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# O6 - Impact of Pedagogical Strategy on Female Students in IT - Case Study

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# CODEIN

Cloud cOmputing for Digital Education INnovation

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# Identification Sheet

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| Abstract | This case study presents the implementation of a distance learning methodology in machine learning and cloud computing courses. The methodology was developed under the CODEIN Erasmus+ project to address the challenges of digitization and inclusivity in higher education during the COVID-19 pandemic. The project collaborated with Oracle Corporation and used Enquiry-Based Learning (EBL) to improve student engagement and knowledge acquisition in the IT sector. The methodology was particularly beneficial for female students and those from economically disadvantaged backgrounds. The study outlines the development of pilot curricula, the integration of modern teaching methodologies, and the utilization of Oracle's educational resources to provide accessible, inclusive, and effective distance learning experiences. Feedback from the female participants indicates high satisfaction with the program's interactivity, resources, and impact on academic performance. This highlights the methodology's success in fostering an inclusive and engaging learning environment. |

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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 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 project also researched teaching strategies that could increase the proportion of girls in ICT study programs, resulting in a particular pedagogical strategy and policy paper on the same topic.

Today, we have become increasingly aware of the issue regarding the underrepresentation of women in the IT sector [1]. Despite women accounting for half of the workforce today, their limited presence in the IT industry is a matter of concern. This goes beyond gender equality; it signifies that the IT industry is not fully tapping into the potential of talent [2].

The primary reason behind this gender gap in the IT industry is the stagnation in the number of women pursuing education in this field [3]. This problem primarily arises from gender stereotypes that discourage women from venturing into technological occupations. These stereotypes create an impression that IT is predominantly male-centric, unfairly excluding women from considering roles within this sector. Another significant factor contributing to this issue is the lack of role models within IT. When women do not see themselves represented in positions, they are less motivated to pursue careers in those fields [4]. Unfortunately, this creates a toxic cycle that makes it challenging to attract generations of women into IT.

Additionally, unsupportive and sometimes hostile classroom environments can deter women from pursuing IT education. Suppose educational institutions do not offer an inclusive and supportive atmosphere. In that case, talented women may give up on other academic paths or careers [4].

To tackle these issues, the Enquiry-based learning (EBL) methodology [5] was explored to increase girls' participation in IT education. This approach focuses on solving real-world problems, providing a hands-on approach to learning. This method is particularly interesting for women because it often involves social or community-related issues, making the learning process more relevant and impactful. EBL improves problem-solving and critical thinking skills and ensures that students are prepared to tackle the challenges they may face in their professional lives.

Additionally, EBL supports collaborative learning, which emphasizes group activities and peer interaction. This approach encourages active participation, fosters communication skills and fosters a sense of community among students. Collaborative learning is particularly effective for women in IT because it creates a supportive environment that can help close the gender gap in this field.

The creation of pilot teaching materials [6] applied recommendations that emphasized the importance of including different perspectives in IT education. The diversity of teaching materials and case studies ensures the accessibility and relevance of the content for all students. It emphasizes the importance of the representation of women in the curriculum. This diversity extends to different cultural, ethnic, and socioeconomic backgrounds, creating an inclusive learning environment that enriches each student's experience and prepares them to work in multicultural and diverse teams, which is critical to their future professional careers.

Finally, the integration of technology in teaching was made attractive and accessible [6]. Interactive tools, virtual reality, and gamification can make learning more engaging and relevant, especially for women who may feel alienated by traditional IT teaching methods. By making technology more accessible, we can encourage greater participation and interest from women, further bridging the gender gap in IT [7].

The innovative pedagogical approaches highlighted in this research can play a significant role in attracting, retaining, and nurturing female talents in IT. In this way, we hope to contribute to a more diverse, inclusive, and productive IT workforce.

## BACKGROUND

As a part of the CODEIN project, teaching strategies were researched and implemented to encourage more girls to pursue study programs in the IT field. The project started by investigating the main obstacles preventing girls from getting involved in IT. It was found that gender stereotypes were the leading cause of this issue. These stereotypes are deeply integrated into social norms and cultures, and they have significant consequences for women's professional development in fields such as IT and STEM.

