Erasmus +: BLISS

Blended Learning Implementation for reSilient, acceSsible and efficient higher education

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

# Project Result 3 –Deliverable 3.1.2

# Syllabus of the proposed Educational Units

Co-funded by the European Union

2022-2025

**Edited By: Antonio Maffei, Fabio Marco Monetti, KTH**

**Reviewed by: Sandi Ljubic, UNIRI**

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them

# Document heading

| | |
|---|---|
| **Project title:** | Blended Learning Implementation for reSilient, acceSsible and efficient higher education |
| **Project result:** | 3 |
| **Leading org.:** | KTH Royal Institute of Technology |
| **Output title**: | Developing of blended learning educational units |
| **Authors**: | KTH Royal Institute of technology with input from the entire consortium |

# Project Result 3 summary:

## Project Result implementation

- **Needs Analysis**: Throughout the course of Result 2, we identified various activities that could significantly benefit from either an entirely new or an updated blended learning approach. In alignment with the project scope and available resources, we selected and developed a subset of candidate activities into fully defined and stand-alone educational units. This initiative was supported by a specific Learning Teaching and Training (LTT) activity called C1, where KTH shared their extensive experience in applying blended learning methodologies as well as Constructive Alignment.
- **Target Groups**: The primary target group for this initiative comprised the specific teachers and prospective students of the selected educational units.
- **Element of Innovation**: The direct outcome of this activity is the creation of at least three new educational units. In reality, given the success of the C1 activity, all the partners have engaged in Ed. Units design. This led to a higher number of proposed units as detailed later on in the report. Furthermore, this initiative has contributed to enriching the methodological approaches to designing blended learning systems, accompanied by relevant case studies.
- **Expected Impact**: Consistent with existing literature, converting traditional activities to blended learning formats has enhanced the effectiveness of transmitting intended learning outcomes. It has also increased accessibility for students and improved the resilience of the overall educational program. A specific investigation into this impact was conducted in the subsequent steps of the BLISS plan (Result 4).
- **Transferability Potential**: The developed educational units were designed as stand-alone courses or components of larger courses. The related learning materials are now available to the entire consortium. Upon project completion, documentation related to these educational units has been made publicly accessible, serving as an inspiration to the broader Higher Education Institution (HEI) community. Additionally, a scientific paper detailing the methodological contributions of this activity has been shared with the academic community.

## Division of work

**Activity Leadership and Planning** KTH led this activity and organized the related work as planned.

**Task 3.1: Selection of Educational Units for Development** Starting from the requirements highlighted in Result 2, the research team was set to identify the most promising candidates for further development based on:

- Expected improvement of the quality of the underlying learning experience using blended learning.
- Specific opportunities/potential for implementation across the consortium.
- Impact of the expected improvement on the sustainability dimension as defined in the SDG agenda from the UN.
- Scope and resources available in the project.

In reality, as a result of the success of the C1 LTT all the partners decided to engage in Ed.Unit design. In view of this, all the Ed. Units proposed and deemed suitable by the expert KTH team were selected for further processing. This led to a higher number of Ed. Units been developed compared to the planned 3.

**Task 3.2: Development of the Focal Educational Unit** After the LTT C1 conducted by KTH, the research team developed the focal educational unit following a pedagogical approach based on constructive theory. The intended learning outcomes were defined along with related teaching and learning activities and assessment tasks, focusing on the student-requested actions and the desired level of understanding of the related concepts.

## Project Result 3 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.

# Results of the activities

The Project Result 3 goal was to develop a series of Educational Units to introduce specific applications of the Blended Learning approaches in the current engineering education activities at involved HEI. The candidate topics from each involved institution were presented at the beginning of the LTT C1 on Blended Learning (BL) and Constructive Alignment (CA) held at KTH. As a result of the elaboration of these proposal within the context of CA, a set of specific Intended Learning Outcomes (ILOs) were formulated. The following table details all the proposals from the partners that have been evaluated by KTH around the proposed criteria and consequently selected for further processing.

| | |
|---|---|
| KTH | **Scientific Debate**:<br>Gather information and elaborate a strategy to qualify and defend an opinion on a controversial topic, and analyse and summarize the consequent debate |
| UNIMA | **Six Sigma:**<br>**ILO1:** Remember and understand the theoretical and background knowledge of Six-sigma process improvement methodologies.<br>**ILO2**: Apply the Six-Sigma process improvement methodologies to an engineering case study.<br>**ILO3**: Present the findings which will be discussed in class<br><br>**Artificial Neural Network (ANN):**<br>**ILO1:** Explain the basic structure and functions of Artificial Neural Networks.<br>**ILO2**: Apply an Artificial Neural Network to solve a classification problem.<br>**ILO3**: Compare the application of Artificial Neural Networks to the K-Nearest Neighbors Algorithm for a classification problem |
| POLITO | **Production System:**<br>**ILO1:** Outline and express with mathematical models the technological properties of the materials used for production.<br>**ILO2**: Evaluate and assess a given manufacturing process, analyzing the technical and economic performances and taking into account quality, safety and sustainability issues.<br>**ILO3**: Choose, integrate and deploy the manufacturing steps as a coordinated system oriented to the making of an industrial product (process plan) |
| UNILJ | **PID Control:**<br>**ILO1:** Program a discrete version of the PID control algorithm on an Arduino microcontroller and analyze the stability of the close loop system.<br><br>**Mechatronic actuators:**<br>**ILO1:** Compare pneumatic, hydraulic and electric actuator and select an appropriate one for a specific application with regard to cost, environmental conditions, operating conditions. |
| UNIRI | **Statistical Testing:**<br>**ILO1:** Select and apply appropriate statistical tests on data obtained from a HCI experiment, and derive the conclusions according to their outcomes.<br><br>**Multithreading in the Operating System:**<br>**ILO1:** Explain multithreading in the Operating System. |
| UNIBG | **Business Process Modelling and Simulation:**<br>**ILO1:** Describe business processes in the operations management domain and illustrate them using BPMN2.0<br>. |

| | |
|---|---|
| | **ILO2**: Produce discrete event simulation models of business processes in the operations management domain with AnyLogic, and analyze and compare their performance |

The PR3 results were produced in parallel with the C1 Workshop on BL and CA held by KTH. The workshop was organized through a series of online lectures where KTH staff introduced the theoretical building blocks of course design using BL and CA as well as showing some example of implementation. The workshop includes also specific homework consisting of completing aptly devised templates (See Appendix). The result of this latter activity is the description of the educational unit that will be presented in the following part of this document.

