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Re/Upskilling The Agricultural Labour Force: Micro-Credentials As Innovative LLL Strategy

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ABSTRACT

Industry 4.0 had a strong impact on globalization by changing the workforce and increasing access to new skills and knowledge. According to the World Economic Forum, by 2025, 50% of all employees will need reskilling due to new technology. Industry 5.0 addresses long term prospects such as sustainability, resilience and human-centricity regarding efficiency and productivity. Agriculture is the most exposed economic sector to climate change with cascade effects on agro ecosystems. Innovations in the agricultural sector are inevitable to ensure food security and social and environmental sustainability.

This paper presents two Erasmus+ projects that highlight the importance of future engineering education in the agricultural sector considering change drivers and challenges (e.g., climate change, labour market needs, digitalization, pedagogical approaches, micro-credentials). The goal is to provide holistic competence-based education that helps learners develop sustainability skills for responsible action. Therefore, we combine innovative pedagogic approaches with substantial content, to allow up/reskilling in a short period of time. We consider opportunities and limitations and how comprehensive agricultural engineering courses must be designed to be effective. We present innovative learning approaches in the realm of agricultural engineering and evaluate the efficiency of short courses (6 ECTS), micro credentials.

Analysing the experiences of several courses conducted at different European universities in past years, we can conclude that if the right pedagogic methods are paired with substantial content, up/reskilling is possible in a short period of time (6 ECTS). Main beneficiaries are agricultural professionals, who are interested in innovative, remote learning opportunities.

1 INTRODUCTION

Lifelong learning (LLL) is important for agriculture and the agricultural machinery industry to adapt to the rapidly changing technological environment (Carnoy and Luschei 2008; Atchoarena and Holmes 2005). The two sectors, like many others, are affected by massive changes, which have a constant impact on the labour market skills requirements. According to the World Economic Forum, by 2025, 50% of all employees will need reskilling in order to adopt to new technology. Industry 5.0 addresses long term prospects such as sustainability, resilience and human-centricity regarding efficiency and productivity. The fourth industrial revolution technologies are the driver for this transformation in the agricultural sector, and generally affect many spheres of life including education.

The increasing world population as well as recent political challenges and changes in production brought by climate change put an increasing demand on efficiency in the agricultural sector. Simultaneously, accelerating technological developments will provide possibilities for a range of novel tools/technologies that can be used to overcome these challenges. These new technologies, based in the digitization of processes, also known as smart farming/ smart agriculture, refer to the modern

application of ICT in agriculture, enabling new practices such as precision agriculture, agricultural automation and robotics, management information systems and more.

According to the OECD study on *Automation, skills use and training*, a high level of automation is likely to occur in routine jobs with low skill and education requirements (Nedelkoska and Quintini 2018, 202:6). This implicates that the highest demand for future skills as result of changes and digital technology is in automation and machine learning. The key processes of promoting learning for sustainable transitions and developments are collaboration, engaging with whole systems applying a holistic approach, innovation in the curriculum, teacher and learning experiences, and active and participatory learning.

International partners from Sweden (SLU), Germany (TUM) and Italy (UNIBZ) formed a working group with BOKU with the aim of an international education program for Re/Up-Skilling agricultural engineering focusing on animal welfare, biodiversity, artificial intelligence, and nutrient efficiency. The goal is to provide holistic competence-based education for required skills by implementing a lifelong learning strategy for agricultural professionals with diverse education and working backgrounds coming from practical farming, agribusiness, the food industry, retail, extension service and administration, the IT sector, environmental science education, and research institutions.

This paper presents the implementation and results of two Erasmus+ strategic partnership projects: **Upskilling the Agricultural Engineering in Europe – USAGE** and **Upskilling the Agricultural Engineering in Europe Next Generation - USAGE NG**. The aim of the projects is to foster Up/Re-skilling agricultural engineering in Europe and to follow labour market requirements through the development of competence based LLL curricula and the implementation of innovative pedagogical approaches. Furthermore, with a special focus on sustainability competences development, these projects use the European sustainability competence framework, GreenComp, to review the curricula, design education programmes, and implement certification, assessment, monitoring, and evaluation.

1.1 Modularity

The concept of up/re-skilling pathways follows modularization at each partner university institution based on standards and guidelines for modules development ensuring quality assurance, implementation of innovative teaching and learning methods, analysis, and improvement. Furthermore, it is built in accordance with the recommendations on the validation of non-formal and informal learning CEDEFOP: **Assessing skills** – identification of existing skills and competences and needs for upskilling; **Tailored learning offer** – competence-based education to meet the needs in skilling; **Validation and recognition** – the acquired knowledge, skills and competences are validated and recognized.