Gender stereotypes often influence the general perception of what is considered "normal" or "appropriate" for a specific gender. For example, it is commonly believed that men are naturally

better at technical and scientific disciplines. This belief can discourage girls and women from entering IT and STEM fields, thereby reducing their participation in these fields [2].

Gender stereotypes are often unconsciously implemented in educational settings, such as schools and textbooks. For instance, textbooks or examples used in classes may depict men as the primary actors in science and technology, while women are rarely mentioned or portrayed in passive roles. This approach can limit women's ability to identify with these areas [4].

Social pressure and expectations also play a significant role in gender stereotypes. Girls who show interest in "male" disciplines often face criticism or disapproval from friends, family, or even teachers, creating unnecessary psychological barriers and reducing their self-confidence.

Unfortunately, gender stereotypes do not end in educational environments. In the workplace, they often lead to unconscious biases in hiring, promotions, and performance recognition. Women in IT often face a "*glass ceiling*" and a "*glass wall*," limiting their opportunities for advancement and relegating them to less technical or less prestigious roles. Gender stereotypes can significantly impact women's self-confidence and academic performance. Suppose society constantly sends the message that girls are not good at math or science. In that case, it can lead to a phenomenon known as the "*self-fulfilling prophecy*," where girls begin to believe and act in accordance with these stereotypes.

Finally, the lack of female role models in IT further reinforces this problem [8]. If girls do not see successful women in these fields, they may conclude that these careers are not suitable for them.

## METHODOLOGY

During our project research, we have identified specific activities that can help address the challenges faced in teaching female students in the field of information technology. To bring distance learning up to date, we have improved upon our existing EBL approaches [5]. We have employed the EBL methodology and made certain modifications to cater to the needs and interests of female students in IT. This innovative pedagogical strategy encourages students to apply their theoretical knowledge to solve real-world problems, leading to a deeper understanding of the subject matter. EBL incorporates actual projects and cases from practice, allowing students to develop solutions to relevant challenges in society and the IT industry. We focus on issues with social and common themes to help female students connect with the material in a more personal

and engaging way.

Creating an inclusive curriculum that promotes diversity and gender equality is crucial. One way to achieve this is by integrating female role models from the IT sector into the teaching material. This inspires girls and shows that they can have a place in the technological world. It's also important to revise existing teaching materials to eliminate gender stereotypes, creating a balanced educational environment. To help girls develop self-confidence and a sense of belonging, a supportive and stimulating learning environment that actively encourages their participation is essential. One way to do this is by organizing IT projects and events specifically aimed at girls, which will provide them with valuable experiences and practical skills. Mentorship and support programs are critical in providing the necessary resources and professional guidance to girls in IT [8]. Finally, promoting leadership among girls in IT projects not only develops their leadership skills but also strengthens their presence in the technology sector.

We should not ignore the importance of using interactive tools and inclusive technologies in IT classes, which play a crucial role in attracting women to the IT field. Through personalized and practical learning, with the help of modern simulation platforms, an engaged and adapted educational environment is created. Modern technologies enable hands-on learning and encourage students to progress at their own pace, which is especially useful for those new to IT.

Mentoring and professional development play an important role in supporting and advancing women in IT, where they often face underrepresentation and limited leadership opportunities [8]. The mentoring process, where more experienced professionals share their knowledge, experiences and advice with less experienced colleagues, is valuable for women in IT. It not only provides them with industry insight and career progression advice but also helps with professional networking. This is extremely important in a male-dominated industry, as mentoring can help break down gender stereotypes and glass ceilings, showing that there are multiple paths to success in the IT sector. In addition, mentoring plays a crucial role in building women's confidence in IT. Through support and positive feedback, mentors can significantly influence the self-perceived competence and ambitions of their students. The advice on industry trends and career development strategies that mentors can provide is valuable, especially in the fast-growing and dynamic IT sector.

