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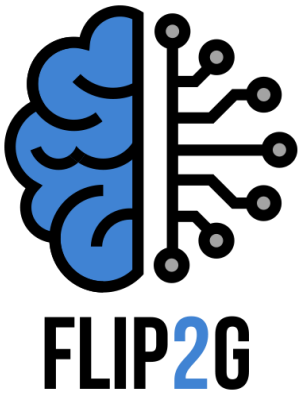

Deliverable 4.1

Pilots Plan

Author(s):	**Maria Athanasiou (Northumbria University)** **Eleni Dermentzi (Northumbria University)**
Editor(s):	**Eleni Dermentzi (Northumbria University)**
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Contributor(s):	**ALL**
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Abstract:	**This deliverable presents the pilot plans of each educational partner of the project. The plans are based on the FLIP2G course design template presented in D3.1 and aim to support the instructors participating in the pilots in delivering their courses according to the FLIP2G model. They can also help instructors outside the consortium understand how the FLIP2G model can be applied in their discipline.**
Keyword List:	**Learning plan, course plan, course design, pilots**

Consortium

	Role	*Name*	*Short Name*	*Country*
1.	Coordinator, PBL	Aalborg University	AAU	Denmark
2.	Games developer	Nurogames GmbH	Nurogames	Germany
3.	PBL, academic partner	University of Macedonia	UOM	Greece
4.	Data analytics	ARTIFICIAL INTELLIGENCE TECHNIQUES, SL	Artelnics	Spain
5.	Academic partner	Northumbria University	Northumbria	UK
6.	Flipped classrooms	EKPAIDEFTIRIA E. MANTOULIDI S.A.	Mantoulides	Greece
7.	Secondary education	Revheim skole, Stavanger Kommune	Revheim	Norway

Revision History

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V01	20/07/2020	Northumbria University	First draft sent to partners for input
V02	24/09/2020	Northumbria University	Input received by educational partners/updating labels of tables/completing table with abbreviations
V03	27/09/2020	UOM	Additional input in v02 provided and review report submitted to Northumbria University
V1	28/09/2020	Northumbria University	Final proof reading

Statement of originality:

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

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List of Abbreviations

The following table presents the acronyms used in the deliverable in alphabetical order.

Abbreviation	*Description*
BSc	Bachelor of Science
DA	Degree Apprenticeship
DL	Distance Learning
FC	Flipped Classroom
GUI	Graphical User Interface
ICT	Information and Communications Technology
LMS	Learning Management System
MSc	Master of Science
MVC	Model-View-Controller
OOP	Object-Oriented Programming
OSI	Open Systems Interconnection
PBL	Problem Based Learning
PC	Personal Computer
PCSS	Programming of Complex Software Systems
PFI	Programming for Interaction
SAD	Systems Analysis and Design
UG	Undergraduate
UI	User Interface
UML	Unified Modeling Language

Executive Summary

This deliverable presents the pilots' plans for each of the educational partners of FLIP2G (i.e. Aalborg University, Northumbria University, University of Macedonia, Mandoulides Schools, and Revheim School). The plans use the FLIP2G course design template presented in D3.1 and aim to support the instructors participating in the pilots in delivering their courses according to the FLIP2G model.

The pilots' plans of the three universities cover courses in the areas of Computer Science, Information Systems, e-Government and Digital Business. The plan is to deliver these courses to a wide variety of students, including undergraduates, postgraduates, and professionals in post-experience education (i.e. Degree Apprenticeships). One of the courses is also designed to be delivered exclusively online and aims to test the FLIP2G model in the distance learning settings. While the rest are expected to be delivered in a blended learning environment, the current circumstances (i.e. measures taken to prevent the spread of Covid-19) may require sudden changes to be made to the delivery of the courses. The next deliverable (i.e. Pilots' report) will present the most up-to-date details of the pilots.

The pilots' plans of the two schools cover a range of subjects (i.e. mathematics, physics, informatics, and social sciences). They also cover different levels of study, with Mandoulides Schools delivering the courses to primary school students and Revheim School to secondary school students. Thus, we expect that the plans can be helpful to both primary and secondary school teachers that may want to understand how they can apply FLIP2G model in their classes. Like in the case of the universities, changes to the courses' delivery may happen due to the social distancing restrictions that may be imposed by the local authorities and/or governments of each country.

1 Introduction

1.1 Scope

The aim of this report is to present the preparatory work carried out for the implementation of the FLIP2G pilots. It focuses on the planning process that will guide the employment of the pilots in different disciplines and different sectors (e.g. higher education, secondary education, adult education) and includes the course plans that each partner developed based on the FLIP2G model.

1.2 Audience

The intended audience for this document is the FLIP2G consortium, the European Commission, and the public interested in adopting the FLIP2G pedagogical approach.

1.3 Structure

The structure of the document is as follows:

- Section 2 briefly presents the generic templates (developed as part of the D3.1) that were used by all the partners to plan for their pilots.
- Section 3 includes the pilots plan for each educational partner.
- Section 4 concludes the report by summarising how the Knowledge Alliance plans to run the pilots of the project.

2 Methodology

The course plans included in this report use the FLIP2G course design template presented in D3.1 – FLIP2G Course Design. The template includes four sections that correspond to the four main stages of the FLIP2G model namely, Concept Exploration, Meaning Making, Demonstration & Application, and Experiential Engagement (Figure 1).

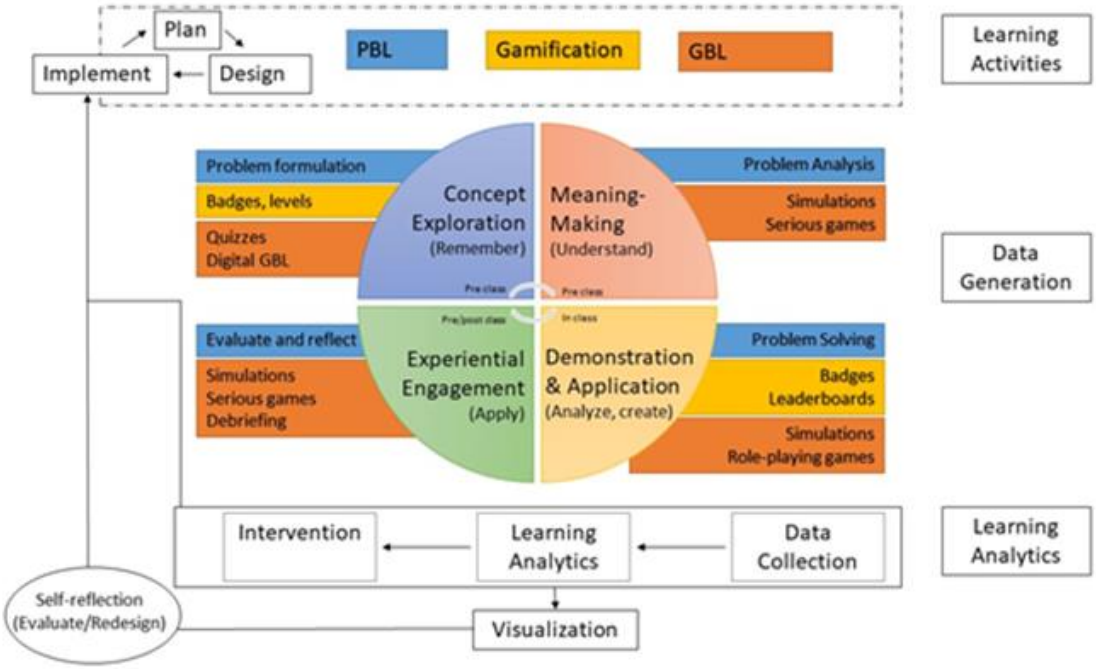

Figure 1 FLIP2G learning model (FLIP2G D2.2)

For each stage, instructors are asked to follow the four steps of the FLIP2G learning process discussed in D3.1. (i.e. Preparation, Engagement, Reflection, and Intervention). For example, for the Concept Exploration stage (Table 1), the instructors are asked to provide information about the learning goals, activities, materials, and tools that will be used in the course as part of the Preparation step. Then, they have to consider how they will engage students in the learning process and evaluate the outcomes of each learning activity. Finally, they are asked to consider the intervention actions that could be taken in their courses at this stage, based on the outcomes of the Reflection step.

Table 1. The first section of the FLIP2G Course Design template (FLIP2G D3.1)

Concept exploration: Pre – class (educator-led part of the process that introduces learners to learning material. This is traditionally the presentation part of a course outside the

classroom (by e.g. video lectures)

PBL step: Problem formulation

Flipped Classroom: Outside of the classroom

Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☐ Discussion		☐Launch game elements for studying ☐Provide external tools	☐ Websites ☐ Slides ☐ Literature ☐ Video lectures / tutorials ☐ Audio lectures	
☐ Accessing learning material				
☐ Concept maps				
☐ Group game				
☐ Simulation				
☐ Quiz/test				
☐ Develop an infographic about the subject				
☐ Keywords on post-It notes				
☐ Watching videos				
Engagement with students				
☐ Monitor students' online interactions ☐ Provide additional content ☐ Change activities (e.g. more or different quizzes)				
Reflection				

Learning activity	Evaluation method	Data	Learning analytics
Discussion	☐ Individual performance ☐ Group performance	☐ Online interactions ☐Number of posts	☐Engagement patterns ☐Clustering ☐Social network analysis ☐Discourse analysis
Material accessed	☐ Individual performance	☐ Material accessed ☐ Number of materials	
Concept maps	☐ Individual performance ☐ Group performance ☐Structure of the map and how elaborate it is	Final product (i.e. map)	
Group game	☐ Individual performance ☐Group's ability to communicate and work together	Outcome/performance in the group game	
Simulation	Degree of interaction with the simulation	Outcome/performance in simulation	
Intervention			
☐Redesign materials ☐Provide feedback ☐Plan additional activities ☐Send email reminders to disengaged students ☐Scaffolding			

Apart from completing the rest of the template (FLIP2G D3.1, pp 43- 48), the instructors are also asked to complete the table with the main information about their course (Table 2). The process is repeated for every course the instructor wants to redesign according to the FLIP2G model. The section that follows includes the course plans for each of the project's partners.

