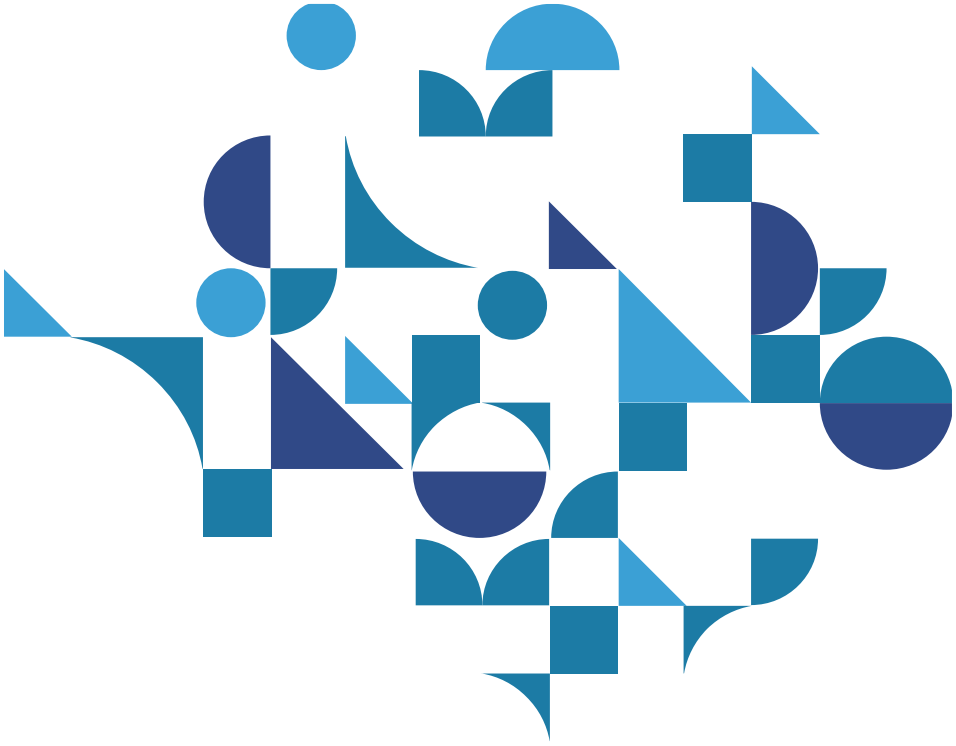
Industrial Engineering and Management of European Higher Education



R3.2 Renewed courses learning materials

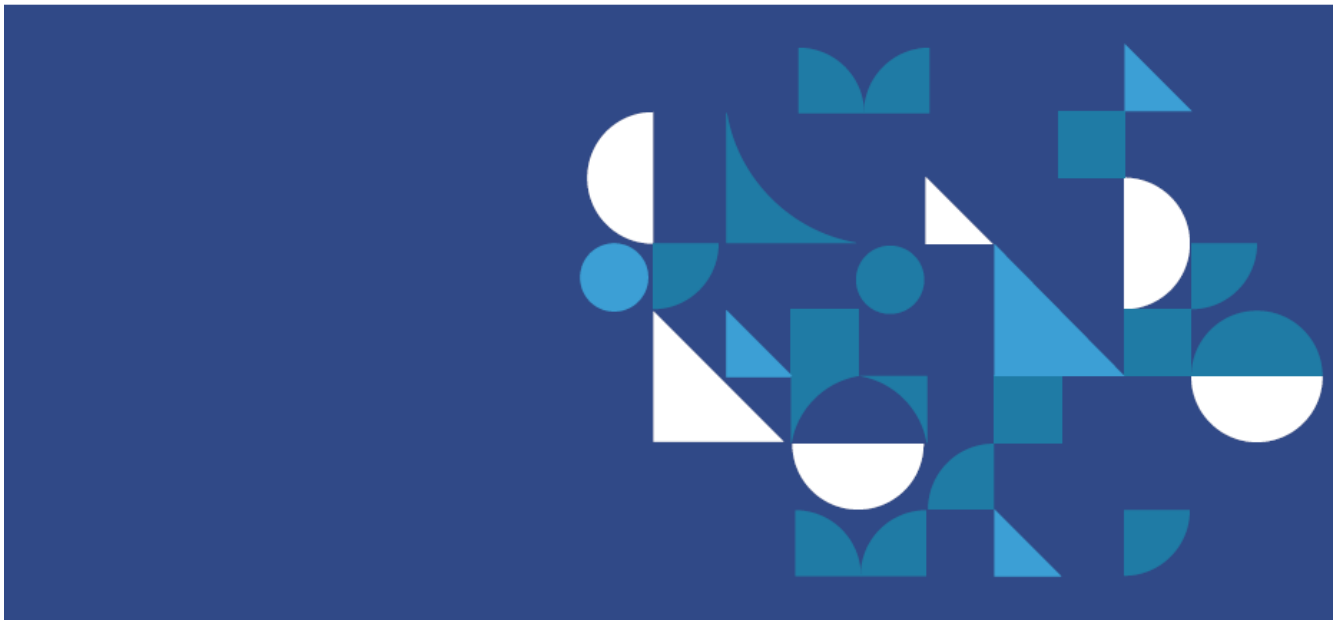
Co-funded by the Erasmus+ Programme of the European Union

This document presents the action plans developed by partner universities in collaboration with the industry partners to renew the training materials of one of their courses. The courses were selected among the ones currently active and were revised according to the guidelines set in the Body of Knowledge (BoK).

Partner Universities and Companies' joint efforts have led to the creation of a prototype of Renewed courses learning materials. The courses were designed to be more engaging and immersive, with a variety of multimedia learning materials such as slides, reference documents, exercises, quizzes, and more. We These changes will not only improve the quality of the courses but also increase their attractiveness to potential stakeholders.

The Renewed courses learning materials have been designed with several essential characteristics in mind. They are clearly divided into topics, and all materials are in English, to cater to a wider audience. Additionally, the learning materials are composed of various media, including texts, infographics, PowerPoint slides, and tests and quizzes.

Industrial Engineering and Management of European Higher Education



IE3 Course Action Plan
REPORT WP3 UPM

Date: 31/01/2022

Co-funded by the
Erasmus+ Programme
of the European Union

UPM Action Plan; Work package 3; Dissemination level CO (Confidential)

Authors and contributors:

Joaquín Ordieres (UPM), Miguel Ortega (UPM), Miguel Gutiérrez (UPM), Gustavo Morales (UPM), Mercedes Grijalvo (UPM), Eduardo Caro (UPM), Javier Cara (UPM), Silvia Villalgordo (UPM), Elcio Mendoça (UPM)

This document is part of the Result 3.1 "IE3 Course Action Plan" of the Erasmus+ Project "Industrial Engineering and Management of European Higher Education / IE3" and it represents the first contribution to this deliverable from the UPM partner. The current version of the report may be subject of changes according to the future project activities and findings. The project partners commit to deliver an improved version of the report no later than four weeks after the end of the course delivery.

Copyright notice

Note:

For anyone interested and having the right to access to further information about the deliverable in the project, please contact us at: info@ie3.eu

OUTLINE

1 EXISTING COURSE MODULE

Course module: Project Management: Advanced Tools and Techniques.
Master Program: Industrial Organization Master
Effort: 6ECTS (165 h)
Students: ~ 70 students
It is a compulsory course in the master program.

1.1 Objectives

The course aims at endowing second level management engineers with the following knowledge:

- Main areas of activity for managing projects in current context.
- Different Project Management methodologies.
- Advanced techniques for managing projects with practicing by managing some academic projects.

1.2 Current Syllabus

The existing syllabus can be seen in Figure 1 below,

1. Introduction
2. Project Management Methodologies
3. Scope Management
4. Time Management
5. Cost Management
6. Risk Management
7. Procurement Management
8. Quality Management
9. Communication Management
10. Human Resources Management
11. Stakeholder Management
12. Project Execution Monitoring
13. Agile Project Management
14. Maturity Models

Figure 1.- Topics covered in the ancient version of the course.

Where the effort per point is 0.4 ECTS, including theory and practice except in the introduction accounting just for 0.1 ECTS (1h in presence) and Risk management and Project Execution Monitoring, which require 0.7 ECTS. Assessment uses the remaining 0.1 ECTS.

1.3 Teaching methods and assessment

The former approach was to split sessions between theory and practice. Concepts are presented in magisterial lessons (14 weeks, 2 hours theory and 2 hours practice per week).

The scoring process is based on written exams being related to the theoretical knowledge (50% of weight). Practical work is summarized by an integrated report as well as team presentation and discussion (50% weight).

When the COVID-19 emergency imposed distant learning, the approach moved to synchronous remote lessons leaving the recordings available for students on the institutional repository (Onedrive).

1.4 Need for revision

The main reason for revision is the ambition to provide master students with actual knowledge in the field of Project management consistent with industry needs.

It requires a significant shift from the traditional view promoted by institutions such as Project management Institute toward a multi-disciplinary view of different methodologies, but also to include digitalization dimension.

Therefore, better integration between practice, looking at bringing alive projects to be handled, in order to provide effective experience of things evolving in real contexts.

To create enough room for practical effort, several mythological changes need to be enforced, because of devoting more time in the face to face sessions to discuss issues and theoretical implications for different situations and deliverables found during practical work. In order to enable such approach, several strategies have been considered, such as:

- Put the theoretical acquisition in flipped classroom approach.
- Provide a microlearning approach with short readings and video content.
- Enable self-diagnosis about the gathered knowledge throughout the microlearning environment.
- Put the highest attention to the managerial deliverables as well as the decision making process, when complexity increases.
- Globally speaking, learners are going to be empowered to decide when they know enough or when they need more information or support.

2 REVISION RELATED TO THE BoK

The UPM is a Madrid-based university but we have international endeavors, and it is in this context in which we have to measure up. We operate in a global playing field, and this should be reflected in all our activities as a university.

The UPM has a lengthy history as an international university, of which it is proud. This strategy aims to build upon this tradition and reputation at the same time as securing a position for a changing future. UPM is already a strong and internationally respected university. It is the leading university in the Spanish-speaking world for engineering. But it is time to go global. We need to put Madrid and

the UPM more firmly on the international map or at least clarify its place in the world rather than just relying on rankings.

Global UPM Strategy: based on ten pillars, which are,

- Forge alliances with the best universities and institutions in the field of the technology.
- Develop mutual confidence and commitment with our partners, identifying common interests and opportunities, focusing on the longer term and opting for the development of joint programmes within the teaching, the research and the innovation fields
- Defend our public service status, preserving the principle of public service as a key component of the mission of our university.
- Be an asset to our country, aligning our international strategies with the policies of our region and country, go with Spanish technology companies in their international expansion.
- Take advantage of national and local strengths: Spanish language, gateway to Latin America and Africa.
- Develop innovative formats of collaboration.
- Be a reference in terms of sustainable development goals.
- Adopt a strategy mainly targeting positioning: defend and boost our brand.
- Do not go it alone: international networks and strategic partnerships.
- International offices as platforms upon which to build and boost the university's strategy in the respective region. The UPM has a networked structure of international offices. It is their job to support UPM students, staff and researchers and promote their internationalization, increase the visibility of the university in the respective region and recruit young researchers.

2.1 BoK considerations

After starting from the strategic pillars, the ambition for the course, connected with the planning phase was also established. Then, the BoK established standards were enforced, including new module configuration, resources, etc.

In the following, the main findings of the BoK affect the course module revision:

> *"By analyzing the knowledge demand expressed by companies in the quantitative survey (questionnaire), the following technical knowledge, skill, and competencies (KSCs) have been identified in descending order of importance:*
>
> *Knowledge, Skill, and Competences*
>
> - ***Project Management***
> - *Operations Management*
> - *Quality Management*
> - *Strategic Management*

- *Safety of Work".*

"As far as digital operational tools are concerned, the high companies' demand values are observed for

(listed in order of descending importance):

- *Management Software Tools (e.g. ERP, CRP)*
- ***Computer-based Statistic Competences***
- *Big Data Analysis."*

Finally, results of the survey carried out in the IE3 project "forced the revision to focus on the "soft skills"

characterized by a high companies' demand (listed in order of descending importance):

- ***Problem Solving and Decision Making;***
- *Team Working;*
- *Communication Skills".*

Another key aspect of the recommendations from the BoK, in addition to the consideration of the KSCs arose from the companies/employers, is to keep the learners in the middle of the learning process.

New generations of learners currently attending university courses exhibit specific behaviour, not observed in earlier generations, as the result of being exposed to internet and social media tools from the beginning.

Currently most of research studies are focused on Millennials, but the younger, lesser-known generation now named as Generation Z grew up without much fanfare [1]. The oldest of this post-Millennial generation arrived to college in 2014-2015, and more than four years later, Generation Z students fill our classrooms, and campus programs [2]. Although not everyone born in a generational period shares the same values or experiences, they do share a common context that shapes their world view. Thus, generational research can provide institutions with valuable information to design effective policies, programs, and practices.

No different from generations before them, Generation Z's focus when coming to college is to learn and acquire the skills necessary for their future careers. Learning for them, however, is markedly different from that of previous generations. Findings from North-eastern University's Innovation Survey highlight that Generation Z students prefer to engage in hands-on learning opportunities in which they can immediately apply what they learn to real life, and they describe the ideal learning environment as "need[ing] to be actively doing the learning to obtain the most information." University officials continue to face new challenges in meeting the needs of an increasingly diverse student body and fulfilling an expansive institutional mission [3]. To configure more efficient learning procedures is a requirement, but this

behaviour can be identified as well as to professionals looking to enlarge their knowledge.

Because of the highlighted characteristics of over-stimulation, digital multichannel sources, lack of patience, it becomes even harder managing classes lasting one hour and a half and involving many slides and concepts. Providing a vibrant learning environment for Generation Z will require creative approaches that combine social interactions, technology, and assignments that simulate real-life work situations or are community outreach projects. New technology platforms may be required as well as faculty development to learn methods for teaching Gen Z that includes more than technical approaches.

Micro learning combined with the Knowledge Graph representation (KG) as well as an advance competence approach enabling embed assessment of knowledge related to both nodes/concepts and arcs/relationships seems to be consistent with the renovation spirit.

The interest of such learning structure is that enables self-guided, independent asynchronous learning of concepts as auxiliary but yet relevant elements. By giving learners the option for such learning path, when the course involves blending or synchronous activities, such organization opens a bigger space for innovation. This is because when formal lecture presentations of contents are removed, more options for training oriented approaches appears, including open discussions about relationship between concepts or case studies.

More practical application to real cases, including software tools are well suited, emphasizing the opportunities to acquire additional soft skills linked to the cooperative work and noisy environments.

In the next section of this report more details about the revised course design will be provided as well as details for course implementation, always inside the section 3.3 of the BoK.

2.2 Contents

The revised content of the course “Project management: Advanced Tools and Techniques” looks to introduce a far more digitalized version of some topics, such as Time and Cost Management, where many different alternatives to the classical scheduling techniques are available, with dozens of cloud and local pieces of software helping to this end.

The same happens with the topic related to Project Execution Monitoring.

Despite of the previous aspects, a specific topic related to Digitalization and Projects, presenting to learners the two way of thinking: managing projects to digitalize processes and digitalization of project management processes.

2.3 Teaching Methodology

According to the main findings and suggestions from the BoK, the following teaching methodologies have been adopted for the pilot course module:

- Asynchronous Learning by LMS in either distant or blended configurations.
- Microlearning approach implemented with LMS (see Figure 2).
- Single path per student can be selected based on their existing knowledge (assessed by specific quizzes) inside each competence.
- Quizz based selftesting for the individual microlearning content.
- Gamification to refresh and review content (see Figure 3).
- Teams to manage in a practical way on-going projects.
- Theory is secondary and serving the decision making and work carried out to manage the assigned projects.
- Minutes of meetings as well as deliverables are assessed and feedback is timely provided.
- Video based presentations for the integrated project as well as for the individual contribution are developed.
- Conferences and E-Conferences have been configured as extra content as optional activities.

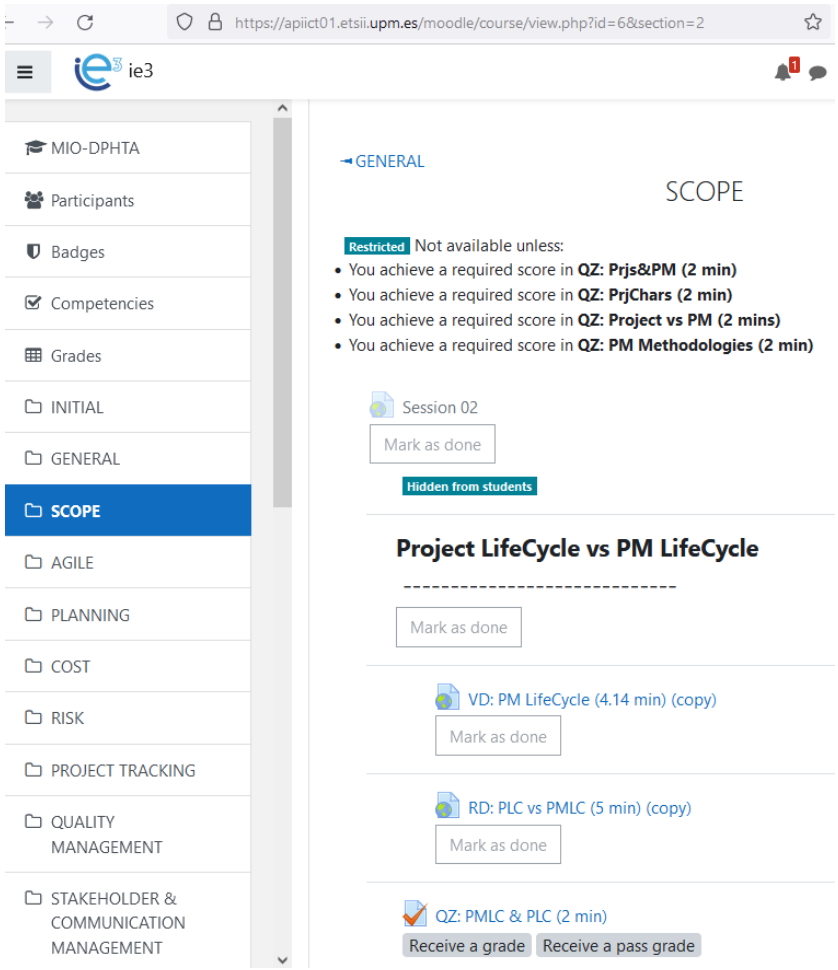


Figure 2.- LMS content with microlearning video and readings, as well as quizes.

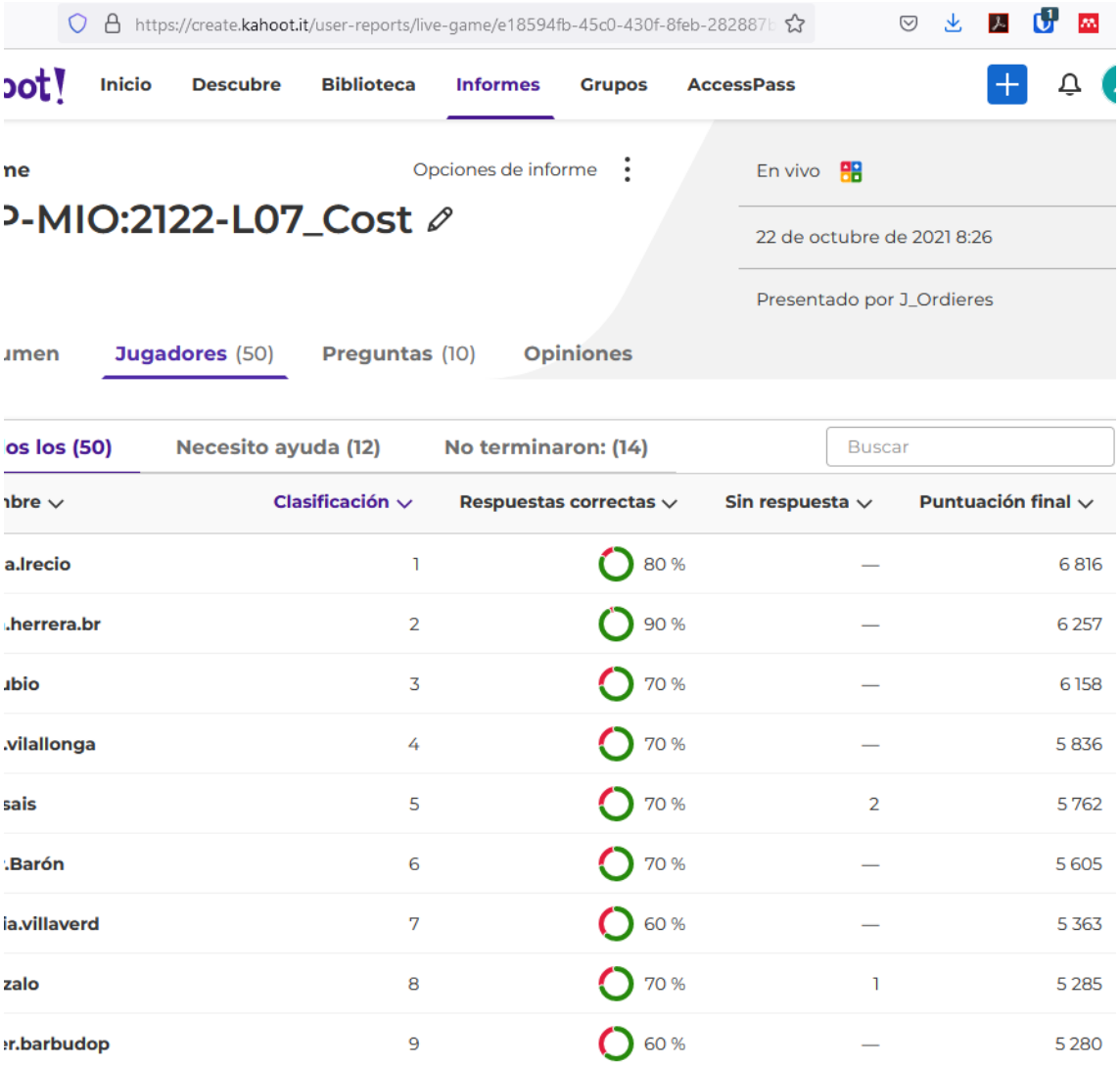


Figure 3.- Scoring in gamification serious games used to test knowledge gathering.

Synchronous sessions will be used to discuss topics based on dynamic html content created with markdown (see Figure 4):

Figure 4.- Dynamic HTML content material to guide interactive synchronous discussions.

3 REVISED COURSE MODULE: Project management: Advanced Tools and Techniques.

Course parameters are the same for this upgraded release of the course:

Course module: Project Management: Advanced Tools and Techniques.
Master Program: Industrial Organization Master
Effort: 6ECTS (165 h)
Students: ~ 75 students
It is a compulsory course in the master program.

3.1 Expected Learning outcomes

Based on the preliminary work carried out in [4] the competence concept was adopted by following the current status of the art, where scholars have identified two main categories of competences, Individual and organizational competencies. Still, independently from the adopted taxonomy, it is convenient to fix the competence understanding, which will require, a definition, a description, and a measurement criteria (see Figure *5*).

Figure 5.- Competence understanding.

Indeed, in order to refine the goals, a case base analysis was adopted as methodology. To this end, aiming to present specific ways of implementing transformed IE&M courses, a Project Management module was selected. Then the KG was established, as summarized in Table 1, where the first column represents the knowledge area, in close relationship with the competences to be mastered, and then the already mentioned triplets are presented for a few cases.

Table 1 Random Entries from the KG for the PM course

Knowledge Area	Subject	Relationship	Object
General	PM	has management capabilities in	Project Integration
General	Phase	has common	Processes
General	Project Management	is different from	Project
General	Project Management	is different from	Project Deliverables
Scope	Scope	aims to deliver	Deliverables
Scope	Scope Management	aims to deliver	Required Deliverables
Scope	Scope Management	includes	Scope Planning
Planning	ROY	is a	Network Diagram

3.2 Revised Syllabus

In Figure 6 the new designed course content is introduced. Therefore, main aspects already discussed have been implemented.

1. Introduction
2. **Digitalization and Projects.**
3. Project Management Methodologies
4. Scope Management
5. **Time and Cost Management**
6. **Project Execution Monitoring**
7. Risk Management
8. Quality Management
9. Communication and Stakeholder Management
10. Agile Project Management
11. **Management of the R&D projects**
12. Maturity Models

Figure 6.- Renovated syllabus.

It is easy to realize that the renovation involves strong changes (media preparation (many small pieces of content) but also knowledge graphs as per big competence (see Figures 7 and 8), including tests for individual assessment and for global one. Indeed, preparation of seminars for flipped approach.

It was decided to use classical Learning Management System (LMS) as a convenient tool to implement the Competence framework, and Moodle was selected for this purpose, as indicated in Figure 2, where its different entries are grouped under the taxonomy keyword [5]. It looks to define every framework row, by setting the language string keys used to describe competencies at each level of the framework [6]. In present case, the adopted taxonomy organizes the knowledge in four layers, where the concept is the atomic item and skill is the capability of getting concepts working together, either for knowledge or just when used by a specific tool to carry out detailed outcome. Combination of skills will provide integrated perspective in a higher level, named competency. Finally, competencies are arranged by Domains of knowledge [7].

For the presented implementation Domains are 'General Knowledge/Organizational', 'Scope', 'Cost', 'Risk', 'Stakeholders', 'Assessment', 'Reporting', and 'Maturity'. For each of the domains or knowledge areas, several competences can be linked. Therefore, when Organizational Domain is considered, it was decided to highlight competency for Setting up the Project Characteristics, as well as Project agents recognition and relevant activities and roles. Finally, it was decided to include the competence to recognize different methodologies relevant for project management (see Figure *5*).

By following the same approach, when a single competency is selected different skill entries become relevant. Just as an example, when Project agents is selected as competence, relevant skills are identifiable, such as,

- understand the value creation for Project Manager as well as their typology,
- understand the relevance and responsibilities for all the legal entities around the project,
- understand the work for different contractors as well as their relationship,
- understand the implications for the project owner / product owner,
- understand the Project Engineering roles and responsibilities,
- understand the team work involved in both, project execution and project management.

Such structure can be realized at the competence framework definition in Figure *6*, where the atomic elements can be related to them as appropriate. In our case, the skill related to the Project Management understanding can rely on her responsibilities, the relevant knowledge areas s/he will be required to manage.

