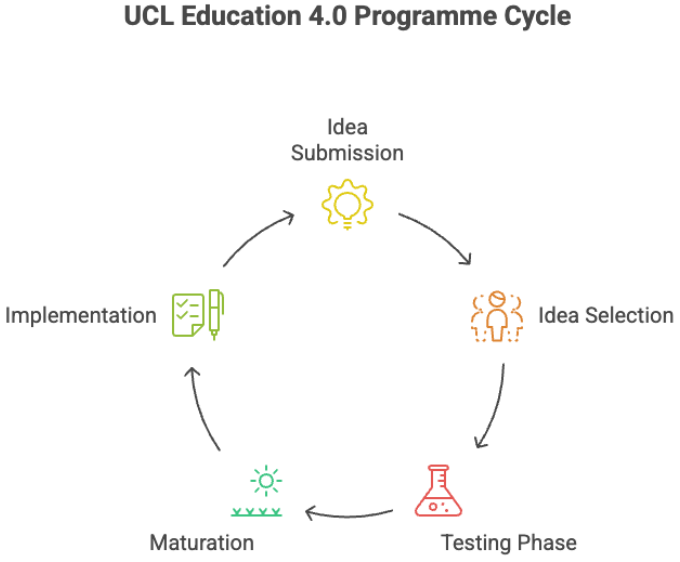

Figure 1

In a Danish context, Education 4.0 came into focus when Christiansen et al. (2018) set out to examine how the influence of Industry 4.0 technologies might transform educational designs. Their study was based on the premise that technological innovations have consequences of social, economic, and cultural character, and it is expected that they will also influence education, hence the term Education 4.0. For the present project, we carried out a literature review of research on how educational development can be achieved through digital transformation (using the concept and / or term education 4.0) in higher education. We found that very little has been published where the concept Education 4.0 is clearly defined and used as a framework or in other ways is seen to influence the educational design process. Overall, the concept is widely used as a general reason for the use of technology in educational design, in curriculum, and in teaching techniques. Often, the term education 4.0 is used in parallel with other generic terms such as 21st Century skills or digitalization in society.

3. Education 4.0 as Driver for Digital Educational Transformation

A literature review was carried out in 2023, targeting peer-reviewed research publications only. 453 studies were identified and subjected to screening. This led to the exclusion of 403 studies, and 48 studies were retrieved and assessed for eligibility. Several of these used the concept of education 4.0 in extension of mentioning Industry 4.0, but without further definition, discussion, or application of the concept in the study. These studies were excluded. Several studies include education 4.0 in a rather broad introduction to societal and technological tendencies, followed by a small case study of experiments with technology in teaching. Such studies were also excluded. A geographical limitation to Europe and North America had to be abandoned due to insufficient information in the databases. In the end, we identified 11 publications of relevance, three of which were review articles (Benavides et al., 2020; Benavides et al., 2023; Fernandez et al., 2023).

Despite the increasing spread of the concept of "Education 4.0" seen in recent years, only a few studies have been published where Education 4.0 seem to have shaped development activities, research projects, or institutional development programs. As mentioned above, in the 48 studies retrieved and assessed, the concept was used very loosely and without any defining effect. In some publications, Education 4.0 is used mainly to mean teaching and learning, where digital technology is integrated into (e.g. Ersoy, 2021) or as a way of describing what one may call a constructivist understanding of teaching and learning such as problem based and other forms of active learning (e.g. Iniesto et al., 2021; Koul & Nayar, 2020). Some studies use Education 4.0 as a reference to an updated view on education, teaching or learning, and then proceeds to present a small-scale experiment with technology in teaching and learning (e.g. Sarango-Lapo et al., 2021; Miranda et al., 2021). As described by several sources, Education 4.0 can be viewed as a response to the technological, social, and economic transformations that have accompanied the rise of Industry 4.0 (Rienties, 2023; Miranda et al., 2021; Salmon, 2019), meaning that as industries increasingly integrate advanced technologies such as AI, big data, and the Internet of Things, institutions of higher education (HE) are similarly compelled to rethink their structures, methods, and objectives. Thus, Education 4.0 aims to equip learners with the skills needed in an evolving digital economy, promoting critical thinking, adaptability, and digital literacy (Oliveira & Souza, 2022; Alenezi, 2021).