Finally, in the implementation of the previous activities, higher education institutions should be

more actively involved in strategic alliances in education that play a key role in overcoming challenges related to gender stereotypes and imbalance. Such partnerships, which include educational institutions, corporations and non-profit organizations, can be highly effective in promoting equality and diversity in the IT sector. As part of our project, we have achieved such a strategic partnership with Oracle within the Oracle Academy program [9]. This collaboration has provided numerous benefits, including access to advanced educational resources, the latest technologies, and expert mentorship. In addition, the cooperation with Oracle Academy provided students with a direct insight into real IT problems and solutions, thus gaining valuable practical knowledge and experience that will be useful in their future careers. Also, this partnership has contributed to the development of a curriculum that promotes gender equality and inclusiveness, creating an inspiring and stimulating environment for all students, especially women who aspire to a career in the IT sector.

## KEY ACTIVITIES AND MILESTONES

Initial research within the project [6], focused on the development and modernization of the learning methodology, quickly pointed to the importance of EBL as a key component. Pilot curricula in the field of machine learning and cloud computing were developed by applying the usual guidelines from the European Qualifications Framework (EQF) [10]. The aforementioned included research among employers from industries whose businesses comprise areas such as information technology, machine learning and cloud computing. The goal was to identify specific sets of learning outcomes that ensure that students acquire skills and knowledge that are directly applicable and in demand in the industry. It has been estimated that 150 hours of student work is needed to master the established learning sets, which is the equivalent of 5 ECTS credits.

In the process of creating teaching materials, guidelines from the applied EBL methodology were used to create interactive teaching materials [6]. These materials, in webinar format, are designed with the aim of providing students with a quick introduction to the relevant fields. Each webinar contains key information and guidelines that serve as a guide for students to research further. This approach enabled students not only to passively gather knowledge but also to actively participate in the learning process through research, analysis, and application of acquired information to real problems and situations.

In addition to the general methodology, a specific strategy for teaching girls in the field of IT was

developed [6]. This strategy was based on research conducted at universities that are members of the project consortium, which included 106 female students of various study levels in the field of IT. The research aimed to identify factors that encourage the active participation of female students in IT and thereby promote gender equality in education and contribute to their engagement in the digital economy. The participants were offered thirteen statements, which they evaluated on a scale from 1 to 5. By analyzing their answers, the most common obstacles and challenges that the students encountered during their studies were identified. Among them, gender bias, discrimination, lack of female role models, and stereotypes about women in IT stood out. In addition, the research revealed students' preference for mixed, collaborative methods of working in groups. Diverse female role models in IT have been shown to have a powerful motivational effect. The importance of using gender-inclusive language and teaching materials was also emphasized as a factor contributing to greater engagement of women.

In light of the research results and the developed methodology, we adapted the curriculum and teaching materials to meet the needs and preferences of female students in IT. The adjustments were aimed at overcoming the identified obstacles and challenges and included the following key aspects.

In order to promote equality and inclusiveness, special attention is paid to the use of gender-neutral and inclusive language in teaching materials [6]. Also, the materials are designed to reflect diversity and eliminate any gender bias. An example of such an approach is visible on one slide that we created in the field of machine learning as an introductory slide for clustering and its applications. The illustration includes both male and female characters, designed to explain key concepts of the curriculum interestingly and interactively. This approach not only encourages student engagement and a better understanding of the material but also promotes inclusivity and diversity in the field of technology.

In line with students' preferences for mixed, collaborative work methods, teaching materials are enriched with Oracle Academy workshops that encourage group work and team dynamics. This included team-based projects, seminars, and case studies that required collective problem-solving, encouraging female students to participate and collaborate actively. Passing such content usually requires 4 to 6 hours of work; experts in certain fields create them, and they deal with very demanding technologies in the cloud on a real problem. Examples of such workshops include Cloud Services - Oracle Cloud Digital Assistant and AI - Create a Digital Assistant, through which

female students could create their digital assistant that was able to process a pizza order. Or, for example, Oracle Red Bull Racing: Find the BEST Race of All Time! in which female students, using machine learning algorithms and based on available data from previous races, discover what is essential for the best result of a Formula 1 car.