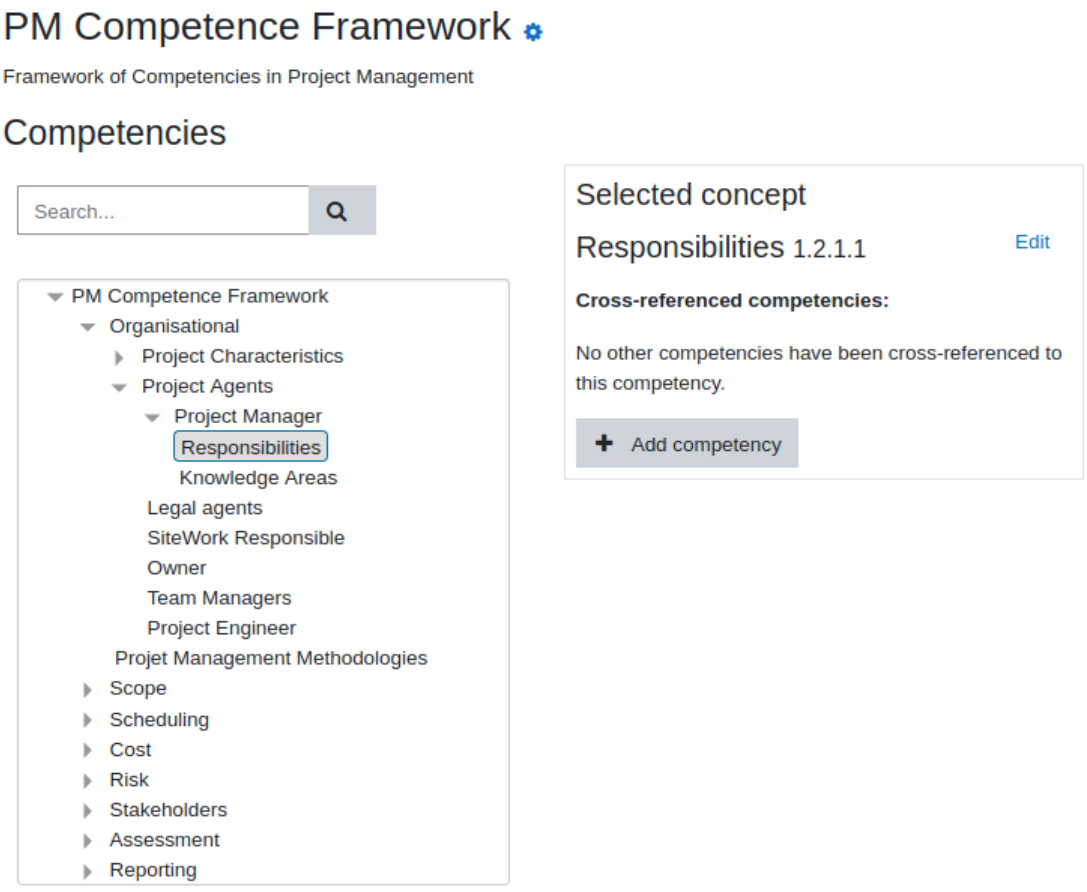


Figure 7.- Implementation of skill items into the Competence Framework.

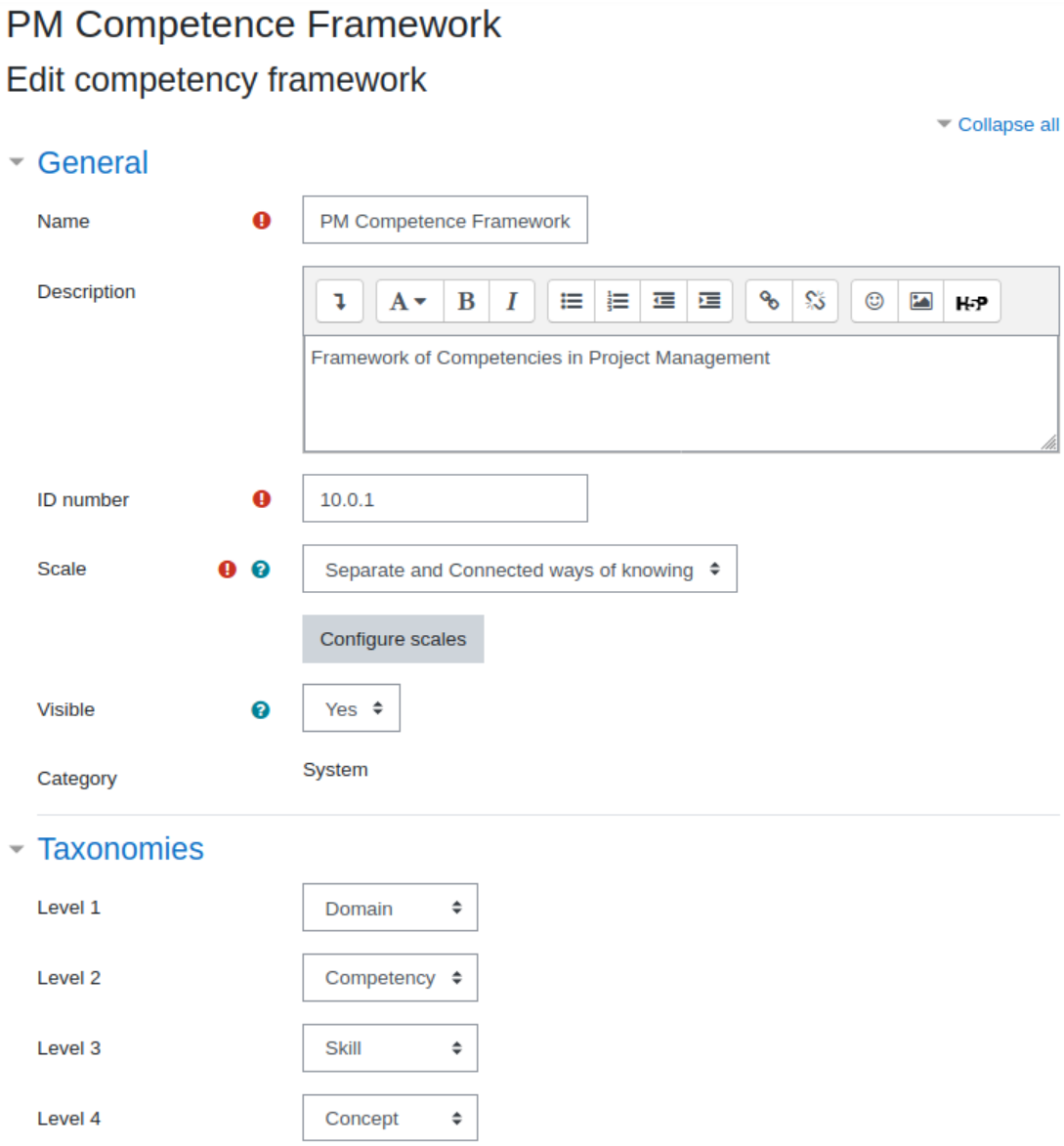


Figure 8.- Implementation of the Competence Framework in Moodle LMS.

The next step to implement a proper micro-learning context is to generate different learning artifacts, including concept and relationship explanations as well as some exercises able to demonstrate gaining enough insights. In Figure 5 different micro-learning items are presented, some of them text based for reading, some of them video based and, to validate the gathered knowledge a quiz linked to a competence rule.

3.3 Evaluation criteria

In opposition to the evaluation criteria depicted in section 1.3, the following scores have been considered for this pilot course:

- 360º assessment inside the project management team (7%).
- 360º assessment with the technical project team (7%).
- Participation and performance for the in-class discussions (6%).

- Proper answer to questions addressed by the course advisor (10%).
- Quizzes performance (20%).
- Practical team performance (35%).
- Individual performance (15%).

For the coming years gamification activities are going to be considered as part of the scoring system as well.

4 IMPLEMENTATION OF THE REVISED COURSE MODULE

The pilot revised course module, designed and developed to meet the goal under the constraints defined in sections 1.4 and section 3, has been delivered between September and December 2021.

Every topic from the syllabus was reviewed in one-week time (2h), whereas the remaining 2h were used for checking the topic implementation in the running projects, and to discuss related aspects including theoretical and practical implications.

Preparing learning experiences to emphasize shared learning, to be developed at least partially at classrooms strongly depend on the topic and the practical capabilities being mobilized. In our particular case, for different project contexts, they are connected to the following topics:

- Project Scope Plan
- Project Schedule Plan
- Project Cost Plan
- Risk management plan.
- Assessment of the project development
- Crisis management, when different issues happen.

It was implemented a proper micro-learning context is to generate different learning artifacts, including concept and relationship explanations as well as some exercises able to demonstrate gaining enough insights.

As the approach is addressing Z-gen participants, which are fully digital, it is clear according to introduction that there are some constraints to consider, such as digital based media where the central element are video content, but also their lack of patience, with attention limited to 8 secs, and clear motivation for the added value for the concepts gathered in relation towards the labor market. Actually, such characteristic behavior is a key element to select a micro-learning based approach to gather fundamental concepts, which is also well connected with some other characteristics from the targeted learners, as they also exhibit social behavior but also individualism for learning patterns and experiences [8], [9].

It is worth to consider some degree of complementarity between the theoretical knowledge background (with good characteristics to be acquired on their own pace, according to their preferences and already existing knowledge) and practical skills, when applied to solve specific engagements (in this case the value comes from sharing different alternative solutions among participants able to understand each alternative as well as to discuss values and limitations).

Providing a hybrid design involving both, synchronous and asynchronous activities as well as individual and social behavior, if combined properly, can make the difference against more classical courses, in particular when new generations are targeted, as they are also concerned with applicability of the university time and opportunities after college.

Competencies describe the level of understanding or proficiency of a learner in certain subject-related skills [10]. On the other side, competency-based learning or skills-based learning, refers to systems of assessment and grading where learners demonstrate these competencies.

The course main references are:

- Managing Knowledge in project Environments [11]
- The major PM Methodologies, such as PMBoK, IPMA ICB4, PM^2 and Prince2

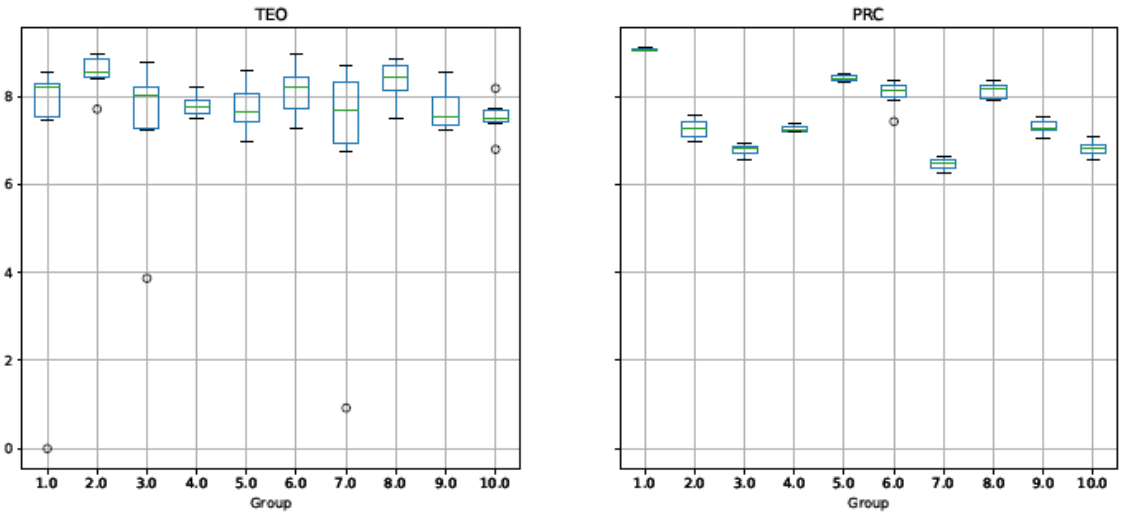


Figure 9.- Theoretical and Practical performance of students.

In addition, still room remains to implement additional serious gamification techniques for synchronous experiences, when competition stimulates participation between learners. Literature show that serious games have a potential of creating learning environments to better reach the educational and training goals [12]. The game design characteristics and game elements are need to be explored in

detail for increasing the expected benefits of the gaming environments, in particular when the synchronous dimensions are used to increase the engagement levels.

Assessment was conducted for both, theoretical and practical dimensions, where performance was measured by practical team, as presented in Figure 9.

On the basis of the current experience, several types of outcome have been identified. The first one is that digital technologies can help the learning process in different ways the learning process. Such ways included not only the content level, but also to improve peer-to-peer assessment. Indeed, it becomes a natural way to check the learners' communication skills.

Initial experiments have been introduced during synchronous sessions through gamification (by using kahoot® tool) to check the degree of penetration of the theoretical knowledge gathered. However, although promising, better integration within the adopted methodology is required. Such activities will be configured for the next releases of the course.

In Figure 10 some of the produced videos are presented

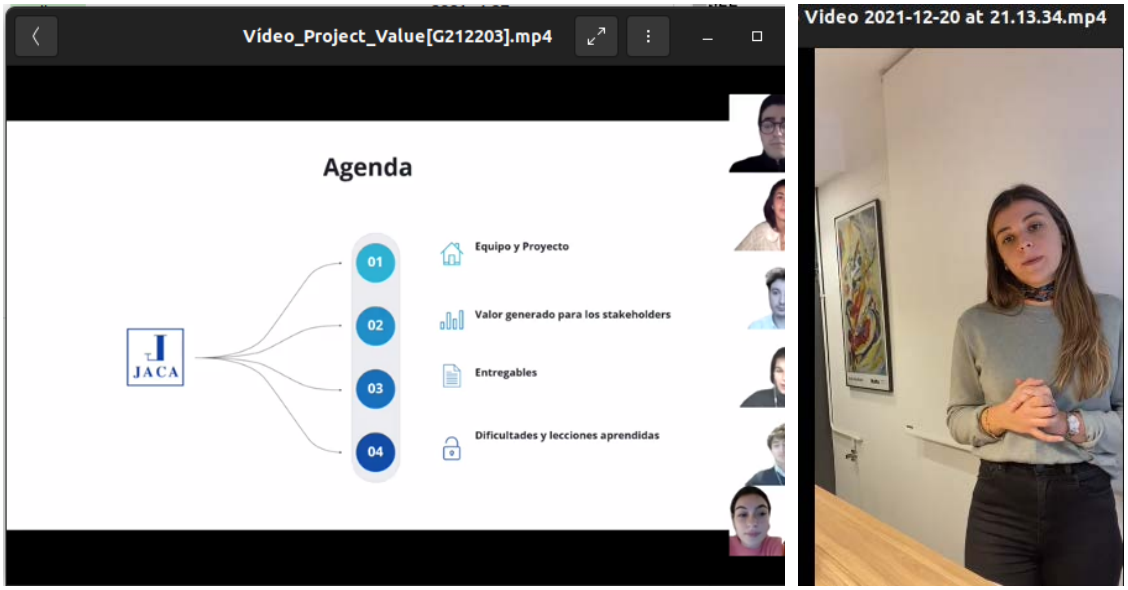


Figure 10.- Videos created by teams (presentations) and by single members to describe their contributions.

Additional benefits can be carried out from the digitalization technology applied to these deliverables, as an audio to text converter, followed by NLP pipeline processing can produce a part of speech analysis, giving some quantitative indicators about topics being covered in presentations.

For the basic knowledge acquisition, where concepts, tools and basic relationships are involved, a micro-learning based context has been proposed, where different type of media content are available, according to the learning preferences of the audience and where some

kind of asynchronous learning is encouraged. In this way implementations of flipped classroom methodologies fit perfectly with the proposed framework.

For the social learning, the focus is to address more sophisticated problems or issues where different solutions can be proposed and where discussing advantages and limitations of each of them are valuable. Indeed, where implementation of specific ideas provides benefits to the participants as they can analyze their own work as well as the work of competitors. Such aspects can be emphasized either by synchronous serious gamification tools, or because of asynchronous assessment tools.

With separation between individual asynchronous concept based learning and synchronous social oriented activities focused on increasing learning practical dimensions through team participation on case study analysis, team oriented project development, discussions, and similar activities, the course design is in accordance to the interest the new generations exhibit regarding its education pattern. Indeed, visual content for learning and micro-learning also match with their requirements for attention and gamification stimulates competitiveness as a key for increasing their engagement. The remaining aspect to be carefully considered is the vertical and horizontal integration, which requires deeply strategic design for the degree, including links to other requirements which are out of the scope of the current planning level as identified in this contribution.

From the formal point of view all the elements required to digitally improve the Industrial Engineering and Management concepts have been reviewed.

5 INVOLVEMENT OF THE INDUSTRIAL PARTNERS

The strong aspect to be emphasized is work carried out in continuous discussion with our industrial partner Arruti Catenaria SA. Different approaches and tools have been discussed, and connection between competences and project contexts were also under review.

In addition, they have reviewed the content of one of the modules, which was selected for the elearning implementation. The company is considering to use such content as part of its internal training program.

6 COURSE MODULE EVALUATION

A survey for which participants of the study voluntarily agreed and gave informed consent to their participation was conducted to collect the learners' opinions about the course and the methodology. All data

from the survey was anonymized before publication. The raised questions are:

- Q1.- With this course, have you acquired valuable knowledge useful in the labor market? (0:Not at all / 5: Excellent)',
- Q2.- Compared to classical methodologies, I appreciate the one used in this course: (-5: The best is the classical / 5: Best this one)',
- Q3.- I prefer the short media content instead long readings or lectures to present concepts (-5: Preferred long readings or lectures / 5: Preferred Short Media Content)',
- Q4.- I prefer asynchronous learning of theoretical contents (blended learning) and use synchronous for discussions / teamworking) (0: Not preferred at all / 5: Fully supported)',
- Q5.- Regarding the practical assignment, I appreciate how it helps to implement Project Management: (0: Strong disagree / 5 Strong agree)',
- Q6.- I am happy with my performance in this course and the provided takeaway (0: Not at all / 5: Excellent)'

The outcome of the survey can be seen in Figure 11.

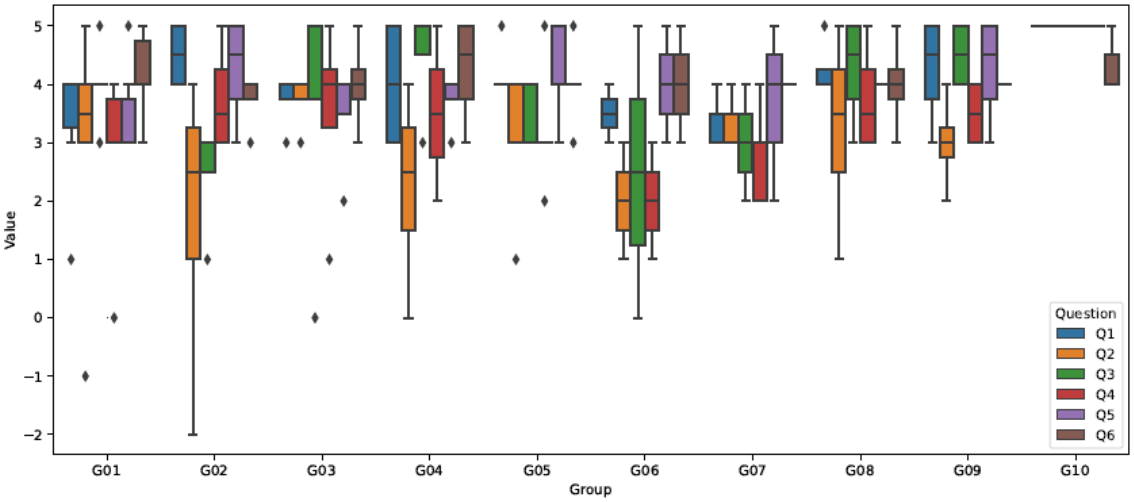


Figure 11.- Assessment of students according to the internal survey.

Main aspects to he highlighted are that in general learners appreciate the way this course was conducted, where the asynchronous blended solution was adopted to gather basic concepts, while discussions were used to clarify doubts or case-based situations. All in all, it was possible to identify a few learners willing to return the magisterial methodology instead of the more participative one, although it was just detected in a few groups.

It was also possible to confirm that learners prefer short video media content to gather knowledge, rather than reading documents or attending long presentations.

It was confirmed that Gen Z learners want to learn by doing, so they appreciate the practical assignment as the natural way of the learning process.

Additionally, international students (G10) are much more homogeneous and they better appreciate the participative methodologies.

In addition to the internal survey, the official University assessment for the course was undertaken.

To compare the effectiveness of the improvement carried out, the same assessment report covering the former course implementation (Academic year 2019-20, the last not affected by pandemic disease) and the renovated version of the course (Academic year 2021-22) are presented both, in summary as well as in the Annexes I and II. Although in Spanish language, it is worth to compare main results.

For the summary the next two figures (Figures 12 and 13) are significant enough:

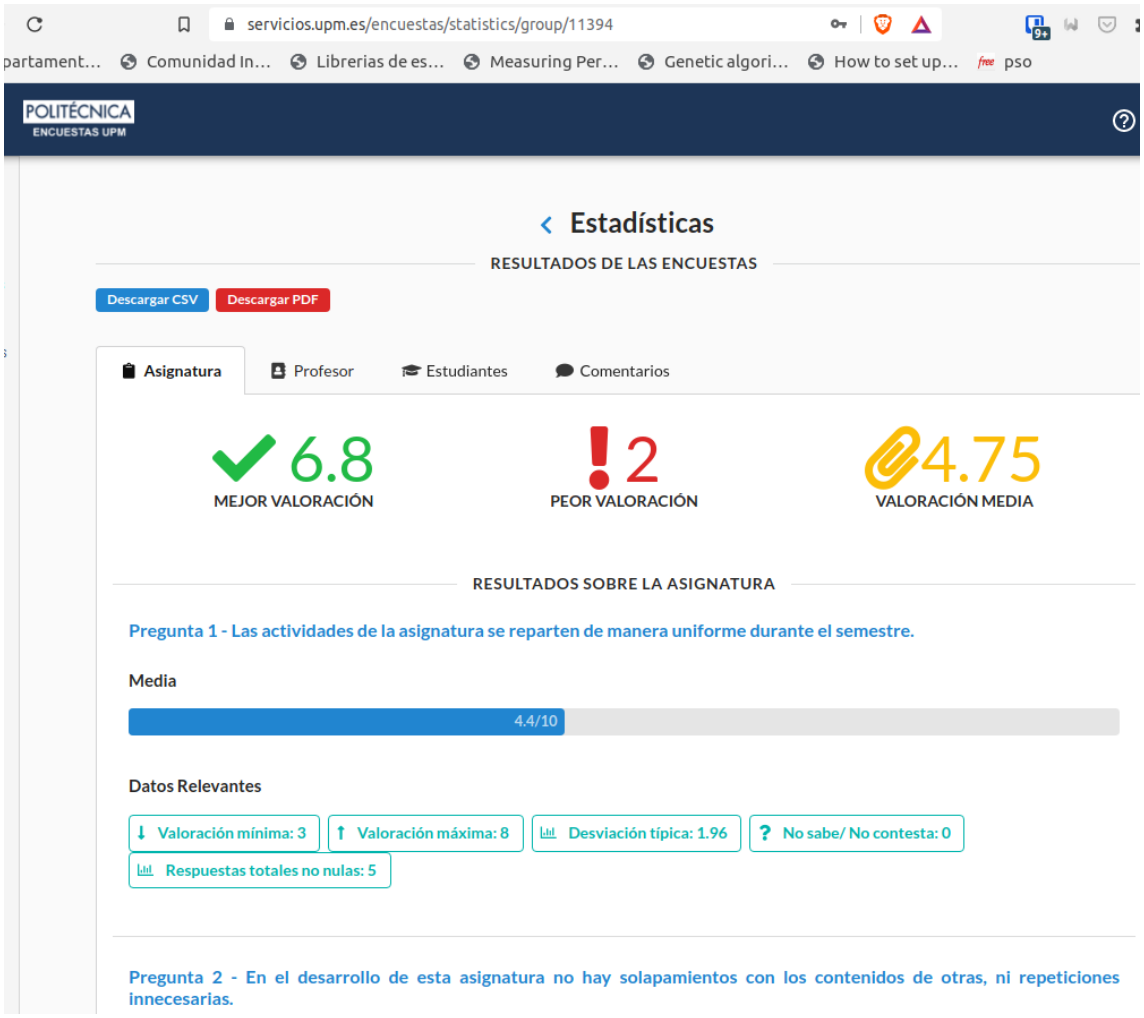


Figure 12.- Summary for the assessment of the 2019-20 edition of the course (former design) as elaborated by the UPM. Big numbers are for the best score, the lowest and the average.

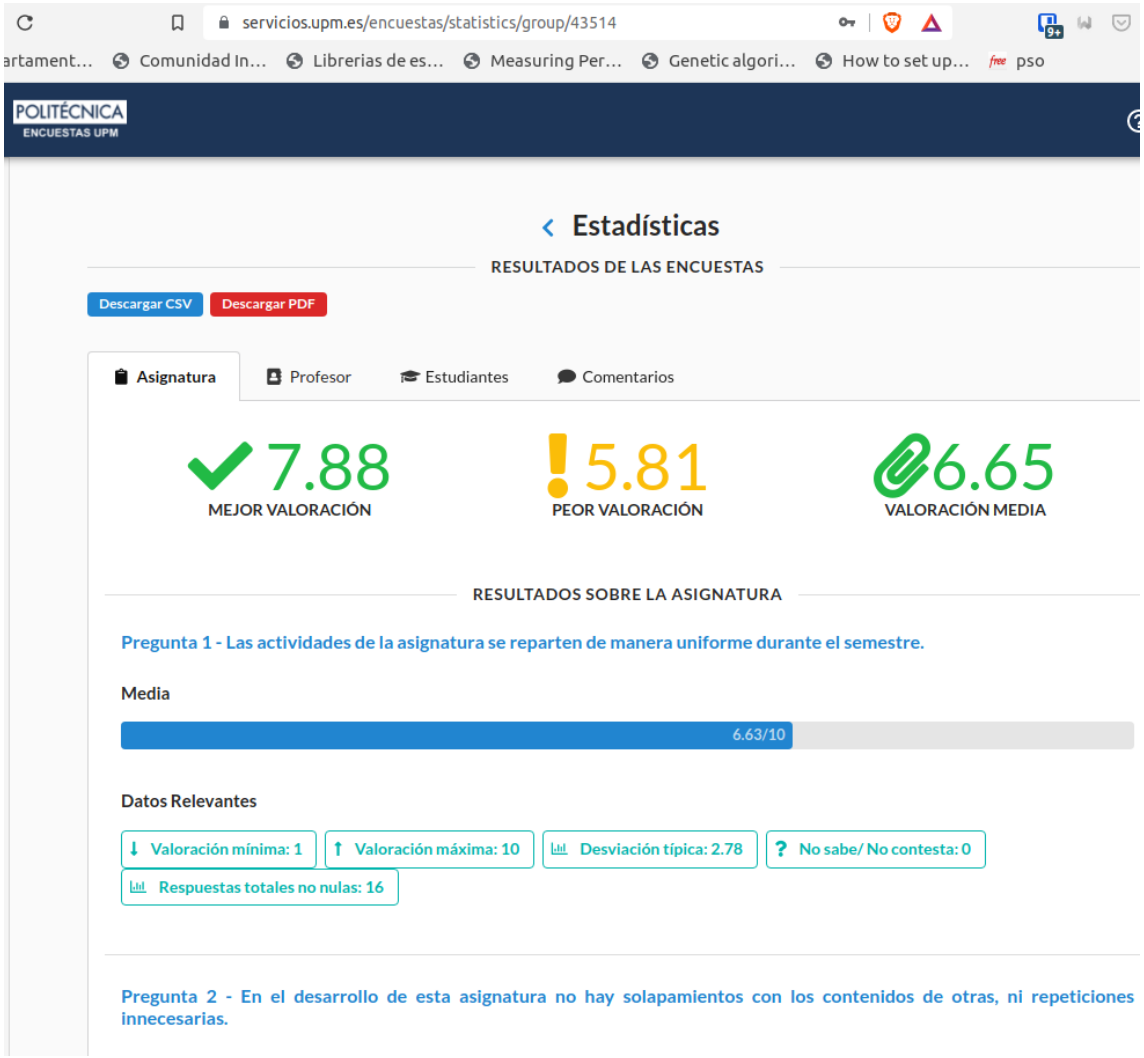


Figure 13.- Summary for the assessment of the 2021-22 edition of the course (former design) as elaborated by the UPM. Big numbers are for the best score, the lowest and the average.

The effectiveness of the implemented changes is clearly demonstrated, with an increase in the averaged scoring of two points out of 10. Despite of it, there are still room for improving and we will continue the transformation towards more added value.

As a takeaway for the IE3 project, it becomes clear that it is not just a matter of content renewal, but also of incorporating digital tools and solutions, while the courses shall incorporate practical work allowing participants to do things and assess the outcome. Indeed, to work in large teams is challenging for Gen Z learners, therefore, additional skills need to be constructed by means of different experiences.

7 REFERENCES

[1] C. Povah and S. Vaukins, “Generation Z is starting university--but is higher education ready,” *Guard.*, vol. 10, 2017.

[2] I. A. Khan and A. H. Al-Shibami, “Generation Z’s learning preferences: impact on organisational learning and development-a study conducted in a vocational institute in UAE,” *Int. J. Learn. Chang.*, vol. 11, no. 4, pp. 379–399, 2019.

