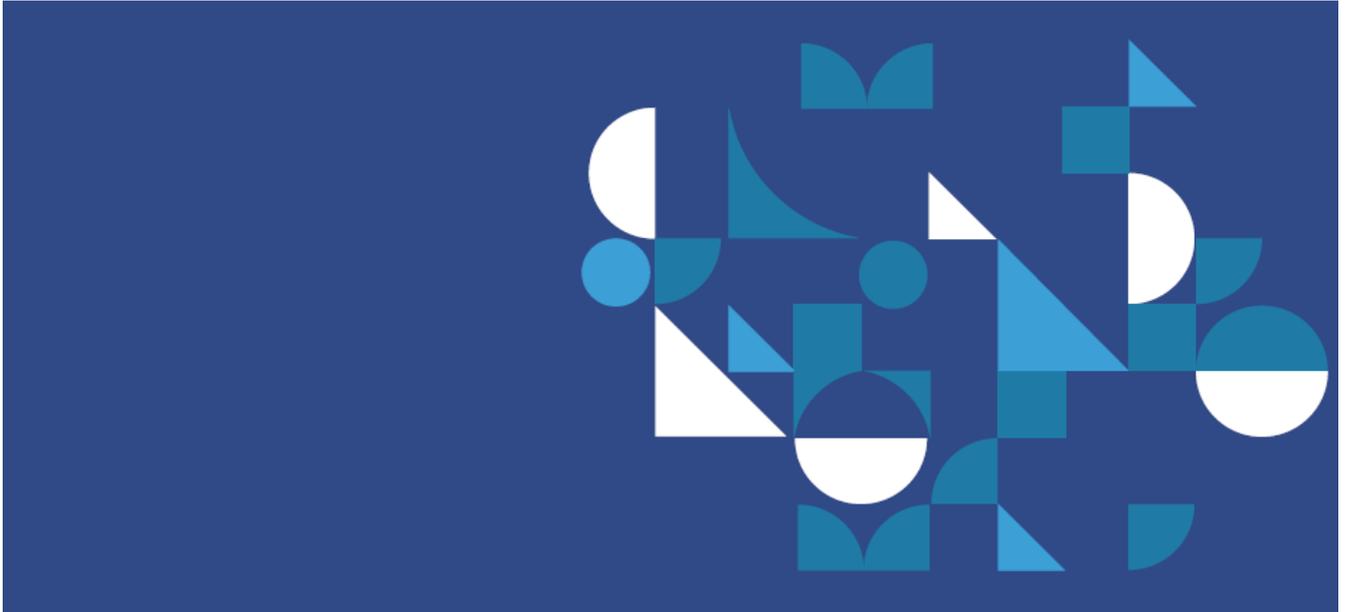




Industrial Engineering and  
Management of European  
Higher Education



## Deliverable: IE3 Course Action Plan: Progress report for the UPM

Date: 31/07/2021



**l.u** LINKING  
UNIVERSITY



POLITÉCNICA

ValueD

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ALCOMOT

implema



ESTIEM



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## Introduction

The main goal of this report is to accomplish the agreement adopted as part of the WP3 action plan, focused on providing a preliminary report. The preliminary report looks to present the initial status for the course, the process of revision based on the BoK and the new design for the course module. Finally, details for the implementation will be addressed and conclusions will be presented.

## Existing Course Module to be Revised

The selected existing course was the Project Management: Advanced Techniques and Tools, belonging to the Industrial Organization Master. A three semester master offered to engineers interested in management aspects provides the context for the course.

The course itself was designed under the classical lecture oriented methodology. The ancient syllabus was conceived as knowledge areas oriented course, according to the Project Management Institute (PMI) perspective as depicted in Figure 1,

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.**

The main approach is to split sessions between theory and practices. In theory concepts are presented in a magisterial lesson (14 weeks with 2h theory + 2h practices per week). Gamification was considered to include some interactions mainly using kahoot® tool.

Practical work is organized in teams, each of them trying to create the Project Management Plan as an integration of the different dimensions (PMI model). Presentations were delivered when required.

The scoring process is based on performance for both theoretical knowledge and practical work.

Main reason supporting the need for renovation is connected to the ambition to bring as much as possible useful and actual knowledge, which require to consider digitalization topics, including advanced tools for project control and execution monitoring. Accomplishing this transformation, it is expected increasing the added value for attendees.

Another relevant ambition was connected with the usage of digital tools in practical applications such as project monitoring and execution control, as it is considered that attendees need to be familiar with them, in order to improve productivity and effectiveness.

Last ambition is to pilot the experience of using technology to transform the way new generations learn, by bring a different and attractive environment application driven.

## Revision Retaled to BoK

The UPM is a Madrid-based university but we have international aspirations, 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.

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.

New generations 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, 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.

