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Education of the Future: Learnings and Experiences from Offering Education to Industry Professionals

Tehseen Aslam[a,1], Ainhoa Goienetxea[a], Henrik Svensson[a]
[a] *University of Skövde*

Abstract. Digitalization is forcing the industry to rethink current practices in all business domains, pushing for a digital transformation of business and operations at a high rate and, thus, paving the way for new business models and making others redundant. For small and medium-sized companies (SME), in particular, it is an enormous challenge to keep up with the pace of technological development. Several initiatives have argued the industry's need for continuous digitalization, innovation, transformation ability, and future skills and competencies development. However, the advancement of the Swedish industry in this area has been uneven, where larger organizations have begun their digital transformation journey to some extent, but SMEs risk falling behind. In addition to the technological transformation, the challenges regarding the industries' skills supply need to be solved, where a workforce with the right competencies, knowledge, and skill sets are equally, if not more, important for remaining competitive. One of the key elements to face these challenges in the companies will be to recruit knowledgeable employees or re-skill the existing ones. Efficient access to relevant knowledge and skills is still a major concern for companies that will surely affect their competitiveness for a long time to come. This paper elaborates on the opportunities and challenges that Swedish universities face in the context of lifelong learning and education for industry professionals. The paper presents results and experiences gained from a lifelong learning project for industry professionals at the University of Skövde in collaboration with ten industry partners. The results from the project show that in addition to pedagogical methods, current structures and policies within academia need to be further developed to effectively serve industry professionals. The paper also presents a concept of education for industry professionals in the lifelong learning context based on the results and experience gained from the project.

Keywords. Education, Lifelong Learning, Digital Transformation, Industry professionals

1. Background

As the fourth industrial revolution unfolds, companies are seeking to utilize new emerging technologies to improve their production efficiency, find new business opportunities, and expand into new markets. The pace of innovation is believed to be accelerated even more which will have a great impact on the current education system, including higher education, as well as the knowledge and skill requirements of the future

[1] Corresponding Author. [tehseen.aslam@his.se]

workforce [1]. In one of their white papers [2], the World Economic Forum points out that Industry 4.0 and its core technologies will have a tremendous impact on the future workforce and estimates the displacement of 74 million jobs worldwide in the coming four years. However, at the same time, it is estimated that around 133 million new jobs will be created. Thus, digitalization, automation, artificial intelligence, and other core technologies of Industry 4.0 are rather shifting the task of the front-line workforces and redefining the skill sets and competencies required to work in this future landscape where current jobs are transformed. Similar to other nations, digitalization is predicted to have a great impact on both the Swedish manufacturing industry and the industry's job market. [3] emphasizes the need for Europe to improve its workforce's skills and competences to meet the requirements of the knowledge based economy, emerging technologies, and the accelerating speed of technological change. [4] point out the need to rethink the current engineering education system in universities to meet the competence and skills requirement not just for Industry 4.0 but also the emerging Industry 5.0 where digitalization plays an important role in both industrial transformations.

The Swedish Agency for Growth Policy Analysis emphasizes that digital transformation will change the demand for jobs, the task content of occupations, as well as the skills needed to execute them [5]. However, at the same time, the report also argues that international research emphasizes that a job usually consists of several tasks, not all of which are easy to automate. Some tasks will be performed by humans and others by artificial intelligence and automation. Thus, in contrast to Swedish research, they argue that work tasks will constantly change rather than all jobs being lost. The report also shows that when it comes to individual work tasks, up to 8% of jobs in Sweden run the risk of being automated within 20 years and that at least 25% of the jobs available today will dramatically change within 10 years [5]. Their analysis shows that industry sectors that are most affected by the digital transformation, in terms of jobs/tasks, will be transport, wholesale & retail, ICT, and manufacturing. At the same time, construction, transport, and manufacturing are identified as industry sectors with the lowest levels of digital maturity [5], which is how companies simultaneously utilize different digital technologies. The ICT sector has the highest digital maturity levels but is still one of the sectors where jobs run the risk of significant change, thus, having high digital maturity is no guarantee of hindering the effects of digitalization.