Table 2. FLIP2G course design horizontal concepts (FLIP2G D3.1)

Target Group	Subject	Time/Duration	Overall Objective	Success metrics
☐ Undergraduate university students ☐ Postgraduate university students ☐ Secondary education students ☐ Primary education students ☐ Professionals				

3 Course Plans

The following course plans include the current information that each instructor has for his/her courses. Some of the details may change during the academic year, especially for the courses that are planned to run during the spring semester. Under the current circumstances (i.e. the social distancing restrictions imposed due to the Covid-19 pandemic), it is also possible that some learning activities initially scheduled to take place within the classroom, may have to take place online (e.g. synchronous online seminars). The Pilots Report (D4.2) will include the updated information for all the pilots that were carried out by each partner.

3.1 Northumbria University

The pilots organised at Northumbria University include 3 courses in the broader area of digital business. The two of them are delivered to Degree Apprenticeship students, one at a Level 4 stage (i.e. 1st year UG) and the other at Level 5 stage (i.e. 2nd year UG). The Digital Business course is also offered to distance learners (at Level 5 stage). Since all the three courses are in the broader area of digital business, there are some similarities in the learning material across them. However, there are also some important differences in the learning goals and activities, due to the different level of study, delivery method or themes covered (e.g. the Digital Business Models course does not cover digital marketing in contrast to the other two courses). The courses that run in these programmes have a shorter duration than the usual UG courses of UK universities (that usually run for 12 weeks), due to the needs of the cohort (e.g. professionals can only take leave on specific dates to attend lectures/seminars at the campus, so relevant sessions are delivered as teaching blocks that usually run for 3 hours).

3.1.1 Digital Business – Degree Apprenticeship (DA) programme

Digital Business is a module offered as part of one of the Degree Apprenticeship programmes that run at Newcastle Business School. The students are professionals that study to get a bachelor's degree in the broader area of Leadership and Management. In order to complete the module, they have to write a business report that identifies areas in which their company's digital strategy and website could be improved (i.e. the problem they need to solve). The first part of the report includes a comparison between their competitors' relevant practices and their company's practices (i.e. problem formulation) and the second part includes their recommendations for their company (i.e. the problem solution), based on the analysis presented in the first part of the report and relevant literature. While students have to complete an individual report, they also have the opportunity to participate in group activities during the 6 interactive workshops scheduled for the module (Table 3).

During the interactive workshops, students are introduced to various concepts in the area of digital business, such as digital business models, digital marketing, information systems, cyber security etc. They are also asked to complete individual or collaborative activities that require the application of the theories/concepts discussed in the classroom and help them prepare for the module's

assessment (i.e. business report). In the past, both the delivery of the learning material and the learning activities took place within the classroom during the workshops. After redesigning it according to the FLIP2G model, the delivery of the learning material happens outside of the classroom (e.g. via Panopto lecture recordings) and the time within the classroom is used for completing learning activities and working on the business reports.

Table 3. Digital Business (DA) - basic information

Target Group	Subject	Time/Duration	Overall Objective	Success metrics
☐ Undergraduate university students ☐ Postgraduate university students ☐ Secondary education students ☐ Primary education students ☒ Professionals	Digital Business	6 workshops x 3 hours	Understand how using online channels impacts upon different parts of the organisation. Three main themes are covered: 1) digital business strategy, 2) marketing, 3) supply chain management and information systems	Assignment marks Student feedback

The problem formulation will take place throughout the module's workshops, as students are introduced to the various digital business concepts. Before each workshop, the students will have to watch the lecture recordings and access any other learning material provided for this workshop (e.g. online articles, case studies, websites etc.). An online forum will be available on the module's LMS (i.e. Blackboard) that will allow students to discuss the concepts and exchange ideas before the workshop (Table 4).

The instructors will monitor the students' interactions on the forum and will answer any queries. Emails and announcements on the LMS will also be used to communicate with the students. Since the online forum will run on Blackboard, learning analytics may not be available for the forum, but the instructors will identify any students that do not seem to participate on the forum and send relevant email reminders. Also, feedback will be provided on the forum and in cases where students seem to have many questions about a concept/need further support, additional learning activities/material will be added. Learning material in broader areas (e.g. marketing, research methods) may be provided for scaffolding as necessary (e.g. based on the students' question on forum/during the workshops).

Table 4. Digital Business (DA) - Concept Exploration stage

Concept exploration: Pre – class (educator-led part of the process that introduces learners to learning material. This is traditionally the presentation part of a course outside the classroom (by e.g. video lectures)

PBL step: Problem formulation

Flipped Classroom: Outside of the classroom

Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒ Discussion	Discuss the learning material Identify concepts that are not clear and ask questions accordingly Respond to questions that other students have	☒Launch game elements for studying ☒Provide external tools	☐ Websites ☒ Slides ☐ Literature ☒ Video lectures / tutorials ☐ Audio lectures	To understand the concepts introduced in the video lectures/slides.
☒ Accessing learning material	Read articles/case studies Explore how the concepts are applied in different settings	☒Provide external tools	☒ Websites ☒ Literature ☒ Case studies	To understand the application of the concepts introduced in each session in different settings (e.g. different industries)
☐ Concept maps				
☐ Group game				
☐ Simulation				
☐ Quiz/test				
☐ Develop an infographic about the subject				
☐ Keywords on post-It notes				

☒ Watching videos	Listen/watch the lecture recordings	☒Provide external tools	☒ Video lectures / tutorials	Each video lecture will have its own learning objectives
Engagement with students				
☒ Monitor students' online interactions ☒ Announcements on LMS ☐ Provide additional content ☐ Change activities (e.g. more or different quizzes)				
Reflection				
Learning activity	**Evaluation method**	**Data**	**Learning analytics**	
Discussion	☒ Individual performance ☐ Group performance	☒ Online interactions ☒Number of posts	☒Engagement patterns ☐Clustering ☐Social network analysis ☐Discourse analysis	
Material accessed	☒ Individual performance	☒ Material accessed ☒ Number of materials		
Concept maps	☐ Individual performance ☐ Group performance ☐Structure of the map and how elaborate it is	Final product (i.e. map)		
Group game	☐ Individual performance ☐Group's ability to communicate and work together	Outcome/performance in the group game		
Simulation	Degree of interaction with the simulation	Outcome/performance in simulation		
Intervention				
☐Redesign materials				

☒Provide feedback ☒Plan additional activities ☒Send email reminders to disengaged students ☒Scaffolding

The pre-work tasks before each workshop will also include some learning activities that will help the students to understand the module's concepts before the workshop (Table 5). One of the main learning activities will be playing the FLIP2G game that will help the students test their understanding of the module's concepts, while at the same time it will ensure that the pre-work is stimulating and will be completed by the students. The game will include questions based on the video lectures/any recommended reading. The forum will also support this stage too, as students will be able to make sense of the module's concepts by participating in the online discussion.

Students' participation in the online discussions, their engagement with the game and their performance on the mini games will be reviewed by the instructors to identify disengaged students and send reminders accordingly. Personalised feedback and recommendations will also be provided by the instructors based on the above data.

Table 5. Digital Business (DA) – Meaning Making stage

Meaning making: Pre – class (Students make meaning out of the information they have been exposed to by engaging in various assessment or reflection activities. Students show their mastery over the concept exploration content by producing their own content that reflects upon their acquisition in a meaningful way) **PBL step**: Problem analysis **Flipped Classroom**: Outside of the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒Content	Read/explore the learning content	☒Launch game elements for studying ☒Provide external tools (e.g. links with books / articles)	☒ Websites ☒ Slides ☒ Literature ☒Video lectures ☐ Audio lectures	☒Learn how to review available information
☒Discussion	Discuss the	☐ Chat room		Understand how

	learning material	☒ Forum		the concepts could be applied in practice.
Quiz		☐ Quiz tool		
☒Game			☒ Slides ☒ Literature ☒ Video lectures ☐ Audio lectures	To consolidate learning/test knowledge
One-minute presentations				
Blog/vlog/social media posts				
Debate				
Producing a short podcast or a video on the subject				☐Learn how to interpret appropriate information

Engagement with students
☒ Monitor students' ongoing progress during the problem analysis phase ☒ Provide additional content if students seem to not have understood part of the subject ☒ Change the activities to ensure more participation for the students that have not understood the material or seem to not collaborate with their team ☒ Challenge/motivate students/groups who understand to dig deeper into the learning material

Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
Discussion	☒ Individual performance ☐Group performance	☐Self-reported perception ☐Academic results ☒Engagement	☒ Participation ☐ Performance ☐Content analysis
Quiz	☐ Individual performance	☐ Answers (correct, incorrect, frequency or	☐ Statistics (more commonly wrong answer, average grades)

		incorrect answers)	☐ Likelihood to fail – prediction based on answers patterns
Game	☒ Individual performance ☐Group performance	☐Task completion time ☐Navigation paths	☒In-game statistics like completion time, completion rate ☒in-game engagement
Intervention			
☒Recommendations ☒Feedback ☒Send email reminders to disengaged students ☐Pop-up tips after a prolonged stay at one level/checkpoint ☒A notification to the teacher that a pupil is stuck and has not progressed.			

During the workshops (i.e. within the classroom), students are asked to apply the knowledge gained in the previous stages by reflecting on their workplace practices. More specifically, they are asked to participate in group discussions and prepare short oral presentations (Table 6) on how their organisation applies the concept under examination (e.g. digital strategy, cyber security policy etc.). This kind of activities help the students prepare the business report, as they give them a chance to receive feedback from the instructors and the other students on the evidence they have collected so far about the problem. If the evidence discussed/presented by the students is not sufficient for writing the report, the instructor discusses with them the alternative options they have when it comes to concepts examined (e.g. focus on aspects of digital business that are more relevant to their organisation) or sources of evidence (e.g. online tools that could be used to collect further information). Since this stage takes place within the classroom and the learning activities take place outside the project's platform, the learning analytics/data collected from this stage is limited.