Despite a growing interest in Education 4.0 illustrated in the literature, we find that the practical implementation of its principles remains under-explored, and the development of institutional strategies that align with Education 4.0 is still in its early stages (Mukul & Büyükozkan, 2024; Christiansen et al., 2018; Hussin, 2018). Central to this challenge is the need for institutions to undergo significant organisational transformation, not only in their pedagogical approaches but also in their internal operations and strategies (Bohari et al., 2024, Benavides et al., 2020). In this paper, we present a study which explores the intricate process of digital transformation within a HE institution, thus addressing the organisational aspects of developing and implementing innovative ways of teaching and learning.

4. Research Design and Methods

The overall research interest in this study is “How may Higher Education Institutions further digital transformation of education (Education 4.0)” and the empirical study has a particular focus on a targeted organisational change program as a mechanism for creating change, enhancing capacity building, and developing new educational designs with digital technologies. For a period of two years, researchers followed the program activities. The agreed approach to the study can be described as *formative dialogue* research or what Van de Ven (2007) calls *engaged scholarship*. The study was characterized by a dialogical approach in which the research findings may or may not shape the activities through formative dialogues. In formative dialogue research, activities are studied in real time without direct involvement of the researchers in the activities. During

the two years, we interviewed key participants, a total of 21 in-depth interviews over 12 months and collected documents for analysis. Observation of teaching activities was planned in relation to some of the ideas developed in the project, however, in this paper, only interviews and document analysis are used. Through interviews with stakeholders across three organisational tiers (the strategic, the tactical, and the operational levels), our study explores the extent to which, and by which means, the targeted program enhanced institutional capacity, contributing to the broader goal of integrating Education 4.0.

The institutional program had two appointed program leaders who were responsible for the design, implementation and progress of the activities. They were key persons in our study, and were formally interviewed at three separate occasions, as well as our dialogue partners in more informal ways. They were also gate keepers for us and among other things they helped set up interviews with others in the organisation. In the following section, we present our analysis of interviews with both the program leaders and members of the steering committee (five people in managerial positions). Inspired by Braun & Clarke (2006), we have carried out thematic analysis of the material, resulting in identification of eight themes across the interviews.

5. Analysis

The eight themes are: Vision and purpose, a catalyst for change; Digital technology: driver, not destination; Bottom-up innovation and ownership; Organisational development and cultural change; Leadership, structure, and strategic framing; Governance, incentives, and organisational alignment; Experimentation, learning, and impact; and Evolution and tensions.

In the following, we illustrate each analytical theme and subsequently discuss the findings. Due to limited space, we do not fully unfold each theme, rather we choose to demonstrate the complexity of viewing educational development in an organisational perspective. The Education 4.0 program aims to reshape educational practices through digital technology, pedagogical innovation, and organisational change. Interviews with both the steering committee and the program leaders provide a rich insight into the program's ambitions, design principles, challenges, and evolving identity. While their perspectives differ slightly in scope and emphasis, a common vision of cross-institutional innovation and future readiness emerges through the analysis.

5.1 Vision and Purpose: A Catalyst for Change

For both the steering committee and program leaders, Education 4.0 represents a significant opportunity to modernise and strengthen the institution's educational formats, teaching practices, and institutional culture. However, their visions are expressed through slightly different lenses. The steering committee members highlight the program's potential for deep and wide-ranging change, from the visible classroom level to broader shifts in educational design, technology integration, and academic culture. One member described the initiative as aiming to "push the development of the teaching culture," while also acknowledging its limitations:

> "The program is also a way of improving the educational quality (...) but if you're talking about the total recalibration of something - I see that as being relatively far-fetched in a program path like this." (Head of Studies)

The program leaders, on the other hand, frame the initiative as a long-standing strategic curiosity driven by the 2018 whitepaper on Education 4.0 (Christiansen et al., 2018). They emphasize that the program is not a fixed solution to a specific problem, but a platform for experimentation, driven by the idea that digital transformation is inevitable.