The Swedish manufacturing industry plays a crucial role in the Swedish economy and society. The manufacturing industry accounts for 20% of the added value in Sweden's GDP [6]; it employs about one million people and accounts for 77% of the total export value [7]. It is therefore clear that the manufacturing industry is strategically and economically important for Sweden and its welfare. At the same time, the Swedish industry is subjected to fierce competition from the emerging economies, which are increasingly competing with knowledge and not just low wages. Countries such as India and China are now investing heavily in new industrialization, industrial digitization, and skill development of the industry's workforce. The Swedish manufacturing industry must, therefore, do the same to be able to stay competitive.

Digitalization is forcing the industry to rethink current practices in all business domains, pushing for a digital transformation of business and operations at a high rate and, thus, paving the way for new business models and making others redundant. For small and medium-sized companies (SME), in particular, it is an enormous challenge to keep up with the pace of technological development. The research institute of Sweden presents an analysis of the Swedish industry's need for continuous digitalization,

innovation, transformation ability, and future skills and competencies development [8]. The report points out, that despite the established advantages of industrial digitalization, the advancement of the Swedish industry in this area has been uneven, where larger organizations have to some extent begun their digital transformation journey, but SMEs risk falling behind. Thus, digitalization and digital transformation of the industry and the capacity to transform enormous quantities of data into new businesses are vital for the industries' future competitiveness. In addition to the technological transformations, the challenges regarding the industries' skills supply need to be solved, where a workforce with the right competencies, knowledge, and skill sets are equally, if not more, important for remaining competitive [9].

In 2016 the Swedish government, through the Ministry of Enterprise and Innovation, announced a strategic agenda for the future of the Swedish industry [4, 7]. This strategy aims to strengthen the competitiveness of the industry and make investments in the Swedish industry more attractive. The presented agenda in this report strongly emphasizes the crucial role of skills development and digitalization for the adaptability and competitiveness of Swedish manufacturing companies, to strengthen Swedish industry to take the lead in digital development, and to exploit digitalization opportunities.

Additionally, the existing knowledge gap between the practice conducted in industry and the research-driven at universities is usually considered big. There is a need for knowledge and technology transfer that will support companies in the digital transformation journey. Therefore, the Swedish government has recently initiated innovation and partnership programs, where one specifically focuses on skills supply and lifelong learning with the strategic aim of mitigating this knowledge gap [10]. Several reserachers within the education domain [1, 3, 11, 12, 13] emphasize on reshaping the current education system towards lifelong learning, where learning is seen as a continuous process rather then a static process. Furthermore, it is through lifelong learning that a continuous learning environment is provided so individuals, e.g. an industry professional, is able to reskill or upskill his/her competencies and skillsets to meet future societal or industrial competence needs.

This paper elaborates on the opportunities and challenges that Swedish universities face in the context of lifelong learning and education for industry professionals. The paper presents results and experiences gained from a lifelong learning project for industry professionals at the University of Skövde (HS from now on) in collaboration with ten industrial partners. The results from the project show that current structures and policies within academia such as the admission process and marketing and communication activities, need to be further developed to effectively serve industry professionals. The pedagogical methods also need to be adapted to be able to offer flexible and engaging courses to industry professionals where they have the opportunity to collaborate in the design of the courses. The paper also presents four key points for the development of education for industry professionals in the lifelong learning context based on the results and experience gained from the project.

The paper is mainly relevant for those working with lifelong learning in academia (project leaders, lecturers, marketing department, admission office, IT department, etc.), as well as for policy-makers defining the policies for industry-university collaboration and lifelong learning. It may also be interesting for industrial companies, and especially for those working with personnel competence development.

The paper is structured as follows: Section 2 presents the background and description of the projects conducted to offer education for industry professionals; Section 3 presents some learnings and experiences; Section 4 summarizes the activities conducted so far; and finally, Section 5 reveals the conclusions and future work.

2. Offering education to Industry Professionals in Digital Transformation

HS applied in 2017 for funding to develop industry-oriented education at advanced level within the Swedish Knowledge Foundation's (KKS) Expertkompetens program. The project started in April 2018 and ended in December 2020. The project was led by researchers of the School of Engineering Science and focused mainly on offering courses for industry professionals within the concept of *Virtual Factory.* These courses offered SMEs, large companies, and individuals the opportunity to expand their competence in the development and use of virtual tools as one of the key areas within digital transformation. The goal of this pilot project was to strengthen the competitiveness of companies and provide them with the conditions to meet current and future challenges in the global market.