Table 6. Digital Business (DA) – Demonstration and Application stage

Demonstration and application (Occurs in the classroom. Students analyse, evaluate and create and engage in peer learning activities or projects, while educators evaluate and offer additional support where needed) **PBL step**: Problem solving **Flipped Classroom**: Inside the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification /**	**Learning**	**Learning goals /**

		tools	materials / media	outcomes
☒Group work	☒Discuss in small groups how the concepts introduced in the workshop apply to different workplaces ☒Collect information/data from different workplaces	☒Peer-recommended sites ☒Subject-based web sites	☒ Slides ☒ Literature	Review practices in the areas under examination
Development and testing of a prototype				
Journal or portfolio				☐Learn how to construct a portfolio of evidence
Focus groups				
Individual reports				
Develop cases studies				
☒ Oral presentations				☒Learn how to present and justify an informed position

Engagement with students
☒ Monitor the problem solved ☒ Provide multiple learning pathways if problem solution is insufficient ☐ Provide multiple ways for students to assess their solution

Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
Group work	☒ Individual performance	☒Self-reported perception	☐ Clustering

	☐Group performance	☐Number of solution versions ☐Engagement ☐Experience points	☐ Engagement ☐Content analysis
Development and testing of a prototype			
Journal / portfolio / wiki			
Focus groups			
Intervention			
☐Scaffolding hints ☒Formative feedback ☐ Reminders			

The students are asked to submit their business reports at the end of the module (i.e. usually 1-2 weeks after the last workshop has taken place). Before they do so, they have the chance to send their drafts to the instructor to get some formative feedback (Table 7). The business reports are used to assess whether the overall learning outcomes of the module have been achieved. After the marking process has been finished, the students receive their marks along with summative feedback that aims to help them identify areas for further improvement. Descriptive statistics are available for the marks of the whole cohort, which allow the instructor to reflect on the student performance and identify any actions that could be taken to improve the learning experience with the module in the next academic year. Similarly, the feedback provided by the students at the end of the last workshop will be used to improve further the delivery of the module.

Table 7. Digital Business (DA) – Experiential Engagement stage

Experiential engagement (occurs when students consolidate their knowledge or explore further. It may occur before the concept exploration stage, when educators engage students in activities with the aim to pique their interest in a topic (e.g. play a game). It may also occur after the meaning-making stage, where students have to apply what they have learned (e.g. practice a skill, work on a project, etc.). At this stage, the educator has a chance to support students in applying their knowledge) **PBL step**: Evaluation and Reporting

Flipped Classroom: After the class				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
Group work				
☒Individual work	☒Write the business report	N/A	Assignment brief	To assess whether the learning goals of the module have been achieved.
Development and testing of a prototype				
Journal or portfolio				
Engagement with students				
☐ Configure the students' project / tasks based on their interactions in the game ☒Provide formative feedback on draft reports prior to the online submission				
Reflection				
Learning activity	**Evaluation method**	**Data**	**Learning analytics**	
Group work	☐ Individual performance ☐Group performance	☐Self-reported perception ☐Number of solution versions ☐Engagement	☐ Clustering ☐ Engagement ☐Content analysis	
☒Report	☒Individual performance	☒Scores ☒Number of submitted reports	☒Descriptive statistics of the marks	
Development and testing of a prototype				
Journal or portfolio				

☒Focus groups	Provide feedback regarding the experience with the module		
Intervention			
☐Scaffolding hints ☐Formative feedback ☐ Reminders ☒Summative feedback ☒ Final marks			

3.1.2 Digital Business – Distance Learning (DL) programme

Digital business is delivered also as a Distance Learning (DL) course. The main difference with the course presented in the previous section is that all the learning activities take place online. The six online sessions (Table 8) include both synchronous and asynchronous learning activities, with the synchronous activities representing the "inside the classroom" aspect of the flipped classroom. The problem that the students are asked to solve is the same with one described above (i.e. a business report about their workplace's practices in the digital business area).

Table 8. Digital Business (DL) - basic information

Target Group	Subject	Time/Duration	Overall Objective	Success metrics
☒Undergraduate university students ☐Postgraduate university students ☐Secondary education students ☐Primary education students ☐Professionals	Digital Business	6 online sessions	Understand how using online channels impacts upon different parts of the organisation. Three main themes are covered: 1) digital business strategy, 2) marketing, 3) supply chain management and information systems	Assignment marks Student feedback

To support the interactions among the students, an online forum will be available on the LMS (i.e. Blackboard). As it happens in the case of the DA course, the students will be asked to watch the lecture recordings and access other relevant learning (Table 9), while emails and announcements on the LMS will be used to communicate with them.

Table 9. Digital Business (DL) – Concept Exploration stage

Concept exploration: Pre – class (educator-led part of the process that introduces learners to learning material. This is traditionally the presentation part of a course outside the classroom (by e.g. video lectures) **PBL step**: Problem formulation **Flipped Classroom**: Outside of the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒ Discussion	Discuss the learning material Identify concepts that are not clear and ask questions accordingly Respond to questions that other students have	☒Launch game elements for studying ☒Provide external tools	☐ Websites ☒ Slides ☐ Literature ☒ Video lectures / tutorials ☐ Audio lectures	To understand the concepts introduced in the video lectures/slides
☒ Accessing learning material	Read articles/case studies Explore how the concepts are applied in different settings	☒Provide external tools	☒ Websites ☒ Literature ☒ Case studies	To understand the application of the concepts introduced in each session in different settings (e.g. different industries)
☐ Concept maps				
☐ Group game				
☐ Simulation				
☐ Quiz/test				

☐ Develop an infographic about the subject				
☐ Keywords on post-It notes				
☒ Watching videos	Listen to/watch the lecture recordings	☒Provide external tools	☒ Video lectures / tutorials	Each video lecture will have its own learning objectives
Engagement with students				
☒ Monitor students' online interactions ☒ Announcements on LMS ☐ Provide additional content ☐ Change activities (e.g. more or different quizzes)				
Reflection				
Learning activity	**Evaluation method**	**Data**	**Learning analytics**	
Discussion	☒ Individual performance ☐ Group performance	☒ Online interactions ☒Number of posts	☒Engagement patterns ☐Clustering ☐Social network analysis ☐Discourse analysis	
Material accessed	☒ Individual performance	☒ Material accessed ☒ Number of materials		
Concept maps	☐ Individual performance ☐ Group performance ☐Structure of the map and how elaborate it is	Final product (i.e. map)		
Group game	☐ Individual performance ☐Group's ability to communicate and work together	Outcome/performance in the group game		

Simulation	Degree of interaction with the simulation	Outcome/performance in simulation	
Intervention			
Redesign materials ☒Provide feedback ☒Plan additional activities ☒Send email reminders to disengaged students ☒Scaffolding			

At the Meaning Making stage (Table 10), the learning activities, engagement with the students, and actions taken as part of the intervention process are the same with the ones described in the case of DA course.

Table 10. Digital Business (DL) – Meaning Making stage

Meaning making: Pre – class (Students make meaning out of the information they have been exposed to by engaging in various assessment or reflection activities. Students show their mastery over the concept exploration content by producing their own content that reflects upon their acquisition in a meaningful way) **PBL step**: Problem analysis **Flipped Classroom**: Outside of the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒Content	Read/explore the learning content	☒Launch game elements for studying ☒Provide external tools (e.g. links with books / articles)	☒ Websites ☒ Slides ☒ Literature ☒ Video lectures ☐ Audio lectures	☒Learn how to review available information
☒Discussion	Discuss the learning material	☐ Chat room ☒ Forum		Understand how the concepts could be applied in practice.

Quiz		☐ Quiz tool		
☒Game			☒Slides ☒ Literature ☒ Video lectures ☐ Audio lectures	To consolidate learning/test knowledge
One-minute presentations				
Blog/vlog/social media posts				
Debate				
Producing a short podcast or a video on the subject				☐Learn how to interpret appropriate information
Engagement with students				
☒Monitor students' ongoing progress during the problem analysis phase ☒ Provide additional content if students seem to not have understood part of the subject ☒ Change the activities to ensure more participation for the students that have not understood the material or seem to not collaborate with their team ☒ Challenge/motivate students/groups who understand to dig deeper into the learning material				
Reflection				
Learning activity	**Evaluation method**	**Data**	**Learning analytics**	
Discussion	☒ Individual performance ☐Group performance	☐Self-reported perception ☐Academic results ☒Engagement	☒ Participation ☐ Performance ☐Content analysis	
Quiz	☐ Individual performance	☐ Answers (correct, incorrect, frequency or incorrect answers)	☐ Statistics (more commonly wrong answer, average grades) ☐ Likelihood to fail – prediction based on answers patterns	
Game	☒ Individual	☐Task completion	☒In-game statistics like	

	performance ☐Group performance	time ☐Navigation paths	completion time, completion rate ☒in-game engagement
Intervention			
☒Recommendations ☒Feedback ☒Send email reminders to disengaged students ☐Pop-up tips after a prolonged stay at one level/checkpoint ☒A notification to the teacher that a pupil is stuck and has not progressed.			

The main difference at the Demonstration and Application stage is that in the case of the DL course, synchronous learning sessions will replace the workshops that take place in the DA module. This means that the learning activities will have to be adapted accordingly (Table 11). The Breakout Groups provided by Blackboard (i.e. LMS used to support the module) will be used to support small group discussions online. Also, the short oral presentations delivered by the students will take place with the use of Blackboard Collaborate (i.e. the tool used to run the synchronous learning sessions).

Table 11. Digital Business (DL) – Demonstration and Application stage

Demonstration and application (Occurs in the classroom. Students analyse, evaluate and create and engage in peer learning activities or projects, while educators evaluate and offer additional support where needed) **PBL step**: Problem solving **Flipped Classroom**: Inside the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒Group work	☒Discuss in small groups how the concepts introduced in the workshop apply to different workplaces ☒Collect	☒Peer-recommended sites ☒Subject-based web sites	☒ Slides ☒ Literature ☒LMS	Review practices in the areas under examination

	information/data from different workplaces			
Development and testing of a prototype				
Journal or portfolio				☐Learn how to construct a portfolio of evidence
Focus groups				
Individual reports				
Develop cases studies				
☒Oral presentations			☒LMS	☒Learn how to present and justify an informed position

Engagement with students
☒Monitor the problem solved ☒ Provide multiple learning pathways if problem solution is insufficient ☐ Provide multiple ways for students to assess their solution

Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
Group work	☒ Individual performance ☐Group performance	☒Self-reported perception ☐Number of solution versions ☐Engagement ☐Experience points	☐ Clustering ☐ Engagement ☐Content analysis
Development and testing of a prototype			

Journal / portfolio / wiki			
Focus groups			
Intervention			
☐Scaffolding hints ☒Formative feedback ☐ Reminders			

As it happens in the case of the DA course, the students will have to submit their work 1-2 weeks after the last online session. The main difference at this stage is that the focus groups scheduled to give the opportunity to students to reflect on their learning experience will happen online with the help of Blackboard Collaborate (Table 12).

