UNIVERZA V LJUBLJANI
University of Ljubljana

BLISS

Erasmus +: BLISS

Blended Learning Implementation for reSilient, acceSsible and efficient higher education

Project 2021-1-SE01-KA220-HED-000023166

Project result 5 - Deliverable 5.2.1 – Adaptation Guidelines for Blended Learning Units

Co-funded by the European Union

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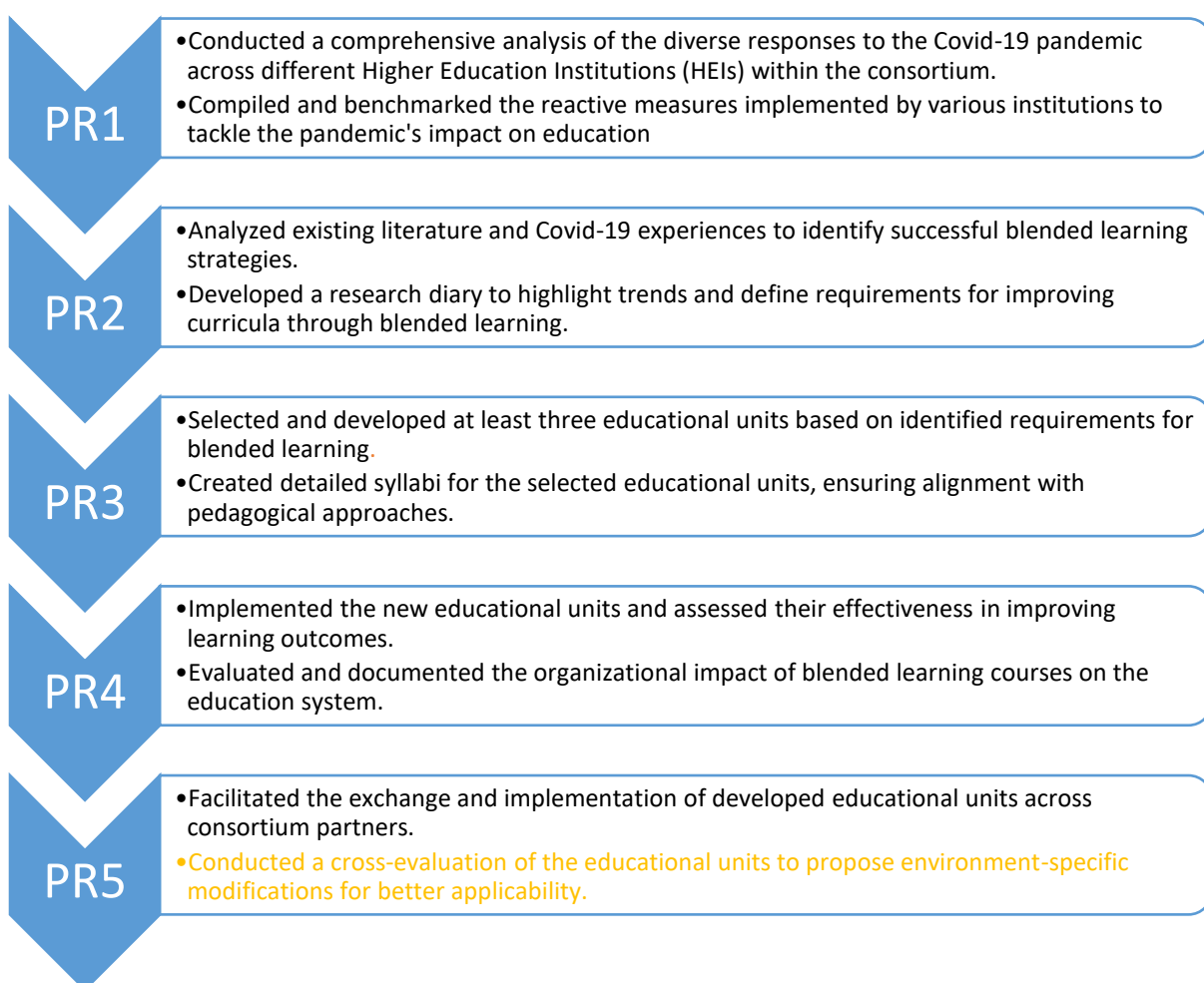|	
Project title:	Blended Learning Implementation for reSilient, acceSsible and efficient higher education
Project result:	5
Leading org.:	University of Ljubljana
Output title:	Cross-application of educational units among the partners
Authors:	University of Ljubljana with input from the entire consortium

Project Deliverable 5.2.1 summary:

Project deliverable implementation

Project result 5 was divided in two tasks. The first one was titled: "Cross evaluation of the developed blended learning educational units by partners throughout the partnership.". The second one was titled: "Proposals for environment specific blended learning modifications". The main idea of the second task was to generate the solutions for addressing the observed deterioration of educational units within task 5.1 and the assess their effectiveness.