[3] J. H. Blake, “The crucial role of student affairs professionals in the learning process,” *New Dir. Student Serv.*, vol. 2007, no. 117, pp. 65–72, 2007.

[4] J. Ordieres Meré, M. Ortega Mier, G. Morales Alonso, and M. Grijalvo Martin, “Retos que la digitalización induce en la educación europea sobre gestión industrial,” 2020.

[5] E. Stefanova and N. Nikolova, “Designing a Competence-Based Learning Course with Digital Tools in Higher Education,” *Trends Appl. Inf. Syst. Technol. Vol. 3*, p. 202.

[6] M. Then, B. Wallenborn, M. Fuchs, and M. Hemmje, “Towards a Domain Model for Integrating Competence Frameworks into Learning Platforms,” *Formamente-International Res. J. Digit. Futur.*, no. 2016/3, p. 4, 2016.

[7] K. Rezgui, H. Mhiri, and K. Ghédira, “Extending Moodle functionalities with ontology-based competency management,” *Procedia Comput. Sci.*, vol. 35, pp. 570–579, 2014.

[8] Forbes, “Council Post: How To Win The Hearts Of The Gen Z Consumer Base In Eight Seconds,” 2017. .

[9] M. Roszak, I. Mokwa-Tarnowska, and B. Kołodziejczak, “E-learning Competencies for University and College Staff,” in *Universities in the Networked Society*, Springer, 2019, pp. 185–200.

[10] R. Whitley, “Developing innovative competences: the role of institutional frameworks,” *Ind. Corp. Chang.*, vol. 11, no. 3, pp. 497–528, 2002.

[11] J. Payne, E. J. Roden, and S. Simister, *Managing Knowledge in Project Environments*. Routledge, 2019.

[12] N. E. Cagiltay, E. Ozcelik, and N. S. Ozcelik, “The effect of competition on learning in games,” *Comput. \& Educ.*, vol. 87, pp. 35–41, 2015.

8 ANNEXES I and II

Asignatura

1-Las actividades de la asignatura se reparten de manera uniforme durante el semestre.

4.4/10

Valoración mínima: 3 | Valoración máxima: 8 | Desviación típica: 1.96 | No sabe/No contesta: 0 | Respuestas totales no nulas: 5

2-En el desarrollo de esta asignatura no hay solapamientos con los contenidos de otras, ni repeticiones innecesarias.

6.8/10

Valoración mínima: 3 | Valoración máxima: 10 | Desviación típica: 2.32 | No sabe/No contesta: 0 | Respuestas totales no nulas: 5

3-Se han coordinado adecuadamente las clases teóricas y prácticas previstas en el programa.

5.4/10

Valoración mínima: 2 | Valoración máxima: 9 | Desviación típica: 2.94 | No sabe/No contesta: 0 | Respuestas totales no nulas: 5

4-Las prácticas de laboratorio y las actividades complementarias (conferencias, seminarios, visitas de estudio, etc.…) ayudan a la comprensión de la asignatura.

4.4/10

Valoración mínima: 1 | Valoración máxima: 9 | Desviación típica: 2.8 | No sabe/No contesta: 0 | Respuestas totales no nulas: 5

5-Los métodos utilizados para mi evaluación (exámenes, memorias de prácticas, trabajos individuales o de grupo, etc.) son adecuados para el tipo de actividades y contenidos de la asignatura.

2/10

Valoración mínima: 1 | Valoración máxima: 3 | Desviación típica: 0.89 | No sabe/No contesta: 0 | Respuestas totales no nulas: 5

6-La carga de trabajo que comprende esta asignatura es adecuada para el número de créditos que tiene asignados.

5.4/10

Valoración mínima: 1 | Valoración máxima: 8 | Desviación típica: 2.58 | No sabe/No contesta: 0 | Respuestas totales no nulas: 5

7-Los conocimientos adquiridos en esta asignatura son importantes para mi actividad profesional.

6.2/10

Valoración mínima: 1 | Valoración máxima: 10 | Desviación típica: 3.92 | No sabe/No contesta: 0 | Respuestas totales no nulas: 5

8-En general, estoy satisfecho con el desarrollo de la asignatura.

3.4/10

Valoración mínima: 1 | Valoración máxima: 8 | Desviación típica: 2.5 | No sabe/No contesta: 0 | Respuestas totales no nulas: 5

Profesor/a JOAQUIN BIENVENIDO ORDIERES MERE

1-El profesor cumple con su horario de clase establecido.

8.75/10

Valoración mínima: 8 | Valoración máxima: 10 | Desviación típica: 0.83 | No sabe/No contesta: 0 | Respuestas totales no nulas: 4

2-El profesor asiste regularmente a clase.

9.5/10

Valoración mínima: 8 | Valoración máxima: 10 | Desviación típica: 0.87 | No sabe/No contesta: 0 | Respuestas totales no nulas: 4

3-El profesor está accesible para tutorías o consultas por parte de los estudiantes en su horario establecido.

6.33/10

Valoración mínima: 2 | Valoración máxima: 9 | Desviación típica: 3.09 | No sabe/No contesta: 1 | Respuestas totales no nulas: 3

4-El profesor prepara, organiza y estructura bien las actividades o tareas que se realizan en la clase (o laboratorio, taller, trabajo de campo, seminario, etc.).

3.75/10

Valoración mínima: 1 | Valoración máxima: 7 | Desviación típica: 2.17 | No sabe/No contesta: 0 | Respuestas totales no nulas: 4

5-El profesor explica de forma clara y comprensible los contenidos de la asignatura.

2.25/10

Valoración mínima: 1 | Valoración máxima: 5 | Desviación típica: 1.64 | No sabe/No contesta: 0 | Respuestas totales no nulas: 4

6-El profesor ha cumplido con lo planificado en la guía de aprendizaje.

4.75/10

Valoración mínima: 1 | Valoración máxima: 8 | Desviación típica: 2.86 | No sabe/No contesta: 0 | Respuestas totales no nulas: 4

7-El profesor resuelve las dudas y orienta a los alumnos en el desarrollo de las tareas.

2.5/10

Valoración mínima: 1 | Valoración máxima: 5 | Desviación típica: 1.66 | No sabe/No contesta: 0 | Respuestas totales no nulas: 4

8-Los materiales docentes utilizados y/o recomendados son útiles para cursar la asignatura y se encuentran disponibles.

2.5/10

Valoración mínima: 1 | Valoración máxima: 6 | Desviación típica: 2.06 | No sabe/No contesta: 0 | Respuestas totales no nulas: 4

9-El profesor utiliza las Tecnologías de Información y Comunicación (TIC) y técnicas docentes innovadoras de forma adecuada.

5/10

Valoración mínima: 2 | Valoración máxima: 8 | Desviación típica: 2.55 | No sabe/No contesta: 0 | Respuestas totales no nulas: 4

10-El profesor despierta mi interés por esta asignatura.

2/10

Valoración mínima: 1 | Valoración máxima: 3 | Desviación típica: 1 | No sabe/No contesta: 0 | Respuestas totales no nulas: 4

11-El profesor ha contribuido en mi adquisición de competencias y destrezas al cursar esta asignatura.

2/10

Valoración mínima: 1 | Valoración máxima: 3 | Desviación típica: 1 | No sabe/No contesta: 0 | Respuestas totales no nulas: 4

12-En general, estoy satisfecho con la labor docente del profesor.

2.75/10

Valoración mínima: 1	Valoración máxima: 4	Desviación típica: 1.09	No sabe/No contesta: 0	Respuestas totales no nulas: 4

13-Señala los aspectos positivos de la docencia impartida por este profesor.

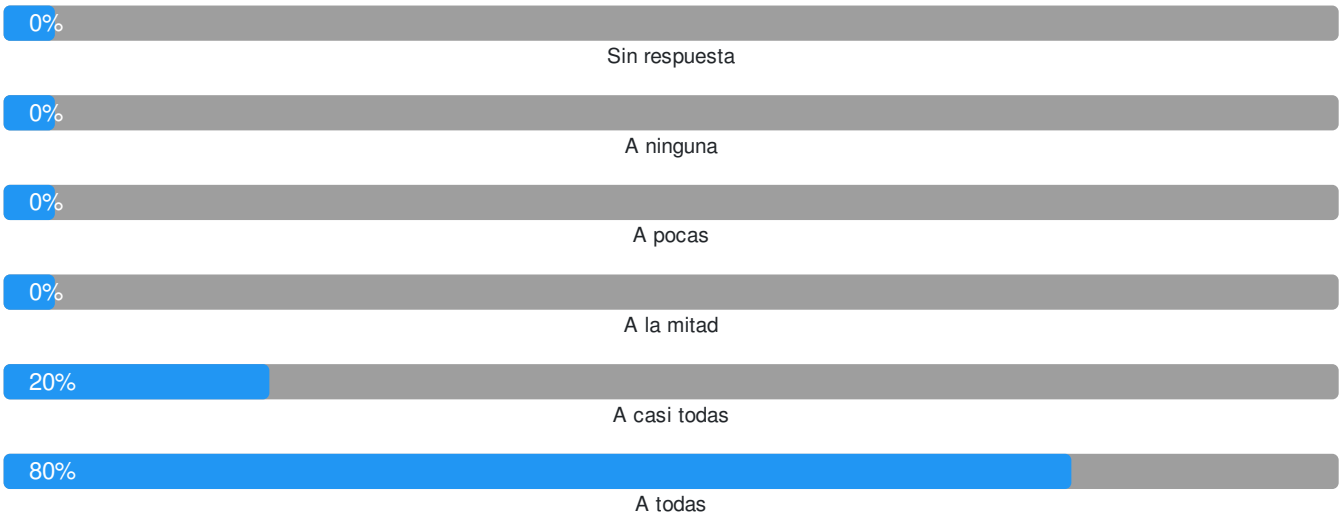
Parece tener gran conocimiento y experiencia en el tema

14-Señala los aspectos negativos de la docencia impartida por este profesor.

Es muy caótico y desordenado, cuesta mucho seguir sus explicaciones, da la sensación de hablar horas y horas sin decir nada, y se empeña en usar un vocabulario poco claro y ambiguo que hacen innecesariamente complicada la asignatura. Le iría bien aplicar el principio de la navaja de Occam

Estudiantes

A-¿A cuántas clases has asistido en esta asignatura?



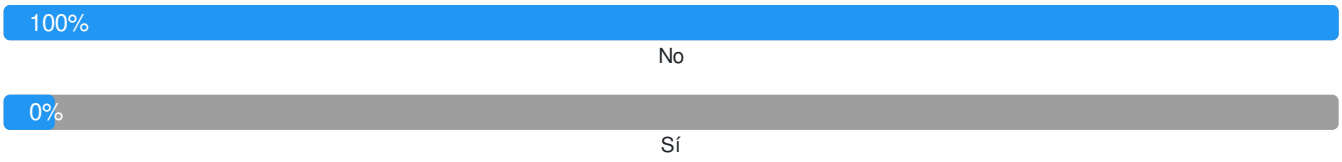
A.1-Motivo por el cual los alumnos respondieron no haber asistido a ninguna clase de la asignatura. (Pregunta A)

No hay datos

A.2-Otros motivos a la pregunta A.1 (Otro)

No hay datos

B-¿Has preparado esta asignatura con la ayuda de un profesor particular o academia?



B.1-Motivo por el cual los alumnos respondieron haber acudido a la ayuda de un profesor particular o academia. (Pregunta B)

No hay datos

B.2-Otros motivos a la pregunta B.1 (Otro)

No hay datos

C-Número medio de matriculas por alumno en la asignatura.

1

Comentarios

Señala los aspectos positivos de la docencia impartida en esta asignatura.

Señala los aspectos negativos de la docencia impartida en esta asignatura.

Sinceramente no sé cual es el objetivo de esta asignatura. No tengo nada claro el temario, ni el objetivo de los temas, ni su estructura ni como estudiarlos. La mayor parte del tiempo siquiera entiendo qué me están contando. Por el amor de Dios, ordenad este temario, dejar de iros por las ramas, fijad un objetivo para el temario y seguidlo.

El tipo de examen para una asignatura tan práctica debería ser del mismo estilo.

Asignatura

1-Las actividades de la asignatura se reparten de manera uniforme durante el semestre.

6.63/10

Valoración mínima: 1 | Valoración máxima: 10 | Desviación típica: 2.78 | No sabe/No contesta: 0 | Respuestas totales no nulas: 16

2-En el desarrollo de esta asignatura no hay solapamientos con los contenidos de otras, ni repeticiones innecesarias.

7.88/10

Valoración mínima: 2 | Valoración máxima: 10 | Desviación típica: 2.37 | No sabe/No contesta: 0 | Respuestas totales no nulas: 16

3-Se han coordinado adecuadamente las clases teóricas y prácticas previstas en el programa.

5.94/10

Valoración mínima: 1 | Valoración máxima: 10 | Desviación típica: 2.99 | No sabe/No contesta: 0 | Respuestas totales no nulas: 16

4-Las prácticas de laboratorio y las actividades complementarias (conferencias, seminarios, visitas de estudio, etc.…) ayudan a la comprensión de la asignatura.

5.86/10

Valoración mínima: 1 | Valoración máxima: 10 | Desviación típica: 2.53 | No sabe/No contesta: 9 | Respuestas totales no nulas: 7

5-Los métodos utilizados para mi evaluación (exámenes, memorias de prácticas, trabajos individuales o de grupo, etc.) son adecuados para el tipo de actividades y contenidos de la asignatura.

7.44/10

Valoración mínima: 2 | Valoración máxima: 10 | Desviación típica: 2.26 | No sabe/No contesta: 0 | Respuestas totales no nulas: 16

6-La carga de trabajo que comprende esta asignatura es adecuada para el número de créditos que tiene asignados.

5.81/10

Valoración mínima: 1 | Valoración máxima: 10 | Desviación típica: 3.52 | No sabe/No contesta: 0 | Respuestas totales no nulas: 16

7-Los conocimientos adquiridos en esta asignatura son importantes para mi actividad profesional.

7.81/10

Valoración mínima: 1 | Valoración máxima: 10 | Desviación típica: 2.4 | No sabe/No contesta: 0 | Respuestas totales no nulas: 16

8-En general, estoy satisfecho con el desarrollo de la asignatura.

5.81/10

Valoración mínima: 1 | Valoración máxima: 10 | Desviación típica: 2.72 | No sabe/No contesta: 0 | Respuestas totales no nulas: 16

Profesor/a JOAQUIN BIENVENIDO ORDIERES MERE

1-El profesor cumple con su horario de clase establecido.

8.69/10

Valoración mínima: 1 | Valoración máxima: 10 | Desviación típica: 2.23 | No sabe/No contesta: 0 | Respuestas totales no nulas: 16

2-El profesor asiste regularmente a clase.

8.94/10

Valoración mínima: 3 | Valoración máxima: 10 | Desviación típica: 1.78 | No sabe/No contesta: 0 | Respuestas totales no nulas: 16

3-El profesor está accesible para tutorías o consultas por parte de los estudiantes en su horario establecido.

8.13/10

Valoración mínima: 3 | Valoración máxima: 10 | Desviación típica: 2.25 | No sabe/No contesta: 1 | Respuestas totales no nulas: 15

4-El profesor prepara, organiza y estructura bien las actividades o tareas que se realizan en la clase (o laboratorio, taller, trabajo de campo, seminario, etc.).

6.63/10

Valoración mínima: 1 | Valoración máxima: 10 | Desviación típica: 2.5 | No sabe/No contesta: 0 | Respuestas totales no nulas: 16

5-El profesor explica de forma clara y comprensible los contenidos de la asignatura.

4.75/10

Valoración mínima: 1 | Valoración máxima: 10 | Desviación típica: 2.61 | No sabe/No contesta: 0 | Respuestas totales no nulas: 16

6-El profesor ha cumplido con lo planificado en la guía de aprendizaje.

7.19/10

Valoración mínima: 1 | Valoración máxima: 10 | Desviación típica: 2.48 | No sabe/No contesta: 0 | Respuestas totales no nulas: 16

7-El profesor resuelve las dudas y orienta a los alumnos en el desarrollo de las tareas.

5.75/10

Valoración mínima: 1 | Valoración máxima: 10 | Desviación típica: 2.49 | No sabe/No contesta: 0 | Respuestas totales no nulas: 16

8-Los materiales docentes utilizados y/o recomendados son útiles para cursar la asignatura y se encuentran disponibles.

4.44/10

Valoración mínima: 1 | Valoración máxima: 10 | Desviación típica: 2.87 | No sabe/No contesta: 0 | Respuestas totales no nulas: 16

9-El profesor utiliza las Tecnologías de Información y Comunicación (TIC) y técnicas docentes innovadoras de forma adecuada.

5.53/10

Valoración mínima: 1 | Valoración máxima: 10 | Desviación típica: 2.96 | No sabe/No contesta: 1 | Respuestas totales no nulas: 15

10-El profesor despierta mi interés por esta asignatura.

5.19/10

Valoración mínima: 1 | Valoración máxima: 10 | Desviación típica: 2.67 | No sabe/No contesta: 0 | Respuestas totales no nulas: 16

11-El profesor ha contribuido en mi adquisición de competencias y destrezas al cursar esta asignatura.

5.88/10

Valoración mínima: 1 | Valoración máxima: 10 | Desviación típica: 2.47 | No sabe/No contesta: 0 | Respuestas totales no nulas: 16

12-En general, estoy satisfecho con la labor docente del profesor.

5.63/10

Valoración mínima: 1	Valoración máxima: 10	Desviación típica: 2.57	No sabe/No contesta: 0	Respuestas totales no nulas: 16

13-Señala los aspectos positivos de la docencia impartida por este profesor.

Sabe muchísimo de dirección de proyectos y podría enseñarnos muchísimo

Un excelente docente, digno de destacar y elogiar, todo lo que esperé al venirme de intercambio a la mejor universidad de ingeniería de toda españa !

14-Señala los aspectos negativos de la docencia impartida por este profesor.

No hay material docente, lo que hay son links de internet y poco más. Estos links están todos en inglés, lo que dificulta en gran medida la comprensión de la asignatura. Tareas sin especificar bien qué hay que hacer y creando incertidumbre que dificulta y hace realmente difícil poder realizar una tarea correctamente.

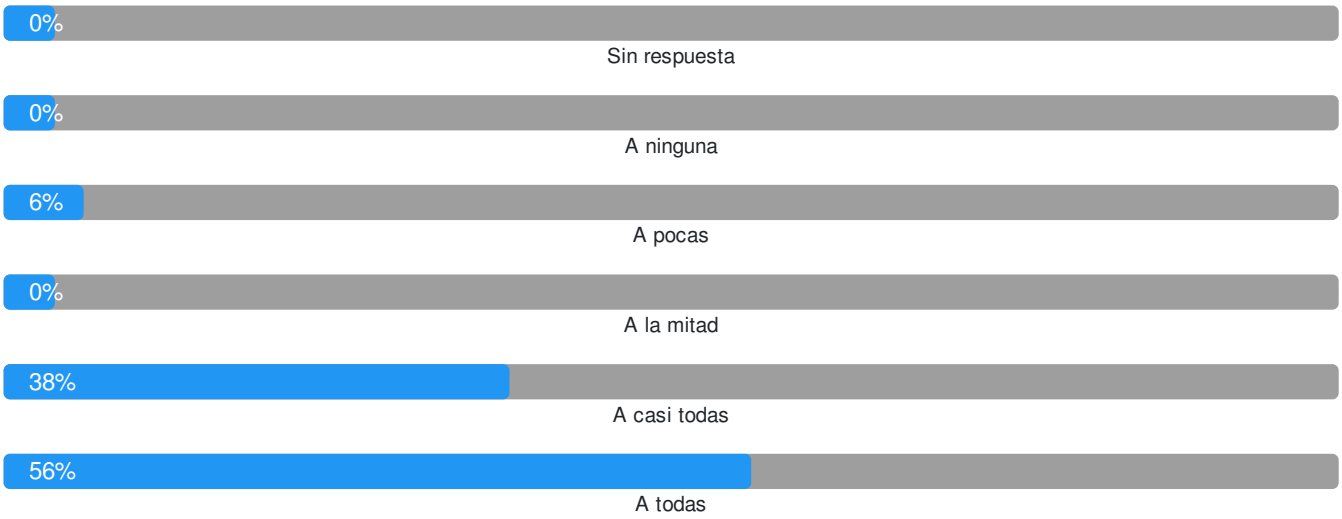
La falta de organización y la forma de afrontar las clases no han sido las más adecuadas dado que a los alumnos se nos complicaba seguir las clases (sin acceso a la diapositivas) y no sabíamos que era lo que teníamos que incluir en las entregas

Muy poca organización con la asignatura, nos habla en español y los correos los redacta en inglés sin sentido. Se pasa mucho de la hora, sin respetar los descansos. Debería planificarnos la asignatura y saber lo que se nos pide.

Las clases inversas son confusas para la realización del proyecto final de la asignatura. Me habría gustado algo más de guía por parte del profesor en este asunto, ya que las primeras semanas debíamos hacer entregables sin tener mucha idea de qué es lo que teníamos que hacer.

Estudiantes

A-¿A cuántas clases has asistido en esta asignatura?



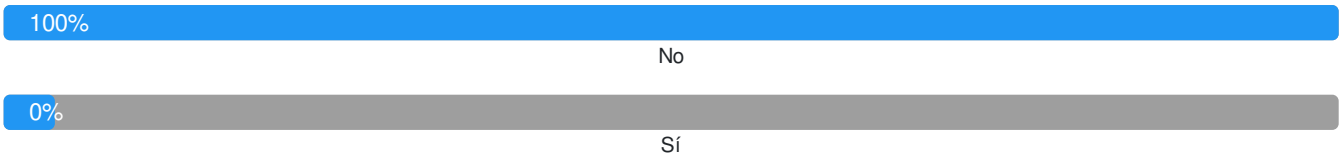
A.1-Motivo por el cual los alumnos respondieron no haber asistido a ninguna clase de la asignatura. (Pregunta A)

No hay datos

A.2-Otros motivos a la pregunta A.1 (Otro)

No hay datos

B-¿Has preparado esta asignatura con la ayuda de un profesor particular o academia?



B.1-Motivo por el cual los alumnos respondieron haber acudido a la ayuda de un profesor particular o academia. (Pregunta B)

No hay datos

B.2-Otros motivos a la pregunta B.1 (Otro)

No hay datos

C-Número medio de matriculas por alumno en la asignatura.

1

Comentarios

Señala los aspectos positivos de la docencia impartida en esta asignatura.

Asignatura interesante

La docencia es completamente destacable, el profesor demuestra completo dominio de la asignatura y lo sabe transmitir de forma positiva y motivadora a los alumnos, además, demuestra preocupación por los proyectos de los alumnos y entrega mucho apoyo a los alumnos extranjeros, cosa que se agradece en demasía.

Señala los aspectos negativos de la docencia impartida en esta asignatura.

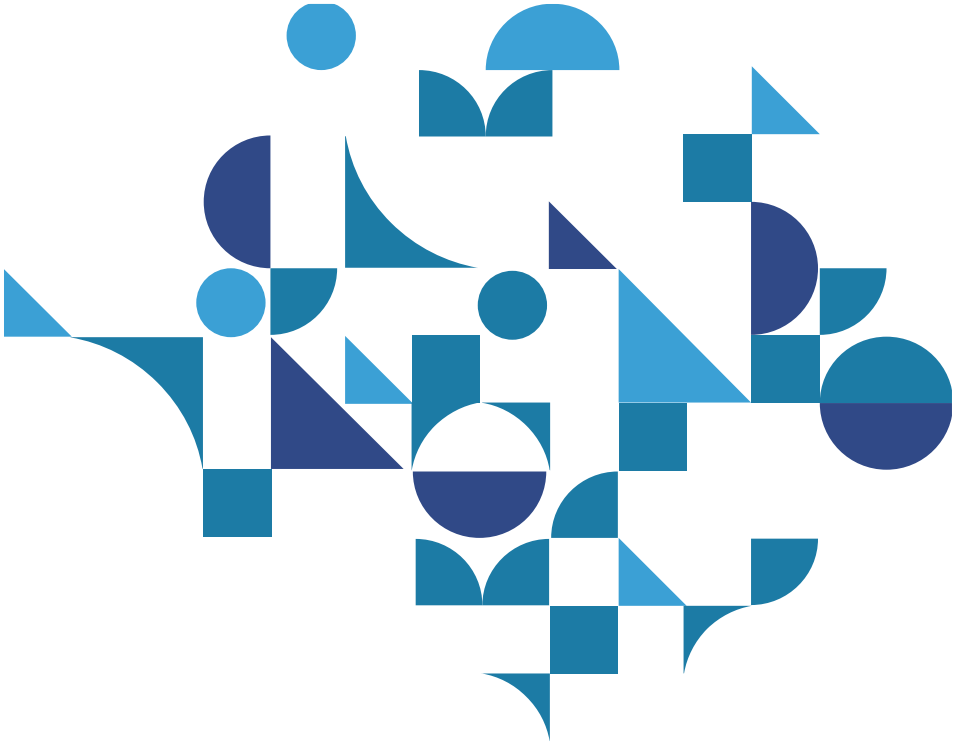
Poco aprovechada para el potencial que podría tener, nal organizada

Como no hay material docente realmente (diapositivas explicativas de la materia), se hace muy difícil entender algo.

La carga de trabajo es improvisada, no es estructurada a lo largo del semestre. No tiene sentido que la asignatura se imparta en español y las diapositivas estén en inglés, y los correos también. Además, se nos dan unos contenidos escasos, y luego se nos exige un trabajo excelente sin saber demasiados conceptos

Ninguno.

Industrial Engineering and Management of European Higher Education



IE3 Course Action Plan

DRAFT REPORT PUT

Co-funded by the Erasmus+ Programme of the European Union

DOCOMENT VERSION 00

16th October, 2021

AUTHORS

Agnieszka Stachowiak (PUT), Joanna Oleśków-Szłapka (PUT), Hanna Gołaś (ALCOMOT), Marek Fertsch (PUT).

This document is part of the Result 3.1 “IE3 Course Action Plan” of the Erasmus+ Project “Industrial Engineering and Management of European Higher Education / IE3”, and it represents the first contribution to this deliverable from the POLIBA and BOSCH partner. The current version of the report may be subject to changes according to future project activities and findings.

Disclaimer

Copyright notice

Note:

For anyone interested in having more information about the project, please contact us at: info@ie3.eu

Table of Contents

1. EXISTING COURSE MODULES

1.1. Course module: Traditional and contemporary manufacturing systems

Master Program: Logistics
Effort: 5 ECTS (125h).
Students: ~ 20 students.
Language: English
It is an elective course in the master program.

1.1.1. Objectives

Mastering the student's knowledge, skills and social competences related to the essence, scope of application and methods of designing and implementing modern production systems.

1.1.2. Current Syllabus

Course-related learning outcomes

Knowledge
1. dependencies in the given area and their relations with logistics [P7S_WG_01]
2. issues in the field of production engineering and its connections with the field of logistics [P7S_WG_02]
3. extended concepts for logistics and its detailed problems and supply chain management [P7S_WG_05]
4. detailed methods, tools and techniques characteristic for studied subject on the course of logistics [P7S_WK_01]

Skills
1. collect on the basis of the literature of the subject and other sources (in Polish and English) and in an orderly manner, provide information on the problem within the framework of logistics and its specific issues and supply chain management [P7S_UW_01]
2. communicate using appropriately selected resources in a professional environment and in other environments as part of logistics and its specific issues as well as supply chain management [P7S_UW_02]
3. make a critical analysis of technical solutions used in the analyzed logistics system (in particular with regard to devices, objects and processes) [P7S_UW_04]
4. assess the suitability and the possibility of using new achievements (techniques and technologies) in the field of logistics and functionally related areas [P7S_UW_06]
5. formulate and solve tasks through interdisciplinary integration of knowledge from different fields and disciplines used to design logistics systems [P7S_UO_01]
6. identify changes in requirements, standards, regulations, technical progress and the reality of the labor market, and on their basis determine the need to supplement own and other knowledge [P7S_UU_01]

Social competences
1. recognize causal relationships in achieving the set goals and grading the significance of alternative or competitive tasks [P7S_KK_01]

2. responsibility for own work and readiness to comply with the rules of working in a team and taking responsibility for the tasks carried out jointly [P7S_KR_01]

Methods for verifying learning outcomes and assessment criteria
Learning outcomes presented above are verified as follows: assessment based on a team-developed project, grade based on written credit (exam)

Programme content
the lecture begins with a reminder of typical production system design methods and techniques used in classic production systems - the balance model and assembly line balancing model, and the classification of classic production units according to the American-European model. Next, the methods of designing production systems according to the JiT concept (0 inventory), lean production systems and agile production systems are discussed. During design classes, students design, according to the teacher's instructions, a selected production system.