At the beginning of the activity, each partner, building upon the knowledge accumulated during Project Results 1 and 2, identified internal educational units that could be improved using Blended Learning. During the subsequent **Blended Learning** course at KTH, a deep discussion with KTH around the aforementioned criteria for selection led to the suggestion of specific educational units for further development.

Following the approval of this proposal by the KTH team, based on the criteria presented above, the group moved on the actual educational unit design based on **Constructive Alignment**. The approach suggested was articulated in three phases where the partners were asked to develop respectively: the Intended Learning Outcome (hence ILO) and the related Teaching and Learning Activities (hence TLA) and Assessment task (hence AT) for their educational units. All the technical details of the approach can be found by reading the related C1 course material that is based on existing content at KTH and re-adapted for the BLISS initiative.

The following Figure 1 details the workflow in PR3.

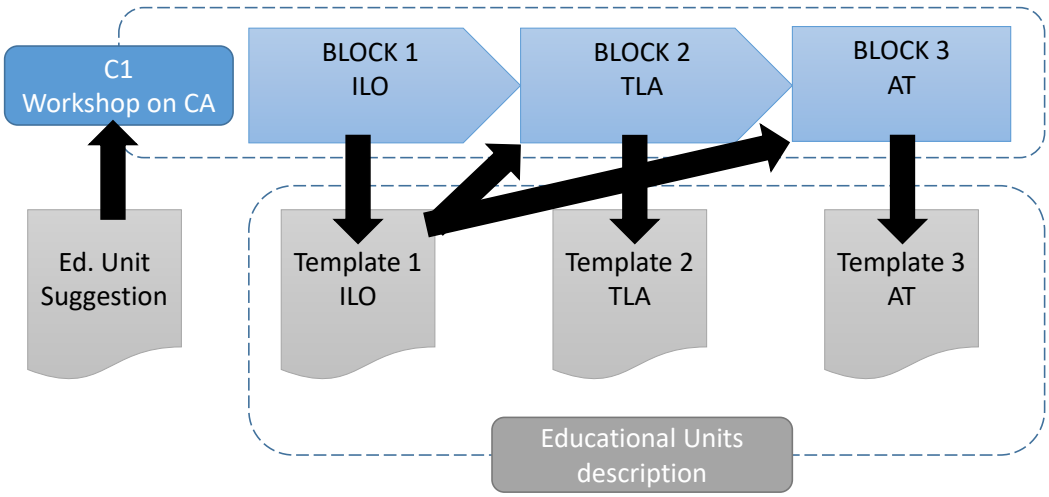


*Figure 1 Graphical depiction of the second part of PR3*

In the following sections the produced contributions are presented according to presented layout. The available information includes the proposed ILOs and the related Teaching and Learning Activities (TLAs), as well as Assessment Tasks (ATs) as formulated during the LTT C1. The combination of the ILO with related TLA and AT represents the information underpinning the related syllabus.

## Syllabi of the proposed Educational Units

In this section, we present the syllabi for the educational units proposed within the BLISS project. Each syllabus encompasses the Intended Learning Outcomes (ILOs), the associated Teaching and Learning Activities (TLAs), and the corresponding Assessment Tasks (ATs) formulated during the LTT C1. This combination of ILOs with their related TLAs and ATs forms the core of each syllabus, providing a comprehensive framework for effective teaching and learning. The consortium has chosen to present this information using the templates provided in the Appendix. This approach ensures that practitioners interested in implementing these units have access to all the essential building blocks in a separate and organized manner, facilitating easier integration into their teaching practices.

## Suggested Intended Learning Outcomes

The template for the formulation of the ILO is emphasizing the student perspective. All the ILOs are formulated to address directly what is expected from the learner after following the related educational unit. Three are the key elements:

- Verb: detailing the action expected and referring to the expected level of understanding as expressed in the well-known Bloom taxonomy[1]
- Content to which the action indicated by the verb refer to
- Context where the action for the related content must be applied

### KTH –Sweden

*Proposal: Scientific Debate*

| | Short description | Verb (level of Understanding in the bloom Taxonomy) | Content | Context |
|---|---|---|---|---|
| ILO1 | Gather information and elaborate a strategy to qualify and defend an opinion on a controversial topic, and analyse and summarize the consequent debate | Gather<br>Elaborate<br>Analyse<br>Summarise | information and a strategy to qualify and defend opinion | a debate |

### UNIMA- Malta

*Proposal 1 Six Sigma*

| | Short description | Verb (level of Understanding in the bloom Taxonomy) | Content | Context |
|---|---|---|---|---|
| ILO 1 | Remember and understand the theoretical and background knowledge of Six-sigma process improvement methodologies. | Remember and understand | Six-sigma process improvement methodologies | Quality & Reliability Engineering – Process improvement |
| ILO 2 | Apply the Six-Sigma process improvement methodologies to an engineering case study. | Apply | Application of tools and formulation of a strategy to solve the problem | Develop a process improvement strategy to address the case study |
| ILO 3 | Present the findings which will be discussed in class | Present | Present w/shop finding | W/shop findings |

[1] Bloom, B.S., et al., *Taxonomy of educational objectives: Handbook I: Cognitive domain.* New York: David McKay, 1956. **19**: p. 56.