Division of work

University of Ljubljana prepared a list of possible solutions to address the difficulties identified within Task 5.1. Special emphasis was given on the Cooperation activities performed so far within the Partnership. For that reason, a detailed list of activities (personnel exchange, common projects, common papers) was prepared. A series of online meetings was organized, where the offered solutions were discussed in the context of improving the performance of educational units in other partners' environments.

Project Deliverable 5.2.1 in the context of the project

PR1
- Conducted a comprehensive analysis of the diverse responses to the Covid-19 pandemic across different Higher Education Institutions (HEIs) within the consortium.
- Compiled and benchmarked the reactive measures implemented by various institutions to tackle the pandemic's impact on education

PR2
- Analyzed existing literature and Covid-19 experiences to identify successful blended learning strategies.
- Developed a research diary to highlight trends and define requirements for improving curricula through blended learning.

PR3
- Selected and developed at least three educational units based on identified requirements for blended learning.
- Created detailed syllabi for the selected educational units, ensuring alignment with pedagogical approaches.

PR4
- Implemented the new educational units and assessed their effectiveness in improving learning outcomes.
- Evaluated and documented the organizational impact of blended learning courses on the education system.

PR5
- Facilitated the exchange and implementation of developed educational units across consortium partners.
- Conducted a cross-evaluation of the educational units to propose environment-specific modifications for better applicability.

Detailed results of the activities

Context

In the Task 5.2. partners a list of some solutions for the problems they identified within 5.1 was offered. The list of the proposed possible solutions:

1. **Laboratories**
   - Hiring facilities from other educational/industrial facilities.
2. **Personnel**
   - Getting suitable personnel via Erasmus+ exchange programs.
   - Getting suitable personnel via part time contract from other universities.
3. **Material**
   - Hiring equipment
   - Using simulation software instead of microcontroller (for example Tinkercad instead of Arduino)
   - Getting trial (temporary) licenses for the software they miss.
4. **Resources**
   - Getting additional funding from other projects.
   - Applying for new course funding within university
5. **Other**
   - Alumni from industry helping in various aspects.

As these activities are often associated with costs, we prepared a list of personnel exchange, common projects and papers that we had, have or plan to have within the partnership, so that all the partners could think of how to best use it in this context.

Cooperation activities

Personnel exchange

Visiting person: Primož Podržaj
Sending institution: University of Ljubljana
Host institution: KTH
Duration: 20.5.2024 ~ 31.5.2024
Context: The visit was part of the Erasmus+ Staff Mobility for Teaching and Training. The teaching program included the following topics: Presentation of artificial intelligence and its role in engineering, Deep learning and its properties, Introduction to Python, Applications of Deep learning. The training part included the following activities: Getting acquainted with the research problems of the PhD students, Presentation of the problems deemed appropriate for deep learning based solutions, Development of the appropriate database(s), Development of the deep learning based control/monitoring systems.

Visiting person: Antonio Maffei
Sending institution: KTH
Host institution: University of Bergamo

Visiting person: Fabio Marco Monetti
Sending institution: KTH
Host institution: Polito

Projects

Title: Blended Learning Implementation for reSilient, accessible and efficient higher education
Acronym: BLISS
Status: Finishing
Duration (when applied for): 1.11.2021 ~ 1.11.2024
Partners: KTH, Polito, University of Ljubljana, University of Malta, University of Bergamo, University of Rijeka
Context: The Covid-19 pandemic forced HEIs to rapidly rethink their learning strategies, accelerating online integration and testing system resilience. Engineering education faced dual challenges: adapting pedagogy and updating curricula to align with Industry 4.0. Blended learning (BL) emerged as a key solution, combining online and face-to-face education. However, financial constraints have hindered HEIs from fully implementing BL. The BLISS initiative aimed to enhance HEI efficiency and accessibility through virtual exchanges and multi-campus integration. Its objectives include designing educational units for engineering curricula and providing methodological support for BL implementation. Lessons from Covid-19 guided its approach. Virtual exchange tracks expand mobility options, ensuring inclusivity and sustainability. The BLISS blueprint, though focused on engineering, will benefit broader disciplines.