## Revised Course Module

In Figure 2 the new designed course content is introduced. Therefore, an analysis of the proposed changes is presented and discussed. Then, details about competence schema and selected trends looking to catch with motivations of newcomers.

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 2.- Renovated syllabus.

Different aspects have been accomplished within the renovation of the course module, both, in terms of course content, as well as in terms of management of the delivery. Content modification looks to integrate R&D and digitalization and providing more time for practical sessions about leadership and decision making negotiation.

Regarding the proposed methodology, the main driving ideas are to,

- Adopt a competence based micro learning educational approach, where every single big competence will be split in smaller basic units (knowledge and/or ability).
- Single path per student can be selected based on their existing knowledge (assessed by specific quizzes) inside each competence.
- Knowledge will be based on short media content (video, audio, short reading, etc. a.k.a. 'knowledge pills') + a quiz to assess the gathered knowledge. Routes to reach the big competence will be followed by students according to their knowledge, avoiding long boring attendance or video watching.
- Most of the theory will be under flipped classroom model and synchronous sessions will be devoted to discuss cases by means of slides with pools and questions.
- Practical sessions will be migrated as much as possible into digital version, including the usage of commercial tools like trello®, etc.

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, including tests for individual assessment and for global one. Indeed, preparation of seminars for flipped approach.

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 3).



Figure 3.- 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**

<b>Knowledge Area</b>	<b>Subject</b>	<b>Relationship</b>	<b>Object</b>
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
Scope	Scope Management	includes	Scope Definition
Scope	Scope Management	includes	Scope Assessment
Scope	Scope Management	includes	Scope Control
Scope	Scope Definition	can build	WBS
Scope	Scope Definition	can build	PBS
Scope	Scope Definition	is critical for	Project Success
Scope	Scope Management	considers	Alternatives
Scope	Scope Management	requires	Stakeholder Analysis
Planning	Project Plan	can include	Scope Planning
Planning	Project Plan	can have	Few Scope Planning Levels
Planning	Prince2	uses	PFD
Planning	Prince2	uses	PDD
Planning	Task Duration	requires	Forecasting Method
General	Methodology	does not require	Specif. Forecasting Method
Planning	GANTT	is a	Scheduling Method
Planning	PERT	is a	Scheduling Method
Planning	CPM	is a	Scheduling Method
Planning	CCPM	is a	Scheduling Method
Planning	ROY	is a	Scheduling Method
Planning	PERT	is a	Network Diagram
Planning	ROY	is a	Network Diagram

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 [5], [6].

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 (see Figure 4), as they are also concerned with applicability of the university time and opportunities after college.



Figure 4.- Typical concerns from Generation Z.

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).

## Implementation of the revised course module

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.

However, far away of the practical assessment of the exhibited performance, including steering information at team level, this work focuses the interest in tools enabling the learning path of the required concepts, tools and relationships. Therefore, the proposal is, when addressing the first aspect, to develop micro-learning content for each of the elements as well as for the relationship themselves, in such a way each learner can define their own path having the opportunity to jump into the concepts and relationships according to their needs, having the opportunity to assess their level of gathered knowledge.

Main reason for micro-learning is to facilitate concept acquisition for Z-gen members as the visual teaching such as tik-tok, youtube, etc., shall be one way but not the exclusive one. To organize concepts and relationships a full competence structure need to be provided. Competencies describe the level of understanding or proficiency of a learner in certain subject-related skills [7]. On the other side, competency-based learning or skills-based learning, refers to systems of assessment and grading where learners demonstrate these competencies.

## PM Competence Framework

### Edit competency framework

▼ Collapse all

#### ▼ General

Name	❗	PM Competence Framework
Description		<div style="border-bottom: 1px solid #ccc; padding: 2px;"> <span>↴</span> <span>A</span> <span>B</span> <span>I</span> <span>☰</span> <span>☰</span> <span>☰</span> <span>☰</span> <span>🔗</span> <span>🔄</span> <span>😊</span> <span>🖼️</span> <span>H:P</span> </div> <div style="padding: 2px;">Framework of Competencies in Project Management</div>
ID number	❗	10.0.1
Scale	❗ ?	Separate and Connected ways of knowing ▾
		<a href="#">Configure scales</a>
Visible	?	Yes ▾
Category		System

#### ▼ Taxonomies

Level 1	Domain ▾
Level 2	Competency ▾
Level 3	Skill ▾
Level 4	Concept ▾

Figure 5.- Implementation of the Competence Framework in Moodle LMS.