*Proposal 2 Artificial Neural Network*

| | Short description | Verb (level of Understanding in the bloom Taxonomy) | Content | Context |
|---|---|---|---|---|
| ILO 1 | Explain the basic structure and functions of Artificial Neural Networks | Explain | basic structure, working and organisation | Artificial Neural Networks |
| ILO 2 | Apply an Artificial Neural Network to solve a classification problem. | Apply | Artificial Neural Network | Solve a classification problem |
| ILO 3 | Compare the application of Artificial Neural Networks to the K-Nearest Neighbors Algorithm for a classification problem | Compare | Artificial Neural Networks vs. K-Nearest Neighbors Algorithm | For a classification problem |

*POLITO – Italy*

*Proposal 1 Production Systems*

| | Short description | Verb (level of Understanding in the bloom Taxonomy) | Content | Context |
|---|---|---|---|---|
| ILO 1 | The student will be able to outline and express with mathematical models the technological properties of the materials used for production | Outline (REMEMBER)<br><br>Express (UNDERSTAND) | Technological properties | Materials for production |
| ILO 2 | The student will evaluate and assess a given manufacturing process, analyzing the technical and economic performances and taking into account quality, safety and sustainability issues. | Evaluate and assess (ANALYZE) | Manufacturing process | Quality, Safety and Sustainability |
| ILO 3 | The student will be able to choose, integrate and deploy the manufacturing steps as a coordinated system oriented to the making of an industrial product (process plan) | Choose (APPLY)<br><br>Integrate (APPLY)<br><br>Deploy (APPLY) | Process plan | Industrial manufacturing |

UNILJ – Slovenia

*Proposal 1 PID Control*

| | Short description | Verb (level of Understanding in the bloom Taxonomy) | Content | Context |
|---|---|---|---|---|
| ILO 1 | The student should be able to program a discrete version of the PID control algorithm on an Arduino microcontroller | Program [Class: Apply]<br>Analyze [Class: Analyze] | PID control algorithm Stability | Microcontroller controlled close loop system |

| | | | | |
|---|---|---|---|---|
| | and analyze the stability of the close loop system | | | |

*Proposal 2 Mechatronic Actuators*

| | Short description | Verb (level of Understanding in the bloom Taxonomy) | Content | Context |
|---|---|---|---|---|
| ILO 1 | The student should be able to compare pneumatic, hydraulic and electric actuator and select an appropriate one for a specific application with regard to cost, environmental conditions, operating conditions | Compare [Class: Understand]<br>Select [Class: Evaluate] | Mechatronic actuators | Specific application (e.g. sorting of objects on a conveyor belt) with regard to cost, environmental conditions, operating conditions |

*Proposal 2.bis UN SDG*

| | Short description | Verb (level of Understanding in the bloom Taxonomy) | Content | Context |
|---|---|---|---|---|
| ILO 1 | Describe the activities relevant to reaching UN SDGs from the perspective of mechanical engineering. | Describe | Activities relevant to reach UN SDG goal | Mechanical engineering |

## UNIRI – Croatia

*Proposal 1 Statistical Testing.*

| | Short description | Verb (level of Understanding in the bloom Taxonomy) | Content | Context |
|---|---|---|---|---|
| ILO 1 | Select and apply appropriate statistical tests on data obtained from a HCI experiment, and derive the conclusions according to their outcomes. | Select [class: REMEMBER]<br>Apply [class: APPLY]<br>Derive [class: APPLY] | Statistical test | HCI (Human-Computer Interaction) experiment |

*Proposal 2 Multithreading in the Operating System.*

| | Short description | Verb (level of Understanding in the bloom Taxonomy) | Content | Context |
|---|---|---|---|---|
| ILO 1 | Explain multithreading in the Operating System. | Explain | multithreading | Operating system |

## UNIBG- Italy

*Proposal Business Process Modelling and simulation*

| | Short description | Verb (level of Understanding in the bloom Taxonomy) | Content | Context |
|---|---|---|---|---|
| ILO 1 | Describe business processes in the operations management domain and illustrate them using BPMN2.0 | Describe (understand) and illustrate (apply) | Modeling methods and tools | business processes in the operations management domain |
| ILO 2 | Produce discrete event simulation models of business processes in the operations management domain with AnyLogic, and analyze and compare their performance | Produce (apply) and analyze (analyze) and compare (analyze) | Simulation methods and tools | business processes in the operations management domain |

## Suggested Teaching and Learning Activities

The template for the formulation of the TLA is emphasizing the following dimensions:

- What is the teacher supposed to do to enact the underlying ILO
- What is the learner supposed to do to enact the underlying ILO
- How does the suggested activity relate to good teaching practices as expressed in the 7 principles of good learning[2]

### KTH –Sweden

*Proposal Scientific Debate*

| ILO reference (Highlight the Verb) | Teaching Activity (What the teachers do) | Learning Activity (What the students do) | How does this use the 7 Principles of good learning |
|---|---|---|---|
| ILO 1<br>Gather information and elaborate a strategy to qualify and defend an opinion on a controversial topic, and analyse and summarize the consequent debate | TA 1.1<br>Present the debate activities (research, organization, refutation, evaluation)<br><br>TA 1.2<br>Describe and show instructions and the topics for the debate.<br><br>TA 1.3<br>Describe how to use digital tool, i.e., ChatGPT, for preparing the debate, and prepare a tutorial on the use of ChatGPT for the debate activity. | LA 1.1<br>Listen to the explanation, take notes, and ask questions.<br><br>LA 1.2 - Review the notes, and elaborate a strategy for the debate on the given topics. Work in groups.<br><br>LA 1.3<br>Listen to the explanation, take notes, and ask questions. Collect information via ChatGPT and analyse the collected information. Work in groups. | Encourages contact between students and faculty,<br>LA 1.1<br>LA1.2<br><br>Encourages active learning<br><br>LA 1.2<br><br>LA 1.3<br><br>develops reciprocity and cooperation among students<br><br>TA 1.2<br><br>LA 1.2<br><br>gives prompt feedback<br>TA1.3<br>LA1.3 |

[2] 7 principles of good learning:

- encourages contact between students and faculty,
- develops reciprocity and cooperation among students,
- encourages active learning,
- gives prompt feedback,
- emphasizes time on task,
- communicates high expectations
- respects diverse talents and ways of learning