For these purposes one of the planned deliverables was the handbook with guidelines on lifelong learning, pedagogical approaches, and validation procedures for non-formal and informal learning.

1.2 Micro credentials

Based on the European approach to micro credentials, the learning offers combine innovative pedagogic approaches (e.g., blended learning, learner centred approach) with substantial content to allow up/reskilling agricultural engineering in a short period of time. We consider opportunities and limitations and how comprehensive engineering courses must be designed to be effective micro credentials.

2 METHODOLOGY

2.1 USAGE Modularization- A competence based LLL education for up/re skilling pathways in agricultural engineering

The afore-mentioned universities developed a common approach towards LLL opportunities about Smart Farming and implemented several independent courses. In order to create a targeted offer from the universities in this growing and proliferating market, a basic demand analysis for the relevance of continuing education was carried out. According to a survey with 70 participants in Germany, Austria, and South Tyrol - agricultural producers and associations, private companies offering products and services to agricultural producers, public facilities as well as NGOs and students - the demand for LLL courses in the field of smart farming was analysed. The topic “Smart Agricultural Engineering” attracted the attention of 74% of the respondents. Out of the eight topics, the highest priority was given to "GIS&FIMS", "Logistics", "Environmental Sustainability" and "Crop Production" (see Figure 1). Furthermore, results show a corresponding interest in offers at universities and modules in the field of smart farming.

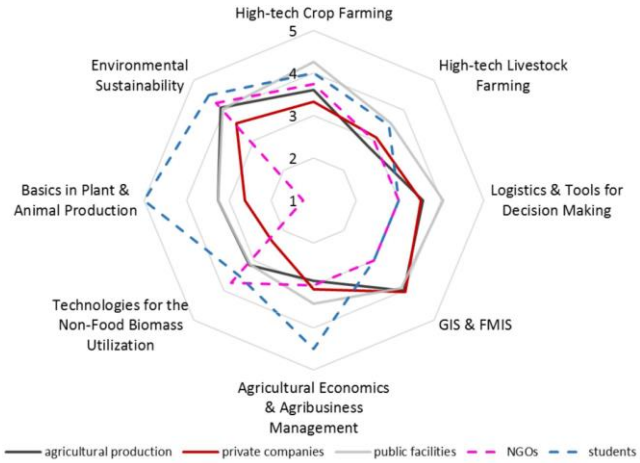

Figure 1: Level of interest in topics by organization type, measured in mean values (n=70) (Bernhardt et al. 2022, 3–4)

The concept consists of several modules that are equivalent to a current university module. This makes it possible to evaluate them similarly to a study module with points in the European Credit Transfer and Accumulation System (ECTS) and thus make them comparable (Bernhardt et al. 2022, 3–4). The continuing education program should comprise 5-6 ECTS modules. The relevant topics in smart crop farming and livestock farming are identified and learning outcomes (knowledge, skills, and

competences) are prepared in compliance with the definitions for EQF level 7 (EQF – European Qualifications Framework definitions). The common language is English. The curriculum and admission requirements for each module are prepared within guidelines from each partner institution, and a local website was provided for dissemination purposes. In addition, this enables transparency of the services provided. A certificate is issued for each module that participants successfully complete. An individual module takes about 3-4 months, which corresponds to 150 working hours.

Admission to each module (course) requires a bachelor´s degree in natural resources, life sciences or technical sciences, or a degree from an advanced technical college. In individual cases also applicants without the above-mentioned degrees but with demonstrated long-standing relevant professional experience may be considered for admission to the certificate courses. This is foreseen by assessing skills through interviews between professors, the program director and candidates including LLL experts and using online examination tools. The admission criteria for the lifelong learning participants are regulated by validation procedures of non-formal and informal learning for the students with diverse education backgrounds. BOKU has developed the concept based on the European Guidelines for the Validation of Non-formal and Informal Learning.

LLL strategy for Teaching methods and learning outcomes

Following the modular approach and to meet the needs in up/re-skilling the expected target groups, the USAGE project partner SLU provided training for teachers on innovative pedagogical approaches, which are flexible and follow a learner-centred approach. It is designed to shift the focus from time-based learning to competency-based learning. Instead of being confined to a certain number of hours in the classroom, learners can progress through the program remotely if they demonstrate that they have acquired the required skills and knowledge.