Title: Talent Acquisition Initiative
Acronym: /
Status: Ongoing
Partners: KTH, University of Ljubljana
Context: The Talent Acquisition initiative fosters collaboration between senior European university staff and emerging scholars from Chongqing University. At its core, the program aims to enhance young researchers' skills through training in scientific research methodologies and academic writing. This initiative is part of the broader BLISS (Blended Learning International Scope Strategy) framework, promoting global scientific and industrial research cooperation. Training follows BLISS-developed methods, focusing on research techniques, scholarly writing, and developing proposals suited to China's academic and industrial landscape. The primary disciplines include manufacturing and industrial engineering, though the project may later expand to other fields. A key aspect is the staff exchange program, facilitating knowledge transfer and deepening institutional ties. By merging European academic expertise with China's growing research ecosystem, the project builds a strong network of skilled researchers.

Title: Advanced MR Training foR HumAn-Centric ProductIon EmpoweriNg Engineering TalEnt
Acronym: TRAINEE
Status: Ongoing
Duration: 1.9.2024 ~ 31.8.2027
Partners: University of Malta, KTH, University of Rijeka

Context: The TRAINEE project is transforming higher education by integrating Mixed Reality (MR) technology into training, creating immersive and accessible learning experiences. It aims to expand remote education, making it more inclusive while reducing environmental impact and infrastructure costs. Aligned with EU goals on sustainability and digital innovation, it prepares the workforce for the high-tech manufacturing sector. Inspired by initiatives like BLISS, TRAINEE focuses on digital and pedagogical innovation, enhancing resilience and efficiency in education. The project fosters collaboration through transnational meetings, ensuring seamless partner engagement. Key efforts include developing MR technology specifications, designing curriculum frameworks, and conducting case studies to refine digital learning tools. By introducing new pedagogical models and content creation tools, TRAINEE seeks to improve accessibility and knowledge transfer across European higher education institutions. The project's results will make MR technology more adaptable and personalized, fostering a future where digital learning is more engaging, sustainable, and impactful.

Title: Fostering Acceptable Use and Responsible Integration of Generative AI in Higher Education
Acronym: FORESIGHT
Status: Planned for resubmission
Duration: 1.9.2024 ~ 31.8.2027
Partners: KTH, University of Bergamo, University of Malta, POLITO, University of Ljubljana, University of Rijeka
Context: The FORESIGHT initiative explores Generative AI's role in higher education, focusing on responsible integration and ethical use. Building on BLISS, it develops policies, training, and ethical frameworks to enhance education quality and align with workforce demands. Key activities include defining acceptable AI use, creating a structured integration framework, and developing AI-focused educational units for engineering curricula. These units address integrity, oversight, bias, and privacy, with pilot testing ensuring effectiveness. FORESIGHT promotes long-term sustainability through joint degrees, industry partnerships, and collaboration. Outcomes include open-access research, AI integration guidelines, updated engineering skill profiles, and specialized training. By leveraging BLISS's blended learning insights, FORESIGHT ensures AI enhances engagement, accessibility, and learning in higher education.

Title: Developing a MIxed Reality Training Toolbox for Higher EduCAtion Institutions to PrepaRe for IndUStry 5.0
Acronym: ICARUS 2
Status: Planned for resubmission
Duration: 1.9.2023 ~ 31.8.2026
Partners: University of Malta, KTH, Univesity of Rijeka
Context: The project leverages Mixed Reality (MR) to revolutionize Industry 4.0/5.0 training in higher education, aligning with EU goals for digital innovation, sustainability, and accessibility. By integrating MR into curricula, it enhances learning through immersive environments, improving comprehension of complex manufacturing concepts while supporting blended and remote education. Building on ICARUS 1.0 and insights from BLISS, the project refines pedagogical frameworks for MR in education, ensuring effective implementation. Key objectives include developing an MR Industry 4.0/5.0 training toolbox, a structured curriculum, modular case studies, and an innovative content creation framework. A knowledge transfer evaluation tool will measure learning effectiveness, optimizing teaching strategies. By reducing reliance on physical infrastructure, MR contributes to the EU Green Deal, lowering carbon footprints in education. This initiative fosters industry collaboration, upskills the workforce, and democratizes MR content creation, making it more accessible. Ultimately, it drives digital transformation, enhances engagement, and strengthens Europe's competitive edge in smart manufacturing education.