Arthur W. Chickering and Zelda F. Gamson (1987)

## UNIMA- Malta

### *Proposal 1 Six Sigma*

| ILO reference (Highlight the Verb) | Teaching Activity (What the teachers do) | Learning Activity (What the students do) | How does this use the 7 Principles of good learning |
|---|---|---|---|
| ILO 1<br>Remember and understand the theoretical and background knowledge of Six-sigma process improvement methodologies. | TA 1.1<br>Present Theoretical and background knowledge of six-sigma process improvement methodologies (Online asynchronous delivery)<br><br>TA 1.2<br>Explain what additional engineering tools can be leveraged in conjunction with these process improvement methodologies. (Online asynchronous delivery) | LA 1.1<br>Listen, take notes and read around the topics. Assess knowledge recall and understand from evaluation multiple choice questions online (in Moodle).<br><br>LA 1.2<br>Listen, take notes and read around the topics. Assess knowledge recall and understand from evaluation multiple choice questions. (In Moodle). | Encourages contact between students and faculty<br>TA 1.1, TA 1.2,<br>LA 1.1, LA 1.2<br><br>encourages active learning.<br>TA 1.1, TA 1.2,<br>LA 1.1, LA 1.2<br><br>gives prompt feedback<br>TA 1.1, TA 1.2,<br>LA 1.1, LA 1.2 |
| ILO 2<br>Apply the Six-Sigma process improvement methodologies to an engineering case study. (in class) | TA 2.1<br>Present brief presentation of the key points of the Theoretical and background knowledge of six-sigma process improvement methodologies<br><br>TA 2.2<br>Make (Introduce) group exercise to apply six-sigma process improvement methodologies to an engineering case study.<br><br>TA 2.3 Support the students during their work with applying. | LA 2.1<br>Listen to presentations, take notes and ask questions.<br><br>LA 2.2<br>Practice (solve) in groups with the support of tutor to solve case study | encourages contact between students and faculty.<br>TA 2.1, TA 2.2<br>LA 2.1, LA 2.2<br><br>develops reciprocity and cooperation among students.<br>TA 2.1, TA 2.2<br>LA 2.1, LA 2.2<br><br>encourages active learning.<br>TA 2.1, TA 2.2<br>LA 2.1, LA 2.2<br><br>gives prompt feedback<br>TA 2.1, TA 2.2<br>LA 2.1, LA 2.2 |
| ILO 3<br>Present and defend the findings which will be discussed in class and criticize the other group's findings. | TA 3.1<br>Organize groups to present findings.<br>Question and stimulate reflection to the students. | LA 3.1<br>Present in groups the finding.<br><br>LA 3.2<br>Discuss group finding and class and defend findings.<br>Question and stimulate reflection to their peers. | encourages contact between students and faculty.<br>TA 3.1<br>LA 3.1, LA 3.2<br><br>develops reciprocity and cooperation among students.<br>TA 3.1<br>LA 3.1, LA 3.2<br><br>encourages active learning.<br>TA 3.1<br>LA 3.1, LA 3.2 |

| ILO reference (Highlight the Verb) | Teaching Activity (What the teachers do) | Learning Activity (What the students do) | How does this use the 7 Principles of good learning |
|---|---|---|---|
| | | | gives prompt feedback<br>TA 3.1<br>LA 3.1, LA 3.2 |

*Proposal 2 Artificial Neural Networks*

| ILO reference (Highlight the Verb) | Teaching Activity (What the teachers do) | Learning Activity (What the students do) | How does this use the 7 Principles of good learning |
|---|---|---|---|
| ILO 1<br>Explain the basic structure and functions of Artificial Neural Networks | TA 1.1<br>Explain using an online platform (Moodle) the basic structure of an Artificial Neural Network.<br><br>TA 1.2<br>Prepare an online quiz (Moodle) Artificial Neural Networks work. | LA 1.1<br>Follow the online presentation, take notes (Moodle).<br><br>LA 1.2<br>Take an online quiz to test their understanding of ANNs (Moodle). | encourages active learning<br>TA 1.1, TA 1.2,<br>LA 1.1, LA 1.2<br><br>gives prompt feedback<br>TA 1.2, LA 1.2 |
| ILO 2<br>Apply an Artificial Neural Network to solve a classification problem. | TA2.1<br>Explain and provide a step-by-step presentation and demonstration in person of how ANNs can be applied to solve a problem.<br><br>TA2.2<br>Provide a problem and support them in class to apply and implement code to solve this problem.<br><br>TA2.3<br>Provide a new problem statement (online) on how ANNs can be applied to solve a specific problem. | LA 2.1<br>Listen to presentation, take notes and ask questions.<br><br>LA2.2<br>Apply knowledge about ANNs to implement ANNs and solve a problem with the support of the lecturer.<br><br>LA2.3<br>Apply knowledge about ANNs to implement ANNs and solve a problem. | Encourages contact between students and faculty<br>TA 2.1, TA 2.2,<br>LA 2.1, LA 2.2<br><br>encourages active learning<br>TA 2.1, TA 2.2, TA 2.3<br>LA 2.1, LA 2.2, LA 2.3<br><br>gives prompt feedback<br>TA 2.1, TA 2.2,<br>LA 2.1, LA 2.2 |
| ILO 3<br>Compare the application of Artificial Neural Networks to the K-Nearest Neighbours Algorithm for a classification problem. | TA3.2<br>Ask students to compare how this problem is formulated differently from when using KNNs (online). | LA3.2<br>Compare how tackling this problem using ANNs is formulated differently from when using KNNs. | encourages active learning<br>TA 3.1,<br>LA 3.1, |