To counter the lack of female role models and stereotypes about women in IT, the teaching materials are enhanced with examples and case studies of successful women in the IT sector. This aimed to inspire and motivate female students, showing them real examples of women who have achieved success in this field. For example, successful stories of IT women called Member Spotlight have been added to the learning channel [9].

Recognizing the importance of extracurricular activities, additional opportunities are integrated into the Oracle Member Hub distance learning system aimed at encouraging greater engagement of women in IT. These activities provided additional support and resources to female students, allowing them to expand their knowledge and skills beyond the traditional curriculum. This was, for example, available on the learning channel in the additional category Career Paths, where female students could find packages of further education for specific jobs in IT (e.g. Database Administrator, Software Developer, Cloud Infrastructure Engineer, etc.)

## RESULTS AND DISCUSSION

At the end of the project activities, the attitudes of female students were examined regarding their experiences of participating in project pilot education in the field of machine learning and cloud computing. A total of 46 female students from partner universities were included in the mentioned education, and 27 of them, or approximately 59% of the participants, answered the questionnaire. All female respondents were bachelor's degree holders. For the comparison, the questionnaire was responded to simultaneously by 36 male respondents out of a total of 57 who were involved in the pilot education, or approximately 63% of them.

Recorded answers to the questions are shown in Table 1. Since the respondents answered on a scale from 1 to 5, only those answers that had the highest rating (4 or 5) were taken into account. The answers by gender are shown separately for all respondents. It is evident from the above that female students gave a higher rating in all categories compared to male participants.

**Table 1 Participant feedback on the CodeIn Distance learning program**

| Question | Agree or strongly agree - all [%] | Agree or strongly agree - male students [%] | Agree or strongly agree - female students [%] |
|---|---|---|---|
| What is your overall satisfaction with the CodeIn distance learning program? | 87% | 83% | 93% |
| How adequate have the resources (software, learning materials, etc.) for the CodeIn program been? | 91% | 89% | 93% |
| Rate your level of interaction in the CodeIn courses. | 68% | 58% | 81% |
| How has this way of online learning impacted your academic performance? | 81% | 69% | 96% |
| How has this way of online learning impacted your study habits and time management? | 70% | 58% | 85% |
| How satisfied are you with the teaching methods used? | 87% | 78% | 93% |
| How fair do you find the assessments and grading? | 91% | 83% | 100% |
| Please rate the relevance and applicability of the course content. | 92% | 86% | 100% |
| How satisfied are you with the support provided (technical, academic, emotional …)? | 87% | 78% | 100% |
| How effectively does this way of distance learning empower students from diverse backgrounds, including those who are economically underprivileged or from minority groups? | 90% | 86% | 96% |
| 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% | 81% | 93% |
| How likely are you to participate in similar programs in the future? | 92% | 86% | 100% |
| How likely will you recommend this distance learning program based on your experience? | 91% | 83% | 100% |

The program received positive feedback from both male and female participants, but the level of satisfaction was notably higher among female students  Female students gave overwhelmingly positive feedback on the program's resources and interaction level, indicating that it effectively met their expectations and learning needs. They perceived a strong positive impact on their academic performance, highlighting the significant influence of the program on their growth and

development.

Our female students also provided positive feedback about the teaching methods, fairness of assessments and grading, course content, and support available to them. This feedback indicates that the program is successful in providing practical and pertinent learning that aligns with their academic and career goals in a nurturing and responsive educational environment.

And finally. female students also found the program empowering, diverse and inclusive.  They expressed eagerness to participate in similar programs in the future. Additionally, they unanimously recommended the program to others. While male students also responded positively, female students had a consistently higher level of approval, highlighting the program's success in creating an inclusive and empowering educational environment.

## CONCLUSION

It seems that the CODEIN project uses innovative teaching methods that have proven highly effective in attracting and retaining female talent in IT. Our strategies included diverse role models, gender-inclusive materials, and enquiry-based learning, which have improved female students' experiences and addressed gender biases and stereotypes.  We hope that our small contribution will offer hope for achieving gender equality and a more diverse and productive IT workforce.

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