Title: Skills and cAPabIlities for future ENgineers working with Sharing and circular economy
Acronym: SAPIENS
Status: Planned for resubmission
Duration: 1.9.2023 ~ 31.8.2026
Partners: University of Rijeka, University of Ljubljana, University of Bergamo, University of Malta, KTH
Context: The SAPIENS project supports the goals of BLISS by integrating sustainability-oriented educational content into engineering programs through blended learning approaches. The project seeks to identify academic and industrial contributions in the circular and sharing economy, aligning them with European strategic plans and UN SDGs. These contributions will inform the development of new educational units, addressing gaps in existing engineering curricula. The project follows a structured process: identifying relevant knowledge, designing targeted educational units, and refining them through stakeholder feedback. Designed using the constructive theory of learning, the courses will ensure an industry-relevant and engaging learning experience. Expected outcomes include open-access research resources, updated engineering skill profiles, training programs, and multiplier events. By integrating BLISS principles, the project enhances accessibility, resilience, and efficiency in engineering education, fostering sustainable competencies through innovative blended learning methodologies.

Title: Virtual lab based education
Acronym: VLAB
Status: Planned for resubmission
Duration: 1.3.2021 ~ 28.2.2023
Partners: University of Ljubljana, KTH
Context: This project enhances remote lab-based education in Mechatronics, Manufacturing Management, Robotics, and Control Engineering by developing virtual lab exercises. While lectures transitioned smoothly to online formats during the pandemic, hands-on training posed challenges. By mapping virtual lab solutions and online resources, the project ensures students gain practical experience despite physical limitations. The first step is reviewing existing virtual lab exercises and supplementary materials like videos, MOOCs, and textbooks. These will then be aligned with Intended Learning Outcomes (ILOs), Teaching and Learning Activities (TLAs), and Assessment Tasks (ATs) to ensure pedagogical effectiveness. Finally, course syllabi will be updated to integrate new and improved virtual labs. Approximately 2,000 students and 100 teachers across partner institutions would participate, refining materials from both instructor and learner perspectives. The initiative fosters interest in virtual labs, broadens access to specialized equipment, and supports institutions lacking physical lab resources. By promoting digital readiness, it ensures modernized and engaging engineering education.

Title: Empowering Future Engineers with Skills for the Sharing and Circular Economy
Acronym: ENGINES
Status: Planned for resubmission
Duration: 1.9.2024 ~ 31.8.2027
Partners: KTH, University of Malta, University of Ljubljana, University of Rijeka, University of Bergamo
Context: The ENGINES project aligns with BLISS by integrating sustainability-focused education into engineering curricula through blended learning strategies. It aims to bridge the gap between academic research, industry contributions, and European/UN sustainability goals by developing modular educational units. These units, based on circular and sharing economy principles, would be incorporated into engineering programs. The project follows a three-phase approach: identifying key contributions, designing targeted curricula, and refining courses through stakeholder feedback. The

constructive theory of learning underpins the pedagogical framework, ensuring an interactive and industry-relevant educational experience. Key outputs include open-access research, updated engineering skill profiles, pilot courses, and training activities. By leveraging BLISS principles, the project enhances accessibility, resilience, and efficiency in engineering education, equipping students with sustainability-oriented competencies through innovative blended learning approaches.