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

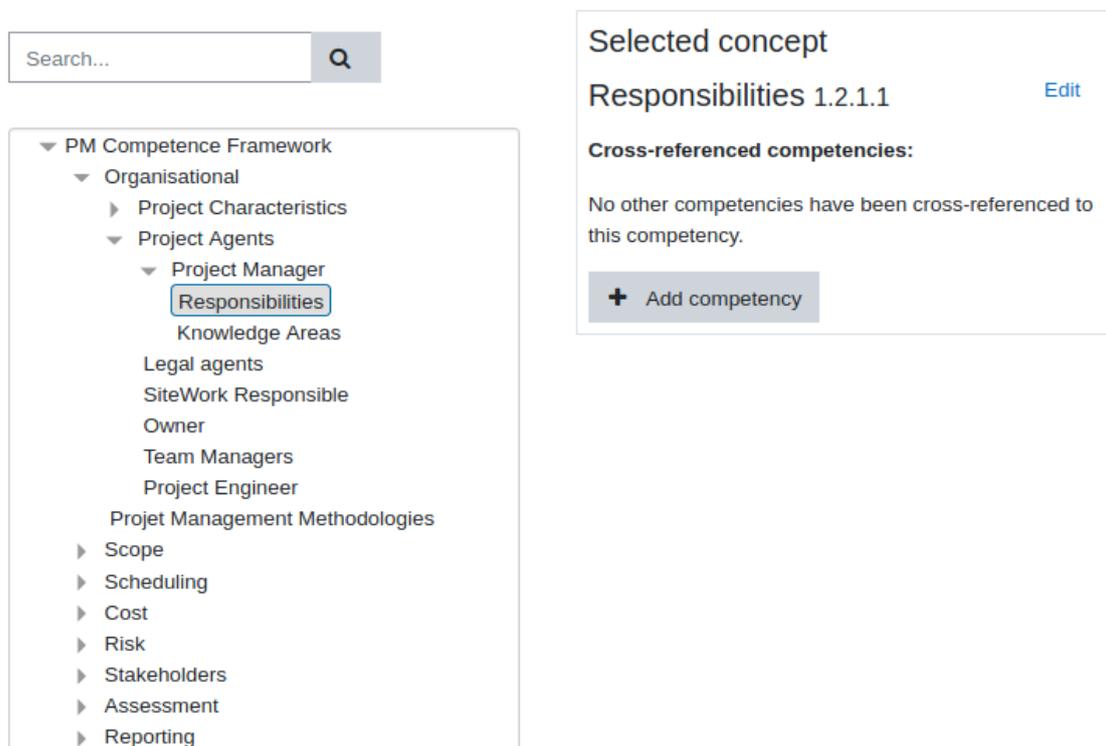
in Figure 2, where its different entries are grouped under the taxonomy keyword [8]. It looks to define every framework row, by setting the language string keys used to describe competencies at each level of the framework [9]. In present case, the adopted taxonomy organizes the knowledge in four layers, 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 [10].

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).

## PM Competence Framework

Framework of Competencies in Project Management

### Competencies



The screenshot displays the 'PM Competence Framework' interface. At the top left is a search bar with the text 'Search...' and a magnifying glass icon. Below it is a tree view of the framework structure. The tree is expanded to show 'Project Manager' > 'Responsibilities', which is highlighted with a blue box. Other visible items include 'Organisational', 'Project Characteristics', 'Project Agents', 'Knowledge Areas', 'Legal agents', 'SiteWork Responsible', 'Owner', 'Team Managers', 'Project Engineer', 'Project Management Methodologies', 'Scope', 'Scheduling', 'Cost', 'Risk', 'Stakeholders', 'Assessment', and 'Reporting'. To the right of the tree view is a panel titled 'Selected concept' showing 'Responsibilities 1.2.1.1' with an 'Edit' link. Below this, it states 'Cross-referenced competencies:' and 'No other competencies have been cross-referenced to this competency.' At the bottom of the panel is a button labeled '+ Add competency'.

Figure 6.- Implementation of skill items into the Competence Framework.

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.

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.

SCOPE ▶

## GENERAL

<b>Project Attributes</b> -----	<input checked="" type="checkbox"/>
VD: Project Attributes (4 min)	<input checked="" type="checkbox"/>
RD: Project Attributes (3 min)	<input checked="" type="checkbox"/>
RD: Projects vs Processes (4 min)	<input checked="" type="checkbox"/>
RD: Process Management vs Project Management (4 min)	<input checked="" type="checkbox"/>
QZ: PrjChars (2 min)	<input checked="" type="checkbox"/>

**Figure 7.- Implementation of micro-learning contents.**

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 [11]. 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.

## Conclusions

The renovated course proposal looks to leverage the new requirements coming from Z-gen learners has been elaborated. The strong aspect to be emphasized is work inside a competence framework approach, but differentiating the personal learning from the shared learning, where both spaces are specific and complementary.

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. However, it is needed to recognize that implementation details need to be collected, by running the experimental courses and identifying aspects to be improved. Such pilot testing process is foreseen for the next academic semester, in Fall 2021.

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