Teaching methods
1. Lecture: multimedia presentation, illustrated with examples on the board.
2. Projects: multimedia presentation illustrated with examples given on the board and performance of tasks given by the teacher.

1.2. Course module: Supply chain management

Master Program: Logistics
Effort: 5 ECTS (125h).
Students: ~ 20 students.
Language: English
It is an compulsory course in the master program.

1.2.1. Objectives

Mastering the student's knowledge, skills and social competences related to supply chain management

1.2.2. Current Syllabus

Course-related learning outcomes
Knowledge
1. dependencies in the given area and their relations with logistics [P7S_WG_01]
2. issues in the field of production engineering and its connections with the field of logistics [P7S_WG_02]
3. extended concepts for logistics and its detailed problems and supply chain management [P7S_WG_05]
4. detailed methods, tools and techniques characteristic for studied subject on the course of logistics [P7S_WK_01]

Skills

1. collect on the basis of the literature of the subject and other sources (in Polish and English) and in an orderly manner, provide information on the problem within the framework of logistics and its specific issues and supply chain management [P7S_UW_01]
2. design, using appropriate methods and techniques, the object, system or logistic process and the process associated with it including defining the path of its implementation and potential threats or limitations in analyzed domain [P7S_UW_05]
3. design, using appropriately selected means, an experiment, a process of analysis or a scientific study solving a problem within the framework of logistics and its specific issues as well as supply chain management [P7S_UK_01]
4. identify changes in requirements, standards, regulations, technical progress and the reality of the labor market, and on their basis determine the need to supplement own and other knowledge [P7S_UU_01]

Social competences

1. responsibility for own work and readiness to comply with the rules of working in a team and taking responsibility for the tasks carried out jointly [P7S_KR_01]

Methods for verifying learning outcomes and assessment criteria
Learning outcomes presented above are verified as follows: assessment based on a team-developed project, 3 grade based on written credit (exam)

Programme content
Lecture: Supply chain as a logistics system. Supply chain models. Choosing a supply chain strategy. Strategic analysis. Krajlic, Cox, Saunders models. Olsen and Ellram model, chain. Supply chain configuration: Supply chain configuration theories. Supply chain dimensions. Physical system management: identification of available alternatives, data collection and use, selection of methods and techniques for analyzing alternatives, selection of criteria for assessing alternatives, analysis of results.
Project: In the design class, students design the supply chain specified by the lecturer.

Teaching methods
1. Lecture: multimedia presentation, illustrated with examples on the board.
2. Projects: multimedia presentation illustrated with examples given on the board and performance of tasks given by the teacher.

1.3 Need for revision

The main reason for revision is the need to update the content provided and minimize the gap between theory and business/industrial practice. Including examples and business problems in the scope of the course will result in increased understanding of manufacturing systems and processes. Analyzing industrial case studies and working in teams will improve soft skills of students by recognizing their communication skills, capabilities and talents, as well as areas for improvement. Students will work with real data, technical parameters, constraints, and industry-sensitive variables solving problems managers face in their work. Elements of experimental learning, project approach, optimization and simulation will be included to stimulate knowledge development and benefit from synergy emerging from cooperation between academia and industry.

2. REVISION RELATED TO THE BoK

The improvement of courses was conducted according to the assumptions of BoK.
The addressed expectations of companies included developing knowledge, skills and competences in:

- Project management – by including project management methodology in the courses
- Operations management – by addressing operational issues in problems to be solved description
- Quality management – by including quality management tools and methods in problems analysis
- Strategic management – by seeking for synergy between company's strategy and operational solutions developed by students

Concerning digital tools, the ones included in courses, due to their scope, are Management Software Tools implemented in the company and supporting manufacturing management and supply chain management. Simulation and expert-based systems implementation for decision making are also included in the course programs.

Concerning Soft the most important addressed in courses and expected from students (as an outcome, after finishing course) include problem solving and decision making; team working and communication skills necessary to analyze and solve problems presented to students.

2.1.Course module: Traditional and contemporary manufacturing systems

- Redesign goal:
    - Improve soft skills: creative thinking, problem solving, group working & hard skills: using simulation and expert-based systems for decision making
- Redesign approach:
    - Benefit from knowledge on lean and agile manufacturing, group working, simulation and expert-based approach for decision making for real-life cases provided by Alco-Mot
- Learning outcomes:
    - As expected according to FEM/PUT/MES

Redesigned content
Focused on project to strengthen soft skills and competences expected by companies:
Course scenario:

- Organizational meeting: presenting goal and scope of the project, forming groups, assigning the topics:

1) Production planning and control in limited resources environment
2) TPM (lean approach)
3) Competences matrix for manufacturing employees (agile approach)

- Industrial visit, data collection
- Problem identification, analysis, solutions development and coordination

- Developing documentation including feasibility study, cost estimates and schedules
- Presentation of the integrated solution

2.2 Course module: Supply chain management

- Redesign goal:
    - Improve soft skills: creative thinking, problem solving, group working & hard skills: using simulation and expert-based systems for decision making
- Redesign approach:
    - Benefit from knowledge on contemporary trends in SCM including closed-loop SCM, global purchasing, group working, simulation and expert-based approach for managing real-life cases provided by Alco-Mot
- Learning outcomes:
    - As expected according to FEM/PUT/MES

Redesigned content

Focused on project to strengthen soft skills and competences expected by companies:

Course scenario:

- Organizational meeting: presenting goal and scope of the project, forming groups, assigning the topics:

1) Closed-loop material flows in supply chain
2) Packaging flows
3) Forecating and purchasing (strategy and operation)

- Industrial visit, data collection
- Problem identification, analysis, solutions development and coordination
- Developing documentation including feasibility study, cost estimates and schedules
- Presentation of the integrated solution

3. TEACHING METHODOLOGY

The teaching methodology implemented needs to respond to requirements of contemporary students and benefit from contemporary technologies providing flexibility of time and space on one hand and mentoring and teacher's support on the other. The set suggested is composed to function both in real and digital conditions, in synchronous and asynchronous mode and includes:

1. Face-to-Face and/or distant content providing in synchronous mode
2. Team working: problem solving in real or virtual environment under teachers supervision
3. On-site/industrial visits and/or Virtual tours of manufacturing facilities;
4. Digital Learning Pills (micro-learning); will be prepared in a further step.

Lectures, supported mainly by PPT presentations and video materials, available at the Moodle platform, conducted face-to-face. Mini-test at Moodle platform to assess material understanding.

Project focused on problem-solving, solutions design and teamwork designed and performed in collaboration with the industrial partner ALCO-MOT (details are in section 4

and section 5).

4. IMPLEMENTATION OF THE REVISED COURSE MODULE

The revised courses are implemented in the winter semester 2021/2022
The content is available at Moodle platform

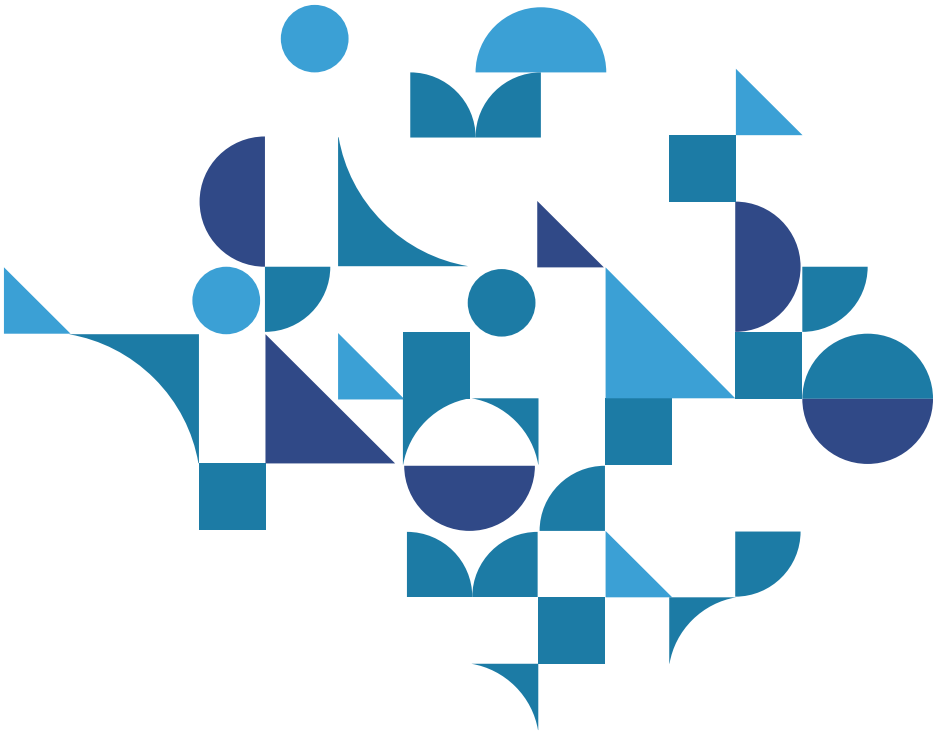
5. INVOLVEMENT OF THE INDUSTRIAL PARTNERS

ALCOMOT contributed to courses redesign by providing business insight and data to be used in the projects for both courses. The company offers on-site/industrial visit opportunity and offers experts knowledge of its employees in the areas of manufacturing and supply chain management.
Course materials were development with strong support of ALCOMOT which resulted in improving practical value of the content provided. High academic competences of ALCOMOT CEO were crucial in providing also high level scientific value in the redesigned courses.
Continuous cooperation with ALCOMOT will provide continuous improvement of the courses and update of problems student need to solve – making them aware of challenges contemporary companies have to face.

6. COURSE MODULE EVALUATION

Courses will be evaluated after they are completed.
There is obligatory course evaluation conducted regularly by FEM PUT, yet to get the feedback in timeframe required by the IE3 project, additional assessment will be made by course teachers.
The questionnaires will be developed basing on the following criteria:
Knowledge content
Teaching Methodology
Practical Value

Industrial Engineering and Management of European Higher Education



IE3 Course Action Plan

DRAFT REPORT WP3 POLIBA

Co-funded by the
Erasmus+ Programme
of the European Union

DOCUMENT VERSION 00

August 31, 2021

Authors and contributors: Giovanni Mummolo (POLIBA), Salvatore Digiesi (POLIBA), *Francesco Facchini (POLIBA), Giorgio Mossa (POLIBA), Giorgio Ante (BOSCH), Paolo Ciannamea (BOSCH), Giuseppe De Benedictis (BOSCH), De Stena Felice (BOSCH).*

This document is part of the Result 3.1 "IE3 Course Action Plan" of the Erasmus+ Project "Industrial Engineering and Management of European Higher Education / IE3", and it represents the first contribution to this deliverable from the POLIBA and BOSCH partner. The current version of the report may be subject to changes according to future project activities and findings.

Disclaimer

Copyright notice

Note:

For anyone interested in having more information about the project, please contact us at: info@ie3.eu

INDEX

1. EXISTING COURSE MODULE

Course module: Operations Management - part B (*Gestione della Produzione Industriale*)

Master Program: Industrial engineering and management (*Ingegneria Gestionale*)

Effort: 6 ECTS (150h).

Students: ~ 120 students.

It is a compulsory course in the master program.

1.1 Objectives

The course aims at endowing second level management engineers with the following knowledge:

- Knowledge of the traditional and innovative paradigms of Operations Management.
- Management of the theoretical and practical tools for medium- and short-term production planning and control.

1.2 Current Syllabus

a. Production systems and strategic planning (1.0 ECTS)
   I. Stages and time horizons of operations management.
   II. Performance measurement of production systems.
   III. Strategic Planning.

b. Aggregate planning (2.0 ECTS)
   I. Aggregate planning. Planning bills.
   II. Master Production Schedule.
   III. Batch production systems: lot sizing

c. Inventory management (2.0 ECTS)
   I. Inventory control models. Inventory indices.
   II. Inventory management techniques (MRP).
   III. Lean systems.

d. Operations Scheduling (1.0 ECTS)
   I. Loading, sequencing and scheduling.
   II. Scheduling Criteria for single machine.
   III. Flow-shop, job-shop and open-shop.

1.3 Teaching methods and assessment

The primary approach is to split sessions between theory and practice. Concepts are presented in magisterial lessons (6 weeks, 5 hours theory and 5 hours exercises per week). Numerical cases are developed.

The scoring process is based on both written and oral exams. Written exam relates to both theoretical knowledge and numerical cases. The oral exam completes the evaluation verifying the student's ability to synthesize and integrate topics, express adequately complex concepts, and use the appropriate terminology.

When the COVID-19 emergency imposed distant learning, the approach moved to synchronous remote lessons leaving all the recordings available for students on the institutional repository (MS Teams).

1.4 Need for revision

The main reason for revision is the ambition to provide master students with actual knowledge in the field of Industrial Engineering and Management consistent with industry needs . It requires a significant shift from the traditional Planning and Control approach to the Lean Production approach based on the data-driven performance evaluation and the continuous improvement philosophy.

Moreover, the focus will be on digitalisation topics in solid connection with the usage of digital tools in industrial applications. By analysing industrial case studies and performing in teams a set of serious games, the course should provide students with evaluation tools that will quantify the efficiency of different system configurations and management options. The student will find the optimal solution for each case concerning technical parameters, constraints, and peculiar decision-making variables.

Moving from the traditional "push-based" learning approach to the flipped and experimental learning approach requires a set of new methodologies and teaching tools and a strong connection between academia and industry.

2. REVISION RELATED TO THE BoK

According to the main finding of the Body of Knowledge (BoK), the course module revision deals with course content, teaching methodology, and the strong University-Companies integration.

In particular, the following outcomes of the BoK led to both the revision and the design of new content and teaching methods for the selected course model.

In the following, the main findings of the BoK pertaining the course module revision:

"By analyzing the knowledge demand expressed by companies in the quantitative survey (questionnaire), the following technical knowledge, skill, and competencies (KSCs) have been identified in descending order of importance:

Knowledge, Skill, and Competences

- *Project Management*
- *Operations Management*
- *Quality Management*
- *Strategic Management*
- *Safety of Work".*

Moreover, *"Among listed KSCs, 'Operations Management', 'Quality Management', and 'Safety of Work' are characterized by the highest demand value for companies in the manufacturing sector".*

"As far as digital operational tools are concerned, the high companies' demand values are observed for (listed in order of descending importance):

- *Management Software Tools (e.g. ERP, CRP)*
- *Computer-based Statistic Competences*
- *Big Data Analysis."*

Finally, results of the survey carried out in the IE3 project *"forced the revision to focus on the "soft skills" characterized by a high companies' demand (listed in order of descending importance):*

- *Problem Solving and Decision Making;*
- *Team Working;*
- *Communication Skills".*

2.1 Contents

The content revision of the Course "Operations Management" primarily looks to integrate the concepts of "lean production" and "continuous performance improvement" in the Industry 4.0 environment; both concepts are the new pillars of the performance-oriented and data-driven management of the digital factory.

2.2 Teaching Methodology

According to the main findings and suggestions from the BoK, the following teaching methodologies have been adopted for the pilot course module:

1. Face-to-Face and/or distant. Balancing synchronous-asynchronous integrated lecturing;
2. Team working simulation and educational games under University/Company' professors guide;
3. Flipped classroom for selected topics;
4. On-site visits and/or Virtual tours of manufacturing facilities;
5. Digital Learning Pills (micro-learning); will be prepared in a further step.

Lectures, supported mainly by PPT presentations, have been integrated by personalized feedback and self-assessment to improve every student's work. The aim was to divide lecture contents into essential parts using quiz for self-assessment of the acquired knowledge several times during the class by the e-learning platform Moodle.

Emphasis has been placed on teamwork, self-assessment, and problem-solving in the new activities designed and performed in strong collaboration with the industrial partner BOSCH (details are in section 4 and section 5).

3. REVISED COURSE MODULE: Operations Management in Advanced Lean Systems

(Gestione della Produzione Industriale nei Sistemi Lean)

Effort: 6 ECTS (150h)

Students: ~120 students.

Schedule: 6 weeks from April to June each year in the 2nd Semester of the academic year.

3.1 Expected learning outcomes

Learning Skills

Students will learn to face the multidimensional performance evaluation of Operations at a strategic, tactical, and operational level. They will acquire methodologies and tools to design, analyze, and continuously improve the operations performance of manufacturing and service companies under the industry 4.0 data-driven environment. Additional didactic supports will also stimulate the learning ability in designing, planning, evaluating and operating lean systems: industrial simulation tools, numerical exercises, serious games, and industrial case studies designed to increase learners' learning abilities.

Judging autonomy

By considering alternative scenarios in serious games and simulations, the students will be able to refine technical knowledge and judgment skills to identify the best operations strategies.

Communicative Skills

Participation in traditional lectures and specialized seminars tenured by industry professors as well as in serious games classroom student's discussions and presentations, and involvement in guided industrial tours will drive students toward acquiring appropriate technical terminology to develop advanced communication skills, both oral and written.

3.2 Revised Syllabus

1. **Operations, Performance, and Continuous Improvement (1.00 ECTS)**
    a. Operations, trade-offs and Performance measures. Losses in production. The Overall Equipment Effectiveness (OEE).
    b. Process Analysis and Process Design. Cycle time. Throughput. WIP. Flow Time. Utilization. Little's Law
    c. Industry 4.0: Standards and Data integration for PMS
    d. Industry 4.0 and Continuous Improvement
2. **Lean systems (1.00 ECTS)**
    a. Lean Systems and Continuous improvement
    b. Value Stream Concepts, Mapping and Design
    c. Cycle time analysis
    d. System Re-design
3. **Production planning and control (2.00 ECTS)**
    a. Stages and time horizons of operations management.
    b. Strategic Planning. Aggregate planning.
    c. Bill of materials. Master Production Schedule.
    d. Short term planning. Loading and Scheduling.
4. **Inventory management (1.00 ECTS)**
    a. Inventory, KPIs and Costs.
    b. Replenishment models. EOQ. POQ. Safety Stocks. ABC Classification.
    c. Material Requirement Planning (MRP). EPQ.
    d. ERP: Production Planning module and shop floor integration
5. **Advanced Lean Systems (1.00 ECTS)**
    a. Pull & Levelling Tools. JIT, Pacemakers, Supermarkets, Kanban Circuits.
    b. Advanced Lean Systems design

3.2 Evaluation criteria

In addition to the evaluation criteria defined in section 1.3, the following specific scores have been determined for the pilot course:

- Written exam (70%);
- Oral exam (20%);
- In-Class Activity (exercises, serious games, seminars) (10%).

In the following years, in-class activities will gain more significant weight in the final grade.

4. IMPLEMENTATION OF THE REVISED COURSE MODULE

The pilot revised course module, designed and developed to meet the goal under the constraints defined in sections 1.4 and section 3, has been delivered in April and May 2021 in 3 distinctive parts.

Part 1a and Part 1b dealing with Operations Performance, Continuous Improvement and Advanced Lean Systems have been designed and delivered with the industrial partner support (BOSCH).

Part 2 focus on "traditional" topics of Production Planning and Control and Inventory Management. Even in these cases, emphasis has been devoted to the problem-solving approach and to the digital aspects of integration of management and the shopfloor operations. The ERP provider EXPRIVIA (SAP Gold Partner) held a seminar on "Production Planning module and shop floor integration in SAP".

The following tables describe the content of each specific topic, with the corresponding teaching methodology and tools adopted, the primary reference, the required students' effort (hours) and the date of the class.

PART 1a

	ECTS	Topic	hour	date	Ed. tool	Reference
Operations, Performance, and Continuous Improvement ***On-site visits of manufacturing facilities [POSTPONED]***	1.00	Operations, trade-offs and Performance measures. Losses in production. The Overall Equipment Effectiveness (OEE).	2.5	26/04/2021	Lecture (PPs, videos)	Jacobs, Chase
		Process Analysis and Process Design. Cycle time. Throughput. WIP. Flow Time. Utilization. Little's Law	2.5	27/04/2021	Lecture (PPs, videos)	Jacobs, Chase
		Industry 4.0: Standards and Data integration for PMS	2.5	27/04/2021	Lecture (PPs, videos)	IEC and ISO Standards
		Industry 4.0 and Continuous Improvement	2.5	04/05/2021	Seminar by Industry professor. (BOSCH) (PPs, videos)	Lecture notes
Lean Systems	1.00	Lean Systems and Continuous Improvement	2.5	29/04/2021	Lecture (PPs, videos)	Jacobs, Chase
		Value Stream Concepts, Mapping and Design	2.5	03/05/2021	Lecture (PPs, videos)	Jacobs, Chase. BOSCH BPS notes
		Cycle Time Analysis	2.5	04/05/2021	Serious game on the shopfloor. Team evaluation (PPs, videos, simulation tools) [on-line]	BOSCH BPS video and notes
		System Re-design & Continuous Improvement	2.5	10/05/2021	Serious game on the shopfloor. Team evaluation	BOSCH BPS videos and notes

					(PPs, videos, simulation tools) [on-line]	

PART 2

	ECTS	Topic	hour	date	Ed. tool	Reference
Production Planning and Control	2.00	Stages and time horizons of operations management. Strategic Planning	2.5	06/05/2021	Lecture (PPs, videos)	Jacobs, Chase
		Aggregate Planning. Strategies and Trade-off	2.5	11/05/2021	Lecture (PPs, videos)	Jacobs, Chase
		Case studies. Problem-solving. Excel solver for linear program	2.5	11/05/2021	Classroom Exercise (Software tools)	Lecture notes
		Bill of Materials. Master Production Schedule	2.5	13/05/2021	Lecture (PPs, videos)	Jacobs, Chase
		Short-term Planning. Loading	2.5	24/05/2021	Lecture (PPs, videos)	Jacobs, Chase
		Short-term Planning. Scheduling	2.5	25/05/2021	Flipped classroom for selected topics (PPs, videos)	Jacobs, Chase
		Case studies. Problem-solving	2.5	25/05/2021	Classroom Exercise (PPs, videos)	Lecture notes
Inventory Management	1.00	Inventory, KPIs and Costs. Replenishment models	2.5	17/05/2021	Lecture (PPs, videos)	Jacobs, Chase
		EOQ. POQ. Safety Stocks. ABC Classification	2.5	18/05/2021	Lecture (PPs, videos)	Jacobs, Chase
		Case studies. Problem-solving	2.5	18/05/2021	Classroom Exercise (PPs, videos, software tools)	Lecture notes
		Material Requirement Planning (MRP). EPQ.	2.5	20/05/2021	Lecture (PPs, videos)	Jacobs, Chase
		ERP: Production Planning module and shop floor integration in SAP	2.5	03/06/2021	Seminar by ERP Provider. Exprivia (Gold	Lecture notes

					Partner SAP) (PPs, videos)	

PART 1b

	ECTS	Topic	hour	date	Ed. tool	Reference
Advanced Lean Systems	1.00	Pull & Levelling Tools: JIT, Pacemakers, Supermarkets, Kanban Circuits.	2.5	27/05/2021	Lecture (PPs, videos)	Jacobs, Chase, BOSCH BPS notes
		Advanced Lean Systems design	5	31/05/2021 01/06/2021	Serious game on the shop floor. Team Evaluation. [on-line]	BOSCH BPS videos and notes
		Transparency, continuous improvement, roles and responsibilities, leadership	2.5	01/06/2021 [Cancelled]	Seminar by Industry professor. BOSCH	Lecture notes
Final Class EXE		Case studies. Problem-solving [Exam simulation]	2.5	03/06/2021	Classroom Exercise (PPs, videos)	Lecture notes

In brackets [] are the activities postponed or modified due to the COVID-19 emergency.

Main references:

JACOBS, CHASE. *OPERATIONS AND SUPPLY CHAIN MANAGEMENT*, FIFTEENTH EDITION. McGraw-Hill Education, 2018

BOSCH BPS. *Lean Production*. Presentations and Case studies.

Due to COVID-19 emergency, all the activities have been carried out on-line synchronous. All the recordings are available for students on the institutional repository (MS Teams).

The existing teaching tools and materials (PPs, videos, computer animations, simulation tools) have been renewed to fit the new objectives and syllabus and fully translated into English. All the teaching material is available on the institutional e-learning repository Moodle (see figure 1 and figure 2).

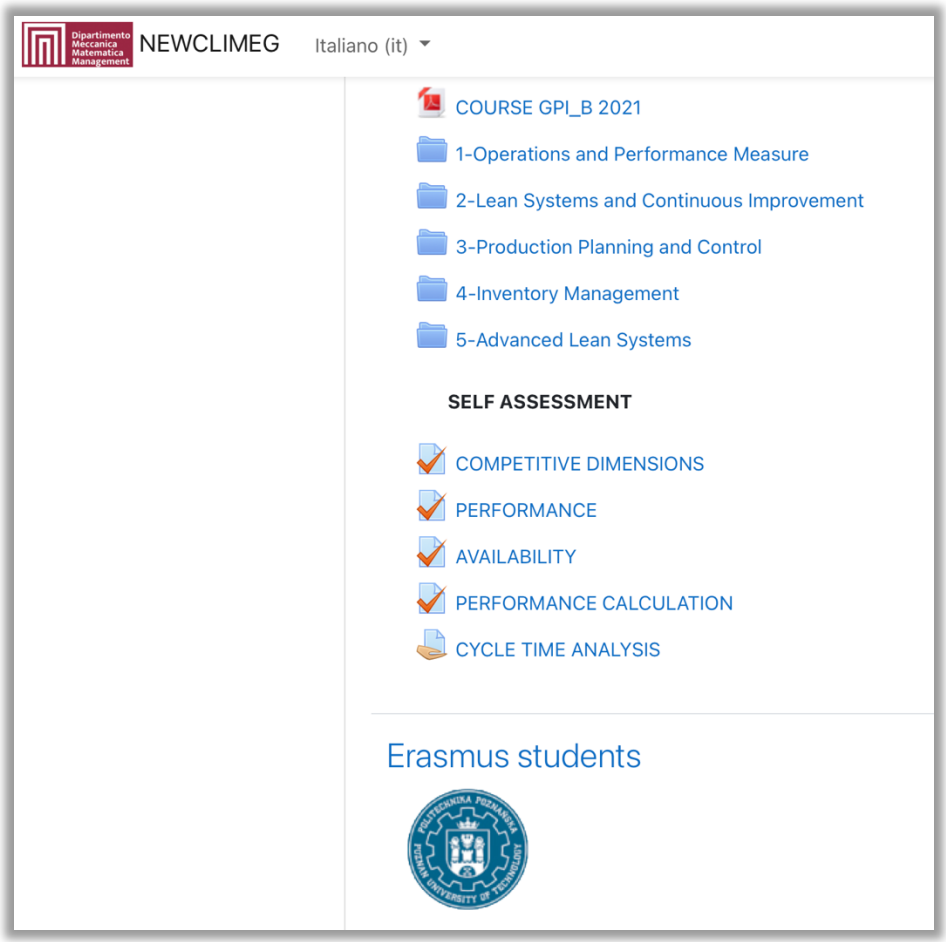


Figure 1 – Teaching material of the revised course module (Moodle)

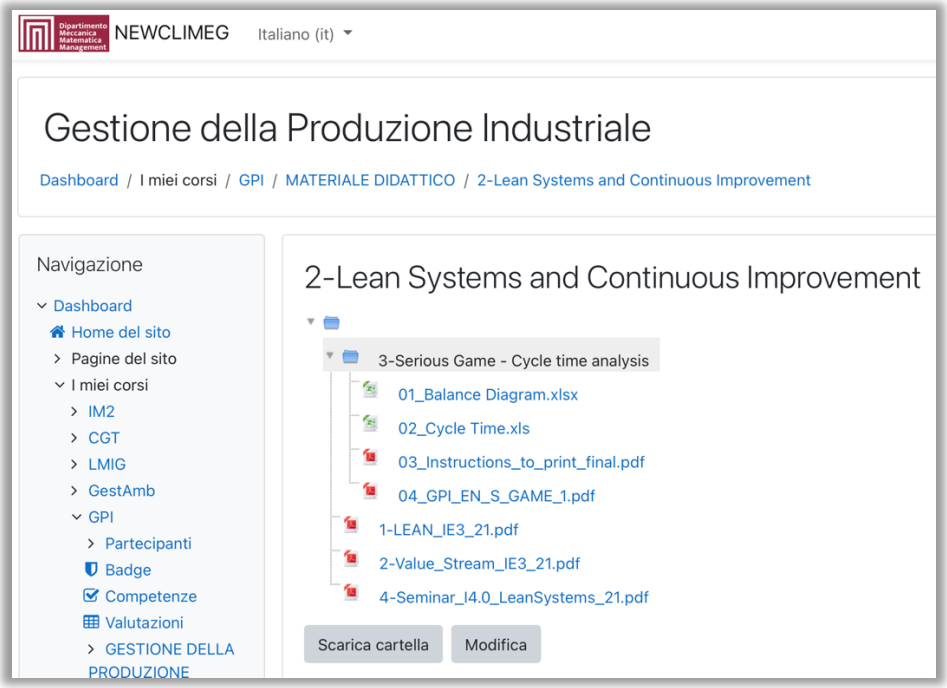


Figure 2 – Teaching material of the topic 2- Lean Systems with a focus on the Serious Game developed with BOSCH

5. INVOLVEMENT OF THE INDUSTRIAL PARTNERS

A key aspect of the project phase was the involvement of the industrial partner - in this case BOSCH. This involvement will also be important in the subsequent implementation, revision, and management phases of the course. The aim of this involvement was to add to the didactic-academic aspect perspective also a pragmatic aspect and daily use of the proposed tools. In addition to this, the participation of high-profile international and technological partners also offers the possibility of updating the course contents to follow and adapt, where possible, the same contents to the needs of the industries, thus offering a better service to the students, the final customer of the project.