> "We must also reach those who shout and scream. Point forward and say: "Something is coming, and we cannot say no to it. We can prepare ourselves as best we can for it". With a future that cannot be described, should we build windmills or shelters? Our opinion is that we must try to prepare for the future that is coming. And as far as possible also try to influence it." (Program leader)

5.2 Digital Technology: Driver, not Destination

Both groups agree that digital technology is a central component, but not the goal of the program. Steering committee members see the program as a natural extension of previous models (e.g., Education 3.0), with the potential to enhance learning formats and pedagogical approaches. As one explained:

> "We will have to see if we can offer education and skills development, perhaps using technologies, in a different way. I believe we will be teaching in new ways." (Head of Studies)

The program leaders stress that technology should not be added for its own sake. Instead, it must serve pedagogical aims and create real value for students.

> "How is it that it (technology) gives students something that has an 'impact' in relation to a reality, a society, and a work life that is changing. A gadget, a device, or an app. It's about framing it in a slightly broader context, so that you also think about which learning activities it is linked to, and in what ways you can draw it into a broader understanding that students should also have some meta-learning that fits into work life". (Program leader)

The program leaders also noted that many teachers were primarily motivated by the opportunity to engage in teaching development, whether it involved technology or not. For that reason, the program leaders sometimes had to remind participants to include a technological element in their project proposals. During the program period, it became clear that the dynamics of technological and pedagogical knowledge is also very much at play when development is framed by Education 4.0.

5.3 Bottom-up Innovation and Ownership

A strong bottom-up approach is a defining feature of the program, especially in the view of the program leaders. They advocate for co-creation, ensuring that those working closest to students, namely the teachers, have real influence.

> "Yes, well it has been a means of trying to achieve the goal of the whole basic idea of co-creation. And we want to go out and believe that it is out there, and this should not be misunderstood negatively, but out there in the outermost link, where the teachers are, and where they stand together with the students every single day. Day in and day out experiencing what is going on. That is where the value is created. And it is also out there that any frustrations, problems, or wishes would arise, and we believe that they will be more validly formulated. And perhaps also in relation to an output - it's easier to create value in the end if there is a bottom-up mindset about where the ideas come from." (Program leader)

While the steering committee supports this participatory model, there is also recognition that organisational transformation requires multi-level engagement. Members act with a dual mandate: representing their home departments and contributing to cross-organizational goals. This sometimes generates tension between local strategies and institutional innovation. Program leaders also emphasize breaking down silos and replacing fragmented, one-off pilot projects with sustained, cross-disciplinary initiatives. They regard the program's cross-institutional structure, including the steering committee's diverse makeup, as essential for legitimacy and reach.

5.4 Organisational Development and Cultural Change

For both leadership groups, the program is about more than educational content: it is about changing how the organisation works. The program leaders envision it as a driver of cultural transformation, seeking to establish a stronger role for innovation and experimentation across the institution.

> "Habits, situated practice, and people's way of thinking are also some of the things we want to influence with this. So, there is something about the governance structure that is different, and which ensures cross-functional management support and anchoring. There is something about the fact that program management lies with us. We can move across the organisation somewhat as free agents. But we also have an obligation to do so. It is stated in our departmental charter. So, there is something about the management mechanism around it that is different from what we have seen before." (Program leader)

The steering committee also expects lasting impact, though they express it more cautiously. One member said:

> "I have no expectation that we will have something that just runs smoothly after this. But I do have an expectation that some of the initiatives that are being tested, that several of them... I believe that most of them (initiatives) will become something that becomes part of the operation." (Dean)

Both groups acknowledge that competence development, particularly in online teaching and modular course delivery, is an important side effect, even if it's not the program's explicit goal. This also relates the above-mentioned dynamics between pedagogy and technology, which often relates to teacher competencies, but also to the competencies of the consultants who give guidance to the participants in the program. The majority of the consultants were from the IT-department, which meant they were technologically knowledgeable, but somewhat distanced from the teaching practices and curriculum of the study programs.

5.5 Leadership, Structure, and Strategic Framing

The steering committee largely views Education 4.0 as a framework for exploring new ways of teaching and organising education. Some emphasize technology, others pedagogy, but they all point to the importance of future-proofing the programs offered in the institution. The program leaders frame their leadership through a strategically placed, cross-sectional unit (named "Digital Learning"), which is designed to operate across departments. They argue that innovation needs this kind of structural flexibility to flourish. One structural innovation they highlight, is the role of the so-called track-leader, which replaces traditional project leadership with a more coaching-oriented model (see figure 1 and section 2 for further explanation).