Table 12. Digital Business (DL) – Experiential Engagement stage

Experiential engagement (occurs when students consolidate their knowledge or explore further. It may occur before the concept exploration stage, when educators engage students in activities with the aim to pique their interest in a topic (e.g. play a game). It may also occur after the meaning-making stage, where students have to apply what they have learned (e.g. practice a skill, work on a project, etc.). At this stage, the educator has a chance to support students in applying their knowledge) **PBL step**: Evaluation and Reporting **Flipped Classroom**: After the class				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
Group work				
☒Individual work	☒Write the business report	N/A	Assignment brief	To assess whether the learning goals of the module have been achieved.
Development and testing of a prototype				

Journal or portfolio				
Engagement with students				
☐ Configure the students' project / tasks based on their interactions in the game ☒Provide formative feedback on draft reports prior to the online submission				
Reflection				
Learning activity	**Evaluation method**	**Data**	**Learning analytics**	
Group work	☐ Individual performance ☐Group performance	☐Self-reported perception ☐Number of solution versions ☐Engagement	☐ Clustering ☐ Engagement ☐Content analysis	
☒Report	☒ Individual performance	☒Scores ☒Number of submitted reports	☒Descriptive statistics of the marks	
Development and testing of a prototype				
Journal or portfolio				
☒Focus groups	Provide feedback regarding the experience with the module			
Intervention				
☐Scaffolding hints ☐Formative feedback ☐ Reminders ☒Summative feedback ☒ Final marks				

3.1.3 Digital Business Models and E-Commerce – Degree Apprenticeship (DA) programme

Digital Business Models and E-Commerce is another course delivered to professionals that study for an UG degree as part of a Degree Apprenticeship programme (Table 13). This course is delivered to Level 4 students (i.e. 1st year UG) so the learning outcomes focus on the acquisition of relevant knowledge and the development of basic analytical/critical skills. The assignment is a business report developed after the students have identified digital business models suitable for their industry and reviewed relevant literature. As part of the report, they have to identify areas in which their organisation needs further improvement (i.e. problem formulation) and develop appropriate recommendations based on the literature (i.e. solution of the problem). Thus, the assignment is different from the previous courses, as it does not require the use of multiple methods/sources for collecting evidence, but rather focuses on the review of the literature and how theory could be applied in practice. Also, this course focuses more on the digital business models/strategies and does not cover areas such as digital marketing.

Table 13. Digital Business Models and E-Commerce (DA) – basic information

Target Group	Subject	Time/Duration	Overall Objective	Success metrics
☐ Undergraduate university students ☐ Postgraduate university students ☐ Secondary education students ☐ Primary education students ☒ Professionals	Digital Business	6 workshops x 3 hours	Understand emerging technologies, trends and themes within the digital marketing environment. Three main concepts are covered: 1) digital business strategy, 2) ethics, law, and e-commerce, 3) supply chain management and information systems	Assignment marks Student feedback

The problem formulation (Table 14) will take place throughout the course's workshops, as it happens in the case of the Digital Business course. The learning activities, engagement with students, and intervention actions are as described in 3.1.1.

Table 14. Digital Business Models and E-Commerce (DA) – Concept Exploration stage

Concept exploration: Pre – class (educator-led part of the process that introduces learners to learning material. This is traditionally the presentation part of a course outside the classroom (by e.g. video lectures)

PBL step: Problem formulation **Flipped Classroom**: Outside of the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒ Discussion	Discuss the learning material Identify concepts that are not clear and ask questions accordingly Respond to questions that other students have	☒Launch game elements for studying ☒Provide external tools	☐ Websites ☒ Slides ☐ Literature ☒ Video lectures / tutorials ☐ Audio lectures	To understand the concepts introduced in the video lectures/slides.
☒ Accessing learning material	Read articles/case studies Explore how the concepts are applied in different settings	☒Provide external tools	☒ Websites ☒ Literature ☒ Case studies	To understand the application of the concepts introduced in each session in different settings (e.g. different industries)
☐ Concept maps				
☐ Group game				
☐ Simulation				
☐ Quiz/test				
☐ Develop an infographic about the subject				
☐ Keywords on post-It notes				
☒ Watching videos	Listen/watch the lecture recordings	☒Provide external tools	☒ Video lectures / tutorials	Each video lecture will have its own learning

				objectives
Engagement with students				
☒ Monitor students' online interactions ☒ Announcements on LMS ☐ Provide additional content ☐ Change activities (e.g. more or different quizzes)				
Reflection				
Learning activity	**Evaluation method**	**Data**	**Learning analytics**	
Discussion	☒ Individual performance ☐ Group performance	☒ Online interactions ☒Number of posts	☒Engagement patterns ☐Clustering ☐Social network analysis ☐Discourse analysis	
Material accessed	☒ Individual performance	☒ Material accessed ☒ Number of materials		
Concept maps	☐ Individual performance ☐ Group performance ☐Structure of the map and how elaborate it is	Final product (i.e. map)		
Group game	☐ Individual performance ☐Group's ability to communicate and work together	Outcome/performance in the group game		
Simulation	Degree of interaction with the simulation	Outcome/performance in simulation		
Intervention				
☐Redesign materials ☒Provide feedback ☒Plan additional activities				

☒Send email reminders to disengaged students ☒Scaffolding

The problem analysis will include the learning activities presented in Table 15. The activities along with the engagement with the students and the intervention actions are described in 3.1.1.

Table 15. Digital Business Models and E-Commerce (DA) – Meaning Making stage

Meaning making: Pre – class (Students make meaning out of the information they have been exposed to by engaging in various assessment or reflection activities. Students show their mastery over the concept exploration content by producing their own content that reflects upon their acquisition in a meaningful way) **PBL step**: Problem analysis **Flipped Classroom**: Outside of the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒Content	Read/explore the learning content	☒Launch game elements for studying ☒Provide external tools (e.g. links with books / articles)	☒ Websites ☒ Slides ☒ Literature ☒ Video lectures ☐ Audio lectures	☒Learn how to review available information
☒Discussion	Discuss the learning material	☐ Chat room ☒ Forum		Understand how the concepts could be applied in practice.
Quiz		☐ Quiz tool		
☒Game			☒ Slides ☒ Literature ☒ Video lectures ☐ Audio lectures	To consolidate learning/test knowledge
One-minute presentations				

Blog/vlog/social media posts				
Debate				
Producing a short podcast or a video on the subject				☐Learn how to interpret appropriate information

Engagement with students
☒ Monitor students' ongoing progress during the problem analysis phase ☒ Provide additional content if students seem to not have understood part of the subject ☒ Change the activities to ensure more participation for the students that have not understood the material or seem to not collaborate with their team ☒ Challenge/motivate students/groups who understand to dig deeper into the learning material

Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
Discussion	☒ Individual performance ☐Group performance	☐Self-reported perception ☐Academic results ☒Engagement	☒ Participation ☐ Performance ☐Content analysis
Quiz	☐ Individual performance	☐ Answers (correct, incorrect, frequency or incorrect answers)	☐ Statistics (more commonly wrong answer, average grades) ☐ Likelihood to fail – prediction based on answers patterns
Game	☒ Individual performance ☐Group performance	☐Task completion time ☐Navigation paths	☒In-game statistics like completion time, completion rate ☒in-game engagement

Intervention
☒Recommendations ☒Feedback ☒Send email reminders to disengaged students

☐Pop-up tips after a prolonged stay at one level/checkpoint ☒A notification to the teacher that a pupil is stuck and has not progressed.

The learning activities that will take place during the Demonstration and Application stage can be seen in Table 16. The detailed description can be found in 3.1.1.

Table 16. Digital Business Models and E-Commerce (DA) – Demonstration and Application stage

Demonstration and application (Occurs in the classroom. Students analyse, evaluate and create and engage in peer learning activities or projects, while educators evaluate and offer additional support where needed) **PBL step**: Problem solving **Flipped Classroom**: Inside the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒Group work	☒Discuss in small groups how the concepts introduced in the workshop apply to different workplaces ☒Collect information/data from different workplaces	☒Peer-recommended sites ☒Subject-based web sites	☒ Slides ☒ Literature	Review practices in the areas under examination
Development and testing of a prototype				
Journal or portfolio				☐Learn how to construct a portfolio of evidence
Focus groups				
Individual reports				

Develop cases studies				
☒Oral presentations				☒Learn how to present and justify an informed position

Engagement with students
☒ Monitor the problem solved ☒ Provide multiple learning pathways if problem solution is insufficient ☐ Provide multiple ways for students to assess their solution

Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
Group work	☒ Individual performance ☐Group performance	☒Self-reported perception ☐Number of solution versions ☐Engagement ☐Experience points	☐ Clustering ☐ Engagement ☐Content analysis
Development and testing of a prototype			
Journal / portfolio / wiki			
Focus groups			

Intervention
☐Scaffolding hints ☒Formative feedback ☐ Reminders

As it happens in the case of the Digital Business course, the individual business report will assess the overall learning goals of the module (Table 17). The marks and summative feedback will be used to

evaluate the success rate of the course, while the feedback provided by the students regarding their learning experience will be used to improve the course in the future years.

Table 17. Digital Business Models and E-Commerce (DA) – Experiential Engagement stage

Experiential engagement (occurs when students consolidate their knowledge or explore further. It may occur before the concept exploration stage, when educators engage students in activities with the aim to pique their interest in a topic (e.g. play a game). It may also occur after the meaning-making stage, where students have to apply what they have learned (e.g. practice a skill, work on a project, etc.). At this stage, the educator has a chance to support students in applying their knowledge) **PBL step**: Evaluation and Reporting **Flipped Classroom**: After the class				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
Group work				
☒Individual work	☒Write the business report	N/A	Assignment brief	To assess whether the learning goals of the module have been achieved.
Development and testing of a prototype				
Journal or portfolio				
Engagement with students				
☐ Configure the students' project / tasks based on their interactions in the game ☒Provide formative feedback on draft reports prior to the online submission				
Reflection				
Learning activity	**Evaluation method**	**Data**	**Learning analytics**	
Group work	☐ Individual performance ☐Group	☐Self-reported perception ☐Number of solution	☐ Clustering ☐ Engagement	

	performance	versions ☐Engagement	☐Content analysis
☒Report	☒Individual performance	☒Scores ☒Number of submitted reports	☒Descriptive statistics of the marks
Development and testing of a prototype			
Journal or portfolio			
☒Focus groups	Feedback regarding the experience with the module		
Intervention			
☐Scaffolding hints ☐Formative feedback ☐ Reminders ☒Summative feedback ☒ Final marks			

3.2 Aalborg University

The pilots organised at Aalborg University include two courses in the broader area of software development. Both courses are delivered to undergraduate students of the Medialogy bachelor program, one in the second semester and the other in the third semester. Both courses focus on software development methods and modelling, and object-oriented programming. The course "Programming for Interaction" delivered in the second semester includes also mobile programming, while the course "Programming of Complex Software Systems" includes advanced programming topics, such as network programming, and theoretical topics of Computer Science (e.g. data structures and algorithms). Each course has its own curriculum and distinct learning activities. They both use the same book but cover different book chapters. Both courses contain lectures that run for 10 weeks and they include a mini project, that students have to complete two weeks after the end of the lectures the latest.