5.1 Serious Games

The contribution of partner BOSCH, derived from actual industrial cases and presented in terms of practical games, aims to train students about concrete and simple contents and to increase their competencies toward the needs of industry.

The gap between the current course and the ideal one has been analyzed. The roadmap to create the defined “Digital Learning Pills” (micro-learning) goes through some crucial reflections about the current situation linked to the COVID-19 pandemic.

The first evolution of the course from a face-to-face mode to the online one was simply forced by the pandemic. It was a first, fast countermeasure, and the “cold shower” gave many precious feedbacks about students involved with the new set-up.

Slide show with a voice is somehow a “one-way” modality and the path to the “Digital Learning pills” needs two key steps to ensure active learning: interaction and gamification.

The educational games have been created to start walking in this direction by leading students:

- using the analytic observation;
- applying PDCA cycle and continuous improvement methodology;
- creating best balancing of shopfloor operations design;
- creating standard reports;
- comparing and evaluating solutions;
- and presenting results to the class.

Main contents of the serious game developed and delivered in collaboration with BOSCH were:

Serious Game 1 Part A - Cycle Time Analysis

- Paper-made airplane production: how to observe running production
- Process confirmation and Cycle time calculation (Best repeatable, average, min, MAX)
- Customer withdrawal time estimation and use of Balancing diagram

Serious Game 1 Part B - System Re-design & Continuous Improvement

- Improvable system, continuous improvement process, PDCA
- Cyclic supply, Point of use provider
- Definition of potentials & measures, lot size definition
- Design of improved balancing diagram.

Serious Game 2 - Advanced Lean Systems simulation and design

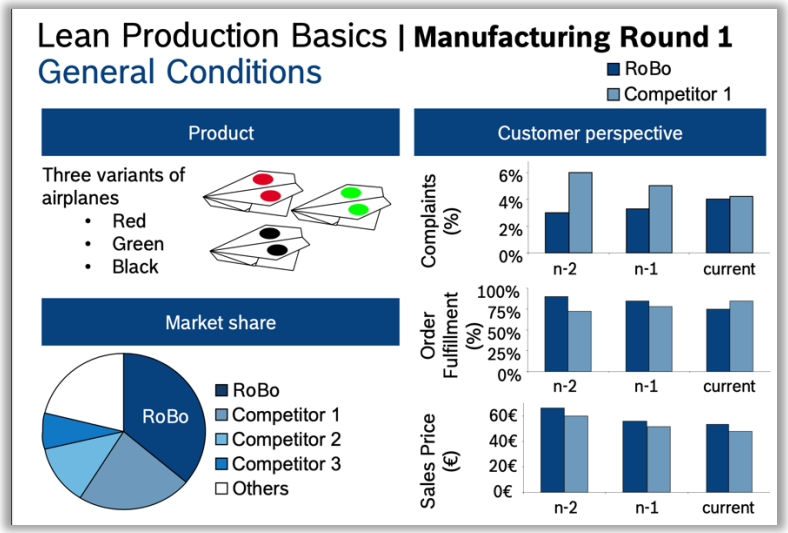
- Closed Loop System Control
- System Decoupling

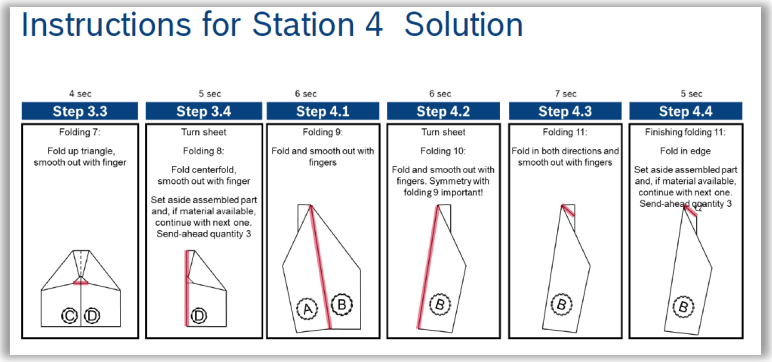
- Pull & Levelling
- Pacemaker
- Kanban calculation.

The idea of developing the game with paper airplanes gave the chance to experience it (also by remote) to the students, even if the competition was only partially allowed.

Gamification and competition are going to be strengthened in the next evolution of the course.

Section 4 shows details on both course content design and class delivery developed with the involvement of the industrial partner.





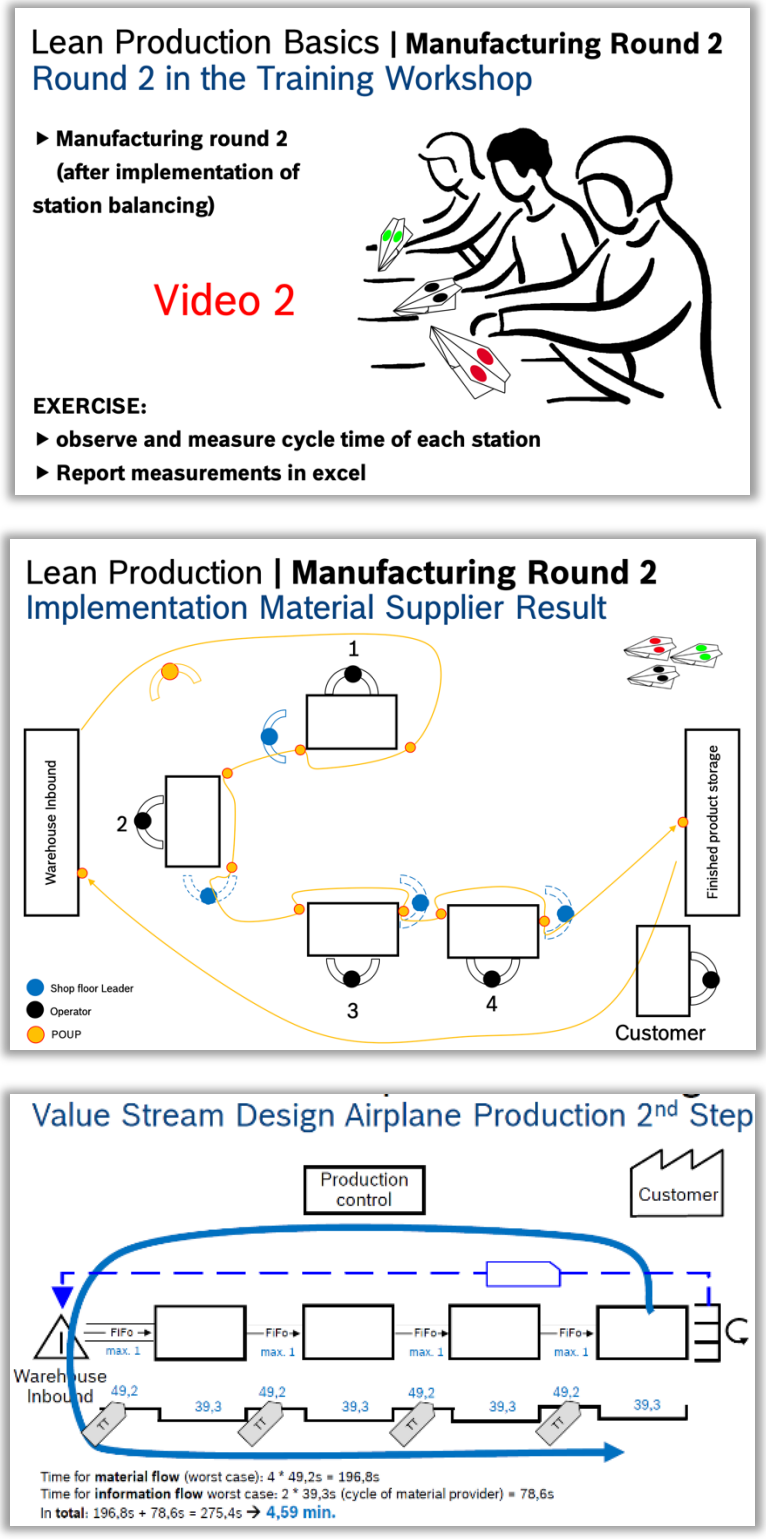


Figure 3 – Screenshot of the Serious Game 1 - Cycle Time Analysis and Continuous Improvement developed by BOSCH

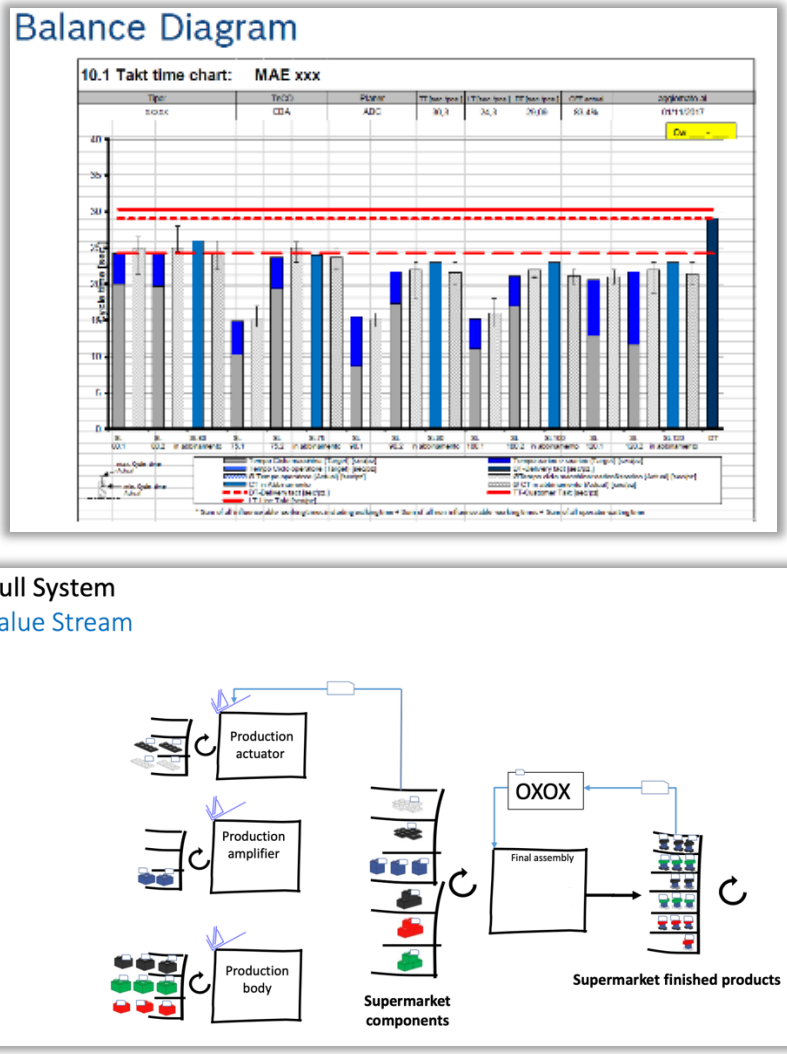


Figure 4 – Screenshot of the Serious Game "Advanced Lean Systems simulation and design" developed by BOSCH

5.2 Seminars

Main contents of the seminars developed and delivered in collaboration with the industrial partners were:

Seminar 1 - Industry 4.0 and Continuous Improvement (BOSCH)

- I4.0: background, the value of data availability
- Enabling technologies for the connected industry
- Opportunities and challenges of the connected world, Digital Twin
- BOSCH Bari approaches and use cases.

Seminar 2 - ERP: Production Planning module and shop floor integration in SAP Seminar by ERP Provider. (Exprivia SpA - Gold Partner SAP)

- SAP Architecture: Lines of Business and module integration
- Production Planning Module: Basic Data and MRP
- Shop Floor Control.

6. COURSE MODULE EVALUATION

The aim of the process is to assure that the pilot courses will meet the planned learning objectives by satisfying the needs of students as well as of the other relevant stakeholders (academic and industrial partners).

Students evaluated the Course module twice according to the newly established evaluation system:

1. At the Polytechnic University of Bari: traditionally, the evaluation is performed at the end of the class when students complete the evaluation form before attending the final exam.
2. In the current academic year: an intermediate online evaluation allowed to assess the synchronous online lessons' performance (student's satisfaction, threats, and opportunities of the distance learning).

6.1 Intermediate online evaluation - Preliminary results

The evaluation form consists of 5 parts:
A - STUDENT ATTENDANCE
B – COURSE EVALUATION
C – TEACHER EVALUATION
D – DISTANCE LEARNING EVALUATION
E – INTEREST IN THE TOPICS AND SUGGESTIONS.

On the days 10 of May to 4 of June, were collected 90 questionnaires from students.
The main results are in figures 5-9.

A - STUDENT ATTENDANCE

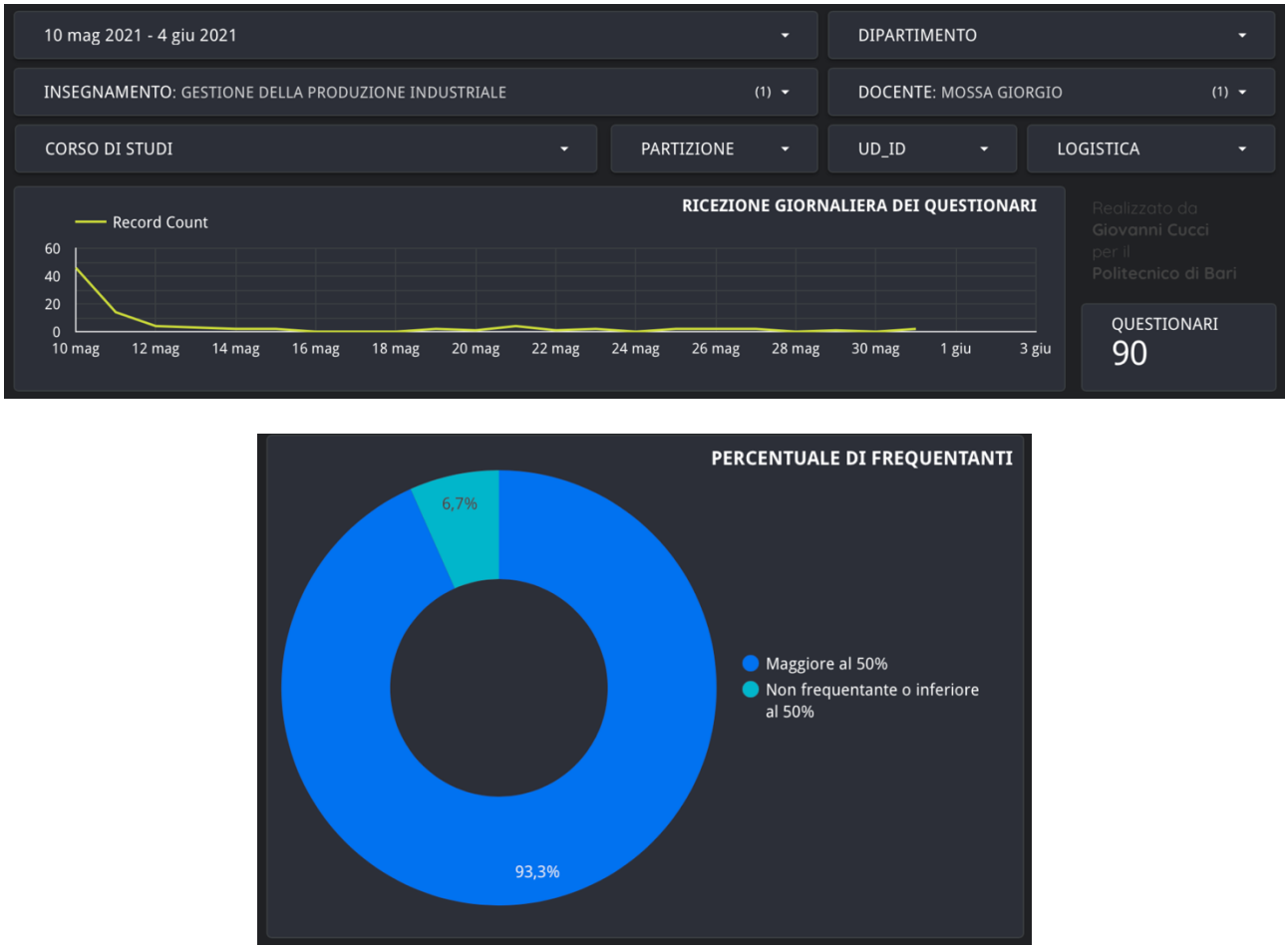


Figure 5 – Students attendance

- Regarding the current year's teaching activities, what percentage of the classes did you take?
  - Less than 50%
  - Greater than 50%

B – COURSE EVALUATION

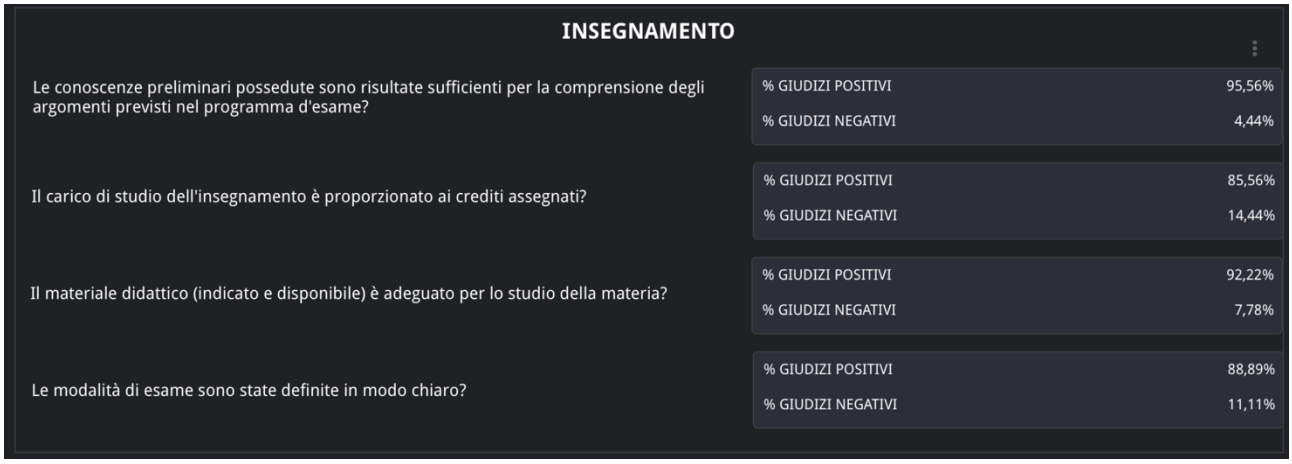


Figure 6 – “Course” Evaluation

The questions in figure 6 are respectively:

- Does your prior knowledge allow you to understand the topics covered in the course?
- Is the effort required by the course consistent with the credit awarded?)
- Is the teaching material (indicated and available) adequate for the study of the subject?
- Are the examination procedures clearly defined?

C – TEACHER EVALUATION

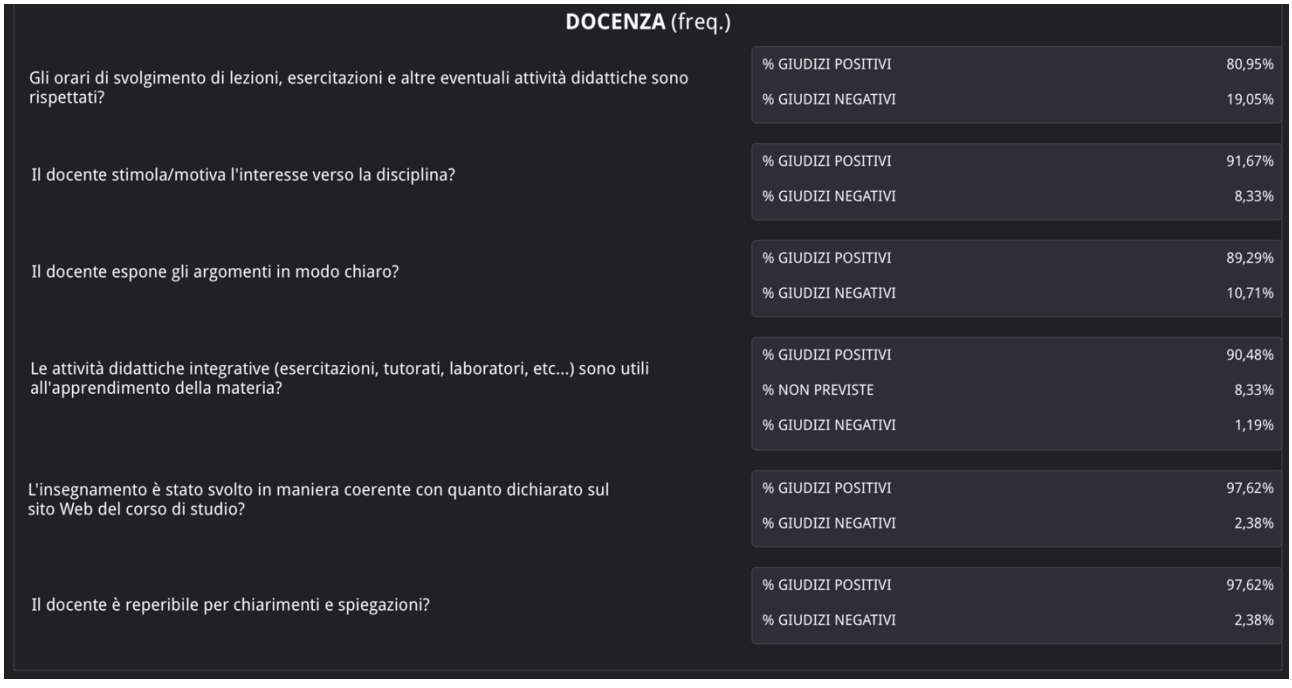


Figure 7 – “Teacher” Evaluation

The questions in figure 7 are respectively:

- Is the schedule for lectures, tutorials and any other teaching activities respected?
- Does the teacher stimulate/motivate interest in the discipline?
- Does the teacher explain the topics clearly?
- Are the supplementary teaching activities (exercises, tutorials, laboratories, etc.) helpful in learning the subject?
- Has the teaching been carried out consistently with the info on the course of study website?
- Is the teacher available for clarification and explanation?

D – DISTANCE LEARNING EVALUATION

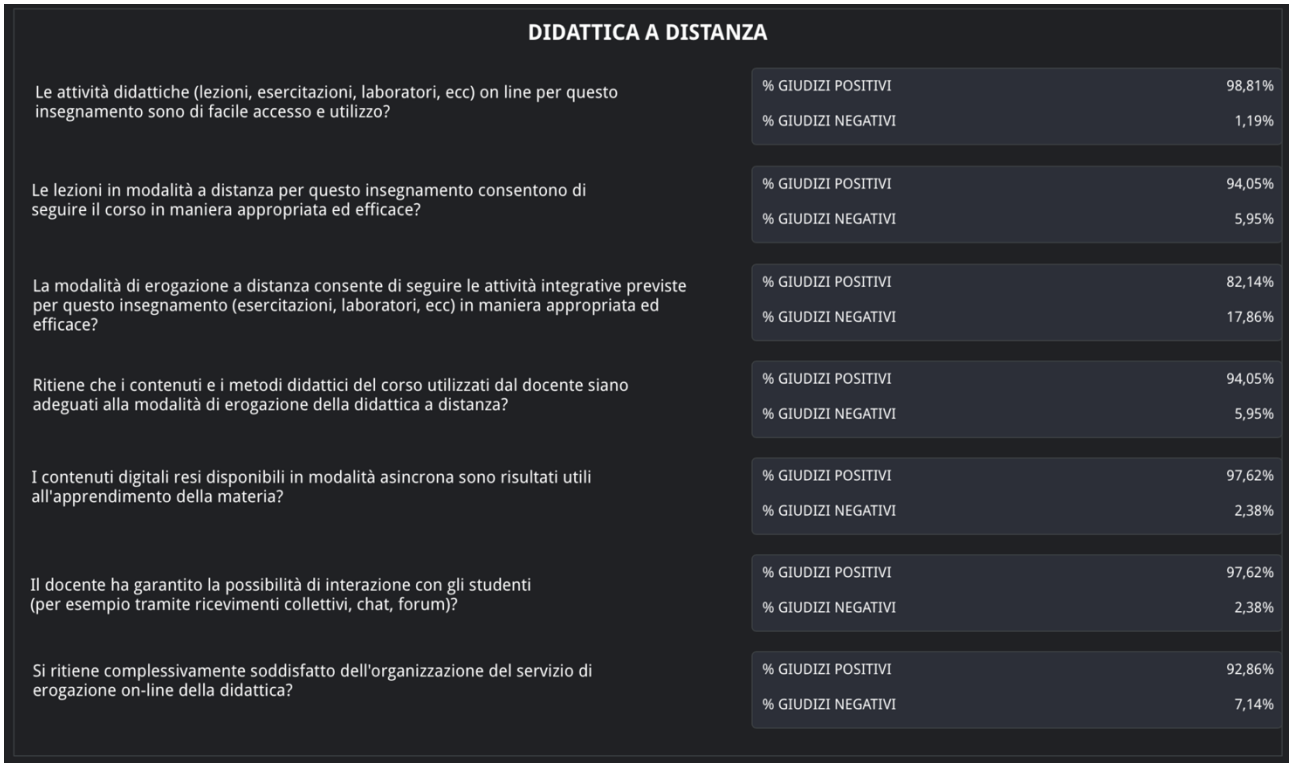


Figure 8 – “Distance Learning” Evaluation

The questions in figure 8 are respectively:

- Are the online instructional activities (lectures, tutorials, labs, etc.) easy to access and use?
- Do the distance learning lectures allow you to follow the course appropriately and effectively?
- Does the distance learning mode allow you to follow the supplementary activities planned for this course (exercises, laboratories, etc.) appropriately and effectively?
- Do you think the course contents and the teaching methods are appropriate to the distance teaching delivery method?
- Were the digital contents made available in asynchronous mode helpful in learning the subject?
- Has the teacher ensured the possibility of interaction with students (e.g. through online meetings, chat, forums)?
- Are you overall satisfied with the organization of the online teaching service?