The methods of student-centred learning range from personalized learning, problem solving learning, critical thinking, flipped classrooms, case-based strategies, and strategies involving small/large group discussions among others. Teachers have implemented these diverse teaching strategies to facilitate transversal and interdisciplinary learning e.g., academic knowledge meet practice, seminar group discussions, observations, and reflections. (Norman and Spohrer 1996, 26)

The consortium partners in collaboration with project industry partners have developed the modules with a focus on “Smart Farming” based on a holistic view on digitally transformed farms and agricultural data mining. A range of e-learning activities (e.g., synchronous/asynchronous, expositive, application, and collaborative methods) support the achievement of the learning objectives. Therefore, different types of lectures and seminars were taken into consideration and a research based Agri-Tech LAB from UNIBZ for the practical studies has been implemented. The focus was on upskilling for the use of technology applications in soil management, seeding management, water management, fertilizer management, grass yield management,

harvesting and production as far as product quality assessment in the fields of crop, fruit and animal production. Therefore, students gathered knowledge, skills, and competences in the application of intelligent information and communication technology systems such as sensors, IoT, GIS, cloud-based processes, machine learning, artificial intelligence, networking to the farming system such as crop cultivation, livestock farming and fruit production. This lead also to the acquisition of transversal skills such as critical thinking ability for applying precision agriculture technologies for decision making.

On the blended learning in the customized and certificate course “Smart Farming and IoT in Agriculture”: TUM implemented the virtual kick-off meeting and team building; all participants had four days of face-to-face learning with practical exercises on tractors and drones at the Campus TUM (see Figure 2). Furthermore, the two following field trips were organised 1. “A Smart Farmer´s Perspective on the Future of Agriculture – at the geo-konzept GmbH company and 2. “A Global Perspective on the Digital Transformation of Agriculture – at BayWa AG”. For the e-learning asynchronous part, TUM provided videos from TUM-streaming servers and guided do-it-yourself@home by using the MOODLE platform. For the practical exercises, TUM supplied participants with the microelectronic skiz Raspberry Pi and Arduino. Certificates are earned after successfully completing a final exam, presentations of participants’ use-cases.