3.2.1 Programming for Interaction – 2nd semester of Medialogy BSc

By completing the module Programming for Interaction, the students should be able to design, programme, and evaluate interactive applications both on the standard PC platform as well as mobile platforms. Furthermore, this module seeks to introduce basic concepts from object-oriented programming. The module covers the fundamentals of the programming of graphical user interfaces (GUIs) as well as interactions in mobile and pervasive environments that afford touch or sensor-based interaction. The objective is that the students acquire the knowledge, skills, and competencies required for the actual planning, implementing, code generation, and evaluation of interactive applications.

Students who complete the project module should obtain the following qualifications:

Knowledge

- Knowledge of fundamental Object-Oriented Programming (OOP) strategies and models used in software development
- Knowledge of rich pictures and use case diagrams to facilitate a user-centred design approach
- Knowledge of mobile development environments, debugging tools and methods for evaluation of mobile applications
- Understanding of basic design patterns relevant to mobile development (Model-View-Controller (MVC), singleton, etc.)
- Knowledge of GUI programming on both PC and mobile platforms
- Understanding the difference between sequential and event-based programme structures (e.g., event listeners, call-back functions)
- Understanding of working with files and file systems in programming
- Understanding different development methods (e.g., Waterfall, Spiral, Agile) in relation to software development

Skills

- Ability to apply OOP in development and design of interactive applications.
- Analyse, interpret and apply design patterns and basic models (entity-relationship diagrams, UI storyboards, or flowcharts, etc.)
- Must be able to implement event-based designs into functioning applications
- Must be able to apply an object-oriented approach to software implementation
- Must be able to implement an application with a GUI

- Must be able to develop, deploy, and test an application on a mobile device such as a smart phone or tablet (application)

Competencies

- Must be able to understand how to systematically design, programme, and evaluate interactive applications
- Must be able to analyse the problem domain and user requirements
- Must be able to synthesise the domain understanding into models (entity-relationship diagrams, UI storyboards, flowcharts, design patterns, etc.)

The module consists of 10 weekly in-class sessions, associated weekly assignments/reading, and an individual mini project. For the mini project, students must develop a mobile or desktop application, which supports a GUI and implements the OOP principles. Moreover, they must deliver a technical report describing the functionality of the application and explaining and reflecting on the development process. The module is evaluated by an individual written exam in the end of the semester. Students must successfully complete the weekly activities and the mini project in order to get access to the final exam.

Table 18. Programming for Interaction (PFI) – basic information

Target Group	Subject	Time/Duration	Overall Objective	Success metrics
☒Undergraduate university students ☐Postgraduate university students ☐Secondary education students ☐Primary education students ☐Professionals	Introductory OOP desktop and mobile programming	10 weekly in-class sessions & a mini project (follows an academic semester)	Convey the knowledge for designing, programming, and evaluating interactive applications both on the standard PC platform as well as mobile platforms, and introducing basic concepts from object-oriented programming	Successful completion of weekly assignments and of mini project Final exam marks Student feedback

Based on the PBL model, all the weekly assignments have been adjusted, so that they constitute problems that are relevant to intermediate deliverables for the mini project. This way, student learning will be scaffolded, and the students will build-up the necessary knowledge to fulfil the requirements for the mini project during the FC sessions.

The problem formulation for each of the weekly assignments will take place between the module's in-class sessions, as students are introduced to the various programming concepts. Before each lecture, the students will have to read relevant book chapters, watch tutorials/videos, and access any other learning material provided for this lecture (e.g. online articles, websites etc.). An online forum will be available on the module's LMS (i.e. Moodle) that will allow students to discuss the concepts and exchange ideas before each lecture (Table 19).

The instructors will monitor the students' interactions on the forum and will answer any queries. Emails and announcements on the LMS will also be used to communicate with the students. Since the online forum will run on Moodle, learning analytics may not be available for the forum, but the instructors will identify any students that do not seem to participate on the forum and send relevant email reminders. Also, feedback will be provided on the forum and in cases where students seem to have many questions about a concept/need further support, additional learning activities/material will be added. Learning material in broader areas (e.g. software development methods) may be provided for scaffolding as necessary (e.g. based on the students' question on forum/during the in-class sessions).

Table 19. Programming for Interaction (PFI) - Concept Exploration stage

Concept exploration: Pre – class (educator-led part of the process that introduces learners to learning material. This is traditionally the presentation part of a course outside the classroom (by e.g. video lectures) **PBL step**: Problem formulation **Flipped Classroom**: Outside of the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒ Accessing learning material	Read literature/articles Study relevant use cases Identify concepts that are not clear and ask questions accordingly	☒ Launch game elements for studying ☒ Provide external tools	☒ Websites ☒ Slides ☒ Literature ☒ Video lectures / tutorials	To understand the concepts introduced in the literature/slides/video tutorials and their application in software development
☐ Concept maps				
☐ Group game				
☐ Simulation				

☐ Quiz/test				
☐ Develop an infographic about the subject				
☐ Keywords on post-It notes				
☒ Watching videos	Listen/watch the lecture recordings	☒Provide external tools	☒ Video lectures / tutorials	Each video lecture will cover different learning objectives
Engagement with students				
☒ Monitor students' online interactions ☒ Provide additional content ☐ Change activities (e.g. more or different quizzes)				
Reflection				
Learning activity	**Evaluation method**	**Data**	**Learning analytics**	
Discussion	☒ Individual performance ☐ Group performance	☒ Online interactions ☒Number of posts	☒Engagement patterns ☐Clustering ☐Social network analysis ☐Discourse analysis	
Material accessed	☒ Individual performance	☒ Material accessed ☒ Number of materials		
Concept maps	☐ Individual performance ☐ Group performance ☐Structure of the map and how elaborate it is	Final product (i.e. map)		
Group game	☐ Individual performance ☐Group's ability to communicate and work together	Outcome/performance in the group game		

Simulation	Degree of interaction with the simulation	Outcome/performance in simulation	
Intervention			
☐Redesign materials ☒Provide feedback ☒Plan additional activities ☒Send email reminders to disengaged students ☒Scaffolding			

Before each in-class session, students will have to engage with learning activities that aim to help them understand the topics covered in the learning material (Table 20). One of the main learning activities will be playing the FLIP2G game that will help the students test their understanding of the module's concepts, while at the same time it will ensure that the pre-work is engaging and will be completed by the students. The game will include questions based on the video lectures and the recommended reading. The forum will also support this stage too, as students will be able to make sense of the module's concepts by participating in the online discussion.

The students' participation in the online discussions, their engagement with the game and their performance on the mini games will be reviewed by the instructors to identify disengaged students and send reminders accordingly. Personalised feedback and recommendations will also be provided by the instructors based on the above data.

Table 20. Programming for Interaction (PFI) – Meaning Making stage

Meaning making: Pre – class (Students make meaning out of the information they have been exposed to by engaging in various assessment or reflection activities. Students show their mastery over the concept exploration content by producing their own content that reflects upon their acquisition in a meaningful way) **PBL step**: Problem analysis **Flipped Classroom**: Outside of the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒Content	Read/explore the learning content	☒Launch game elements for studying	☒ Websites ☒ Slides	☒Learn how to review available information

		☒Provide external tools (e.g. links with books / articles)	☒ Literature ☒Video lectures ☐ Audio lectures	
☒Discussion	Discuss the learning material Respond to questions that other students have	☐ Chat room ☒ Forum		Understand how the concepts could be applied in practice.
Quiz		☐ Quiz tool		
☒Game			☒ Slides ☒ Literature ☒ Video lectures ☐ Audio lectures	To consolidate learning/test knowledge
One-minute presentations				
Blog/vlog/social media posts				
Debate				
Producing a short podcast or a video on the subject				☐Learn how to interpret appropriate information

Engagement with students
☒ Monitor students' ongoing progress during the problem analysis phase ☒ Provide additional content if students seem to not have understood part of the subject ☒ Change the activities to ensure more participation for the students that have not understood the material or seem to not collaborate with their team ☒ Challenge/motivate students/groups who understand to dig deeper into the learning material

Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**

Discussion	☒ Individual performance ☐Group performance	☐Self-reported perception ☐Academic results ☒Engagement	☒ Participation ☐ Performance ☐Content analysis
Quiz	☐ Individual performance	☐ Answers (correct, incorrect, frequency or incorrect answers)	☐ Statistics (more commonly wrong answer, average grades) ☐ Likelihood to fail – prediction based on answers patterns
Game	☒ Individual performance ☐Group performance	☐Task completion time ☐Navigation paths	☒In-game statistics like completion time, completion rate ☒in-game engagement
Intervention			
☒Recommendations ☒Feedback ☒Send email reminders to disengaged students ☐Pop-up tips after a prolonged stay at one level/checkpoint ☒A notification to the teacher that a pupil is stuck and has not progressed.			

During the in-class sessions, students are first asked to play a multiplayer game that contains questions on the topics that were addressed during the previous out-of-class sessions. In this game, two or more students get the same question and in order to gain points, all students must select the same right answer. This process is expected to allow students to discuss among themselves the question and remind them of the content they had to cover before the in-class sessions. Moreover, it is expected that this activity can help students, who come to the in-class session unprepared, to familiarize themselves with the topics of the current session. Since the multiplayer game is hosted on the gaming platform, analytics are available after this session regarding the time spent in the multiplayer game, the collaborative score, the percentage of correct answers in the multiplayer game, and the number of collaborative games played. After this activity, students are asked to apply the knowledge gained in the previous stages by completing programming assignments. As mentioned before, these assignments concern sub-parts of the application that the students should develop for their mini projects. More specifically, they are asked to work in small groups for solving the assignments (Table 21). This kind of activities help the students develop the application for the mini project, as they give them a chance to receive feedback from the instructors and the other

students on their code. If students face any problem while implementing the solutions to the assignments, the instructors provide students with hints on how to move forward/correct errors in their code. Since this stage takes place within the classroom and the learning activities take place outside the project's platform, the learning analytics/data collected from this stage is limited.