E – INTEREST IN THE TOPICS AND SUGGESTIONS

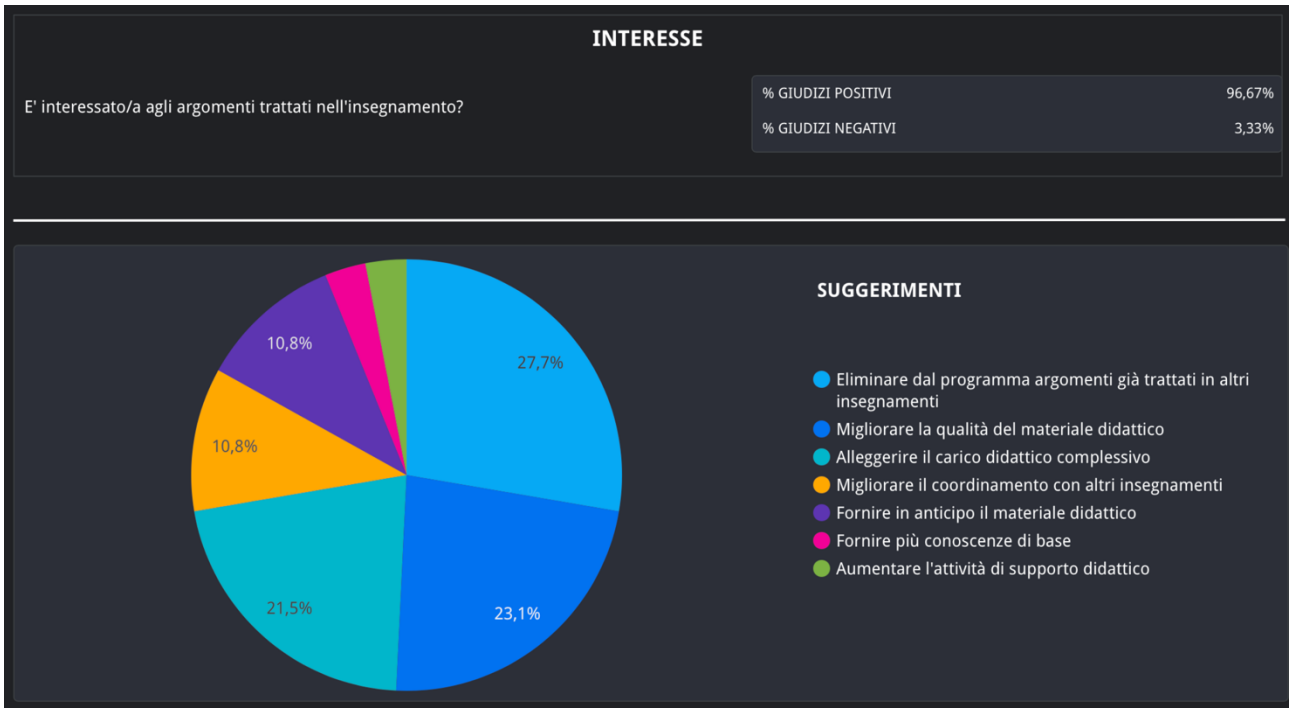


Figure 9 – Interest in the topics and suggestions

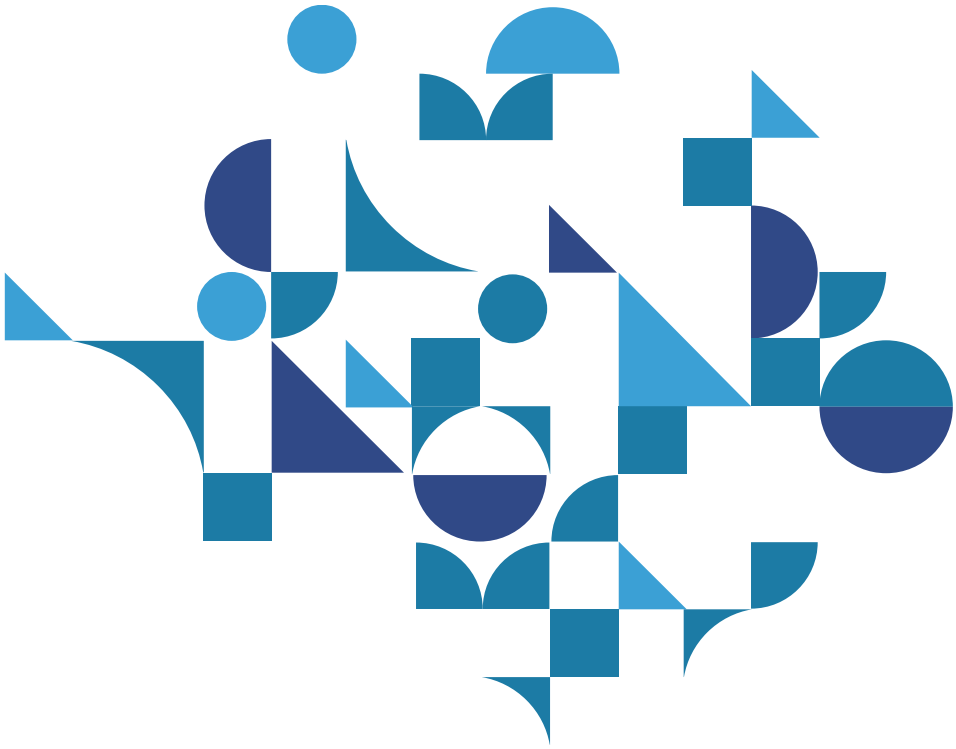
The questions in figure 9 are respectively:

- Are you interested in the topics covered in the course?

Suggestions

- Eliminate topics already covered in other courses from the program
- Improve the quality of teaching materials
- Lighten the overall teaching load
- Improve coordination with other courses
- Provide teaching materials in advance
- Provide more basic knowledge
- Increase the teaching support activity

Industrial Engineering and Management of European Higher Education



IE3 Course Action Plan

Draft Report LiU

Co-funded by the Erasmus+ Programme of the European Union

The European Commission support for the production of this publication does

not constitute endorsement of the contents which reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

DOCUMENT VERSION 01

20th October, 2021

AUTHORS

Janerik Lundquist (LiU), Mathias Henningsson (LiU), Fredrik Persson (LiU), and Eskil Rehme (Implema).

This document is part of the Result 3.1 "IE3 Course Action Plan" of the Erasmus+ Project "Industrial Engineering and Management of European Higher Education / IE3", and it represents the first contribution to this deliverable from the POLIBA and BOSCH partner. The current version of the report may be subject to changes according to future project activities and findings.

Disclaimer

Copyright notice

Note:

For anyone interested in having more information about the project, please contact us at: info@ie3.eu

Table of Contents

1. EXISTING COURSE MODULES

The existing course modules are in this report the course Design and Development of Manufacturing Operations (TPPE74) and Production System Planning and Management (TPPE91) given by the division Production economics at Linköping University.

1.1. Course Module: Design and Development of Manufacturing Operations

Master Program: Mechanical Engineering and Industrial Engineering and Management
Effort: 6 ECTS (160h)
Course code: TPPE74
Students: ~ 50 students
Language: English
It is an elective course in the master program.

1.1.1. Objectives

The course presents different perspectives on how manufacturing operations can be designed and developed and how the value of the company's manufacturing processes can be improved. After completion of the course, the student should possess enhanced knowledge of various analytical tools and approaches of both conceptual and operational nature. The course includes a project (project task) where a company is analysed, using a simulation model, to improve the company's operations. Emphasis is placed on using theoretical models in a practical environment.

1.1.2. Current Syllabus

The current course syllabus is valid since 2021-01-01.

Learning Outcomes

After this course the student should be able to:

- design and develop manufacturing operations using static analysis models
- design and develop manufacturing operations using dynamic analysis models
- understand cause-and-effect relationships within manufacturing operations relating to rate, inventory, and time
- use and evaluate appropriate planning and control methods in operations management
- use and evaluate contemporary development methods in operations management

Examination

UPG1: Seminar Project (U, G) – Project task, 3 hp
TEN1: Written Examination (U, 3, 4, 5) – 3 hp

The project task consists of a larger problem in which a simulation tool is used to design and develop the manufacturing operations of a company. The project task is graded based on the grading criteria for a passing level in the project document. There are 17 possibilities to run the simulations in Task B of the project. Each group is allowed a maximum of 10 simulation runs. If the group fail to run all 10 runs at the final simulation opportunity, the last simulation runs are forfeited. There are 6 possibilities to run the simulations in Task C and D respectively. Each group is allowed a maximum of 3 simulation runs. If the group fail to run all 3 runs at the final simulation opportunity, the last simulation runs are forfeited. Before the simulation runs, Quizzes are used to make sure that pre-knowledge and system design is correct.

Written examination is carried out three times per year. The written examination constitutes the final grade of the whole course. The written examination is done in English, meaning that the questions are in English and the only possible language to write the answers in is English. It is not possible to hand in a completion if the written examination is failed.

Course Content

Designing Manufacturing Operations: Analyze lead-times, capacity, material flow, customer and manufacturing orders, delivery service, inventories, an information from a systems perspective to meet system requirements by changing system parameters. Developing Manufacturing Operations: Value-based process enhancements through improvements in time, cost, flexibility, and quality, with a special focus on setup-time reduction. Simulation as Support for design and development of operations: Relationships among lead-times, capacity, material flow, inventories, orders, delivery service, costs, information, and planning strategy.

Teaching Methods

The teaching is organized in lectures and seminars and laboratories. The lectures deal with the theoretical approaches and the seminars and laboratory sessions deal with a project.

- Lectures: 14 hours (Filmed lectures in Lisam, Live question sessions)
- Seminars: ca 14 hours (Filmed seminars in Lisam, Live questions session)
- Project (not in Time Edit) in group: 80 hours.
- Own studies: 52 hours
- Sum: 160 hours

1.2. Course Module: Production System Planning and Management

5-year Master of Science in Mechanical Engineering program
Effort: 6 ECTS (160h)
Course code: TPPE91
Students: ~ 120 students
Language: Swedish
Compulsory course year 3

1.1.1. Objectives

The course will give the students insights into economic issues concerning industrial production. After the course, the students must be able to use the most common methods for forecasting, design of production systems and material and production control, and understand the relationships between production, planning and the industrial company's other functions.

1.1.2. Current Syllabus

The current course syllabus is valid since 2021-09-01.

Learning Outcomes

After taking this course, the student should:

- have knowledge in the relation between a production system and a industry company other functions
- have knowledge about the most important business processes in a manufacturing company, and understand the internal and external supply chains
- have knowledge about the basics in production economics, economical issues for industrial production and the connection to business strategies
- be able to describe different production systems and their layout and be able to identify critical factors when designing a production system
- have knowledge about different ways of organising material handling and distribution
- be able to describe and use demand models and forecast methods to evaluate future demand
- be able to describe material- and production management, in both a long and a short horizon, and their methods, from forecast, via sale and production planning, main planning and material and resource planning down to detail planning
- have basic knowledge about lean production

- be able to describe and use the most common methods for inventory control
- be able do describe inportant factors regarding purchase/manufacturing decisions and decisions about outsourcing
- have knowledge about different way of measure flow- and resource efficiency and have understanding how they are related
- have a basic knowledge in the methology how to analyse and improve flows and processes

Examination

PRA2: Project work (Fail/Pass), 2 hp
TEN2: Written Examination (Fail, 3, 4, 5), 4 hp

The project task consists of a larger problem divided into three parts, Inventory control, Purchase or inhouse manufacturing, and Value stream mapping. The first and the last parts are examined through a quiz and an oral examination in groups of 4 students. The students need to answer all questions in the quiz correctly before coming to the oral examination. The questions are some multichoice questions and some questions that need a numerical value, where the students are using evaluations in excel to come up with the answers. The second part is examined by a written report and seminar.

Written examination is carried out three times per year. The written examination constitutes the final grade of the whole course. It is not possible to hand in a completion if the written examination is failed.

Course Content

The basics in Production economics, important concepts and categorising of companies. Developing and construction of production systems for effective production based on essential business management. Different production systems, Sale- and production planning, main planning and resource material planning, detail planning, inventory control, business processes, economical key factors. Principles for distribution and lean production. Purchase and distribution in a manufacturing industry. Purchase/manaufacturing decisions and the basic knowledge about outsourcing.

Teaching Methods

Lectures are mainly concerned with introduces theoretical issues and conscepts, but also ties together various parts of the course. The lessons are concentrating on exercises connected to the most important course sections. A practical case runs through the course, where different approaches are presented and discussed at the seminars. A number of assignments in various parts of the case study are the basis for examination.

1.3 Need for Revision

TPPE74 Design and development of manufacturing operations has been developed in several steps for the last 30 years. Now, we see a high potential to include digitalization and especially AI technologies in the course.

TPPE91 Production System Planning and Management is a rather new courses (started 2015) giving the students basic knowledge of production and logistics. We also here see a high potential to include basic knowledge and understanding about Industry 4.0, big data and how to use digitalization in a production industry.

2. REVISION RELATED TO THE BODY OF KNOWLEDGE

From the outcomes of the Body of Knowledge (BoK), these course modules are strongly connected to Problem Solving and Decision Making, Team Working, and Operations Management from A1(Knowledge, Skills and Competencies). In A2 (Operations tools) these modules are strongly connected to Management Software Tools, Big Data Analysis, and Machine Learning/AI Competences addressing mainly the Analytical components.

In the Body of Knowledge, there is a large gap between Problem Solving and Decision Making in A1, Big Data Analysis and Machine Learning/AI Competences in A2 which are easily filled in these two courses. By adding a module in the basic course TPPE91, our aim is to take a first step to fill that gap, and in the second course TPPE74, we chose to work with a stand-alone lecture for AI and update the project for Problem Solving and Decision Making.

2.1. Course Module: Design and Development of Manufacturing Operations

In the course TPPE74 Design and development of manufacturing operations, two modules have been part of the IE3 project.

2.1.1. Module: Project

A project is part of the course (3 credits) which have been updated as part of the IE3 initiative. The project has been added two new tasks aiming at introducing Expert system-like knowledge-based rules and regulations.

The project PicSim is a simulation model driven design and development project where students develop a manufacturing system towards specific cost targets, see Figure 2.1. Task A (New) contains understanding of interrelationships between design parameters and economic measures. Task D (New) contains a re-optimization of the system under new stochastic behavior, see Figure 2.2.

In the last lecture, we address the knowledge-based solution (Task B) and compare to the use of DoE and regression analysis. We see this as the first step towards Machine Learning. As part of this, all seminars in the project and the last lecture have been newly developed.

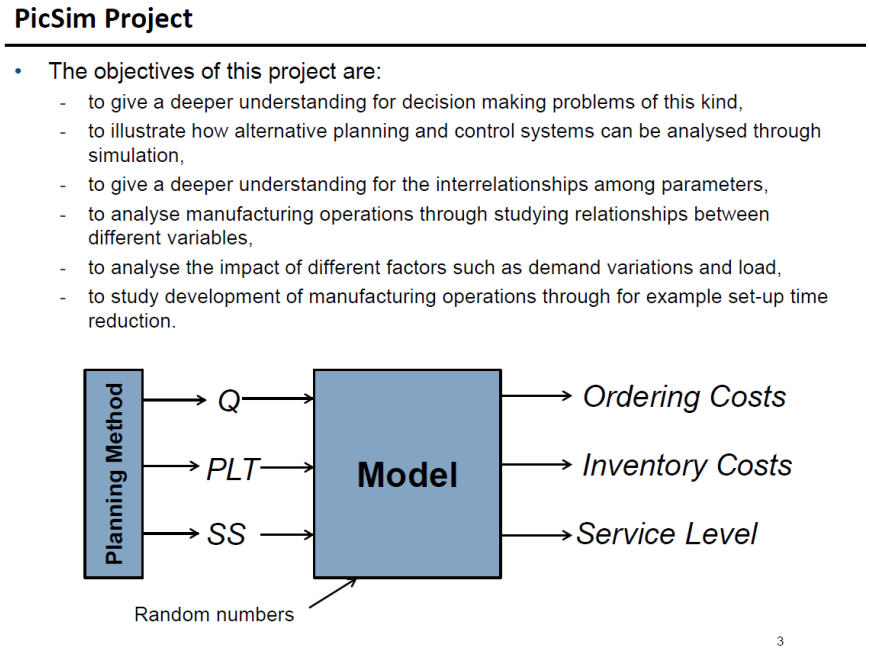


Figure 2.1: Project PicSim

Four Tasks in the Project

- Task A
  - Create graphs over nine different relationships.
  - Lisam Quiz to test conceptual shape.
- Task B
  - Run 10 simulations (we run the model) with the target to reach:
    Inventory cost: 340 000 kr
    Service level: 95 %
    Total Cost: 680 000 kr
  - Test all different planning methods
  - Lisam Quiz before simulations (at least one in each group needs to pass)
- Task C
  - Carry out a setup time reduction and study the effects.
  - Run 3 simulations (we run the model) to study the effects.
- Task D
  - Formulate system specific guidelines and rules that apply to the design parameters.
  - Run 3 simulations (we run the model) to "optimize" the system.
  - Competition!

5

Figure 2.2: Project Tasks

2.1.2. Module: Lecture in AI

The company Implema AB have been responsible for a lecture in AI and a corresponding seminar, see Figures 2.3 and 2.4. Both carried out by Eskil Rehme at Implema AB. This highlights the new focus on machine learning in the course even further and gives the students a deeper understanding about how to use AI in operations management.

Both project and AI lecture and seminar adds on a new dimension of the course where novel technologies such as AI and other digital solutions to the course. The developed material will not be available on the open market. The combination of AI, machine learning, DoE and regression analysis gives a high-level knowledge in the field of Industry 4.0 relevant techniques in operations management.

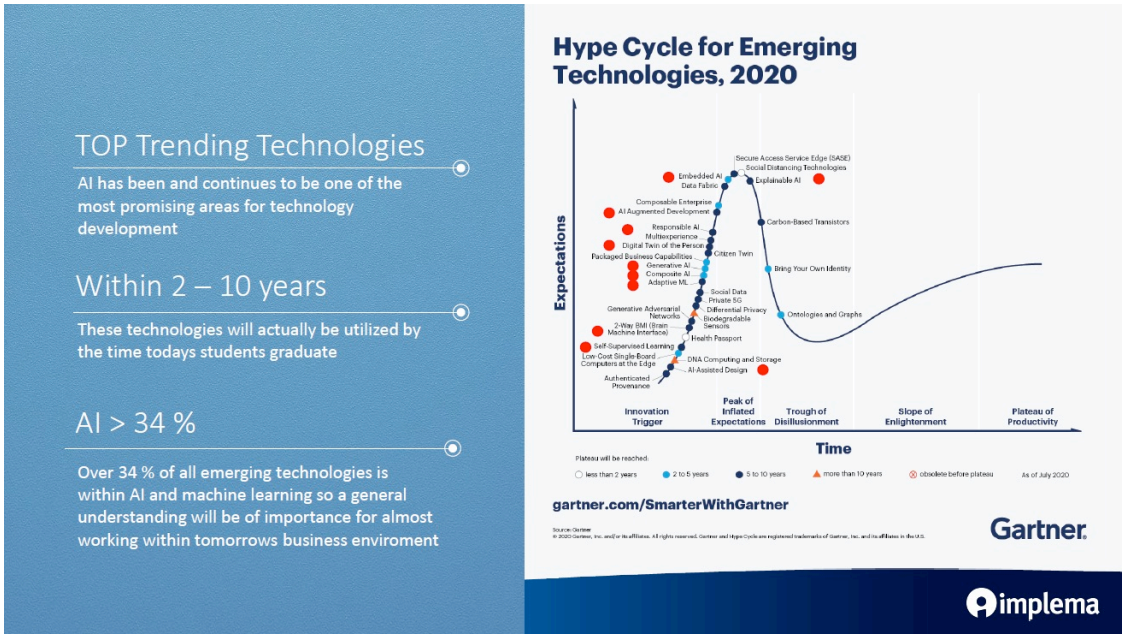


Figure 2.3: Overview of the AI area

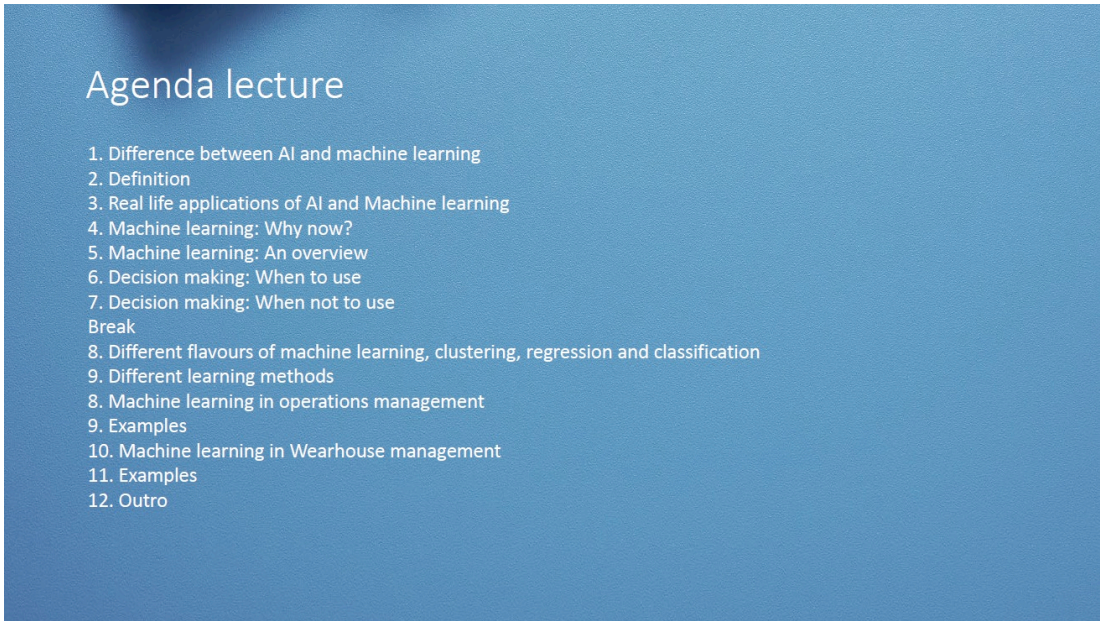


Figure 2.4: Lecture Agenda

2.2. Course Module: Production System Planning and Management

The course content is about the basics in production economics, important concepts and categorising of companies. The main parts are different production systems, sale- and production planning, main planning and resource material planning, detail planning, inventory control, lean production and distribution in a manufacturing industry. The course includes a "real world" case with a number of assignments with "real" data. However, what has been missing in this course is the connection to how the above methods are used in the industry and how established ERP-system on the market looks like. The purpose of the module included in the course in to give the students a first glimpse of an ERP-system and see that standard methods in the course are used frequently in commercial ERP-systems. Therefore, the course TPPE91 Production System Planning and Management, includes two modules that have been a part of the IE3 project, one laboration with assignments using an ERP-system and one lecture about digitalization in the manufacturing industry.

2.2.1 Module: Laboration in an ERP-system

The laboration was included, for the first time, in the course 2020 just before the covid pandemic, given by our industry partner Implema. However, during the covid pandemic, we have focused on online material, but with clear thoughts about how to expand this module 2022. The new learning material 2021 are a film made by our industry partner, Implema, where they describe how Material Resource Planning (MRPII) is working and used in an ERP-system (SAP) and a lecture, also from Implema, where they, based on the film, are extending the material about MRP in an ERP-system. The film and the powerpoint-presentations are available for the students on the course internal homepage. This course module will be extended in coming years and Implema will support this during the IE3 project. There are ideas with hand on assignments or a game for the students. The figures below show screenshots from the SAP system, mainly describing MRPII and Inventory control.

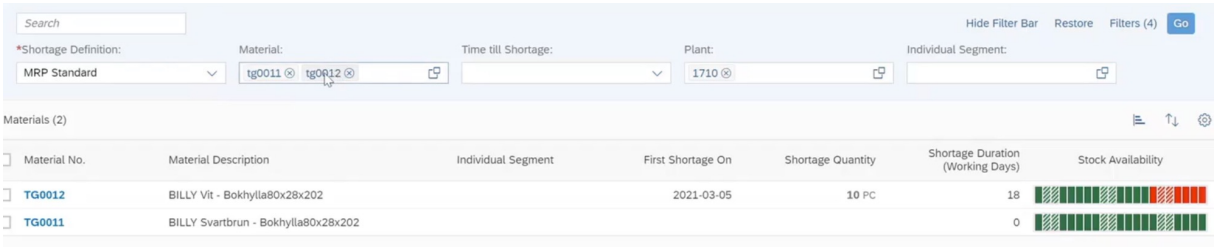


Figure 2.5 Screenshot from MRP Standards, Materials from the SAP film and lecture

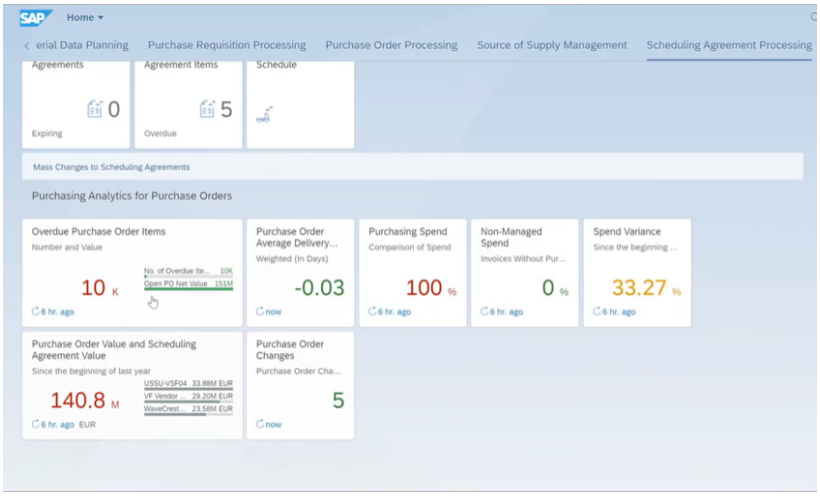


Figure 2.6 Screenshot of Purchasing Analytics for Purchase Orders from the SAP film and lecture

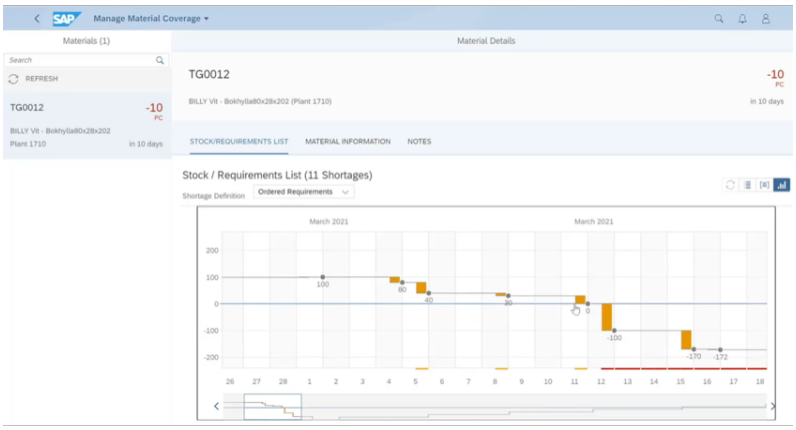


Figure 2.7 Screenshot of Stock / Requirement List from the SAP film and lecture

2.2.2 Module: Lecture About Industry 4.0, Smart Factories and Digitalization

The new learning material also includes a new developed lecture about Industry 4.0, smart factories and big data. The aim with the lecture is to give the students some basic knowledge about Industry 4.0 and what is happening in the manufacturing industry. Two of the slides in the presentation are shown below in figure 2.8 and 2.9.

