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**O6 - Distance Learning
Methodology in Machine Learning
and Cloud Computing Courses –
Case Study**

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CODEIN

Cloud cOmputing for Digital Education INnovation

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Abstract	<p>This case study presents the implementation of a distance learning methodology for machine learning and cloud computing courses that was developed under the CODEIN Erasmus+ project with the aim of addressing the challenges of digitization and inclusivity in higher education during the COVID-19 pandemic. The project collaborated with Oracle Corporation to leverage Enquiry-based learning (EBL) to enhance student engagement and knowledge acquisition, particularly among female students and those from economically disadvantaged backgrounds in the IT sector. The study outlines the development of pilot curricula, the integration of modern teaching methodologies, and the use of Oracle's educational resources to provide accessible, inclusive, and effective remote learning experiences. Feedback from the participants indicates high satisfaction with the program's interactivity, resources, and impact on academic performance, highlighting the methodology's success in fostering an inclusive and engaging learning environment.</p>
Disclaimer	<p>This project has been funded with support from the European Commission. This publication reflects the author's views only, and the Commission cannot be held responsible for any use that may be made of the information contained therein.</p>

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INTRODUCTION

The CODEIN Erasmus+ project was launched to address the digitization and challenges faced by higher education during the COVID-19 pandemic. The project consortium comprised of five EU higher education institutions, including the Polytechnic of Šibenik, Lodz University of Technology, University of Žilina, University of Aveiro, and LUISS University.

The project's primary goal was to modernize remote learning methodologies, which were then incorporated into pilot curricula of machine learning and cloud computing. The consortium members utilized the modern EBL (Enquiry-Based Learning) teaching methodology to focus on the students. To familiarize teachers with this methodology, the approach dealt with significant topics such as research approach to learning, critical thinking, and group work. The pilot curricula were developed using the experiences gained from previous project results.

The project focused on democratizing education with inclusivity and openness of higher education in mind. The teaching materials for the pilot curricula were developed while exploring approaches to teaching that could enhance female participation in ICT education and adjust pedagogical strategies to change the current state. The project also researched teaching strategies that could increase the proportion of girls in ICT study programs, resulting in a particular policy paper on the same topic.

This document presents a case study for implementing the machine learning and cloud computing pilot curricula in collaboration with Oracle Corporation, the project's associated partner. The IT sector's job market is highly internationalized, with trends driven by international corporations that often run their educational academies. The project connected the above results with the educational resources developed by Oracle within the Oracle Academy program. The applied EBL teaching methodology and developed pilot curricula were thus implemented on the Oracle Member Hub LMS platform. For practical work and additional research, students had access to user accounts for the Oracle Cloud Infrastructure (OCI) platform.

BACKGROUND

The educational systems in the European Union (EU) are facing challenges in providing equal opportunities to all student groups, particularly female students and those from economically disadvantaged backgrounds [1]. Students from less privileged families and those with special needs have limited access to educational resources such as the Internet and technology tools, which are necessary for learning. Geographic barriers, especially in rural areas, continue to limit access to higher education. Stereotypes and gender biases often limit the participation and advancement of female students in IT and STEM fields [2]. The challenges faced by women in higher education, particularly in IT, reflect the broader societal context of gender inequality. Despite making up approximately half of the global workforce, women are significantly underrepresented in the IT sector. This gap is a matter of equality and a missed opportunity for individuals and the industry.

The EU actively addresses these issues through various programs and initiatives to create inclusive educational environments supporting diverse learning needs. For example, the Erasmus+ program [3] allows students from different socioeconomic backgrounds to study abroad, encouraging equality and access to higher education. The EU's Action Plan for Digital Education (2021-2027) [4] promotes digital literacy and access to digital resources, crucial for students from remote and economically weaker areas. For students with special needs, the EU has implemented initiatives such as the European Accessibility Act [5] and the EU Strategy for the rights of persons with disabilities 2021-2030 [6]. Programs like the European Commission's Rural Vision [7] are essential in reducing these barriers by enabling better internet connectivity and digital resources. Additionally, scholarship programs such as the DAAD and Eiffel Excellence Scholarship Program are critical to providing financial support to students from less privileged backgrounds, thus ensuring more equitable access to education.