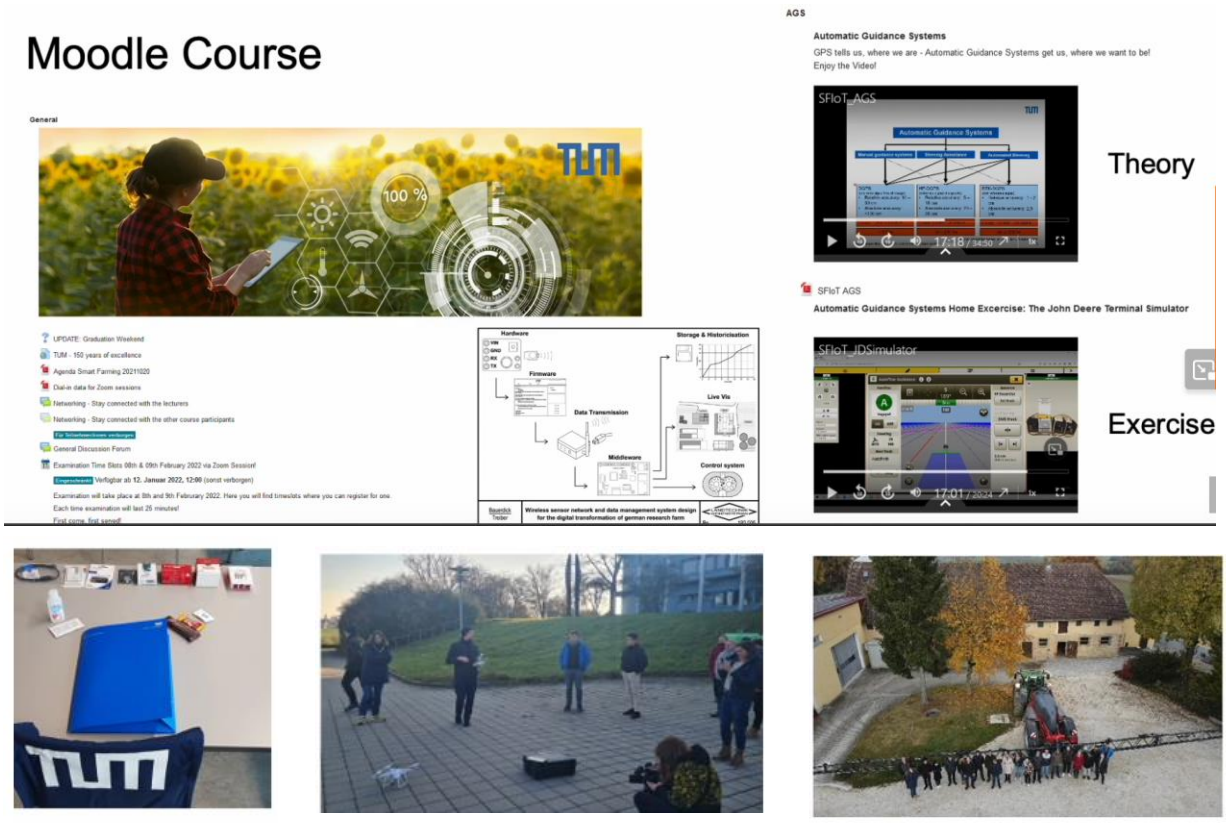

Figure 2: Blended learning in the TUM course “Smart Farming and IoT in Agriculture”

2.2 Section 2 Micro credentials development as innovative LLL strategy – USAGE NG

The objective of the USAGE NG project is to make learning paths more flexible at different stages of life by increasing modularity of studies and providing learners micro credentials. Therefore, we examined the role of micro credentials in the agricultural sector and assessed which micro credentials are relevant. What is the university strategy for micro credentials development and what are the main challenges? What are the added values: better job opportunities, reskilling, involvement of industry in education, or personal motivation? We apply desktop research as the qualitative method that contains elements of thematic analysis, secondary data analysis, and a bottom-up approach. This research is related to the collection, review, and analysis of data on micro credentials in agricultural engineering. We will provide a post survey among graduates, a digital-based-review of acquired new skills at work regarding employability enhancement.

USAGE NG is using these findings on micro-credentials as a tool for flexible and extra-curricular learning offers that address competences that go beyond the typical core curricula. The development of micro-credentials as a basis serves modules development and applied innovative pedagogic approaches in the USAGE project. *This experience will be integrated into the micro credentials - competence oriented short courses (1-15 ECTS) with the focus on skills and how they will be put into actual practice and how they will be reflected in the evidence*. (Maina et al. 2022, 12–15)

Based on the European approach to micro-credentials, our learning offers merge different perspectives of the various backgrounds of learners and teachers and are linked with a distinct, targeted learning experience with clearly defined learning outcomes that are assessed against transparent standards. The main objective of the European approach to micro-credentials is to facilitate their validation, recognition, and portability. Therefore, we implement four phases of validation procedures: Identification, Documentation, Assessment and Certification based on the CEDEFOP guidelines adopted for micro credentials (CEDEFOP 2015, chap. 3). We are considering who the validation process responds to, and the interests of the target groups; taking serious care about the target guidance and counselling services; choosing the right tools and instruments for the identification, documentation, and assessment of learning. The validation process will be linked to national qualifications frameworks of the partners as well to the European Qualifications Framework taking into account that the outcomes of validation refer to the same or equivalent standards as those used for formal education.

3 RESULTS

3.1 Analysis

In the meantime, at partners institutions a wide variety of course concepts have been developed and implemented in two rounds during the project lifetime. A key aspect resulting from the experience of the individual courses is the further adjustment of the educational offer. To this end, surveys were conducted among course/module/micro

credential graduates. The qualitative analysis follows content analysis based on feedback provided by the survey to evaluate and to improve the content, to determine graduate preferences, and setting the direction for future developments. A teacher and teaching methods evaluation was also included. Two out of five respondents replied that most of their expectations regarding the course were satisfied; three respondents replied that some of their expectations were satisfied.

Due to the need and request for the courses to take place outside of normal working hours, one course was organized on two dates as a weekend course from Thursday evening to Sunday. The learning was rather intense, however, reflection time on the learning was limited. Another course was, also because of the COVID-19 pandemic, a complete online offer with prepared learning units and additional online discussion groups. Although the learning material was conveyed well, the participants missed the group exchanges. Therefore, the next course was developed considering this initial experience; two weekend dates (Friday to Sunday) are offered at the beginning and end of the course with special emphasis on group cooperation with excursions and group work. In between, prepared teaching and practice sessions are offered for participants to work on independently. For communication there is a weekly online meeting where the progress of the projects is discussed. Thus, a good balance between communication and teaching content is achieved.