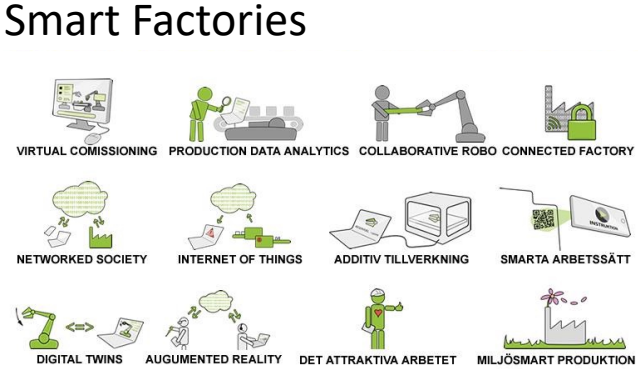


Figure 2.8 Smart Factories from the lecture about Industry 4.0 and Digitalization

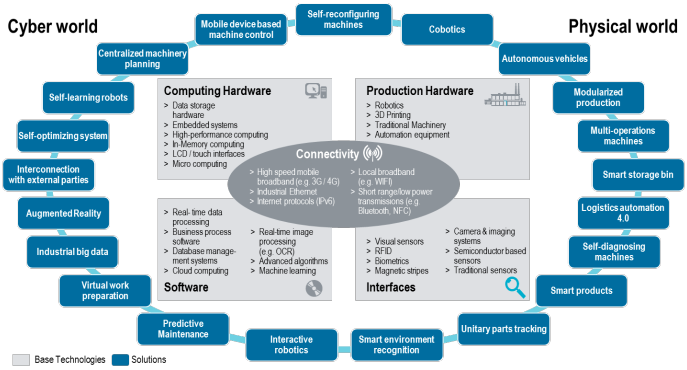


Figure 2.9 Cyber world and Physical world from the lecture about Industry 4.0 and Digitalization

3. TEACHING METHODOLOGY

Linköping University works with several different digital platforms for teaching. The main course resource is called Lisam and is developed by the university based on MS Share Point. In Lisam, all digital resources such a lecture slides and documents in PDF, recorded material, and information is stored and published. Lisam also contain functionality to give quizzes, have signup lists, do submissions, and grade students. Lisam is also connected to MS Teams where all courses in Lisam have a corresponding Team setup automatically.

In the courses TPPE74 Design and Development of Manufacturing Operations all lectures are pre-recorded and a session for questions is given for each lecture according to the time schedule. In the course TPPE91 Production System Planning and Management most of the lectures and the seminars were given live in Teams and recorded during the live presentation. Some of the lectures were pre-recorded. All supervision in both courses has been caried out in Teams and communications have utilized both Lisam and emails.

The basic pedagogical method has been to first introduce a topic area, then to do simple applications on the area, to later in the projects do a full-scale implementation. One example of this is the implementation of Cyclic planning (periodic planning) in TPPE74. First, the concept of cyclic planning is covered at a lecture. The next step is to solve simple problems in the range of three products in one resource at a seminar. The final step is to implement cyclic planning in a larger environment including five resources and nine products.

4. IMPLEMENTATION OF THE REVISED COURSE MODULES

All course modules were implemented and tested during the spring 2021. See the subheadings below for the details of each course module.

4.1. Course Module: Design and Development of Manufacturing Operations

The course module stared 2021-03-29 with the first lecture and ended 2021-05-24 with the last lecture, see the game plan for the course in figure 4.1.

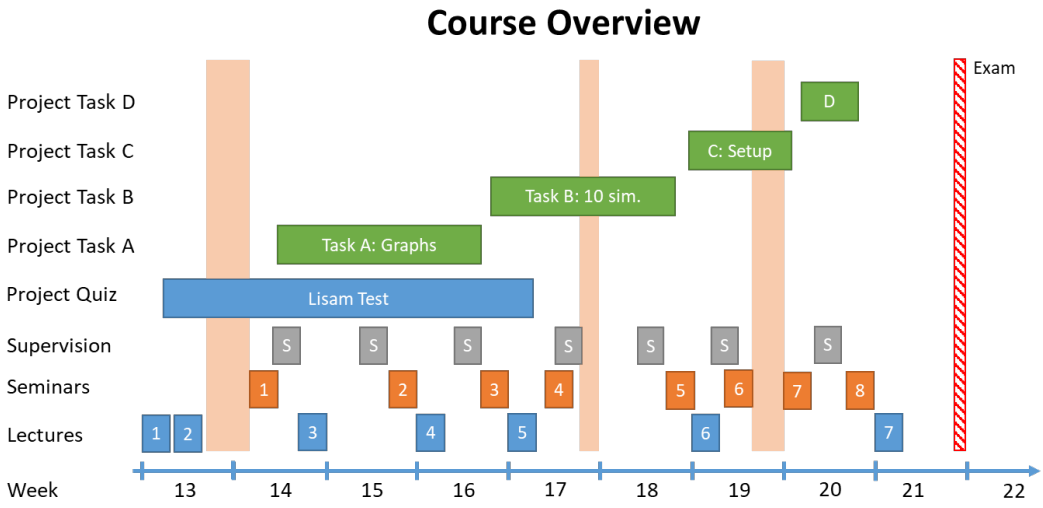


Figure 4.1. TPPE74 Course Plan

In the Project part of the course, newly developed tasks were Task A and Task D. The Lecture in AI is Lecture 6 together with seminar 6.

4.2. Course Module: Production System Planning and Management

The course module stared 2021-01-18 (week 3) with the first lecture and ended 2021-03-12 (week 10) with the last lecture, see the game plan for the course in figure 4.2

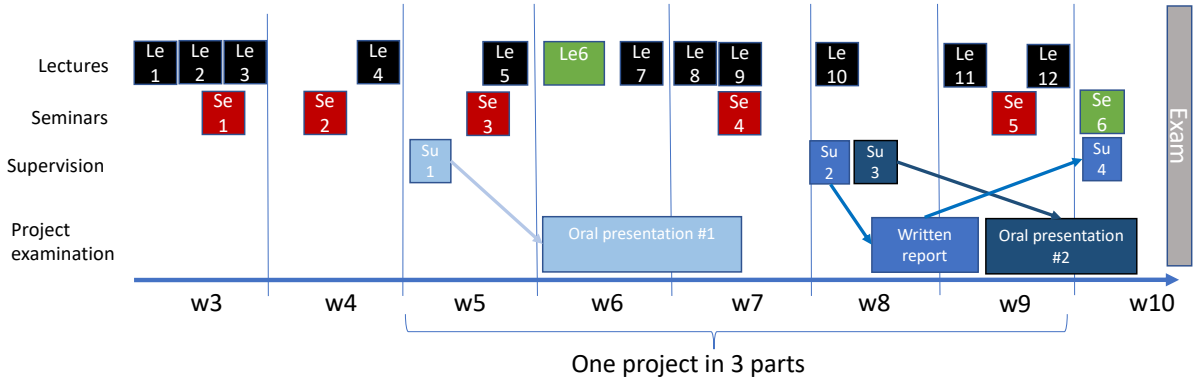


Figure 4.2. TPPE91 Course Plan

The newly developed tasks were lecture 6 and seminar 6, marked green in the figure.

5. INVOLVEMENT OF THE INDUSTRIAL PARTNERS

The industrial partner Implema AB has been discussion partner in the development of all the modules and being in charge of development of module 2 in TPPE74 Design and Development of Manufacturing Operations and module 1 in TPPE91 Production System Planning and Management.

6. COURSE MODULE EVALUATION

All courses at LiU will automatically be subject to course evaluation in Evaliuate. A questionnaire will be sent to all registered students on every course when the course ends. The questionnaire contains 10 university-wide questions and some others that are specific to the faculty. Further questions can be added, if desired.

6.1. Course Module: Design and Development of Manufacturing Operations

The course evaluation opened 2021-05-31 and closed 2021-06-21.

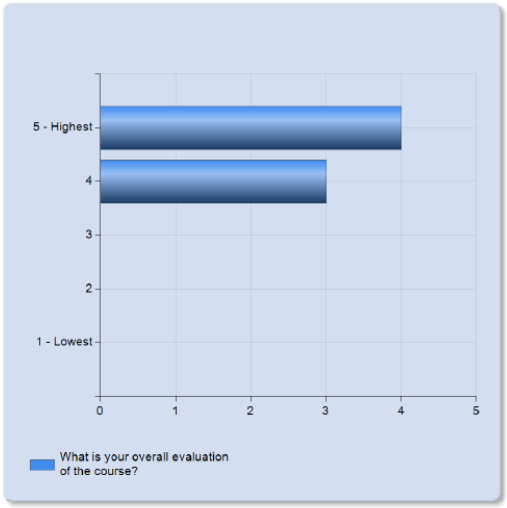
Table 6.1: Response rate for TPPE74

Evaliuate TPPE74	Number
Number of respondents	44
Number of answers	7 (15.9 %)

For the results of the course evaluation, the results of two questions are reported. Question 9 concerns the whole course and an overall evaluation. For TPPE74 in 2021, this result was 4.57 on a scale from 1 to 5, see Figure 6.1.

9. What is your overall evaluation of the course?

What is your overall evaluation of the course?	Number of Responses
5 - Highest	4 (57%)
4	3 (43%)
3	0 (0%)
2	0 (0%)
1 - Lowest	0 (0%)
Total	7 (100%)



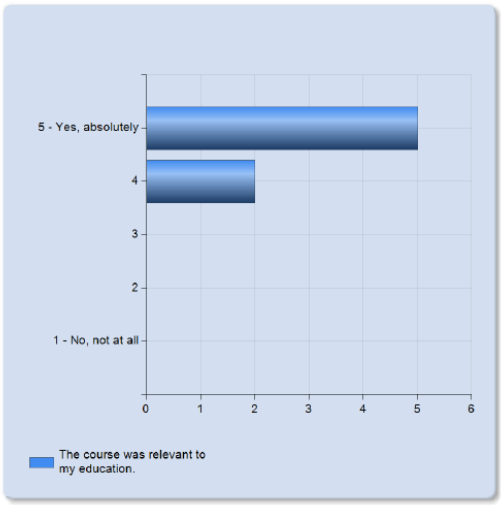
	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
What is your overall evaluation of the course?	4.57	0.53	11.69 %	4.00	4.00	5.00	5.00	5.00

Figure 6.1: Answers for question 9 in the course TPPE74

The answers for question 14 are also relevant since the question is about how relevant the course is in the study program. For TPPE74 in 2021, this result was 4.71 on a scale from 1 to 5, see Figure 6.2.

14. The course was relevant to my education.

The course was relevant to my education.	Number of Responses
5 - Yes, absolutely	5 (71%)
4	2 (29%)
3	0 (0%)
2	0 (0%)
1 - No, not at all	0 (0%)
Total	7 (100%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
The course was relevant to my education.	4.71	0.49	10.35 %	4.00	4.50	5.00	5.00	5.00

Figure 6.2: Answers for question 14 in the course TPPE74

6.2. Course Module: Production System Planning and Management

The course evaluation opened 2021-03-22 and closed 2021-04-11.

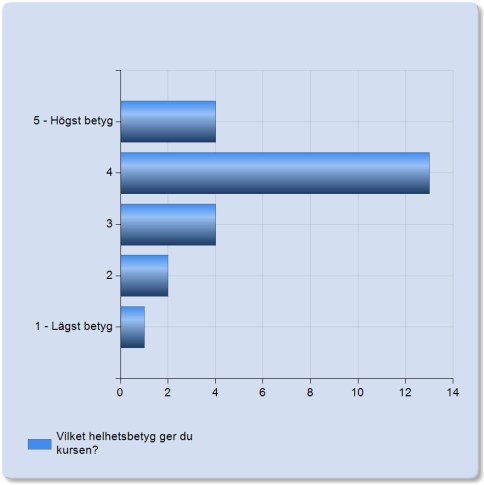
Table 6.2: Response rate

Evaluate TPPE91	Number
Number of respondents	120
Number of answers	24 (20 %)

For the results of the course evaluation, the same two questions are reported as in the previous section (in Swedish). Question 9 concerns the whole course and an overall evaluation and for TPPE91 in 2021, this result was 3.71 on a scale from 1 to 5, see Figure 6.1.

9. Vilket helhetsbetyg ger du kursen?

Vilket helhetsbetyg ger du kursen?	Antal svar
5 - Högst betyg	4 (17%)
4	13 (54%)
3	4 (17%)
2	2 (8%)
1 - Lägst betyg	1 (4%)
Summa	24 (100%)



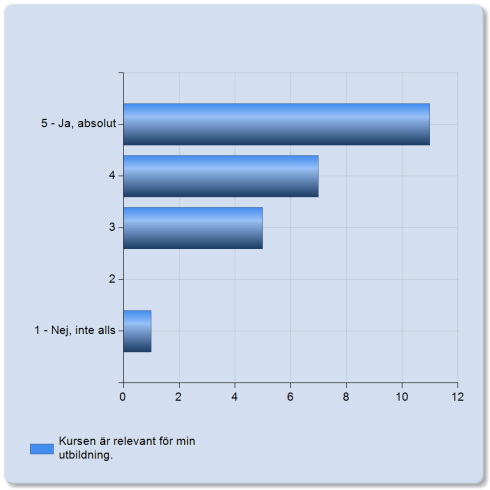
	Medelvärde	Standardavvikelse	Variationskoefficient	Min	Undre kvartil	Median	Övre kvartil	Max
Vilket helhetsbetyg ger du kursen?	3,71	1,00	26,94 %	1,00	3,00	4,00	4,00	5,00

Figure 6.3 Answers to the question "What is your overall evaluation of the course?" in the course TPPE91

Finally, the answers for question 14 with the statement “The course was relevant to my study program”. For TPPE91 in 2021, this result was 4.13 on a scale from 1 to 5, see Figure 6.4.

1. Kursen är relevant för min utbildning.

Kursen är relevant för min utbildning.	Antal svar
5 - Ja, absolut	11 (46%)
4	7 (29%)
3	5 (21%)
2	0 (0%)
1 - Nej, inte alls	1 (4%)
Summa	24 (100%)



	Medelvärde	Standardavvikelse	Variationskoefficient	Min	Undre kvartil	Median	Övre kvartil	Max
Kursen är relevant för min utbildning.	4,13	1,03	25,08 %	1,00	3,50	4,00	5,00	5,00

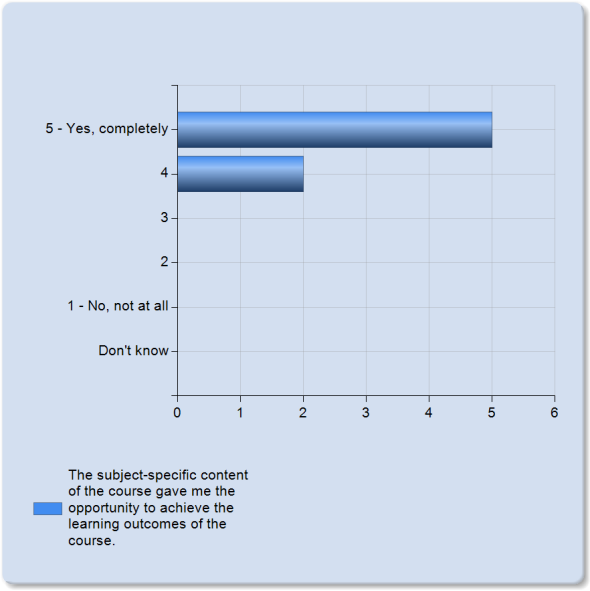
Figure 6.4 Answers to the statement “The course was relevant to my study program” in the course TPPE91

Design and Development of Manufacturing Operations (TPPE74 2021-05-31 Lin 1338527)

Respondents: 44
Answer Count: 7
Answer Frequency: 15.91%

1. The subject-specific content of the course gave me the opportunity to achieve the learning outcomes of the course.

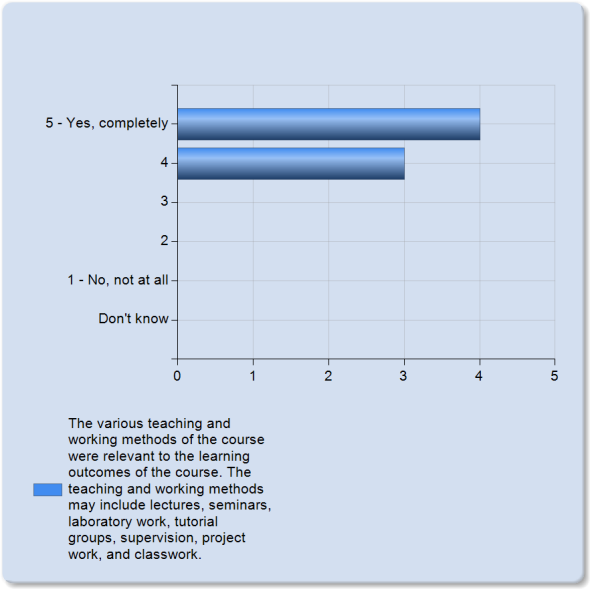
The subject-specific content of the course gave me the opportunity to achieve the learning outcomes of the course.	Number of Responses
5 - Yes, completely	5 (71%)
4	2 (29%)
3	0 (0%)
2	0 (0%)
1 - No, not at all	0 (0%)
Don't know	0 (0%)
Total	7 (100%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
The subject-specific content of the course gave me the opportunity to achieve the learning outcomes of the course.	4.71	0.49	10.35 %	4.00	4.50	5.00	5.00	5.00

2. The various teaching and working methods of the course were relevant to the learning outcomes of the course. The teaching and working methods may include lectures, seminars, laboratory work, tutorial groups, supervision, project work, and classwork.

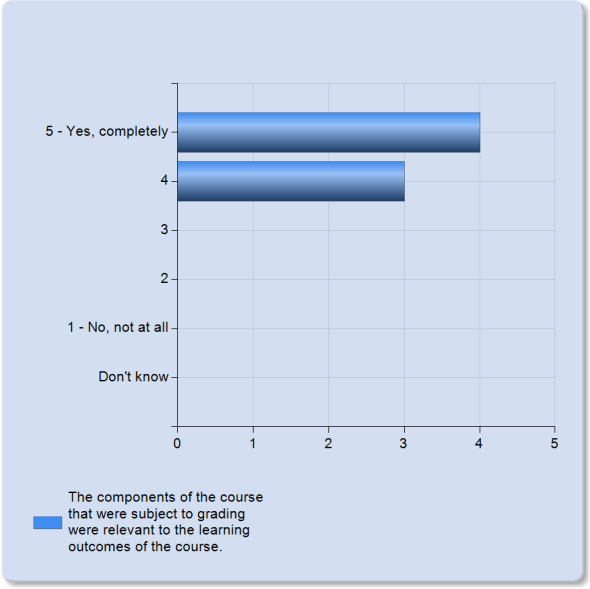
The various teaching and working methods of the course were relevant to the learning outcomes of the course. The teaching and working methods may include lectures, seminars, laboratory work, tutorial groups, supervision, project work, and classwork.	Number of Responses
5 - Yes, completely	4 (57%)
4	3 (43%)
3	0 (0%)
2	0 (0%)
1 - No, not at all	0 (0%)
Don't know	0 (0%)
Total	7 (100%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
The various teaching and working methods of the course were relevant to the learning outcomes of the course. The teaching and working methods may include lectures, seminars, laboratory work, tutorial groups, supervision, project work, and classwork.	4.57	0.53	11.69 %	4.00	4.00	5.00	5.00	5.00

3. The components of the course that were subject to grading were relevant to the learning outcomes of the course.

The components of the course that were subject to grading were relevant to the learning outcomes of the course.	Number of Responses
5 - Yes, completely	4 (57%)
4	3 (43%)
3	0 (0%)
2	0 (0%)
1 - No, not at all	0 (0%)
Don't know	0 (0%)
Total	7 (100%)

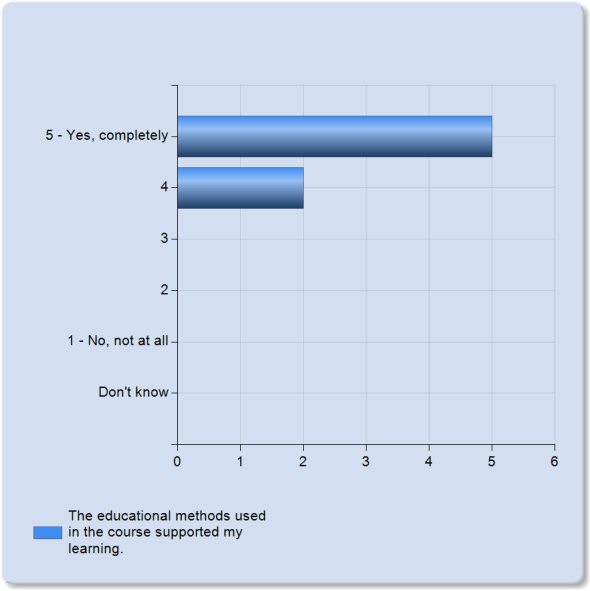


	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
The components of the course that were subject to grading were relevant to the learning outcomes of the course.	4.57	0.53	11.69 %	4.00	4.00	5.00	5.00	5.00

---

4. The educational methods used in the course supported my learning.

The educational methods used in the course supported my learning.	Number of Responses
5 - Yes, completely	5 (71%)
4	2 (29%)
3	0 (0%)
2	0 (0%)
1 - No, not at all	0 (0%)
Don't know	0 (0%)
Total	7 (100%)

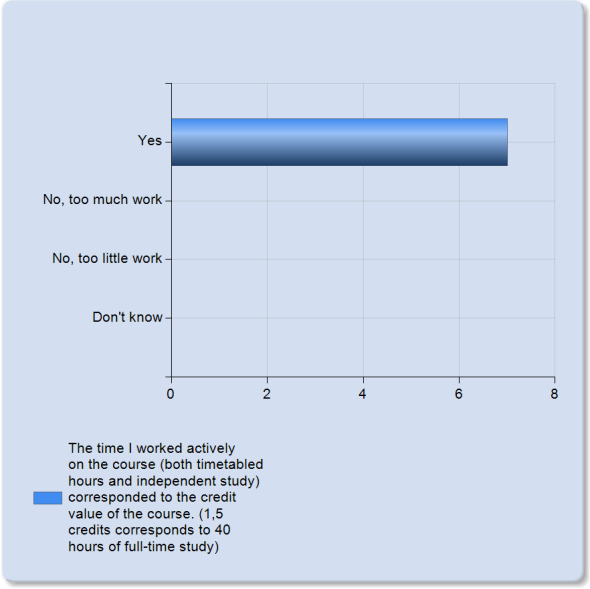


	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
The educational methods used in the course supported my learning.	4.71	0.49	10.35 %	4.00	4.50	5.00	5.00	5.00

---

5. The time I worked actively on the course (both timetabled hours and independent study) corresponded to the credit value of the course. *(1,5 credits corresponds to 40 hours of full-time study)*

The time I worked actively on the course (both timetabled hours and independent study) corresponded to the credit value of the course. *(1,5 credits corresponds to 40 hours of full-time study)*	Number of Responses
Yes	7 (100%)
No, too much work	0 (0%)
No, too little work	0 (0%)
Don't know	0 (0%)
Total	7 (100%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
The time I worked actively on the course (both timetabled hours and independent study) corresponded to the credit value of the course. *(1,5 credits corresponds to 40 hours of full-time study)*	3.00	0.00	0.00 %	3.00	3.00	3.00	3.00	3.00

---

6. What changes do you consider to be possible that would improve the course with respect to, for example, content, teaching principles, administration, teaching methods, or examination forms? Specify the most important first.

Make your voice heard through constructive criticism! Remember that constructive criticism is easier for the receiver to absorb and act on, so you should avoid unpleasant comments and "ad hominem" attacks. The Student portal gives more information about the principles of anonymity when giving free-text responses.

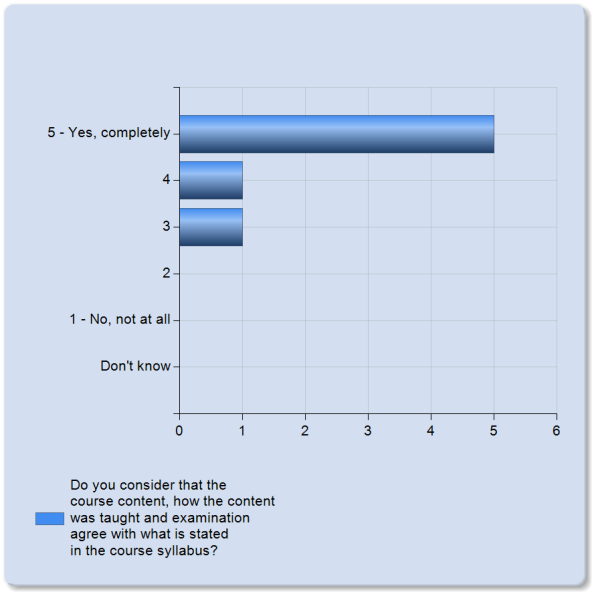
What changes do you consider to be possible that would improve the course with respect to, for example, content, teaching principles, administration, teaching methods, or examination forms? Specify the most important first.
Make your voice heard through constructive criticism! Remember that constructive criticism is easier for the receiver to absorb and act on, so you should avoid unpleasant comments and "ad hominem" attacks. The Student portal gives more information about the principles of anonymity when giving free-text responses.
No, I don't think any changes need to be made.
Maybe groups of 2 or 3 instead of 4.
The time period för task A (picsim) aws to long.
I really appreciate the fact that almost all the seminars and lectures were registered.

7. Give examples of content, teaching principles, teaching methods, examination forms, or any other aspect of the course that you consider to have been particularly successful.

Give examples of content, teaching principles, teaching methods, examination forms, or any other aspect of the course that you consider to have been particularly successful.
I liked the quiz and the project a lot! I think the project was a great way to test one's knowledge taken from the lectures, and a good way to understand different design parameters effect on each other in a production process. On a side note, I personally also like when the examinator also mentions continuation courses and other courses that could be relevant to read after this course to further improve one's knowledge.
Great seminars and lectures, very helpful in any way. Profesional through the whole course.
Att ha möjlighet att prata och diskutera med examinatorn så pass mycket har varit mycket uppskattat!
Recorded videos/lectures
The lecture and the seminars were well presented and easy to understand everythings.

8. Do you consider that the course content, how the content was taught and examination agree with what is stated in the course syllabus?