As a result of this pilot project, the competence needs of different industrial partners were mapped via interviews and surveys. Different areas were preferred among the respondents, such as getting knowledge on Industry 4.0 transformation, Simulation, Robotics, and Virtual commissioning, directly related to the *Virtual Factory* concept. However, almost all the respondents also showed interest in the areas of Leadership and organizational transformation, Artificial Intelligence, and Business intelligence. The analysis also showed that SMEs in general are more interested in gaining a general understanding of what Industry 4.0 will mean to them, while large companies had also more concrete needs related to specific technologies and functions in the company. From the analysis, it became clear that the needs of the industry today, and even more in the future, are tied to digital transformation. It also became clear that a combination of knowledge from different disciplines was needed.

Additionally, different questions were posed about the preferred forms of teaching (online, blended, or campus) and the length of the courses (e.g. intensive one-day courses, half-day seminars every second week). There is no clear consensus on whether completely online is better than campus. Most of the respondents agreed on the need for flexibility and therefore it seems that online education is a better choice, however, many pointed out the difficulties of studying at home or work. As a result, HS offered the open space in ASSAR Innovation Arena (a meeting place for industry and academia) every Friday for companies that had course participants, to provide a physical study environment for competence development. On the other hand, all the respondents agreed on the need for short courses.

Based on all this knowledge and experience, HS applied for new funding, this time with a broader focus on industrial digital transformation. In April 2021, the School of Engineering Science together with the School of Informatics at HS launched a new project called *WISER: Digital Transformation and Industrial Excellence* (*WISER* from now on). *WISER* is a four-year project with twenty-one partner companies involved (SMEs and large companies) that offers short courses (3ECTS) at advanced level, online, and free of charge for European students. *WISER* is composed of twelve

domain areas, all of which are key for the digital transformation of industry. These are represented in Figure 1.

Figure 1: WISER's twelve domain areas.

The next section provides a summary of the most important learnings and experiences drawn from the pilot project *Virtual Factory*. These have strongly affected the design and development of the current *WISER* project.

3. Education of the future: How can the universities succeed with lifelong learning initiatives? Learnings and Experiences

Conducting the initial steps towards a more structured lifelong learning program provided by HS has provided many learnings and experiences that are shaping the future academic offer for industry professionals. The staff involved has also gained useful experiences from developing new courses based on new methods for course design, with new pedagogical tools, and in close collaboration with different organizations. Additionally, the administrative structures of the university have actively participated in the admission and validation of the professional students, and provided the required IT and pedagogical support to teachers. There are many learnings from the pilot project that will be taken as input for *WISER* and successful future lifelong learning initiatives, the most important ones are summarized in Figure 2 and described in the paragraphs below.

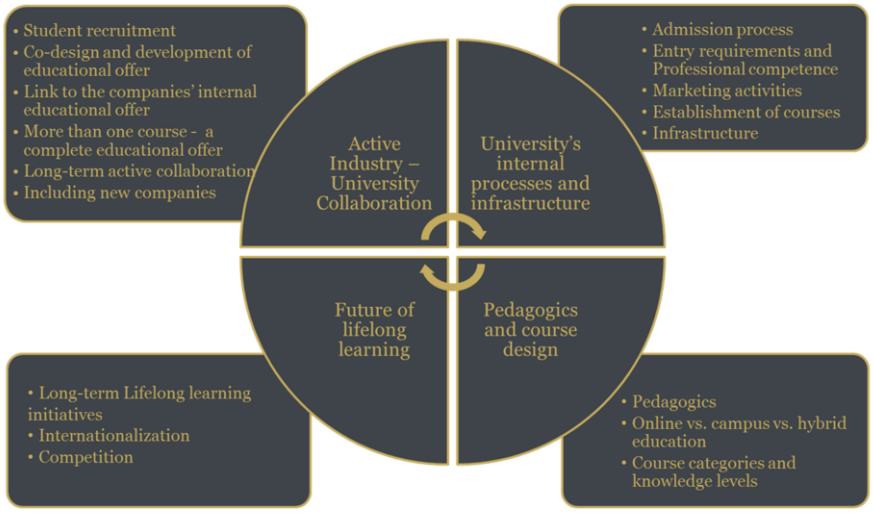

Figure 2: Summary of the learnings gained from the lifelong learning initiatives at the HS.