Table 21. Programming for Interaction (PFI) – Demonstration and Application stage

Demonstration and application (Occurs in the classroom. Students analyse, evaluate and create and engage in peer learning activities or projects, while educators evaluate and offer additional support where needed) **PBL step**: Problem solving **Flipped Classroom**: Inside the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒Group work	☒Answer questions on the topics covered in the out-of-class sessions	☒Multiplayer game	☒ Slides ☒ Literature	Review knowledge in the topics under examination
☒Development and testing of a prototype	☒Solve programming assignments that constitute parts of a bigger application	☒Software development environment	☒ Examples contained in the learning material	Apply knowledge gained on software development
☐Journal or portfolio				
☐Focus groups				
☒Individual reports				☒Learn how to write a technical documentation for an application and reflect on the software development process
☐Develop cases				

studies				
☐Oral presentations				
Engagement with students				
☒ Monitor the problem solved ☒ Provide multiple learning pathways if problem solution is insufficient ☐ Provide multiple ways for students to assess their solution				
Reflection				
Learning activity	**Evaluation method**	**Data**	**Learning analytics**	
☒Group work	☒ Individual performance ☒Group performance	☒Self-reported perception ☐Number of solution versions ☒Engagement ☒Game score	☐ Clustering ☒ Engagement ☐Content analysis	
☐Development and testing of a prototype				
☐Journal / portfolio / wiki				
☐Focus groups				
Intervention				
☒Scaffolding hints ☒Formative feedback ☐ Reminders				

The students are asked to submit their mini projects (finished application and report) at the end of the module (i.e. usually 2 weeks after the last in-class session has taken place). Before they do so, they have the chance to discuss their drafts with the instructors to get some formative feedback (Table 22). The mini projects are used to assess whether the main learning outcomes of the module have been achieved. The students must submit a mini project of adequate quality in order to be able to sit the final exam. The students, who fail in the mini project, also fail in the whole module. The

students only receive summative feedback on their mini project, no marks. The feedback aims to help them identify areas for further improvement before the final exam. The final exam is multiple choice quiz, where students receive individual marks. Descriptive statistics are available for the marks of the whole cohort, which allow the instructor to reflect on the student performance and identify any actions that could be taken to improve the learning experience with the module in the next academic year. Similarly, the feedback provided by the students at the end of the semester will be used to improve further the delivery of the module.

Table 22. Programming for Interaction (PFI) - Experiential Engagement stage

Experiential engagement (occurs when students consolidate their knowledge or explore further. It may occur before the concept exploration stage, when educators engage students in activities with the aim to pique their interest in a topic (e.g. play a game). It may also occur after the meaning-making stage, where students have to apply what they have learned (e.g. practice a skill, work on a project, etc.). At this stage, the educator has a chance to support students in applying their knowledge) **PBL step**: Evaluation and Reporting **Flipped Classroom**: After the class				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☐Group work				
☒Individual work	☒Write the technical report	N/A	Assignment brief	To assess whether the learning goals of the module have been achieved
☒Development and testing of a prototype	☒Develop a mobile or desktop application	N/A	Assignment brief	To assess whether the learning goals of the module have been achieved
☐Journal or portfolio				
Engagement with students				
☐ Configure the students' project / tasks based on their interactions in the game				

☒Provide formative feedback on draft reports prior to the online submission			
Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
☐Group work	☐ Individual performance ☐Group performance	☐Self-reported perception ☐Number of solution versions ☐Engagement	☐ Clustering ☐ Engagement ☐Content analysis
☒Report	☒Individual performance	☒Number of submitted reports	☒Descriptive statistics of the performance in the mini projects
☒Development and testing of a prototype	☒Individual performance	☒Number of submitted prototypes	☒Descriptive statistics of the performance in the mini projects
☐Journal or portfolio			
☐Focus groups			
Intervention			
☐Scaffolding hints ☒Formative feedback ☐ Reminders ☒Summative feedback ☒ Final marks			

3.2.2 Programming of Complex Software Systems – 3rd semester of Medialogy BSc

The module Programming of Complex Software Systems (PCSS) introduces several methods that are relevant when developing and using large software systems. The objective is to give the students an understanding of object-oriented software analysis and design methods. Furthermore, an introduction to network programming and parallel programming, data structures and algorithms is also given.

Students who complete the project module should obtain the following qualifications:

Knowledge

- Understanding of the basic concepts of object-oriented design and analysis (e.g., encapsulation, inheritance, composition, association, interfaces)
- Understanding of using the UML language to produce and communicate an object-oriented software design (structure, behaviour, and interaction diagrams)
- Understanding of structure and tools for documenting codebases
- Understanding of data structures used for search and sort algorithms (graphs, linked lists, queues, stacks, trees, heaps, hash tables)
- Understanding of the concept of the complexity of an algorithm and big-O notation
- Understanding of programming concepts related to networks: clients and servers, sockets, ports, IP address (static/dynamic), Ethernet address
- Understanding digital application and communication protocols: the OSI model, TCP and UDP.
- Understanding the concepts behind parallel programming: processes and threads, scheduling, bottlenecks and deadlocks, shared data, mutex locks, race conditions
- Understanding of common versioning software practices and terminology

Skills

- Ability to both produce and understand UML-based diagrams in order to work with object-oriented design and analysis (application, analysis)
- Ability to implement an object-oriented design from a UML description (application)
- Ability to choose and apply appropriate data-structures to create efficient Programmes for searching and sorting
- Ability to apply to design a fitting software solution both in the field of networking and multi-threaded programming
- Ability to apply programming skills to implement a multithreaded Programme that uses the network to communicate between two digital devices (application)
- Ability to use a commonly used software versioning system (application)

Competencies

- Produce and implement object-oriented software designs (application)
- Document an object-oriented software system using UML (application)

- Evaluate existing code in the fields of network and multithreading, judge its design and recommend changes
- Must have competencies in designing efficient solutions using advanced data structures to solve programming tasks, especially programming tasks related to medialogy, communication and IT/new media (application)
- Read and design algorithms and analyse their complexity

The module consists of nine weekly in-class sessions, associated weekly assignments/reading, and a mini project. For the mini project, students in groups of 6-7 must develop a server-client application that can accommodate at least three clients in parallel. Students should also follow an agile software development process. Moreover, they must deliver a technical report describing the functionality of the application and explaining and reflecting on the development process. The module is evaluated by an individual written exam in the end of the semester. Students must successfully complete the weekly activities and the mini project in order to get access to the final exam.

Table 23. Programming of Complex Software Systems (PCSS) – basic information

Target Group	Subject	Time/Duration	Overall Objective	Success metrics
☒Undergraduate university students ☐Postgraduate university students ☐Secondary education students ☐Primary education students ☐Professionals	Advanced topics of programming	9 weekly in-class sessions & a mini project (follows an academic semester)	Convey the knowledge for designing, programming, and evaluating complex software systems involving multiple devices, processors, users, and complex algorithms	Successful completion of weekly assignments and of mini project Final exam marks Student feedback

Based on the PBL model, the mini project module is conducted by following the main phases in the PBL process: problem formulation, problem analysis, problem solving, evaluation and reflection. The initial phases are distributed among the first five sessions, since the knowledge needed for completing the mini project is taught during these sessions. After these five sessions, students get two weeks to dedicate mainly to the problem solving, and evaluation and reflection phases.

The topic of each session together with the associated assignment(s) are as follows:

1. UML and Software Engineering – Problem formulation (brainstorming, concept exploration, initial problem statement and initial UML diagrams)
2. Multithreading I – Problem analysis (concrete UML diagrams, final problem statement)
3. Multithreading II – Problem solving (design of system architecture)
4. Network Programming I - Problem solving (initial development of the client application)
5. Network Programming II – Problem solving (development of client application, initial development of the server application)

After the fifth session, there is a break for two weeks, where the students work further in the problem solving phase (finalizing the implementation of the client-server application) and the evaluation and reflection phase (testing of the client-server application and reflection on further improvements). The rest of the session topics are the following (however, they were not part of the mini project development).

6. Algorithm Complexity
7. Data structures
8. Sorting and Searching Algorithms
9. Trees, Hashing, and Graphs

Before each in-class session, the students will have to read relevant book chapters, watch tutorials/videos, and access any other learning material provided for this in-class session (e.g. online articles, websites etc.). An online forum will be available on the module's LMS (i.e. Moodle) that will allow students to discuss the concepts and exchange ideas before each in-class session (Table 24).

The instructors will monitor the students' interactions on the forum and will answer any queries. Emails and announcements on the LMS will also be used to communicate with the students. Since the online forum will run on Moodle, learning analytics may not be available for the forum, but the instructors will identify any students that do not seem to participate on the forum and send relevant email reminders. Also, feedback will be provided on the forum and in cases where students seem to have many questions about a concept/need further support, additional learning activities/material will be added. Learning material in broader areas (e.g. software development methods) may be provided for scaffolding as necessary (e.g. based on the students' question on forum/during the in-class sessions).

Table 24. Programming of Complex Software Systems (PCSS) - Concept Exploration stage

Concept exploration: Pre – class (educator-led part of the process that introduces learners to learning material. This is traditionally the presentation part of a course outside the classroom (by e.g. video lectures) **PBL step**: Problem formulation

Flipped Classroom: Outside of the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒ Accessing learning material	Read literature/articles Study relevant use cases Identify concepts that are not clear and ask questions accordingly	☒ Launch game elements for studying ☒ Provide external tools	☒ Websites ☒ Slides ☒ Literature ☒ Video lectures / tutorials	To understand the concepts introduced in the literature/slides/video tutorials and their application in software development
☐ Concept maps				
☐ Group game				
☐ Simulation				
☐ Quiz/test				
☐ Develop an infographic about the subject				
☐ Keywords on post-It notes				
☒ Watching videos	Listen/watch the lecture recordings	☒Provide external tools	☒ Video lectures / tutorials	Each video lecture will cover different learning objectives
Engagement with students				
☒ Monitor students' online interactions ☒ Provide additional content ☐ Change activities (e.g. more or different quizzes)				
Reflection				
Learning activity	**Evaluation method**	**Data**	**Learning analytics**	
Discussion	☒ Individual performance	☒ Online interactions	☒Engagement patterns	

	☐ Group performance	☒Number of posts	☐Clustering ☐Social network analysis ☐Discourse analysis
Material accessed	☒ Individual performance	☒ Material accessed ☒ Number of materials	
Concept maps	☐ Individual performance ☐ Group performance ☐Structure of the map and how elaborate it is	Final product (i.e. map)	
Group game	☐ Individual performance ☐Group's ability to communicate and work together	Outcome/performance in the group game	
Simulation	Degree of interaction with the simulation	Outcome/performance in simulation	
Intervention			
☐Redesign materials ☒Provide feedback ☒Plan additional activities ☒Send email reminders to disengaged students ☒Scaffolding			

Before each in-class session, students will have to engage with learning activities that aim to help them understand the topics covered in the learning material (Table 25). One of the main learning activities will be playing the FLIP2G game that will help the students test their understanding of the module's concepts, while at the same time it will ensure that the pre-work is engaging and will be completed by the students. The game will include questions based on the video lectures and the recommended reading. The forum will also support this stage too, as students will be able to make sense of the module's concepts by participating in the online discussion.