## POLITO – Italy

### *Proposal 1 Production Systems*

| ILO reference (Highlight the Verb) | Teaching Activity (What the teachers do) | Learning Activity (What the students do) | How does this use the 7 Principles of good learning[3] |
|---|---|---|---|
| ILO 1 - The student will be able to outline and express with mathematical models the technological properties of the materials used for production | TA 1.1 – Presentation of the technological properties of materials<br><br>TA 1.2 – Proposal of selected exercises and calculation examples<br><br>TA 1.3 – (F2F) Feedback on students' solution to the proposed exercises<br><br>TA 1.4 – Preparation of questions and answers for optional online test and upload them on Moodle | LA 1.1 - Listen to the explanation, take notes, and ask questions.<br><br>LA 1.2 – Review the notes and find similar solutions applicable to the given problems and exercises.<br><br>LA 1.3 – Compare the solutions with the correction given by the teacher<br><br>LA 1.4 – Answer the online test on a voluntary basis<br><br>LA 1.5 – Compare the answers to the test with teacher's answers provided by Moodle | • The 1st principle is reflected in LA numbers: 1.1.<br><br>• The 2nd principle is not reflected here<br><br>• The 3rd principle is reflected in LA numbers: 1.2.<br><br>• The 4th principle is reflected in LA numbers: 1.3.<br><br>• The 5th principle is reflected in LA numbers: 1.1, 1.2.<br><br>• The 6th principle is reflected in LA numbers: LA 1.2.<br><br>• The 7th principle is reflected in LA numbers: 1.2 and 1.3. |
| ILO 2 - The student will evaluate and assess a given manufacturing process, analyzing the technical and economic performances and taking into account quality, safety and sustainability issues. | TA 2.1 – (F2F & online) Presentation of the analysis method for process performances<br><br>TA 2.2 - Explain the procedures for executing the feasibility study and performance analysis of manufacturing processes<br><br>TA 2.3 – Introduce the problems to the students | LA 2.1 - Listen to the explanation, take notes, and ask questions<br><br>LA 2.2 – Review the notes, find similar solutions applicable to the given problem<br><br>LA 2.3 – Analyze the problems, explicit the quality constraints, apply the known solution methods | • The 1st principle is reflected in LA numbers: 2.1.<br><br>• The 2nd principle is not reflected.<br><br>• The 3rd principle is reflected in LA numbers: 2.2, 2.3.<br><br>• The 4th principle is reflected in LA numbers: 2.3.<br><br>• The 5th principle is reflected in LA |

[3] 7 principles of good learning:

1. encourages contact between students and faculty,
2. develops reciprocity and cooperation among students,
3. encourages active learning,
4. gives prompt feedback,
5. emphasizes time on task,
6. communicates high expectations
7. respects diverse talents and ways of learning - Arthur W. Chickering and Zelda F. Gamson (1987)

| | | | |
|---|---|---|---|
| | TA 2.3 – (F2F) Assist students during the analysis of the problems<br><br>TA 2.4 – Develop exercises in Excel with randomization of input data and publish them on Moodle for optional online access | LA 2.4 – Solve the optional online exercises on Moodle<br><br>LA 2.5 - Compare the solution with the one provided by Moodle | numbers: 2.1, 2.2, 2.3.<br>• The 6th principle is reflected in LA numbers: LA 2.3.<br>• The 7th principle is reflected in LA numbers: 2.1, 2.2, 2.3. |
| ILO 3 - The student will be able to choose, integrate and deploy the manufacturing steps as a coordinated system oriented to the making of an industrial product (process plan) | TA 3.1 - Assign individual classwork to apply conceptual process planning<br><br>TA 3.2 - Assign group classwork to choose, integrate and deploy the manufacturing steps of a detailed process plan<br><br>TA 3.3 – (F2F) Participate to the discussion groups of students, moderating the discussion<br><br>TA 3.4 – (F2F) Supporting the students in the final wrap up | LA 3.1 – Review the notes, find similar solutions applicable to the given problem<br><br>LA 3.2 - Distribute tasks within the team.<br><br>LA 3.3 - Write a checklist of activities and monitor the progress of the work.<br><br>LA 3.4 - Discuss in groups and solve the case study. | • The 1st principle is reflected in LA numbers: 3.1.<br>• The 2nd principle is reflected in LA numbers: 3.2 and 3.3.<br>• The 3rd principle is reflected in LA numbers: 3.4.<br>• The 4th principle is reflected in LA numbers: 3.4.<br>• The 5th principle is reflected in LA numbers: 3.1, 3.2, 3.3, 3.4.<br>• The 6th principle is reflected in LA numbers: LA 3.2.<br>• The 7th principle is reflected in LA numbers: 3.1 and 3.2. |

## UNILJ – Slovenia

### *Proposal 1 PID Control*

| ILO reference (Highlight the Verb) | Teaching Activity (What the teachers do) | Learning Activity (What the students do) | How does this use the 7 Principles of good learning |
|---|---|---|---|
| ILO 1<br><br>The student should be able to program a discrete version of the PID control algorithm on an Arduino microcontroller and | TA 1.1<br><br>The teacher presents (lecture) the PID control algorithm, z Transform, teacher hands out self-assessment questionnaires. | LA 1.1<br><br>Students write notes and fulfill self-assessment questionnaires (online; 10 minutes with prompt feedback) | Prompt feedback, respects diverse talents and ways of learning, develops reciprocity and cooperation among students, encourages active learning, |

| | | | |
|---|---|---|---|
| analyze the stability of the close loop system | TA 1.2<br><br>The teacher explains (lecture) the concept of stability and introduces criteria for system stability. The teacher presents ICCT-Interactive Course for Control Theory (developed within previous Erasmus+ project).<br><br>TA 1.3<br><br>The teaching assistant demonstrates how to program a PID control algorithm on an Arduino microcontroller | LA 1.2<br><br>Students write notes, use ICCT to gain additional knowledge (interactive examples, self-assessment tasks)<br><br>LA 1.3<br><br>Students are divided into pairs and program a control algorithm on an Arduino microcontroller | |

*Proposal 2 Mechatronic Actuators*

| ILO reference (Highlight the Verb) | Teaching Activity (What the teachers do) | Learning Activity (What the students do) | How does this use the 7 Principles of good learning |
|---|---|---|---|
| ILO 1<br><br>The student should be able to compare pneumatic, hydraulic and electric actuator and select an appropriate one for a specific application with regard to cost, environmental conditions, operating conditions | TA 2.1<br><br>The teacher explains (lecture) the basics of pneumatic, hydraulic and electric actuators. | LA 2.1<br><br>The students are divided in groups. Each group presents a more detailed analysis on advantages and drawbacks of three types of actuators for their specific project. | Develops reciprocity and cooperation among students, encourages active learning, emphasizes time on task |

.