Title: Empowering African Progress in Engineering Education - An Initiative for Industry 5.0 and Blended Learning
Knowledge Transfer
Acronym: ENGAGE
Status: Planned for resubmission
Partners: KTH, University of Ljubljana
Context: ENGAGE (Empowering African Progress in Engineering Education) focuses on addressing the urgent need for updated engineering education in Africa. It emphasizes the integration of Human-centered Industry 5.0 technologies and modern pedagogical knowledge and methodologies in the domain of Blended Learning and constructivist theory of learning to enhance both educational quality and its accessibility, resilience and inclusiveness. The initiative is a collaborative effort between European and African HEIs. ENGAGE is spearheaded by the KTH Royal Institute of Technology and it features a selected roster of European top HEIs. The initiative leverages existing cooperation and is built on a foundation of thorough needs assessment, derived from both surveys and in-person visits to African partners, ensuring a deep understanding of their specific requirements. This meticulous analysis has led to the identification of key themes for collaboration, which are central to the initiative's relevance and its anticipated positive impact. A large selection of associated partners among other HEIs, governmental bodies and SMEs will help ENGAGE to reach the critical mass to pivot the envisaged long term effects of the initiative.

Title: Flexible & modular machine feeding system for lean production
Acronym: FLEXiLOAD
Status: Planned for resubmission
Duration: 48 months
Partners: University of Ljubljana, KTH
Context: The FLEXiLOAD project addresses production bottlenecks in multiple European industries by developing a flexible, adaptive, and modular automated handling system. Many production sectors struggle with inefficient material handling at entry points, requiring frequent manual intervention, increasing downtime, and limiting production agility. FLEXiLOAD introduces reconfigurable automation solutions based on human-robot collaboration, adaptive workplace perception, and sensorized workpiece grasping technologies. The project pioneers beyond-state-of-the-art developments and validates them in both lab environments and real industrial shop floors across four sectors: automotive, electronics, cosmetics, and food. A key innovation is the Configure-to-Order automation business model, enhancing manufacturing flexibility. The initiative is supported by a diverse 13-partner consortium from 7 countries, including large enterprises, SMEs, universities, research organizations, and a Digital Innovation Hub. By integrating cutting-edge automation research with practical industrial applications, FLEXiLOAD enhances manufacturing efficiency and adaptability in dynamic supply chain environments.

Papers

Title: Mapping industry 4.0 enabling technologies into united nations sustainability development goals
Journal/Conference: Sustainability MDPI, 13, 2560 (2021), https://doi.org/10.3390/su13052560

Authors' affiliations: KTH, Polito, University of Ljubljana, University of Malta, University of Bergamo, University of Rijeka

Context: The Fourth Industrial Revolution (Industry 4.0) is expected to drive economic growth while enabling a greener future. The UN's 2030 Agenda outlines goals to balance economic, social, and ecological sustainability. However, the impact of I4.0 technologies on achieving the Sustainable Development Goals (SDGs) remains underexplored. This study examined the relationship between I4.0 technologies and SDGs to support policy harmonization. Key technologies were classified and mapped to the 17 SDGs quantitatively. Findings showed that most I4.0 technologies positively contribute to sustainability, though their impact varies in strength.

Title: Toward a sustainable educational engineer archetype through Industry 4.0

Journal/Conference: Computers in Industry, Volume 134, 103543, 2022, https://doi.org/10.1016/j.compind.2021.103543

Authors' affiliations: KTH, Polito, University of Ljubljana

Context: Over the last decade, Sustainable Development (SD) has gained importance in engineering education and industry. This created the need to redefine engineering professional roles. However, no formal methodology existed to standardize engineer archetypes or assess their contribution to SD. This study addressed these gaps by defining engineer archetypes using educational (SS-ILOs) and occupational (ESCO) frameworks. A procedural method now maps these archetypes to UN-SDGs through Industry 4.0 (I4.0) technologies. The proposed methodology was applied to industrial engineering, revealing key sustainability challenges. Results showed that industrial engineers align with specific SDGs, forming a distinct sustainability signature.

Title: Tiphys: an open networked platform for higher education on industry 4.0

Journal/Conference: Procedia CIRP 79 (2019): 706-711, https://doi.org/10.1016/j.procir.2019.02.128

Authors' affiliations: KTH, Polito

Context: The Tiphys project was aimed to build an Open Networked Platform for learning Industry 4.0 concepts. It developed a Virtual Reality (VR) platform where users can design and simulate industrial processes. Users can select standardized models to represent real industrial processes and interactions. A modular approach ensures integration with existing systems and future adaptability. Students can co-create learning tracks and content through collaboration. The paper presented the development and validation of the learning model based on the CONALI learning ontology. The ontology concepts and platform functions was demonstrated through selected use cases.