The students' participation in the online discussions, their engagement with the game and their performance on the mini games will be reviewed by the instructors to identify disengaged students and send reminders accordingly. Personalised feedback and recommendations will also be provided by the instructors based on the above data.

Table 25. Programming of Complex Software Systems (PCSS) – Meaning Making stage

Meaning making: Pre – class (Students make meaning out of the information they have been exposed to by engaging in various assessment or reflection activities. Students show their mastery over the concept exploration content by producing their own content that reflects upon their acquisition in a meaningful way) **PBL step**: Problem analysis **Flipped Classroom**: Outside of the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒Content	Read/explore the learning content	☒Launch game elements for studying ☒Provide external tools (e.g. links with books / articles)	☒ Websites ☒ Slides ☒ Literature ☒Video lectures ☐ Audio lectures	☒Learn how to review available information
☒Discussion	Discuss the learning material Respond to questions that other students have	☐ Chat room ☒ Forum		Understand how the concepts could be applied in practice.
Quiz		☐ Quiz tool		
☒Game			☒ Slides ☒ Literature ☒ Video lectures ☐ Audio lectures	To consolidate learning/test knowledge
One-minute presentations				

Blog/vlog/social media posts				
Debate				
Producing a short podcast or a video on the subject				☐Learn how to interpret appropriate information

Engagement with students
☒ Monitor students' ongoing progress during the problem analysis phase ☒ Provide additional content if students seem to not have understood part of the subject ☒ Change the activities to ensure more participation for the students that have not understood the material or seem to not collaborate with their team ☒ Challenge/motivate students/groups who understand to dig deeper into the learning material

Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
Discussion	☒ Individual performance ☐Group performance	☐Self-reported perception ☐Academic results ☒Engagement	☒ Participation ☐ Performance ☐Content analysis
Quiz	☐ Individual performance	☐ Answers (correct, incorrect, frequency or incorrect answers)	☐ Statistics (more commonly wrong answer, average grades) ☐ Likelihood to fail – prediction based on answers patterns
Game	☒ Individual performance ☐Group performance	☐Task completion time ☐Navigation paths	☒In-game statistics like completion time, completion rate ☒in-game engagement

Intervention
☒Recommendations ☒Feedback ☒Send email reminders to disengaged students

☐Pop-up tips after a prolonged stay at one level/checkpoint ☒A notification to the teacher that a pupil is stuck and has not progressed.

During the in-class sessions, students are first asked to play a multiplayer game that contains questions on the topics that were addressed during the previous out-of-class sessions. In this game, two or more students get the same question and in order to gain points, all students must select the same right answer. This process is expected to allow students to discuss among themselves the question and remind them of the content they had to cover before the in-class sessions. Moreover, it is expected that this activity can help students, who come to the in-class session unprepared, to familiarize themselves with the topics of the current session. Since the multiplayer game is hosted on the gaming platform, analytics are available after this session regarding the time spent in the multiplayer game, the collaborative score, the percentage of correct answers in the multiplayer game, and the number of collaborative games played. After this activity, students are asked to apply the knowledge gained in the previous stages by completing programming assignments. As mentioned before, these assignments concern sub-parts of the application that the students should develop for their mini projects. More specifically, they are asked to work in small groups for solving the assignments (Table 26). This kind of activities help the students develop the application for the mini project, as they give them a chance to receive feedback from the instructors and the other students on their code. If students face any problem while implementing the solutions to the assignments, the instructors provide students with hints on how to move forward/correct errors in their code. Since this stage takes place within the classroom and the learning activities take place outside the project's platform, the learning analytics/data collected from this stage is limited.

Table 26. Programming of Complex Software Systems (PCSS) – Demonstration and Application stage

Demonstration and application (Occurs in the classroom. Students analyse, evaluate and create and engage in peer learning activities or projects, while educators evaluate and offer additional support where needed) **PBL step**: Problem solving **Flipped Classroom**: Inside the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒Group work	☒Answer questions on the topics covered in the out-of-class	☒Multiplayer game	☒ Slides ☒ Literature	Review knowledge in the topics under examination

	sessions			
☒Development and testing of a prototype	☒Solve programming assignments that constitute parts of a bigger application	☒Software development environment	☒ Examples contained in the learning material	Apply knowledge gained on software development
☐Journal or portfolio				
☐Focus groups				
☒Individual reports				☒Learn how to write a technical documentation for an application and reflect on the software development process
☐Develop cases studies				
☐Oral presentations				

Engagement with students
☒ Monitor the problem solved ☒ Provide multiple learning pathways if problem solution is insufficient ☐ Provide multiple ways for students to assess their solution

Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
☒Group work	☒ Individual performance ☒Group performance	☒Self-reported perception ☐Number of solution versions ☒Engagement ☒Game score	☐ Clustering ☒ Engagement ☐Content analysis

☐Development and testing of a prototype			
☐Journal / portfolio / wiki			
☐Focus groups			
Intervention			
☒Scaffolding hints ☒Formative feedback ☐ Reminders			

The students are asked to submit their mini projects (finished application and report) 2 weeks after the last relevant in-class session has taken place. Before they do so, they have the chance to discuss their drafts with the instructors to get some formative feedback (Table 27). The mini projects are used to assess whether the main learning outcomes of the module have been achieved. The students must submit a mini project of adequate quality in order to be able to sit the final exam. The students, who fail in the mini project, also fail in the whole module. The students only receive summative feedback on their mini project, no marks. The feedback aims to help them identify areas for further improvement before the final exam. The final exam is multiple choice quiz, where students receive individual marks. Descriptive statistics are available for the marks of the whole cohort, which allow the instructor to reflect on the student performance and identify any actions that could be taken to improve the learning experience with the module in the next academic year. Similarly, the feedback provided by the students at the end of the semester will be used to improve further the delivery of the module.

Table 27. Programming of Complex Software Systems (PCSS) - Experiential Engagement stage

Experiential engagement (occurs when students consolidate their knowledge or explore further. It may occur before the concept exploration stage, when educators engage students in activities with the aim to pique their interest in a topic (e.g. play a game). It may also occur after the meaning-making stage, where students have to apply what they have learned (e.g. practice a skill, work on a project, etc.). At this stage, the educator has a chance to support students in applying their knowledge) **PBL step**: Evaluation and Reporting **Flipped Classroom**: After the class

Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☐Group work				
☒Individual work	☒Write the technical report	N/A	Assignment brief	To assess whether the learning goals of the module have been achieved
☒Development and testing of a prototype	☒Develop a server-client application	N/A	Assignment brief	To assess whether the learning goals of the module have been achieved
☐Journal or portfolio				
Engagement with students				
☐ Configure the students' project / tasks based on their interactions in the game ☒Provide formative feedback on draft reports prior to the online submission				
Reflection				
Learning activity	**Evaluation method**	**Data**	**Learning analytics**	
☐Group work	☐ Individual performance ☐Group performance	☐Self-reported perception ☐Number of solution versions ☐Engagement	☐ Clustering ☐ Engagement ☐Content analysis	
☒Report	☒Individual performance	☒Number of submitted reports	☒Descriptive statistics of the performance in the mini projects	
☒Development and testing of a prototype	☒Individual performance	☒Number of submitted prototypes	☒Descriptive statistics of the performance in the mini projects	
☐Journal or				

portfolio			
☐Focus groups			
Intervention			
☐Scaffolding hints ☒Formative feedback ☐ Reminders ☒Summative feedback ☒ Final marks			

3.3 University of Macedonia

The pilots organised at UOM include 3 courses in the broader area of computer science. The Information Systems Analysis and Design (SAD) course is taught in the Interdepartmental Programme of Postgraduate Studies in Information Systems during the fall semester, the e-Government course is taught in the Applied Informatics department during the fall semester, while the Innovative e-Business Systems course is taught in the Postgraduate program of the Applied Informatics Department of UOM during the spring semester.

All courses run for all 13 weeks of each semester and usually follow a blended learning strategy and a combination of lectures and assignments.

UOM might be able to host additional pilots for other courses, depending on the number of students that will be enrolled in the following semesters. If new pilots arise that are not described below, the relevant information of the course design will be provided in D4.2.

3.3.1 Information Systems Analysis and Design – MSc Programme

In the Information Systems Analysis and Design (SAD) module, students learn to analyse and design information systems with the use of the Unified Modelling Language (UML). The lectures are already organised based on the Flipped Classroom approach, which means that the students are expected to study the theory that can be found on the textbook and the module's LMS (Moodle), prior to the lecture.

By the end of the module, students are expected to have acquired the necessary knowledge that will allow them to recount the basic steps of a SAD method and understand the use of the basic UML diagrams (i.e. activity, use case, class, robustness, and sequence diagrams). Also, they are expected to have acquired practical skills, such as a) using the Visual Paradigm software for the analysis and design of information systems based on the UML, and b) converting UML diagrams to Java code. Finally, the module aims to facilitate the development of transferable skills, such as the ability to

develop an information system that covers the needs of an organisation with the use of a SAD method and UML.

Students will have to work on a group project as part of the module assessment. More specifically, they will have to analyse and design an information system for a small company, based on the information provided by the module's case study. The project will have to follow the SAD method discussed in the classroom and use UML, which is going to be taught during the module's workshops.

Table 28 presents some basic information regarding the course based on the learning design template available in D3.1.