Technology plays a vital role in addressing some of the educational challenges. Digital platforms have become increasingly popular as they offer personalized learning experiences that are especially useful for those who are geographically or economically constrained. However, it is essential to ensure that diverse educational perspectives are included to guarantee that all students see themselves represented in the curriculum. This includes presenting teaching materials and case studies that reflect gender, cultural, ethnic, and socioeconomic diversity.

Innovative pedagogical approaches are essential in attracting, retaining, and nurturing talent in IT. Collaborative learning, which emphasizes group activities and peer interaction, is one method that encourages active participation and a sense of community, which is particularly beneficial for women in IT. EBL methodology [8], which focuses on solving real-world problems, also provides a practical approach that appeals to women, often involving social issues or community questions. Integrating technology into teaching in an engaging and accessible way, such as using interactive tools, virtual reality, and gamification, can make learning more attractive and relevant for all.

DISTANCE LEARNING METHODOLOGY

In the first phase of the project, a research study [9] was conducted to find answers to critical questions related to the methodology of distance learning. In June 2021, 148 teachers, lecturers, and assistants from five European countries (Croatia, Italy, Poland, Portugal, and Slovakia) participated in this study. The participants were presented with ten statements about online learning, and they were asked to express their opinions on a scale of 1 to 5. During the study, initial problems related to online learning, previously highlighted by the educational community during the first phase of the COVID-19 pandemic, were confirmed. The participants' opinions were mainly divided on whether students receive online information that is equally valuable as traditional teaching. Most teachers believe that preparing online lessons requires more effort than designing for traditional classroom teaching, and online teaching is a source of stress for both teachers and students.

However, the study also noted positive aspects of online learning, especially regarding students' acquisition of digital skills. The teachers confirmed the main guidelines for the development and application of a teaching methodology to be developed within the project. It was particularly emphasized that enhancing the effectiveness of online learning is possible through student-centered teaching that promotes collaboration and group work among students, the development of critical thinking, and the improvement of scientific literacy.

The research results indicate the need to apply a teaching methodology known as EBL, which emphasizes the need for the student to become a researcher during learning. By applying such a methodology to distance learning, it is crucial to use technology to give students access to verified sources of knowledge that they can independently explore and from which they can acquire practical (strong) knowledge.

This teaching methodology requires teachers to acquire some competencies that may not be necessary in traditional teaching. Researchers have identified several main competencies teachers should master when applying the EBL methodology. These competencies include gamification in education, developing critical thinking, and various aspects of scientific literacy. To help teachers acquire these competencies, 15 short materials were created and published as webinars within the project [9].

A standard EQF methodology [10] was used to create a pilot curriculum in machine learning and cloud computing, which is now implemented in the qualification frameworks of all EU member countries. Initially, the competencies required in the labor market were identified through questionnaires sent to employers who needed them in their business. These competencies were then translated into appropriate learning outcomes and teaching units. That means 150 hours of learning per curriculum, representing a significant commitment from students (approximately 5 ECTS credits per curriculum).

However, in distance learning, student engagement differs significantly from standard learning. In distance learning, the teacher introduces students to basic concepts through an introductory online lecture, informs them about teaching materials and platforms, and provides help and mentoring in mastering the material. This approach avoids a common mistake in distance learning, especially highlighted during the COVID-19 pandemic, where classroom lectures were reduced to teaching content online without particular interaction with students.

This method of teaching requires better quality interactive teaching materials designed for independent student work and practical knowledge acquisition. Oracle, a partner in the project, provided valuable technologies and experiences through their Oracle Academy (OA) remote learning program [11], which has similar curricula. The OA Member Hub [12] system was also utilized to post teaching materials, allowing interaction with students and monitoring their progress in mastering the learning materials.