Title: Blended learning in the engineering field: A systematic literature review

Journal/Conference: Computer applications in engineering education 32, no. 3 (2024), https://doi.org/10.1002/cae.22712

Authors' affiliations: KTH, Polito, University of Ljubljana, University of Malta, University of Bergamo, University of Rijeka

Context: Blended Learning (BL) combines face-to-face and digital activities, increasingly adopted by HEIs. In engineering, BL fosters problem-solving skills through industry-like challenges, enhancing traditional learning. The COVID-19 pandemic forced an abrupt shift to digital teaching, requiring adaptation. This paper reviews BL implementation in engineering, analyzing its impact on learning expectations using Bloom's Taxonomy. It explores how content is distributed between digital and face-to-face settings. The study also examines COVID-19's lasting influence on BL adoption.

Title: Examining the implementation of Blended Learning in the Engineering field

Journal/Conference: 5th International Conference on Higher Education Learning Methodologies and Technologies Online - Book of Abstracts. Foggia, Italy, 2023. p. 83-84, ISBN 978-88-99978-64-8, LINK

Authors' affiliations: KTH, Polito, University of Ljubljana, University of Malta, University of Bergamo, University of Rijeka

Context: Blended Learning (BL) combines in-person and remote methods to enhance student learning. Traditional approaches in engineering often lack technology integration, failing to meet industry demands. BL addresses this by immersing students in problem-solving activities within industry-relevant scenarios. Before the pandemic, teachers structured BL courses freely using Constructive Alignment principles. During COVID-19, they had to adjust Intended Learning Outcomes (ILOs) and adapt face-to-face content for remote teaching. This study examined BL adoption in engineering courses, incorporating lessons learned from the pandemic. The goal was to improve BL implementation for future educational challenges.

Title: Enhancing instructional design: The impact of CONALI ontology and ChatGPT in primary education training

Journal/Conference: CEUR Workshop Proceedings Vol-3879. Proceedings of the Second International Workshop on Artificial Intelligence Systems in Education (AIxEDU 2024), Bolzano, Italy, November 26, 2024, LINK

Authors' affiliations: KTH, University of Ljubljana

Context: The integration of AI in education is crucial, particularly for training future educators. However, there is a lack of AI-related training courses. AI-driven tools help personalize and simplify certain educational pathways. This study examined the use of the CONALI Ontology and ChatGPT in instructional design among 110 students at the University of Foggia. Participants received training in the CONALI framework before using ChatGPT to design Learning Units (LUs). Results showed that CONALI helped students define SMART objectives, while ChatGPT enhanced efficiency and creativity. The study underscores AI's potential to enrich instructional design and educator training.

Title: Development of an Agile Blended Learning Framework for Engineering Higher Educational Instutions post Covid-19

Journal/Conference: Proceedings of the 33rd International Electrotechnical and Computer Science Conference, pages 644-647, e-ISSN 2591-0442, LINK

Authors' affiliations: KTH, Polito, University of Ljubljana, University of Malta, University of Bergamo, University of Rijeka

Context: The increasing demand for online tools challenges Higher Education Institutes (HEIs) in resource availability and accessibility. Post-Covid-19, HEIs must adapt swiftly to blended learning (BL) models. This study introduced the ABL-HEIs framework, assessing HEIs' agility, resilience, and readiness for BL. A case study of Engineering Faculties in six European universities was conducted. The framework provides a knowledge transfer roadmap for an ABL-Resilience Index. The research yielded that universities had higher agility in 2019-2020. By 2020-2021, most demonstrated similar resilience levels across institutions.

Title: Exploring the limitations and potential of digital twins for mobile manipulators in industry

Journal/Conference: Procedia Computer Science, V. 232, P. 1121-1130, https://doi.org/10.1016/j.procs.2024.01.110

Authors' affiliations: KTH, Polito

Context: This work examined the qualification of a digital twin (DT) for a mobile manipulator (MOMA) in industry. Various DT models were developed based on industrial needs, with accuracy dependent on sensor precision. Some limitations arose from challenges in modeling unstructured factory environments. A case study highlighted both the potential and constraints of DTs for MOMA. Key challenges included fidelity, real-time operation, and environment modeling. It was established that the difficulty of fully replicating the surrounding environment hinders true DT implementation. This showed that future research should address these limitations to improve DT effectiveness in Industry 4.0 and smart manufacturing.