3.1. Need for an active Industry-University collaboration: matching the Industry's competence need and the educational offer

The university personnel in charge of the lifelong learning initiatives should be aware of the competence needs of the companies. Continuous and strategic collaboration between the university and industrial companies is and will be a key aspect for offering relevant education to industry professionals. Visits and interviews with companies will be a must to understand the actual and future competence needs. These interviews should preferably be conducted with different key roles in the organizations including managers in key areas (e.g. production manager, IT manager, etc.), human resources personnel, and even the CEO depending on the size of the company. According to the authors' experience, these interviews offered a great opportunity to get to know the companies, their needs, but also an opportunity to further expand the existing collaboration between the university and the companies. In the pilot project, different collaboration formulas resulted after these interviews, including final year projects for engineers, and the participation of new companies in the company network for lifelong learning. An additional interesting opportunity that arises from these interviews is also the possibility to include the courses offered at the university as part of the internal education provided in the companies so that the courses are even more accessible for the company employees.

Large companies seem to have clear internal educational processes for the employees, while SMEs usually provide specific ad-hoc courses depending on the competence need. Therefore, the collaboration with the companies needs to be adapted to their internal processes.

It will also be important to be able to transfer the research results from the research projects developed at the university to the companies so that improvements or new possible business opportunities arise.

Additionally, the educational offer should be defined and developed in close co-production with industrial companies. This is of course challenging in many ways, as industry professionals are not used to working with academic documents or academic terminology, have limited time, and may not even be experts in the course content.

However, if the universities can find collaboration models that facilitate continuous interaction and communication between the teachers/researchers and the industry and industry professionals, these challenges will be easily overcome by the benefits that a relevant educational package can offer in contrast to general course offers with no link to the companies' needs. This will benefit not just the courses developed within the lifelong learning initiative, but even program courses. The knowledge transfer from the industry professionals in form of challenges they are facing, projects they work with, etc. are extremely valuable so that apart from the theoretical content, teachers can provide knowledge based on real-world problems and with high industrial relevance to students.

On the other hand, long-term and active collaboration with companies should be maintained so that they want to be part of the industrial network for lifelong learning. This will help ensure a sufficiently large recruitment base for the courses and will efficiently provide the knowledge and competence for the involved companies so that they can keep it up with the technological advances in the market. Additionally, the analysis of the student performance in the courses from the pilot project showed that students from the industrial network more often finalized the courses in comparison to private individuals from outside the industrial network. It is clear that a close collaboration also builds up confidence and engagement.

An important aspect of the quality of the courses is also the course assessment. A learning drawn from the experience during the pilot project is that a seemingly minor detail such as sending the assessments to the student's job or personal emails (as opposed to the default student email address) was important to facilitate a high response rate.

3.2. Adjusting University's internal processes: how to offer an excellent service to a different type of customer?

The traditional students for university education are young persons that attend three-year programmes to attain their first university degree. Universities have well-defined internal processes related to marketing and admission for these types of students. However, these internal processes need to be analyzed and updated if the goal is to offer an excellent service for industry professionals, which could be seen as a different type of student or customer.

The marketing and communication channels need to be adjusted to access these types of students. Industry professionals' motivation to be enrolled in a course to broaden or deepen his/her knowledge or competence is different to the motivation of a student choosing a three-year study program. Furthermore, the communication channels used by industry professionals are different to those used by young people searching for their future careers. Even the name chosen for the courses has an impact on the number of applicants, and therefore it should be thought through with a technical and marketing perspective in mind.

Regarding the admission processes, it is extremely important to ensure that the entry requirements for the courses take into account not just the academic merits of the person applying for the course, but even his/her professional experience in the relevant area for the course. Many industry professionals do not have academic merits but have long industrial experience and they should be offered the possibility to further deepen or broaden their knowledge. This makes of course the admission process more challenging. However, to be able to re-skill industry professionals, this consideration will be essential.

On the other hand, when establishing a new course, the course plan has to be presented one year in advance in the educational committee that approves new courses.

This may work for courses within the usual educational offer of the universities, e.g. program courses. However, when companies have a competence need, they are used to buying the courses they require in a relatively short amount of time. Therefore, if universities want to become competitive in this market, they will need to make their internal processes more agile to be able to respond quickly.

Besides, the IT and physical infrastructure need to be developed at the universities to be prepared to increase the offer in online education and maintain a high standard. There is a lot of competition in the market and the courses should be designed and developed professionally not just in their content but also in their form.