Do you consider that the course content, how the content was taught and examination agree with what is stated in the course syllabus?	Number of Responses
5 - Yes, completely	5 (71%)
4	1 (14%)
3	1 (14%)
2	0 (0%)
1 - No, not at all	0 (0%)
Don't know	0 (0%)
Total	7 (100%)

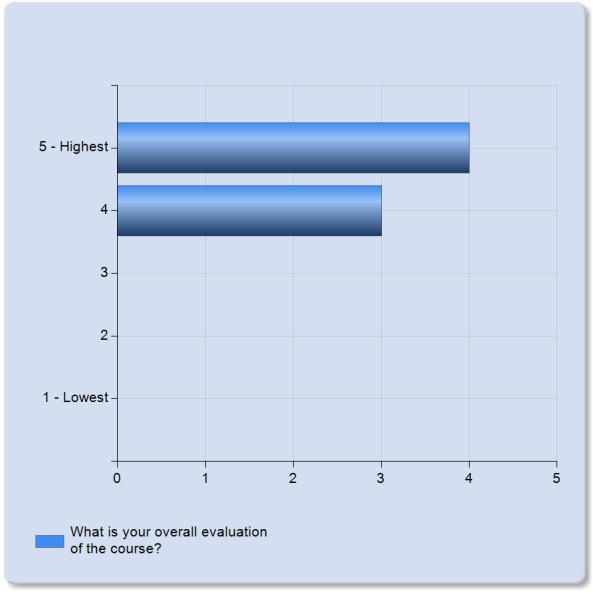


	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
Do you consider that the course content, how the content was taught and examination agree with what is stated in the course syllabus?	4.57	0.79	17.21 %	3.00	4.50	5.00	5.00	5.00

---

9. What is your overall evaluation of the course?

What is your overall evaluation of the course?	Number of Responses
5 - Highest	4 (57%)
4	3 (43%)
3	0 (0%)
2	0 (0%)
1 - Lowest	0 (0%)
Total	7 (100%)



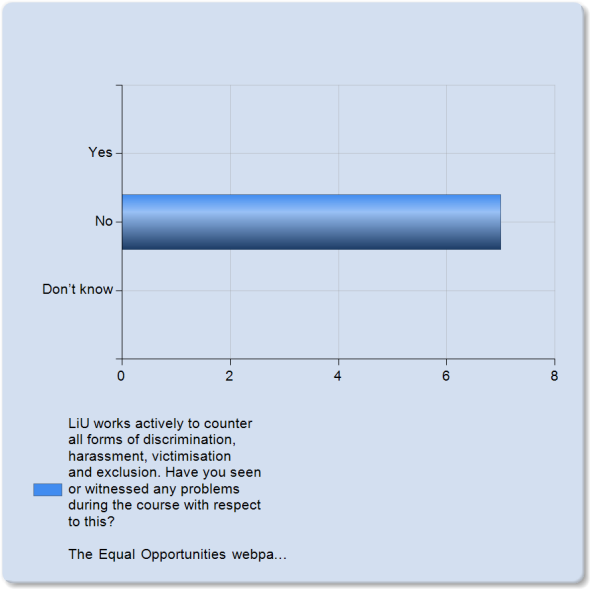
	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
What is your overall evaluation of the course?	4.57	0.53	11.69 %	4.00	4.00	5.00	5.00	5.00

10. LiU works actively to counter all forms of discrimination, harassment, victimisation and exclusion. Have you seen or witnessed any problems during the course with respect to this?

The Equal Opportunities webpage gives more information about how to report if you or someone else has been the subject of abuse.

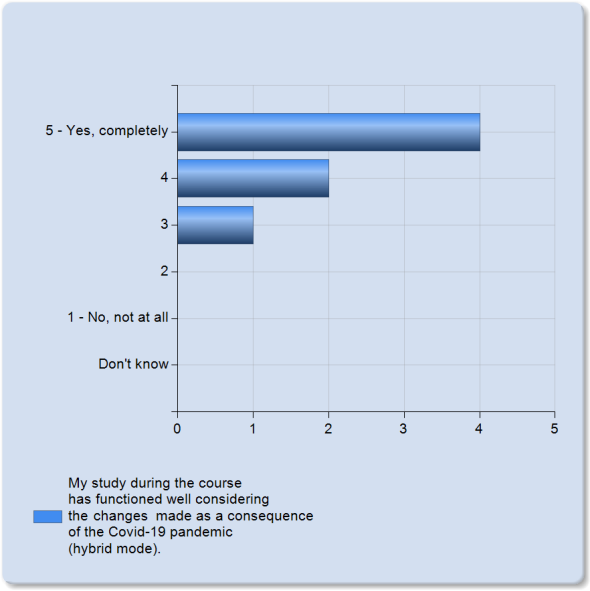
LiU works actively to counter all forms of discrimination, harassment, victimisation and exclusion. Have you seen or witnessed any problems during the course with respect to this?

The Equal Opportunities webpage gives more information about how to report if you or someone else has been the subject of abuse.	Number of Responses	Cumulated Responses
Yes	0 (0.0%)	0 (0.0%)
No	7 (100.0%)	7 (100.0%)
Don't know	0 (0.0%)	7 (100.0%)
Total	7 (100.0%)	7 (100.0%)



11. My study during the course has functioned well considering the changes made as a consequence of the Covid-19 pandemic (hybrid mode).

My study during the course has functioned well considering the changes made as a consequence of the Covid-19 pandemic (hybrid mode).	Number of Responses
5 - Yes, completely	4 (57%)
4	2 (29%)
3	1 (14%)
2	0 (0%)
1 - No, not at all	0 (0%)
Don't know	0 (0%)
Total	7 (100%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
My study during the course has functioned well considering the changes made as a consequence of the Covid-19 pandemic (hybrid mode).	4.43	0.79	17.77 %	3.00	4.00	5.00	5.00	5.00

---

12. Describe one component that has functioned extremely well in hybrid mode. Why was this component successful?

Describe one component that has functioned extremely well in hybrid mode. Why was this component successful?
I liked that the lectures were prerecorded and online, since I had another course in the same block. I also liked that some parts, as in the seminars, were live since that made the listener more engaged in the lecture. Also, by having the seminars live, the students could ask questions in real time which according to me was good.
The whole course to be honest. It's easy to say that Fredrik spent time doing the lectures and seminars adapted to Corona by using programs. By far the most adapted course. Great work.
Boka teamsmöten
The registered lectures were extremely well in hybrid mode.

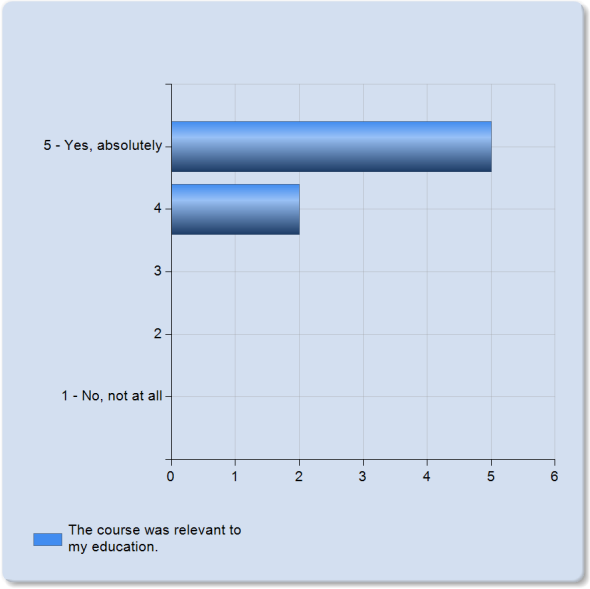
---

13. Describe one component that has not functioned well in hybrid mode. How could this component be changed to make it better?

Describe one component that has not functioned well in hybrid mode. How could this component be changed to make it better?
I don't think anything went wrong.
?
The teamwork in the project was difficult on my part.

14. The course was relevant to my education.

The course was relevant to my education.	Number of Responses
5 - Yes, absolutely	5 (71%)
4	2 (29%)
3	0 (0%)
2	0 (0%)
1 - No, not at all	0 (0%)
Total	7 (100%)



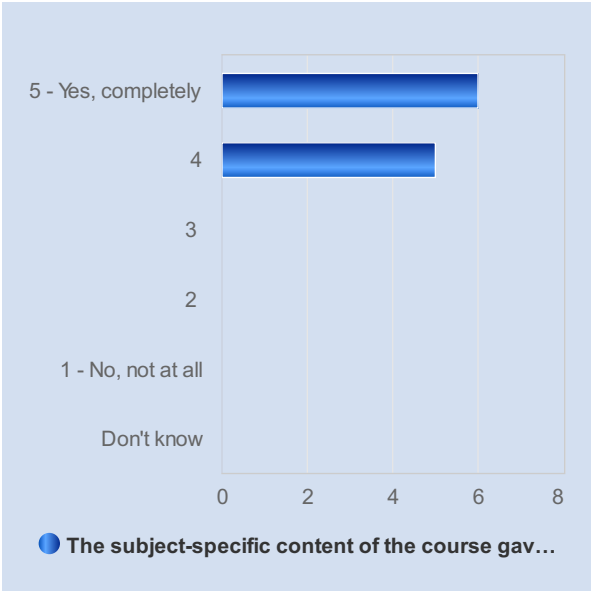
	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
The course was relevant to my education.	4.71	0.49	10.35 %	4.00	4.50	5.00	5.00	5.00

Design and Development of Manufacturing Operations (TPPE74 2022-05-30 Lin 1376712)

Respondents: 35
Answer Count: 11
Answer Frequency: 31.43%

1. The subject-specific content of the course gave me the opportunity to achieve the learning outcomes of the course.

The subject-specific content of the course gave me the opportunity to achieve the learning outcomes of the course.	Number of responses
5 - Yes, completely	6 (55%)
4	5 (45%)
3	0 (0%)
2	0 (0%)
1 - No, not at all	0 (0%)
Don't know	0 (0%)
Total	11 (100%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
The subject-specific content of the course gave me the opportunity to achieve the learning outcomes of the course.	4.55	0.52	11.49 %	4.00	4.00	5.00	5.00	5.00

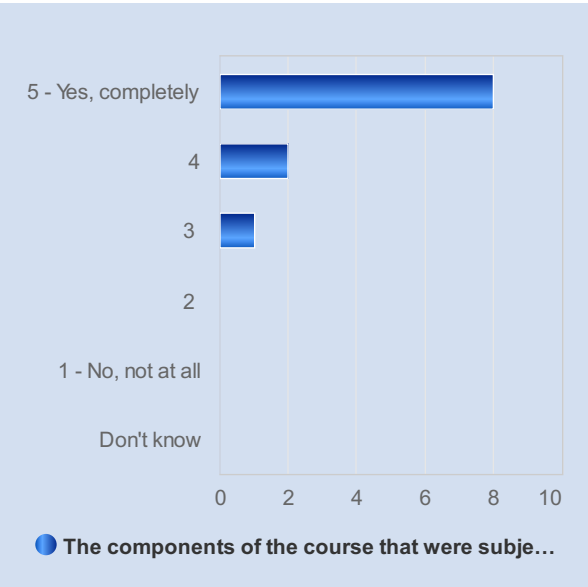
2. The various teaching and working methods of the course were relevant to the learning outcomes of the course. The teaching and working methods may include lectures, seminars, laboratory work, tutorial groups, supervision, project work, and classwork.

The various teaching and working methods of the course were relevant to the learning outcomes of the course. The teaching and working methods may include lectures, seminars, laboratory work, tutorial groups, supervision, project work, and classwork.	Number of responses
5 - Yes, completely	5 (45%)
4	6 (55%)
3	0 (0%)
2	0 (0%)
1 - No, not at all	0 (0%)
Don't know	0 (0%)
Total	11 (100%)

	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
The various teaching and working methods of the course were relevant to the learning outcomes of the course. The teaching and working methods may include lectures, seminars, laboratory work, tutorial groups, supervision, project work, and classwork.	4.45	0.52	11.72 %	4.00	4.00	4.00	5.00	5.00

3. The components of the course that were subject to grading were relevant to the learning outcomes of the course.

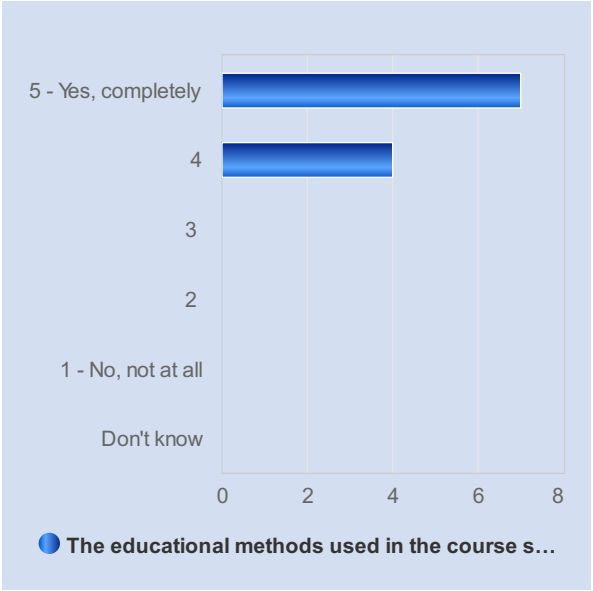
The components of the course that were subject to grading were relevant to the learning outcomes of the course.	Number of responses
5 - Yes, completely	8 (73%)
4	2 (18%)
3	1 (9%)
2	0 (0%)
1 - No, not at all	0 (0%)
Don't know	0 (0%)
Total	11 (100%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
The components of the course that were subject to grading were relevant to the learning outcomes of the course.	4.64	0.67	14.54 %	3.00	4.50	5.00	5.00	5.00

4. The educational methods used in the course supported my learning.

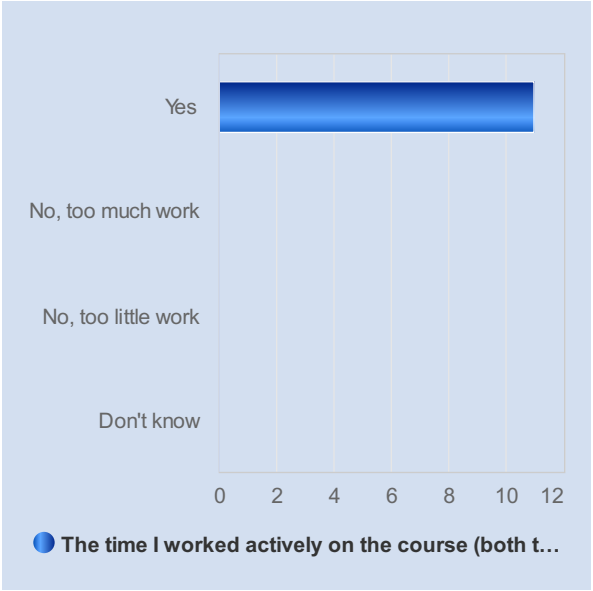
The educational methods used in the course supported my learning.	Number of responses
5 - Yes, completely	7 (64%)
4	4 (36%)
3	0 (0%)
2	0 (0%)
1 - No, not at all	0 (0%)
Don't know	0 (0%)
Total	11 (100%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
The educational methods used in the course supported my learning.	4.64	0.50	10.88 %	4.00	4.00	5.00	5.00	5.00

5. The time I worked actively on the course (both timetabled hours and independent study) corresponded to the credit value of the course. *(1,5 credits corresponds to 40 hours of full-time study)*

The time I worked actively on the course (both timetabled hours and independent study) corresponded to the credit value of the course. *(1,5 credits corresponds to 40 hours of full-time study)*	Number of responses
Yes	11 (100%)
No, too much work	0 (0%)
No, too little work	0 (0%)
Don't know	0 (0%)
Total	11 (100%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
The time I worked actively on the course (both timetabled hours and independent study) corresponded to the credit value of the course. *(1,5 credits corresponds to 40 hours of full-time study)*	3.00	0.00	0.00 %	3.00	3.00	3.00	3.00	3.00

6. What changes do you consider to be possible that would improve the course with respect to, for example, content, teaching principles, administration, teaching methods, or examination forms? Specify the most important first.

Make your voice heard through constructive criticism! Remember that constructive criticism is easier for the receiver to absorb and act on, so you should avoid unpleasant comments and "ad hominem" attacks. The Course evaluation page on Lisam gives more information about the principles of anonymity when giving free-text responses.

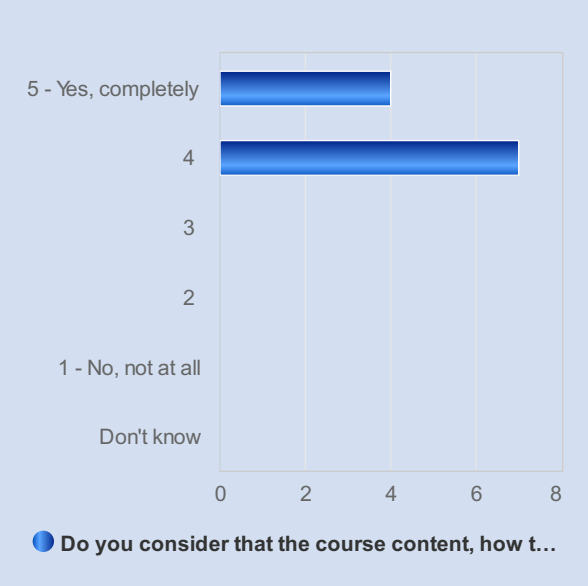
What changes do you consider to be possible that would improve the course with respect to, for example, content, teaching principles, administration, teaching methods, or examination forms? Specify the most important first.
Make your voice heard through constructive criticism! Remember that constructive criticism is easier for the receiver to absorb and act on, so you should avoid unpleasant comments and "ad hominem" attacks. The Course evaluation page on Lisam gives more information about the principles of anonymity when giving free-text responses.
I would have loved to run more simulations, and see how small changes were able to effect the overall outcome. Sometimes we could not grasp all the underlying variables of the simulation, and why it reacted the way it did. But to try something small to test our own hypothesis, there were not enough trials available. Further I thought some lectures lacked a little bit of structure/red line, instead of the simulation lecture, i would have found it more interesting to learn how the simulation for the pic sim project was build, also it would be awesome, if the same variables for the TC functions would be used as in Ou Tangs course :) Otherwise good work!
More simulation test since this was the fun part to see how the changes the outcome
Kommer inte på något som borde ändras, tycker snarare att kursens upplägg borde behållas såsom det är. :)
O Tycker man skulle kunna korta ner task A lite så att det finns mer tid för typ task B som kräver lite mer tid och att det inte blir så tajt i slutet innan tentaperioden
give more details regarding those theory
The fact that different notations and equations are used in this course and in TPPE78 and TPP74 made the entire course pretty messy. Both the kingman equations and the base period approach are used differently new notations are introduced for each course. If these were used unitary it would be much simpler the follow and understand the grater picture.

7. Give examples of content, teaching principles, teaching methods, examination forms, or any other aspect of the course that you consider to have been particularly successful.

Give examples of content, teaching principles, teaching methods, examination forms, or any other aspect of the course that you consider to have been particularly successful.
I really liked the simulation project, it was quite fun to work with real data.
The group work gave us the opportunity to fully emerse ourselves into the planning systems. This resulted in deep learning on the topic.
Tycker uppdelningen mellan föreläsningar och seminarier, där seminarierna var dedikerade till olika Tasks av projektet, var strukturerat och bra. Uppskattade även mycket att det erbjöds handledning varje tisdag mellan 9-11, det var väldigt generöst av Fredrik och väldigt hjälpsamt för oss. Fredrik var generellt väldigt hjälpsam genom hela projektet vilket uppskattas enormt! Det finns alldeles för många kurser där handledare vägrar hjälpa till när man fastnar. Projektet var bra upplagt och man lärde sig väldigt mycket. Tycker även tentan var rimlig utifrån kursinnehåll och svårighetsgrad. Mycket nöjd med kursen!
O bra med hybridläget O tycker ändån projektet har speglat kursen väldigt bra och tycker kanske att man skulle kunna försöka göra det ännu större och kanske lägga till någon mer del O bra blandning mellan föreläsningar och seminarier som gjorde att projektet gick bättre
the old exam documents are pretty good
I think the project was top notch. Lectures gave the content necessary to complete the course. Overall, very good.

8. Do you consider that the course content, how the content was taught and examination agree with what is stated in the course syllabus?

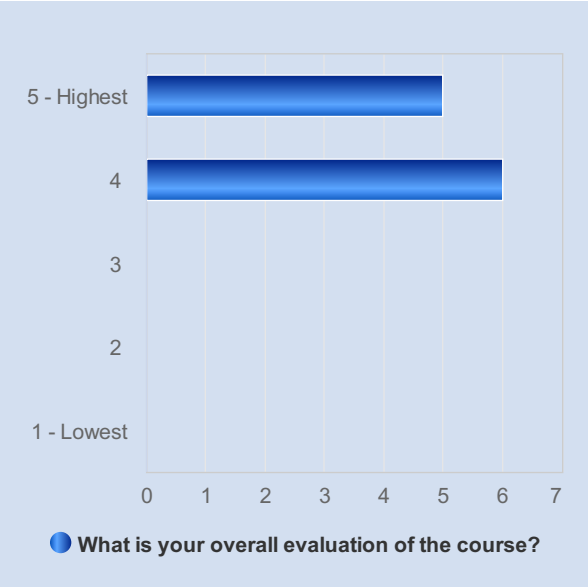
Do you consider that the course content, how the content was taught and examination agree with what is stated in the course syllabus?	Number of responses
5 - Yes, completely	4 (36%)
4	7 (64%)
3	0 (0%)
2	0 (0%)
1 - No, not at all	0 (0%)
Don't know	0 (0%)
Total	11 (100%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
Do you consider that the course content, how the content was taught and examination agree with what is stated in the course syllabus?	4.36	0.50	11.56 %	4.00	4.00	4.00	5.00	5.00

9. What is your overall evaluation of the course?

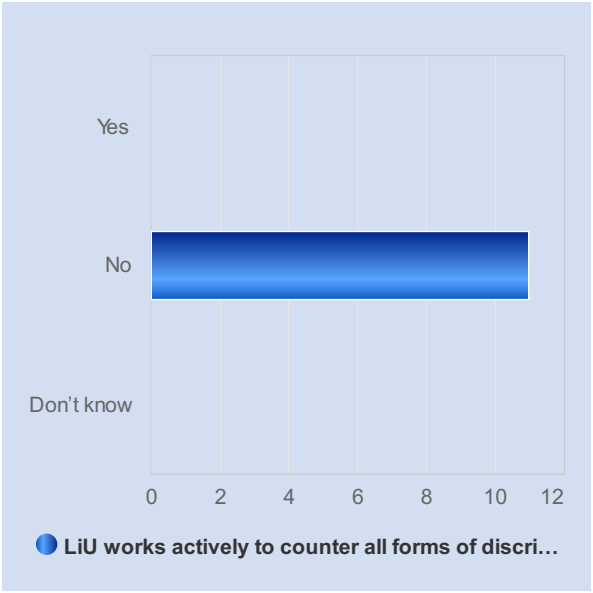
What is your overall evaluation of the course?	Number of responses
5 - Highest	5 (45%)
4	6 (55%)
3	0 (0%)
2	0 (0%)
1 - Lowest	0 (0%)
Total	11 (100%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
What is your overall evaluation of the course?	4.45	0.52	11.72 %	4.00	4.00	4.00	5.00	5.00

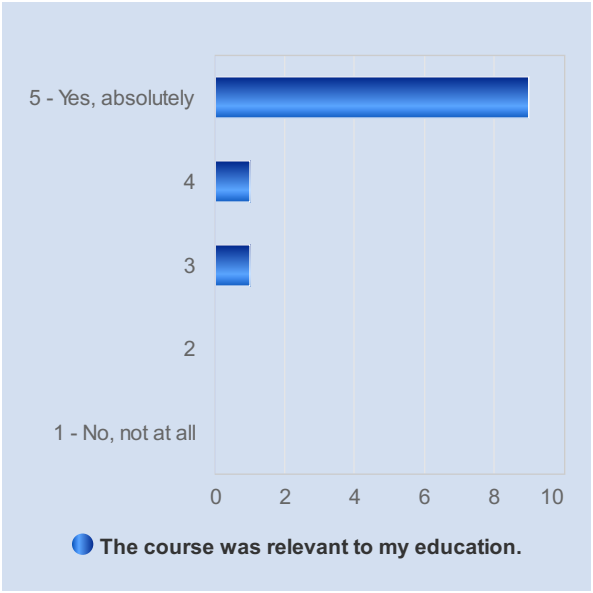
10. LiU works actively to counter all forms of discrimination, harassment, victimisation and exclusion. Have you seen or witnessed any problems during the course with respect to this? *The Equal Opportunities webpage gives more information about how to report if you or someone else has been the subject of abuse.*

LiU works actively to counter all forms of discrimination, harassment, victimisation and exclusion. Have you seen or witnessed any problems during the course with respect to this? *The Equal Opportunities webpage gives more information about how to report if you or someone else has been the subject of abuse.*	Number of responses	Cumulated responses
Yes	0 (0.0%)	0 (0.0%)
No	11 (100.0%)	11 (100.0%)
Don't know	0 (0.0%)	11 (100.0%)
Total	11 (100.0%)	11 (100.0%)



11. The course was relevant to my education.

The course was relevant to my education.	Number of responses
5 - Yes, absolutely	9 (82%)
4	1 (9%)
3	1 (9%)
2	0 (0%)
1 - No, not at all	0 (0%)
Total	11 (100%)



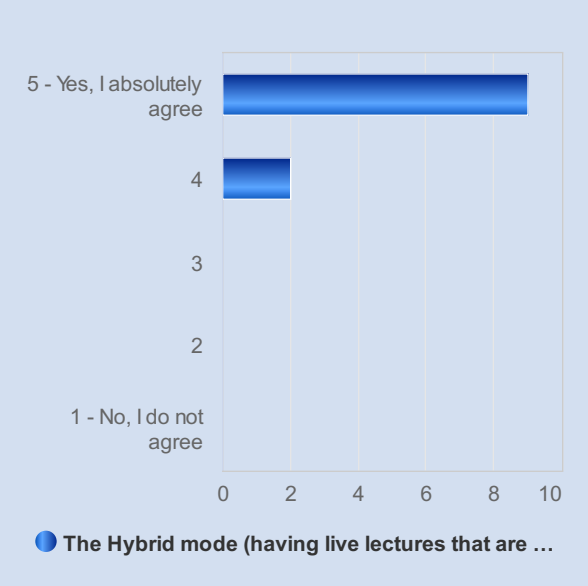
	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
The course was relevant to my education.	4.73	0.65	13.68 %	3.00	5.00	5.00	5.00	5.00

Course specific questions

This part of the survey contains course specific questions.

12. The Hybrid mode (having live lectures that are streamed and recorded) is a preferred teaching style.

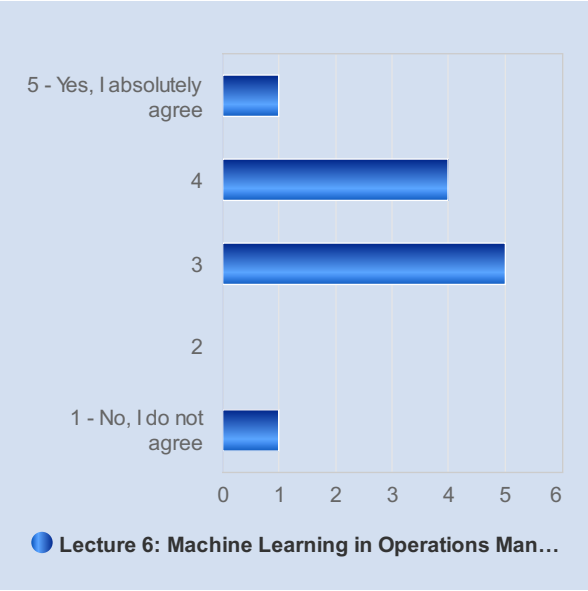
The Hybrid mode (having live lectures that are streamed and recorded) is a preferred teaching style.	Number of responses
5 - Yes, I absolutely agree	9 (82%)
4	2 (18%)
3	0 (0%)
2	0 (0%)
1 - No, I do not agree	0 (0%)
Total	11 (100%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
The Hybrid mode (having live lectures that are streamed and recorded) is a preferred teaching style.	4.82	0.40	8.40 %	4.00	5.00	5.00	5.00	5.00

13. Lecture 6: Machine Learning in Operations Management, was a module with recoded materials and quizzes. This is a preferred way of teaching compared to live lectures/seminars.

Lecture 6: Machine Learning in Operations Management, was a module with recoded materials and quizzes. This is a preferred way of teaching compared to live lectures/seminars.	Number of responses
5 - Yes, I absolutely agree	1 (9%)
4	4 (36%)
3	5 (45%)
2	0 (0%)
1 - No, I do not agree	1 (9%)
Total	11 (100%)



	Mean	Standard Deviation	Coefficient of Variation	Min	Lower Quartile	Median	Upper Quartile	Max
Lecture 6: Machine Learning in Operations Management, was a module with recoded materials and quizzes. This is a preferred way of teaching compared to live lectures/seminars.	3.36	1.03	30.53 %	1.00	3.00	3.00	4.00	5.00