## UNIRI – Croatia

*Proposal 1 Statistical Testing*

| ILO reference (Highlight the Verb) | Teaching Activity (What the teachers do) | Learning Activity (What the students do) | How does this use the 7 Principles of good learning[i] |
|---|---|---|---|
| ILO 1<br><br>Select and apply appropriate statistical tests on data obtained from a HCI experiment, and derive the conclusions | TA 1.1<br>Present standard statistical tests typically used for data obtained from a HCI experiment.<br><br>TA 1.2 | LA 1.1<br>[in classroom] Listen to the presentation, take notes and ask questions.<br><br>LA 1.2 | Encourages contact between students and faculty<br>LA 1.1, LA 1.2, LA 1.3, LA 1.4, LA 1.5<br>TA 1.1, TA 1.2, TA 1.3, TA 1.4, TA 1.5 |

| | | | |
|---|---|---|---|
| according to their outcomes. | Explain how the appropriate test should be chosen, according to the design of the HCI experiment.<br><br>TA 1.3<br>Demonstrate an example of applying a statistical test, and how results and conclusions should be reported.<br><br>TA 1.4<br>Present (prepare and deliver via LMS) a small-scale case study: a hypothetical HCI experiment (description) and corresponding data. Provide online tutorials, possible software tools, report template and "rubrics". Support students online.<br><br>TA 1.5<br>Encourage joint discussion on the case study analyses, following students' presentations. | [in classroom] Listen to the presentation, take notes and ask questions.<br><br>LA 1.3<br>[in classroom] Listen to the presentation, observe the demonstration, take notes and ask questions.<br><br>LA 1.4<br>[outside classroom] Select the appropriate statistical test for a given case study, use online tutorial, apply statistical analysis (within software tool), derive conclusions, submit report (teacher online support available)<br><br>LA 1.5<br>[in classroom] Present case study analysis and participate in a joint discussion. | Develops reciprocity and cooperation among students<br>LA 1.5<br>TA 1.5<br><br>Encourages active learning<br>LA 1.3, LA 1.4, LA 1.5<br>TA 1.3, TA 1.4, TA 1.5<br><br>Gives prompt feedback<br>LA 1.3, LA 1.5<br>TA 1.3, TA 1.5<br><br>Respects diverse talents and ways of learning<br>LA 1.5<br>TA 1.5 |

*Proposal 2 Multithreading in Operative Systems*

| ILO reference (Highlight the Verb) | Teaching Activity (What the teachers do) | Learning Activity (What the students do) | How does this use the 7 Principles of good learning[4] |
|---|---|---|---|
| ILO 1<br>Explain multithreading in the Operating System. | TA 1.1<br>Present multithreading concept with its benefits and flaws.<br><br>TA 1.2<br>Explain how to resolve race condition problem. | LA 1.1<br>Listen to presentation, take notes and ask questions.<br><br>LA 1.2<br>Listen to presentation, take notes and ask questions. | encourages contact between students and faculty,<br><br>encourages active learning,<br><br>gives prompt feedback, |

[4] 7 principles of good learning:

- encourages contact between students and faculty,
- develops reciprocity and cooperation among students,
- encourages active learning,
- gives prompt feedback,
- emphasizes time on task,
- communicates high expectations
- respects diverse talents and ways of learning

Arthur W. Chickering and Zelda F. Gamson (1987)

| | | | |
|---|---|---|---|
| | TA 1.3<br>Live coding session which presents and explains how to solve race condition problems.<br><br>TA 1.4<br>Support to students in other self-assessment examples of race condition problems. | LA 1.3<br>Copy and listen to the coding tutorial.<br><br>LA 1.4<br>Apply the knowledge on other race condition problems with the supervision of the teacher. | TA 1.1, TA 1.2, TA 1.3, TA 1.4<br>LA 1.1, LA 1.2, LA 1.3, LA 1.4 |

## UNIBG- Italy

*Proposal Business Process Modelling and Simulation*

| ILO reference (Highlight the Verb) | Teaching Activity (What the teachers do) | Learning Activity (What the students do) | How does this use the 7 Principles of good learning |
|---|---|---|---|
| ILO 1:<br><br>Describe business processes in the operations management domain and illustrate them using BPMN2.0 | TA 1.1<br><br>Theoretically present methods to model business processes<br><br>TA 1.2<br><br>Provide tutorials to model business processes using BPMN2.0<br><br>TA 1.3<br><br>Assist students and provide feedback in group exercises on the application of methods to model business processes | LA 1.1<br><br>Listen, take notes, and ask questions<br><br>LA 1.2<br><br>Listen and practice with exercises to model business processes using BPMN2.0<br><br>LA 1.3<br><br>Practice with case study resolution in groups and ask for support for clarification of doubts. | encourages contact between students and faculty<br><br>LA 1.1, LA 1.2, LA 1.3<br><br>develops reciprocity and cooperation among students<br><br>TA 1.2, TA 1.3<br><br>LA 1.2, LA 1.3<br><br>encourages active learning<br><br>TA 1.1, TA 1.2, TA 1.3,<br><br>LA 1.1, LA 1.2, LA 1.3<br><br>gives prompt feedback<br><br>TA 1.3,<br><br>LA 1.1, LA 1.2, LA 1.3<br><br>respects diverse talents and ways of learning<br><br>TA 1.1, TA 1.2, TA 1.3,<br><br>LA 1.2, LA 1.3 |
| ILO 2<br><br>Produce discrete event simulation models of business processes in the operations management domain with AnyLogic, | TA 2.1<br><br>Theoretically present methods to simulate business processes | LA 2.1<br><br>Listen, take notes, and ask questions | encourages contact between students and faculty<br><br>LA 2.1, LA 2.2, LA 2.3 |