3.3. Adapting the concept of education: towards a more flexible and industry-relevant education

During the pilot project, different teaching modalities (online, campus and hybrid), number of credits, and pace were used in the courses to analyze the preferences of the participants. Overall, the conclusion from informal conversations with the participants, as well as the interviews and surveys conducted, is that the online modality works best, but optional campus meetings are much appreciated by the course participants, especially to share experiences among peers and to build a network. The analysis regarding pace and structure shows that companies have a mixed view on the best type of course modality: online, blended, or campus-based. Some praise online-based arrangements as they provide flexibility and staff may participate in the course more based on their conditions. Others suggested that courses should have a mix of online and campus-based activities, where the latter has the advantage of getting away from the workplace to concentrate on studies.

In terms of the number of credits, the courses in the pilot project ranged between 3, 4, and 6 ECTS. From the results from interviews, surveys, and student opinions, it seems that the correct standard for future courses is 3 ECTS, i.e. short courses. This poses, of course, an economical challenge to universities that will require that many students finalize the course for it to be financially viable.

Regarding the pace of the courses, a majority stated in the pilot project that courses should be run at a pace of about 25% or lower so that work, private life and studies can be combined.

Some of the challenges identified from the experiences in the pilot project are related to the need to support the teachers in designing and developing courses online for a different type of student. Industry professionals are usually not interested in the credits they get from the course, but rather the knowledge they get. Many of them have extensive industrial experience and can and want to contribute during the course with interesting discussions. All this should be taken into account when designing the course and when providing it. Different pedagogical methods and tools should be provided to teachers so that they can create relevant courses that promote interaction between the students. At the same time, the Covid-19 pandemics has accelerated the digitalization of education towards offering more online education. In online education, syncronous activities (e.g. lectures or discussions via video conferencing tools or chat systems) can be combined with asynchronous activies and communication (e.g. communication via mail, message boards, and the use of pre-recorded lectures). The advantage of the asynchronous mode lies in its flexibility for students to study when it best suits them and the possibility to combine studies with work and home life. But it has also proven beneficial for reflecting on complicated tasks as the time constraint is relaxed [14]. However, it lacks the instant

feedback from an interaction with other peers, that is important for motivation [14]. Still, knowledge on how to effectively design online asynchronous education is still lacking among university teachers. Pedagogical education in online teaching and learning will be needed to increase the competence of the teaching staff. A corresponding gap has been seen in the students' ability to use communication and learning platforms such as e.g. Canvas. Therefore, clear guidelines should be provided in the learning platform so that industry professionals can understand how to use it and navigate through the course content.

Additionally, when designing the courses for industry professionals, it is important to take into account the specifics of adult learning. Adults are not so willing to take part in education if it is not meaningful or relevant to them. Therefore, addressing the question of meaningfulness and relevance is important. Four principles that should be applied to adult learning are suggested by [15]:

- *Autonomy:* Adults need to be involved in the planning and evaluation of their instruction. This will be done with the Industrial Reference Group companies in the course design stage.
- *Variation*: Adults are not a homogenous group therefore different approaches are needed. These will be analyzed with the ABC method and will affect the course development.
- *Experience*: Experience (including mistakes) provides the basis for the learning activities.
- *Relevance*: Adults are most interested in learning subjects that have immediate relevance and impact on their job or personal life.

Adult learning is, therefore, problem-centred rather than content-oriented. Every course within *WISER* will have a problem-centred approach where the students will be guided through the course to critically reflect, discuss, and solve their job-related problems with the new knowledge acquired in the courses. This is also the base for the CDIO educational framework [16] which has been applied in our engineering and informatics programs with positive results.

3.4. Education for industry professionals and organizations: Course Categories and Knowledge Levels

The survey and interview sessions conducted within the *Virtual Factory* identified that individuals and organizations have different experiences and knowledge of diverse domain areas. For instance, some of the School of Engineering's research partners and participating organizations in the project have through a long and extensive collaboration, narrowed the gap between the research conducted at e.g. simulation and how the companies work with this technology. Other organizations and individuals have only heard of simulation and do not have the competence to identify the advantages and possibilities this technology brings. Thus, there is a large span of knowledge levels in the organizations and industry professionals.

The *Virtual Factory* project identified the need for three categories of courses, to be able to offer knowledge to all these professional students no matter their knowledge level. These are exemplified in Figure 3 and are namely: *essential, specialist, and state-of-the-art (SOTA)*.

Figure 3: Three categories of courses.