The methodology for distance learning was refined within the project to include research results that addressed inclusivity issues. A strategy for teaching girls in the IT field was developed based on research conducted at universities that are project consortium members [9]. The research aimed to identify factors that increase the active participation of female students in the IT field, promoting gender equality in education and contributing to women's engagement in the digital

economy. The research identified common barriers and challenges faced by female students, including gender bias, discrimination, lack of female role models, and stereotypes about women in IT. The research also determined the importance of using gender-inclusive language and teaching materials. Extracurricular activities, such as summer schools and workshops, were highlighted as significant in encouraging greater participation of women in IT programs. Two policy papers [9] were ultimately developed and published based on the experiences in inclusion issues that influenced the development of the distance learning methodology. The first policy paper relates to women in the IT sector and increasing the number of women in higher education IT programs. The second policy paper pertains to modular, open-access education in the cloud, promoting the openness of higher education institutions to offer distance courses accessible to the broader public. Six short webinars [9] were also developed and published for each policy paper. The target groups for both policy papers are teaching and managerial staff at higher education institutions who should be encouraged to implement these recommendations.

KEY ACTIVITIES AND MILESTONES IN COURSE PILOTING

The distance learning methodology described earlier has been implemented and piloted for over 100 participants. This included 103 participants from universities that are members of the project consortium and 7 participants from the NEET population. These participants had the opportunity to learn about machine learning and cloud computing. During the registration process for the pilot education programs, we collected detailed information about the participants' demographic characteristics, educational background, and understanding and interest in specific areas of the curriculum. The aim of collecting this information was to gain insight into the current knowledge level of the students, their readiness to learn and work in these areas, and their interests and previous experiences. Using this information, we adapted the teaching materials to improve and encourage greater student engagement.

We found that the students involved in the pilot program showed varying levels of knowledge and interest in machine learning and cloud computing. Although many students had a basic understanding of these technologies, many needed to familiarize themselves with them (approximately 70% in machine learning and 60% in cloud computing). Among the participants, 86% were undergraduates, with a slight majority of male participants (52%). We also identified high motivation for learning, with 86% of students expressing a strong desire to learn about

machine learning and 79% showing a similar motivation for cloud computing.

Adjustments were made to the teaching resources based on previous findings and guidelines of the developed teaching methodology. Short webinars were created for each course (15 webinars for each curriculum) with presentation materials where fundamental concepts were explained. This format allowed students to learn at their own pace, which was particularly beneficial for complex learning topics. The teaching materials served as visual support, which helped students better understand and retain information. This way, the knowledge gap among students was bridged, making learning more accessible and efficient. Additionally, links to high-quality online resources were prepared for independent research and learning. For instance, a list of the 30 most influential books in machine learning was made available to students for free online under the Creative Commons (CC) non-commercial license.

The OA Member Hub platform, developed by Oracle within the Oracle Academy program, was used as the platform for learning management. This platform allowed for creating special learning channels by combining teaching materials developed within the project with various Oracle Academy resources. These resources ranged from complete curriculums (e.g., *AiML Artificial Intelligence with Machine Learning*, *Oracle Cloud Infrastructure Foundations I*) to short education programs named Oracle Academy Education Bytes, which top experts designed for quick mastery of specific technologies (e.g., *Oracle Red Bull Racing: Find the BEST Race of All Time*, in which students are provided with a fun insight into advanced big data analysis technologies).

Once the learning channels were prepared, user accounts for students were created along with their initial passwords. Special attention was given to GDPR provisions regarding using personal data and sending customized notifications at different stages of education. Collecting personal data on a personal computer and creating email lists to send messages to all participants is not recommended. Such actions could block the teacher's email account. It was determined that the Microsoft Power Automate platform [13] could provide secure and personalized notifications, so automated flows were created based on participants' actions. During registration, personal data was processed and stored through the Microsoft Forms platform [14], and users received individualized notifications of successful course registration. The data collected were also used to supplement access data for the OA Member Hub platform. Participants were then emailed with access data for the OA Member Hub platform and instructions. Other flows were triggered, including individual notifications about the dates of introductory online lectures, consultation

schedules, news, and more. Student progress was monitored through the OA Member Hub platform, and additional messages were sent to inactive students, offering them extra help in mastering the material.