Title: Automatic definition of engineer archetypes: A text mining approach
Journal/Conference: Computers in Industry, Volume 152, 103996 (2023),
https://doi.org/10.1016/j.compind.2023.103996
Authors' affiliations: KTH, Polito
Context: The rapid evolution of technology and engineering competences necessitates harmonizing engineering professional archetypes. Defining and updating these archetypes is hindered by the lack of structured automation for processing educational and occupational data. This study enhanced archetype definition through text mining and topic modeling. By automating this process, a structured and objective methodology was created. The approach bridges educational and occupational frameworks, ensuring up-to-date engineering profiles. A unified archetype was tailored to specialization, period, and expertise level. The proposed industrial engineer archetype was validated against a manually defined profile.

Title: Ontology for Constructively Aligned, Collaborative, and Evolving Engineer Knowledge-management Platforms
Journal/Conference: Casalino, G., et al. Higher Education Learning Methodologies and Technologies Online. HELMeTO 2023. Communications in Computer and Information Science, vol. 2076, https://doi.org/10.1007/978-3-031-67351-1_10
Authors' affiliations: KTH, University of Ljubljana
Context: This paper deals with updating learning materials for engineers. Constructive Alignment helps standardize learning content while implementing modern pedagogical methods. This article explored models for creating, using, and sharing constructively aligned content. Building on prior research, it updated the CONALI ontology for an online collaborative platform managing digitalized knowledge. The updated CONALI 3.0 ontology introduced new key concepts and semantic relations. Its application to four Erasmus project universities supported a dynamic, digitalized educational knowledge base.

Title: Beyond the pandemic: How has Covid-19 shaped the capability to adopt an Agile Blended Learning in HEI?
Journal/Conference: 5th International Conference on Higher Education Learning Methodologies and Technologies Online - Book of Abstracts. Foggia, Italy, 2023, p. 29-30, ISBN: 978-88-99978-64-8, LINK
Authors' affiliations: KTH, Polito, University of Ljubljana, University of Malta, University of Bergamo, University of Rijeka
Context: Blended Learning (BL) has been widely debated in academia for years. During the Covid-19 pandemic, in-person teaching was rapidly replaced by new pedagogical approaches. This created a growing demand for online skills and tools, putting pressure on HEIs' resources and their ability to ensure efficient remote access. This study examined how different HEIs adapted to BL, while assessing their agility in response to change. The effort was aimed to anticipate future needs and support long-term sustainability of blended learning models.

Title: Introducing sustainability themes in STEM education: evidences from some European countries
Journal/Conference: 4th International Conference on Higher Education Learning Methodologies and Technologies Online HELMeTO2022, September 21-23, 2022, Palermo, Italy, Book of Abstracts, p. 312-314, LINK
Authors' affiliations: KTH, Polito, University of Ljubljana
Context: The gap between education and industry necessitates the urgent standardization of professional figure descriptions for course design, assessment, communication and job market integration. Two key industrial priorities—Industry 4.0 technologies and sustainability remain unaligned within educational and occupational engineering frameworks. This study introduced a standardized professional figure description using the archetype concept, which represented an

artificially generated centroid of multiple instances. Archetypes dynamic nature enabled continuous adaptation to evolving industry demands, ensuring better alignment between education and the job market.

Title: Overcoming the obstacles hindering the application of Virtual Reality to e-learning
Journal/Conference: HELMeTO 2021 Third International Workshop on Higher Education Learning Methodologies and Technologies Online, ISBN 978-88-99978-36-5, [LINK](#)
Authors' affiliations: KTH, Polito
Context: This study presented the approach and key findings of the Erasmus+ Tiphys project, which developed an Open Networked Platform for learning Industry 4.0 (I4.0) concepts. A Virtual Reality (VR) platform was created to train users and simulate industrial processes involving I4.0 technologies. The study highlighted the didactic experience, emphasizing self-learning over traditional teaching methods.

Results

In a series of online meetings the partners discussed how the proposed solutions would improve the applicability of educational units in other environments given the offered list of solutions. All the partners agreed that the proposed offered solutions solve the problems they identified within Task 5.1, with the exception of some material being available only in one of the partner's language. We all however agreed that an AI assisted translation of the material would be able to solve this problem as well.