The *essential* courses provide the student with a first knowledge base within the domain/technology/method. They provide insight into how they can utilize the technology/method to develop their organization as well as reflect upon what benefits and possibilities it brings in comparison to the current way of practice. An example of a course in this category is "Possibilities and benefits of simulation for decision support", provided in the pilot project. The idea of the course is to introduce the simulation technique and the advantages it brings. Throughout the course, students should be able to evaluate and gain insight into how to use simulation for their operations, as well as identify if the technology is of any further interest to the organization without greater investment in terms of time and effort.

In *specialist* courses, the course participants learn craftsmanship. If we return to the simulation example, a specialist course would mean to teach how to build simulation models, verify, and validate models, as well as set up and run experiments. Thus, the *specialist* courses assist individuals and companies to apply and implement the technology/method in their organizations.

Courses within *SOTA* are based on the research conducted at the university and the research results generated from ongoing or recently completed research projects. A simulation course within the *SOTA* category might for instance be "Simulation-based multi-objective optimization of industrial processes". The *SOTA* courses are also conducive to establishing HS in the international education market with courses that compete with top-ranked universities in the world. Being present on this international level will also assist in developing contacts and associating internationally recognized professors.

The progression through the three levels is handled through prerequisites.

3.5. Future of lifelong learning: How to remain competitive?

A big challenge to be overcome to succeed with the lifelong learning initiatives is to remain competitive among all the competitors offering education in the market such as other national and international universities, private companies, educational platforms e.g. edX or Coursera, youtube, etc. A clear offer with a specific niche linked to the research conducted at the university will be a key to differentiating the educational offer from others.

On the other hand, the lifelong learning initiatives started in the last couple of years by many Swedish universities are based on the funding received by the Government. The

question remains how to still be able to offer education to support the industry and industry professionals even when this funding is finalized. The reflections provided in the above paragraphs may guide universities to rethink and update their current internal processes and structures so that the lifelong initiatives perdure far beyond the project lifetime.

4. How far have we come?

While the *WISER* project is only on year one out of four, different initiatives have been started in the key areas identified above:

- *Active industry-university collaboration*: A process for generating courses and course content has been established with the network of companies that are part of *WISER*. Rough ideas for courses are pitched to a large group of companies and organisations (including SMEs). The ones generating interest are refined more by senior lecturers and professors in each domain area of *WISER.* Based on this a course syllabus is formed. The syllabus is then presented to the companies and organisations most interested and they give feedback to both content and procedural aspects of the course.
- *University's internal processes and infrastructure*: The *WISER* courses and course syllabus are allowed to be approved closer to the start of the course and students are allowed to sign up for the course very close to the start of the course. While this puts some strain on the system, it is a necessity to attract personnel from companies. Communication and marketing channels to these types of students have also been adapted.
- *Pedagogics and course design*: The *WISER* courses have almost exclusively been 3ECTS and given online in asynchronous format This is breaking the consensus that long campus-based synchronous courses are the best way of doing courses. Specific pedagogics about online teaching and learning are also provided to teachers. *WISER* courses also apply the proposed course categories identified in the pilot project *Virtual Factories.* By doing so the *WISER* project has been able to create a progression through the courses within the same domain area as well as built a recruitment base from *essential* level to *specialist* and *SOTA* (see figure 3).
- *Future of lifelong learning*: The leading team in *WISER* is already now having discussions regarding the possible development of *WISER* after the project finalizes to ensure a relevant and economically viable solution for lifelong learning initiatives at the HS.

5. Conclusions

It is clear that lifelong learning is extremely important now, but will be even more in the future to ensure that industry and its workforce is adapting continuously and quickly to the technological and market advances. This paper has presented different learnings and experiences from the lifelong learning initiatives offered by the University of Skövde for industry professionals which have a focus on providing knowledge and competence in digital transformation. The paper discusses the need for transforming and

adapting the actual structures and processes at the universities to be able to offer quality education for these types of students. The key areas identified are: 1) the need for an active industry-university collaboration; 2) the need to adapt universities' internal processes and infrastructures; 3) the adaptation of the pedagogics and course design; and 4) the requirement to ensure the future of lifelong learning initiatives at universities.

The paper also presents a summary of the conducted steps so-far in the actual lifelong learning project *WISER*. The next steps include offering a complete educational package but even ensuring the future of the lifelong learning initiative at the university in the long term.

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