Another interesting aspect is the group composition of the individual courses. Employees of agricultural companies use the course to reach the next level of development in their companies, whereas doctoral students - in or after the final phase of their doctorate - are interested in further orientation. International master's students have similar interests; some of these students had already completed extensive studies abroad and came to Europe to pursue a master's degree. For managers from agricultural engineering companies, who often had a very high level of knowledge in the field of smart farming, knowledge transfer plays only a subordinate role in the course as they are much more interested in making new contacts with the other participants and talking to the lecturers at the same level.

The below feedback (Figure 3) on the course Smart Farming and IoT in Agriculture – TUM is consistently positive. The videos and exercises were particularly well received; so was the overall course organisation and related communications. Although there are minor variances on the responses related to questions on the online elements, the overall level of satisfaction is very high.

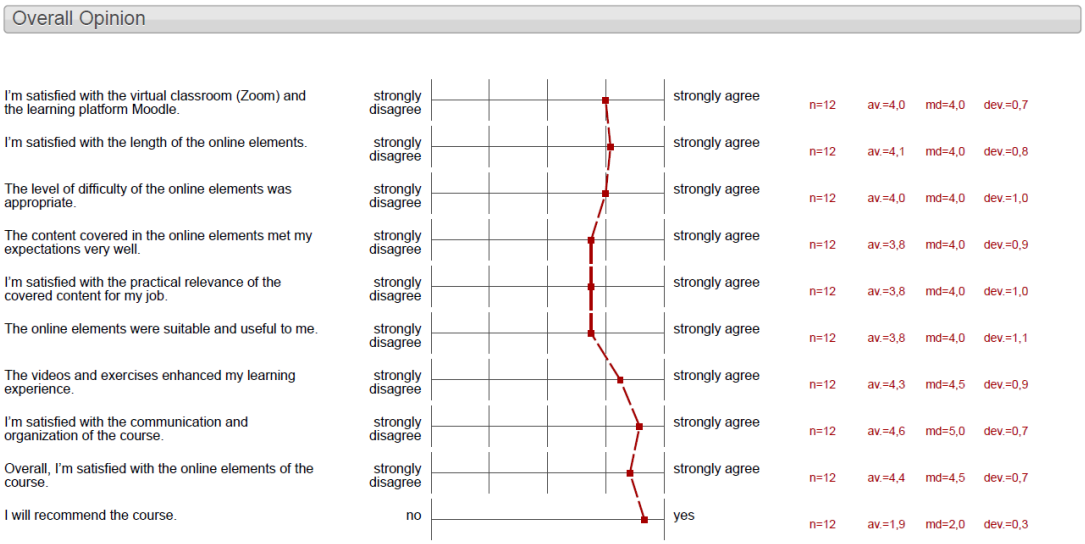

Figure 3: Smart Farming and IoT in Agriculture Online Sessions (n=12) feedback

Local language is the preferred graduate language which is included in the second round of courses development. An important aspect for some participants was that the courses are included in the ECTS through the universities, which makes it possible to apply the work done in the course to other continuing education programs based on it. With the full costs of the courses between EUR 2.000 and 5.000, the survey revealed that these prices lie generally at the upper edge of the participants' willingness or ability to pay. Here the universities must consider which service they want to offer for which price. This is still an unfamiliar area for many European universities, and it has become clear in the course development and implementation that this cannot be done on the side by a professorship or the university. The courses need to be marketed at full cost on the free market and they must therefore also offer the generally required service. Hence, special organizational units with appropriate equipment must be created to develop this additional offer sustainably for the universities in the long run. It becomes clear that for LLL special offers are necessary, which differ from the normal teaching concepts of universities, and which are specially aligned to the target groups (Bernhardt et al. 2022, 4–5).

3.2 Conclusions

The analysis of the experiences of several LLL courses conducted in past years shows that if the right pedagogic methods are paired with substantial content, e.g., smart agriculture with a learner centred approach, up/reskilling is possible in a short period of time (6 ECTS). Furthermore, pedagogical innovations such as micro credentials enhance the visibility, transparency and trustability of new skills and enable a better understanding of the collaboration between higher education institutions and the agricultural business sector. Results also show that students have increased the awareness of their employability skills and of the labour market expectations. Micro credentials create a basis for transdisciplinary cooperation and for collaboratively handling professional and societal challenges.

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