| | | | |
|---|---|---|---|
| and analyze and compare their performance | TA 2.2<br><br>Provide tutorial to simulate business processes using discrete event simulation in AnyLogic<br><br>TA 2.3<br><br>Assist students and provide feedback on the production of simulation models to analyze business processes through meetings and in-class support | LA 2.2<br><br>Listen and practice with exercises to simulate business processes with discrete event simulation in AnyLogic<br><br>LA 1.3<br><br>Practice with case study resolution in groups and ask for support for clarification of doubts. | develops reciprocity and cooperation among students<br><br>TA 2.2, TA 2.3,<br><br>LA 2.2, LA 2.3<br><br>encourages active learning<br><br>TA 2.1, TA 2.2, TA 2.3,<br><br>LA 2.1, LA 2.2, LA 2.3<br><br>gives prompt feedback<br><br>TA 2.1, TA 2.2, TA 2.3,<br><br>LA 2.1, LA 2.2, LA 2.3<br><br>respects diverse talents and ways of learning<br><br>TA 2.1, TA 2.2, TA 2.3,<br><br>LA 2.1, LA 2.2, LA 2.3 |

## Suggested Assessment Task

The template for the formulation of the AT is emphasizing different assessment strategies for different verbs and different learning style.

### KTH –Sweden

*Proposal Scientific Debate*

| ILO reference (Highlight the Verb) | Assessment task 1 | Assessment task 2 | |
|---|---|---|---|
| ILO 1<br>Gather information and elaborate a strategy to qualify and defend an opinion on a controversial topic, and analyse and summarize the consequent debate | verb: gather, analyse<br><br>Activity type: Written report<br>Retrieve information related to the topics using ChatGPT. Analyse relevant information given the group debate strategy.<br>List the motivation for all arguments choices and the related references.<br>Report the collected and analysed information.<br><br>Grading: pass/fail | verb: summarise<br><br>Activity type: Oral presentation<br>Present orally the results of the debate in front of the class.<br><br>Grading: pass/fail | verb: elaborate<br><br>Activity type: Debate exercise<br>Create the debate strategy based on the different roles in the debate.<br>Implement the created strategy during the debate.<br><br>Grading: pass/fail |

### UNIMA- Malta

*Proposal 1 Six Sigma*

| ILO reference (Highlight the Verb) | Assessment task 1 | Assessment task 2 |
|---|---|---|
| ILO 1<br>Remember and understand the theoretical and background knowledge of Six-sigma process improvement methodologies. | Verb: Remember and Understand - multiple choice questions<br><br>Mark the correct / incorrect statements.<br><br>Grading: points (0 - 10) | Verb: Remember and Understand - Exam essay question<br><br>Describe the concept presented in the class on an example use-case.<br><br>Grading: points (0 - 10) |
| ILO 2<br>Apply the Six-Sigma process improvement methodologies to an engineering case study. | Group work in which students have to develop a strategy using a six-sigma process improvement methodology to address the presented problem.<br><br>Grading: points (0 - 10) | Group work create a poster showing the developed strategy to address the presented problem.<br><br>Grading: points (0 - 10) |
| ILO 3<br>Present the findings which will be discussed in class | As a group the students need to present and defend their finding that will be discussed in class.<br><br>Grading: points (0 - 10) | |

*Proposal 2 Artificial Neural Networks*

| ILO reference (Highlight the Verb) | Assessment task 1 | Assessment task 2 |
|---|---|---|
| ILO 1 | Verb: explain | Verb: explain |

| | | |
|---|---|---|
| Explain the basic structure and functions of Artificial Neural Networks | - multiple choice questions<br><br>Mark the correct / incorrect statements regarding the structure of an ANN.<br><br>Grading: points (0 - 20) | - true/false<br><br>Mark true/false the function of ANNs.<br><br>Grading: points (0 - 20) |
| ILO 2<br>Apply an Artificial Neural Network to solve a classification problem. | Verb: Apply<br>- Case Study<br><br>Apply by compiling code on how ANNs can be used to solve a classification problem.<br><br>Grading: points (0 - 70) | |
| ILO3<br>Analyse the application of Artificial Neural Networks to the K-Nearest Neighbours Algorithm for a classification problem. | Verb: Analyse<br>- Discussion<br><br>Analyse and compare the difference between how tackling this problem using ANNs is formulated differently from when using KNNs.<br><br>Grading: points (0 - 30) | |

## POLITO – Italy

### *Proposal 1 Production Systems*

| ILO reference (Highlight the Verb) | Assessment task 1 | Assessment task 2 |
|---|---|---|
| ILO 1 - The student will be able to outline and express with mathematical models the technological properties of the materials used for production | Verb outline<br><br>Activity type: Written questions<br><br>Answer theoretical questions on the technological properties.<br><br>Grading: assessing by scores: 1 for exact answer, -1/4 for wrong answer, 0 for no answer | Verb express<br><br>Activity type: Written exercises<br><br>Solve numerical problems on the technological properties.<br><br>Grading: assessing by scores: [0-8] |
| ILO 2 - The student will evaluate and assess a given manufacturing process, analyzing the technical and economic performances and taking into account quality, safety and sustainability issues. | Verb ANALYZE<br><br>Activity type: Written exercises<br><br>Solve numerical problems on the process analysis.<br><br>Grading: assessing by scores: [0-8]<br><br>The total number of exercises plus questions must total 32 points | |
| ILO3 - The student will be able to choose, integrate and deploy the manufacturing steps as a coordinated system oriented to | Verb Integrate<br><br>Activity type: Written exercises | Verb Deploy<br><br>Activity type oral presentation at the optional |

| | | |
|---|---|---|
| the making of an industrial product (process plan) | Solve numerical problems on the process planning.<br><br>Grading: assessing by scores: [0-8]<br><br>The total number of exercises plus questions must total 32 points | request of the student: present and discuss a given process plan<br><br>Grading: assessing by scores: [-3:+3]<br><br>(modify the final score) |