The education process started with short introductory online lectures via the Zoom platform, where participants were shown how to use the OA Member Hub platform, where to find things on the learning channels, and how their progress in learning was recorded. They were also shown how to use the Oracle Cloud Infrastructure (OCI) platform, where they could solve practical exercises and implement their projects. Additionally, a weekly Zoom office hours schedule was arranged where students could get individual consultations and help master the material. Instructors were also available for other student requests that they could send via email messages.

Access to all learning channels is permanent for all participants without any restrictions. Upon successful midterm and final exams, the OA Member Hub platform automatically generates a certificate of completed education with the achieved success, which participants can download as a signed PDF document.

RESULTS AND DISCUSSION

After the completion of machine learning and cloud computing pilot courses, we surveyed the students' attitudes toward their experiences [9]. Around 70% of the students who participated earlier responded to the questionnaire. The majority of the respondents (84%) were undergraduate students, and male students (62%) were more in number. Each question was rated on a scale of 1 to 5, and Table 1 shows the percentage of responses rated 4 or 5.

The following summarizes participants' feedback on a conducted distance learning program. Overall, 87% of participants reported being highly satisfied with the education provided and the available learning resources, which suggests that the teaching methodology was effective and the resources provided were adequate and valuable. Additionally, 68% of participants rated the level of interaction during the courses highly, indicating that the program was interactive and provided good communication between teachers and students, which is essential in distance learning.

Table 1 Participant feedback on the CodeIn Distance learning program

Question	Agree (4) or strongly agree (5)
What is your overall satisfaction with the CodeIn distance learning program?	87%
How adequate have the resources (software, learning materials, etc.) for the CodeIn program been?	91%
Rate your level of interaction in the CodeIn courses.	68%
How has this way of online learning impacted your academic performance?	81%
How has this way of online learning impacted your study habits and time management?	70%
How satisfied are you with the teaching methods used?	87%
How fair do you find the assessments and grading?	91%
Please rate the relevance and applicability of the course content.	92%
How satisfied are you with the support provided (technical, academic, emotional ...)?	87%
How effectively does this way of distance learning empower students from diverse backgrounds, including those who are economically underprivileged or from minority groups?	90%
How well do you think this way of distance learning reflects the perspectives and experiences of diverse groups, including women and economically underprivileged students?	85%
How likely are you to participate in similar programs in the future?	92%
How likely will you recommend this distance learning program based on your experience?	91%

The conducted distance learning positively impacted 81% of participants in the context of their academic skills, which is crucial for academic excellence and research work and 70% of participants reported that their participation positively influenced their study habits and time management, which is essential for success in any educational environment.

Most participants rated the applied distance learning methodology highly (87%), and the relevance

of the teaching materials and covered contents was rated remarkably high (91%). These ratings prove that the approach to learning and content was relevant and well-adapted to the needs of the students, which was crucial to their engagement and learning.

The support provided to students, including technical, academic, and emotional, was also rated positively (87% of respondents). Most participants (90%) rated the applied teaching methodology as effective in empowering students from diverse backgrounds, including those economically underprivileged or from minority groups. At the same time, most participants (85%) rated the applied teaching methodology as reflecting the perspectives and experiences of various groups, including women and economically less privileged students. These results demonstrate that the program was sensitive to diversity and included perspectives of different social groups, which is crucial to creating an inclusive educational environment that empowers students from diverse and less privileged groups.

Finally, 92% of participants expressed a high willingness to participate in similar programs in the future, as well as an increased likelihood (91%) of recommending this program to others based on their learning experience. Such feedback reflects not only the participants' satisfaction but also their belief in the efficiency and usefulness of the methodology, which is an essential indicator of its success.

CONCLUSION

This case study has demonstrated that using the EBL distance learning methodology has significantly improved the pedagogical approach, increased student engagement, and better knowledge acquisition. The implementation of this approach has shown a remarkable adaptation of teaching content to the needs of individual students, leading to an increase in their motivation and learning efficiency. The adapted EBL methodology for distance learning has also laid the foundation for further innovations in education, particularly in the growing need for digital education and skill development in technologically advanced areas. Furthermore, the experiences gained from implementing this methodology highlight the critical importance of accessibility and inclusiveness in education. This indicates the need for further research and development to ensure that educational opportunities are accessible to many students, regardless of their geographic or socioeconomic background.

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