Conclusion

Based on the results of Task 5.2, we can infer that our solutions help with transferability of educational units in other environments. In future, it would be interesting to test how these educational units would perform in an environment (at an institution) that was not part of the project partnership. We are however pretty confident that the results would be positive.

Suggested readings

1. M. Mabkhot, Mohammed, et al. "Mapping industry 4.0 enabling technologies into united nations sustainability development goals." Sustainability 13.5 (2021): 2560, https://doi.org/10.3390/su13052560
2. Lupi, Francesco, et al. "Toward a sustainable educational engineer archetype through Industry 4.0." Computers in Industry 134 (2022): 103543, https://doi.org/10.1016/j.compind.2021.103543
3. Antonelli, Dario, et al. "Tiphys: an open networked platform for higher education on industry 4.0." Procedia CIRP 79 (2019): 706-711, https://doi.org/10.1016/j.procir.2019.02.128
4. Maffei, Antonio, et al. "CONALI ontology. A framework for design and evaluation of constructively aligned courses in higher education: putting in focus the educational goal verbs." Procedia CIRP 50 (2016): 765-772, https://doi.org/10.1016/j.procir.2016.06.004
5. Maffei, Antonio, et al. "On the design of constructively aligned educational unit." Education sciences 12.7 (2022): 438, https://doi.org/10.3390/educsci12070438

6. Sala, Roberto, et al. "Blended learning in the engineering field: A systematic literature review." + Computer applications in engineering education 32.3 (2024): e22712, https://doi.org/10.1002/cae.22712

7. Maffei, Antonio, and Fredrik Enoksson. "What is the optimal blended learning strategy throughout engineering curricula? Lesson learned during Covid-19 pandemic." 2023 IEEE Global Engineering Education Conference (EDUCON). IEEE, 2023, https://doi.org/10.1109/EDUCON54358.2023.10125225

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9. Lombardi, Dario; Traetta, Luigi; Maffei, Antonio; Podržaj, Primož. "Enhancing Instructional Design: The Impact of CONALI Ontology and ChatGPT in Primary Education Training." Computer applications in engineering education 32, no. 3 (2024), https://doi.org/10.1002/cae.22712

10. Bonello, Amberlynn, et al. "Development of an Agile Blended Learning Framework for Engineering Higher Educational Instutions post Covid-19. " Journal/Conference: Proceedings of the 33rd International Electrotechnical and Computer Science Conference, pages 644-647, e-ISSN 2591-0442, LINK

11. Antonelli, Dario, et. al. "Exploring the limitations and potential of digital twins for mobile manipulators in industry" Procedia Computer Science, V. 232, P. 1121-1130, https://doi.org/10.1016/j.procs.2024.01.110

12. Lupi, Francesco, et al. "Automatic definition of engineer archetypes: A text mining approach." Computers in Industry, Volume 152, 103996 (2023), https://doi.org/10.1016/j.compind.2023.103996

13. Lupi, Francesco, et al. "Ontology for Constructively Aligned, Collaborative, and Evolving Engineer Knowledge-management Platforms ." Casalino, G., et al. Higher Education Learning Methodologies and Technologies Online. HELMeTO 2023. Communications in Computer and Information Science, vol. 2076, https://doi.org/10.1007/978-3-031-67351-1_10

14. Bonello, Amberlynn, et al. "Beyond the pandemic: How has Covid-19 shaped the capability to adopt an Agile Blended Learning in HEI?" 5th International Conference on Higher Education Learning Methodologies and Technologies Online - Book of Abstracts. Foggia, Italy, 2023, p. 29-30, ISBN: 978-88-99978-64-8, LINK

15. Antonelli, Dario, et al. "Introducing sustainability themes in STEM education: evidences from some European countries." 4th International Conference on Higher Education Learning Methodologies and Technologies Online HELMeTO2022, September 21-23, 2022, Palermo, Italy, Book of Abstracts, p. 312-314, LINK

16. Maffei, Antonio; Antonelli, Dario; Stylios, Chrysostomos "Overcoming the obstacles hindering the application of Virtual Reality to e-learning." HELMeTO 2021 Third International Workshop on Higher Education Learning Methodologies and Technologies Online, ISBN 978-88-99978-36-5, LINK