## UNILJ – Slovenia

### *Proposal 1 PID Control*

| ILO reference (Highlight the Verb) | Assessment task 1 | Assessment task 2 |
|---|---|---|
| The student should be able to program a discrete version of the PID control algorithm on an Arduino microcontroller and analyze the stability of the close loop system | At the beginning of each lecture a short online test is executed (formative). | Based on a system model the students should tune the PID controller and program the algorithm on an Arduino microcontroller (lab work summative). |

### *Proposal 2 Mechatronic Actuators*

| ILO reference (Highlight the Verb) | Assessment task 1 | |
|---|---|---|
| The student should be able to compare pneumatic, hydraulic and electric actuator and select an appropriate one for a specific application with regard to cost, environmental conditions, operating conditions | At the beginning of each lecture a short online test is executed (formative). | For a specific example, students compare pneumatic, hydraulic and electric actuator and select the best solution. The solution is handed in in the form of a report (summative). |

## UNIRI – Croatia

### *Proposal 1 Statistical Testing*

| ILO reference (Highlight the Verb) | Assessment task 1 | Assessment task 2 |
|---|---|---|
| Select and apply appropriate statistical tests on data obtained from a HCI experiment, and derive the conclusions according to their outcomes. | Verb: Select<br>Exam question<br><br>Answer questions regarding the selection of the appropriate statistical test, according to the given description of the HCI experiment design and the available data.<br><br>Grading: assessment by grade | Verb: Apply, derive<br>Project activity / Project report<br><br>Apply the appropriate statistical tests on data obtained within a Project (HCI empirical research). Report the results in a standard/formal way, and derive the conclusions (generalizations) accordingly.<br><br>Grading: In overall project assessment, points are awarded or not, depending on the success of this project activity. |

*Proposal 2 Multithreading in Operative Systems*

| ILO reference (Highlight the Verb) | Assessment task 1 | Assessment task 2 |
|---|---|---|
| ILO 1<br>Explain multithreading in the Operating System. | Verb: explain<br>- multiple choice questions<br><br>Mark the correct / incorrect statements.<br><br>Grading: points (0 - 20) | Verb: explain<br>- Exam essay question<br><br>Describe the concept presented in the class on an example use-case.<br><br>Grading: points (0 - 20) |

## UNIBG- Italy

*Proposal 1 AM in medical implants*

| ILO reference (Highlight the Verb) | Assessment task 1 | Assessment task 2 |
|---|---|---|
| ILO 1<br><br>Describe business processes in the operations management domain and illustrate them using BPMN2.0 | True/false question<br><br>Essay question<br><br>Modeling exercise<br><br>Grade 0 – 10 | Project work in which students have to model a business process<br><br>Grade 0 - 1 |
| ILO 2<br><br>Produce discrete event simulation models of business processes in the operations management domain with AnyLogic, and analyze and compare their performance | True/false question<br><br>Essay question<br><br>Grade 0 - 10 | Project work in which students have to simulate a business process and analyze the results<br><br>Grade 0 - 1 |

## Summary of the proposed educational units and plan for the implementation

| Institution | Proposal | Implementation |
|---|---|---|
| KTH | Scientific Debate | Yes |
| UNIMA | Six Sigma | Yes |
| | Artificial Neural Network | Yes |
| POLITO | Life-Cycle Assessment | Yes |
| UNILJ | PID Control | |
| | Mechatronic Actuators | |
| UNIRI | Statistical Testing | Yes |
| | Multithreading in Operative Systems | Yes |
| UNIBG | Business Process Modelling and Simulation | Yes |

## 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.
2. Lupi, Francesco, et al. "Toward a sustainable educational engineer archetype through Industry 4.0." *Computers in Industry* 134 (2022): 103543.
3. Antonelli, Dario, et al. "Tiphys: an open networked platform for higher education on industry 4.0." *Procedia CIRP* 79 (2019): 706-711.
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.
5. Maffei, Antonio, et al. "On the design of constructively aligned educational unit." *Education sciences* 12.7 (2022): 438.
6. Sala, Roberto, et al. "Blended learning in the engineering field: A systematic literature review." *Computer applications in engineering education* 32.3 (2024): e22712.
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.
8. Sala, Roberto, et al. "Examining the implementation of Blended Learning in the Engineering field." *5th International Conference on Higher Education Learning Methodologies and Technologies Online*. 2023.

# Appendix: Template for the homework in C1

## Template for the ILO formulation

BLISS Erasmus + project

Project Result 3
Workshop on BL and CA
Block 1: Designing Intended Learning Outcomes

| | Short description | Verb (level of Understanding in the bloom Taxonomy) | Content | Context |
|---|---|---|---|---|
| ILO 1 | | | | |
| ILO 2 | | | | |
| | | | | |

## Template for the TLA formulation

BLISS Erasmus + project

Project Result 3
Workshop on BL and CA
Block 2: Designing Teaching and Learning Activities

| ILO reference (Highlight the Verb) | Teaching Activity (What the teachers do) | Learning Activity (What the students do) | How does this use the 7 Principles of good learning[5] |
|---|---|---|---|
| ILO 1 | TA 1.1<br>TA 1.2<br>…. | LA 1.1<br>LA 1.2 | |
| ILO 2 | TA 2.1<br>…. | LA 2.1<br>…. | |
| | | | |

[5] 7 principles of good learning:

- encourages contact between students and faculty,
- develops reciprocity and cooperation among students,
- encourages active learning,
- gives prompt feedback,
- emphasizes time on task,
- communicates high expectations
- respects diverse talents and ways of learning

Arthur W. Chickering and Zelda F. Gamson (1987)

## Template for the AT formulation

BLISS Erasmus + project

Project Result 3
Workshop on BL and CA
Block 3: Designing the Assessment Task

| ILO reference (Highlight the Verb) | Assessment task 1 | Assessment task 2 | …… AT X |
|---|---|---|---|
| ILO 1 | | | |
| ILO 2 | | | |
| | | | |