> "It is no coincidence that we have chosen the structure that is based on organizational theory when it comes to the program. We also considered everything up to portfolio management. When we are program leaders, we need some project managers. They shouldn't be called project managers because that sends the wrong message, so we changed it to track leaders. And it went from a more documenting role to a more coaching role. But the idea is the same. Always make sure that we are responsible for the track managers in terms of helping them. And they are responsible for their idea creators. So, the responsibility falls upwards, but the tasks fall downwards." (Program leader)

Although resource-intensive, this function is seen as a long-term investment in organizational competence and innovation capacity.

5.6 Governance, Incentives, and Organisational Alignment

Both the program leaders and the steering committee are mindful of incentive structures. Program leaders emphasize co-funding and cross-functionality as levers to ensure participation and institutional anchoring. The steering committee underscores the need to balance experimentation with operational relevance. Some expressed concern about resource demands, particularly on teachers and IT staff, and the need for low entry thresholds to encourage broad participation. A shared concern is that Education 4.0 competes with other institutional priorities. One steering committee member observed:

> "Education 4.0 as a program competes with so many other agendas in our institution. So, the risk of being downgraded is always there. So, there is also a resource battle over what you should invest development hours in on the programs." (Head of studies)

5.7 Experimentation, Learning, and Impact

The program was intentionally designed to encourage experimentation without rigid goals. For the program leaders, this is essential to stimulating creativity and agency:

> "It's about spotting and experimenting with attractive new opportunities… and developing new ways of thinking." (Program leader)

Rather than determining outcomes in advance, they prefer to let ideas evolve and consolidate learning across projects. While program targets (like the intended number of ideas and participants) were established, they were never intended to restrict creativity or local ownership. The ultimate hope is to influence not only practices but mindsets, instilling a lasting capacity for innovation within the institution. One program leader reflected:

> "I actually think that the programme has achieved what I wanted. Cultural change is of course a big word (...). But for me it has been to spread knowledge of 4.0, and some insight into what it will come to mean. (...) Then there is an understanding that the future is more digital, asynchronous and data-based, and that is the cultural change that I was interested in from the start. That, and then having some people out there who see the potential in it (...). I think we

> have achieved that too. It has been written into our foundation, in the new strategic guidelines for our institution. Education 4.0 is also mentioned there." (Program leader)

5.8 Evolution and Tensions

Over time, both program leaders and the steering committee have acknowledged shifts in the program's focus. Notably, the original bottom-up emphasis has given way, at least partly, to strategic top-down impulses, such as introducing AI as a new theme. This reflects a growing tolerance for hybrid leadership, where ideas may emerge both from the grassroots and management. While this challenges the original co-creation model, program leaders recognize its necessity in certain contexts.

> "We'd rather see leaders cultivating environments where people can raise their hands and say: 'I'd like to try this.'" (Program leader)

6. Conclusion

In this paper, we have investigated how a targeted organisational change program can enhance capacity building to support the implementation of Education 4.0 in higher education. Through analysis of a series of in-depth interviews, we have found that the program has addressed all organisational levels with different impact. Structural and strategic changes introduced by the Education 4.0 program led to strategic management focus on several issues which may not necessarily be easily combined: Breaking down silo mentality, strengthening inter-departmental collaboration, and long-term capacity building. At the operational level, participants in the program were caught in a dilemma between the free experimentation in the co-creation process and the restrictions of study regulations and institutional structures, which seem to hinder innovation. The program focuses on integrating technology into the program, not just as a tool but as a key driver for transforming teaching, learning, and educational formats. However, we find both tensions, ambitions, and successes related to incorporating digital technology into teaching and educational designs. We also find that the use of design principles may hinder rather than further direction in the experiments.

In summary, we find that the program takes a technology-driven approach despite intentions of the opposite; that management of the institution see great potential for change in the program; and that participants in the program's experimental activities can get caught between innovation and everyday practices and educational culture.

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Ethics Declaration

No ethical clearance was required for this study. In connection with the interviews, we have obtained informed consent from the participants for the interviews and for publication of our results of the study.

AI Declaration

We have used Napkin.ai to generate figure 1.

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