Table 28. Information Systems Analysis and Design (SAD) – basic information

Target Group	Subject	Time/Duration	Overall Objective	Success metrics
☐ Undergraduate university students ☒ Postgraduate university students ☐ Secondary education students ☐ Primary education students ☐ Professionals	Information Systems Analysis and Design	12 weeks x 3 hours	Learn to analyse and design information systems with the use of UML	Assignment marks Student presentations Final exams

During the problem formulation phase, the groups of students decide on ideas / functionalities to be supported by the information system they are required to design. Before each decision, students will have to read the material provided to them before the classroom and understand the basic concepts of each information system's component. An internal LMS will be used for announcements of the course and communication between the teacher and the students.

Table 29. Information Systems Analysis and Design (SAD) –- Concept Exploration stage

Concept exploration: Pre – class (educator-led part of the process that introduces learners to learning material. This is traditionally the presentation part of a course outside the classroom (by e.g. video lectures) **PBL step**: Problem formulation

Flipped Classroom: Outside of the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒ Discussion	Discuss the learning material Identify concepts that are not clear and ask questions accordingly Respond to questions that other students have	☒Launch game elements for studying ☒Provide external tools	☐ Websites ☒ Slides ☐ Literature ☐ Video lectures / tutorials ☐ Audio lectures	To understand the concepts introduced in the lectures/slides.
☒ Accessing learning material	Read articles Explore how the concepts are applied in different information systems	☒Provide external tools	☒ Websites ☒ Literature ☒ Case studies	To understand the application of the concepts introduced in each session in different settings (e.g. different industries)
☐ Concept maps				
☐ Group game				
☐ Simulation				
☒Quiz/test	Answer questions in quizzes on the material read	☒Launch game elements for quizzes		Identify possible misconceptions
☐ Develop an infographic about the subject				
☐ Keywords on post-It notes				
☐ Watching videos				
Engagement with students				

☒ Monitor students' online interactions ☒ Announcements on LMS ☒ Provide additional content ☐ Change activities (e.g. more or different quizzes)			
Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
Discussion	☒ Individual performance ☐ Group performance	☒ Online interactions ☒Number of posts	☒Engagement patterns ☐Clustering ☐Social network analysis ☐Discourse analysis
Material accessed	☒ Individual performance	☒ Material accessed ☒ Number of materials	
Concept maps	☐ Individual performance ☐ Group performance ☐Structure of the map and how elaborate it is	Final product (i.e. map)	
Group game	☐ Individual performance ☐Group's ability to communicate and work together	Outcome/performance in the group game	
Simulation	Degree of interaction with the simulation	Outcome/performance in simulation	
Intervention			
☐Redesign materials ☒Provide feedback ☒Plan additional activities ☒Send email reminders to disengaged students ☒Scaffolding			

During the problem analysis phase, students will have to analyse the different concepts of the information system they have to design. Students are divided into groups and they are required to study the learning material taught and read outside of the classroom and make sense of how the information system will be designed. Table 30 shows the Meaning Making stage of the learning model for the SAD course.

Table 30. Information Systems Analysis and Design (SAD) – Meaning Making stage

Meaning making: Pre – class (Students make meaning out of the information they have been exposed to by engaging in various assessment or reflection activities. Students show their mastery over the concept exploration content by producing their own content that reflects upon their acquisition in a meaningful way) **PBL step**: Problem analysis **Flipped Classroom**: Outside of the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒Content	Read/explore the learning content	☒Launch game elements for studying ☒Provide external tools (e.g. links with books / articles)	☒ Websites ☒ Slides ☒ Literature ☐Video lectures ☐ Audio lectures	☒Learn how to review available information
☒Discussion	Discuss the learning material and the concepts per UML diagram	☐ Chat room ☒ Forum		Understand how the concepts of each diagram could be applied in real information systems
☒Quiz	Answer questions on diagrams taught	☒ Quiz tool	☒ Quiz questions in game / Mentimeter	Understand the differences between the different UML diagrams
☒Game	Read learning content		☒ Slides ☒ Literature ☐ Video lectures	To consolidate learning/test knowledge

			☐ Audio lectures	
Presentations				
Blog/vlog/social media posts				
Debate				
Producing a short podcast or a video on the subject				☐Learn how to interpret appropriate information

Engagement with students
☒ Monitor students' ongoing progress during the problem analysis phase ☒ Provide additional content if students seem to not have understood part of the subject ☒ Change the activities to ensure more participation for the students that have not understood the material or seem to not collaborate with their team ☒ Challenge/motivate students/groups who understand to dig deeper into the learning material

Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
Discussion	☒ Individual performance ☒Group performance	☒Self-reported perception ☐Academic results ☒Engagement	☒ Participation ☐ Performance ☐Content analysis
Quiz	☒ Individual performance	☒ Answers (correct, incorrect, frequency or incorrect answers)	☒ Statistics (more commonly wrong answer, average grades) ☒ Likelihood to fail – prediction based on answers patterns
Game	☒ Individual performance ☐Group performance	☐Task completion time ☐Navigation paths	☒In-game statistics like completion time, completion rate ☒in-game engagement

Intervention
☒Recommendations

☒Feedback ☒Send email reminders to disengaged students ☐Pop-up tips after a prolonged stay at one level/checkpoint ☒A notification to the teacher that a pupil is stuck and has not progressed.

In the problem-solving step of the PBL model, the course groups will design the different diagrams that correspond to the information system they are required to design. Each diagram will be designed according to the learning material taught and read outside of the classroom using the FLIP2G learning model. Students will then demonstrate the diagrams within the classroom through oral presentations and present ways the information system can be applied in real world settings.

Table 31. Information Systems Analysis and Design (SAD) – Demonstration and Application stage

Demonstration and application (Occurs in the classroom. Students analyse, evaluate and create and engage in peer learning activities or projects, while educators evaluate and offer additional support where needed) **PBL step**: Problem solving **Flipped Classroom**: Inside the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒Group work	☒ Joint creation of different diagrams		☒ Slides ☒ Literature	Understand the different ways diagrams are designed
Development and testing of a prototype				
Journal or portfolio				☐Learn how to construct a portfolio of evidence
Focus groups				
Individual reports				
Develop cases studies				

☒ Oral presentations	☒ Present each diagram created and its rationale		☒ Slides	☒Learn how to present and justify decisions made during system design
Engagement with students				
☒ Monitor the problem solved ☒ Provide multiple learning pathways if problem solution is insufficient ☐ Provide multiple ways for students to assess their solution				
Reflection				
Learning activity	**Evaluation method**	**Data**	**Learning analytics**	
Group work	☒ Individual performance ☒Group performance	☒Self-reported perception ☐Number of solution versions ☐Engagement ☐Experience points	☐ Clustering ☐ Engagement ☐Content analysis	
Development and testing of a prototype				
Journal / portfolio / wiki				
Focus groups				
Intervention				
☐Scaffolding hints ☒Formative feedback ☐ Reminders				

Once all diagrams are designed by the student groups, a reflection process is carried out by the group members. Each group receives feedback on a weekly basis from their presentations and makes changes in their project based on the observation remarks by other students and by the

teacher. The final process of the project work is the overall report, where all the knowledge taught is applied and explained in the report.

Table 32. Information Systems Analysis and Design (SAD) – Experiential Engagement stage

<table>
<tr><td colspan="5">Experiential engagement (occurs when students consolidate their knowledge or explore further. It may occur before the concept exploration stage, when educators engage students in activities with the aim to pique their interest in a topic (e.g. play a game). It may also occur after the meaning-making stage, where students have to apply what they have learned (e.g. practice a skill, work on a project, etc.). At this stage, the educator has a chance to support students in applying their knowledge)

PBL step: Evaluation and Reporting

Flipped Classroom: After the class</td></tr>
<tr><td colspan="5">Preparation</td></tr>
<tr><td>Learning activity</td><td>Tasks</td><td>Gamification / tools</td><td>Learning materials / media</td><td>Learning goals / outcomes</td></tr>
<tr><td>☒Group work</td><td>☒Write the report</td><td></td><td>Project results</td><td>Work together to form a comprehensive presentation of the group work</td></tr>
<tr><td>☒Individual work</td><td>☒Write the report</td><td>N/A</td><td>Project results</td><td>To assess whether the learning goals of the course have been achieved.</td></tr>
<tr><td>Development and testing of a prototype</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Journal or portfolio</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="5">Engagement with students</td></tr>
<tr><td colspan="5">☐ Configure the students' project / tasks based on their interactions in the game

☒Provide formative feedback on draft reports prior to the online submission</td></tr>
<tr><td colspan="5">Reflection</td></tr>
<tr><td>Learning activity</td><td>Evaluation method</td><td>Data</td><td colspan="2">Learning analytics</td></tr>
</table>

Group work	☐ Individual performance ☐Group performance	☐Self-reported perception ☐Number of solution versions ☐Engagement	☐ Clustering ☐ Engagement ☐Content analysis
☒Report	☒Individual performance ☒Group performance	☒Scores ☒Number of submitted reports	☒Descriptive statistics of the marks
Development and testing of a prototype			
Journal or portfolio			
☒Focus groups	Provide feedback regarding the experience with the course		
Intervention			
☐Scaffolding hints ☐Formative feedback ☐ Reminders ☒Summative feedback ☒ Final marks			

3.3.2 Electronic Government – BSc Programme

The e-Government course is elective and runs during the 7th semester of the Applied Informatics department at UOM. This course aims at developing the following skills and competences:

- decision making
- organizational, collaborative learning
- presentation and defence of positions
- writing skills

- teamwork
- evaluation and self-evaluation

After completing the course students will be able to:

- understand the role and capabilities of implementing Information Systems in the Public Sector
- use eGovernment and eParticipation applications
- develop simple applications based on linked open government data.

The structure of the course includes the following main subject areas:

- Introduction to eGovernment
- Open Government Data and Linked Open Data
- Provision of Public Information and Services
- One-stop Government
- Interoperability
- eParticipation.

Currently, student assessment is based on two main criteria with the corresponding percentage weighting:

- Final Examination: 50%
- Project score: 50%

Using the FLIP2G paradigm, students will also be assessed during the entire course, based on the Learning Analytics information teachers will gather from their interaction with the game.

Students will also be informed about the obligations, policy and requirements of the six-month group work (3-4 students), where they will be invited to create applications and/or analyse "hidden" Open-Data and publish a relevant data story. In addition, individual tasks will be given on issues of eParticipation, one-stop Government etc. At the beginning of the semester, instructions, technical specifications, as well as the way of evaluating of projects are announced. Exam and Project grades are announced on the local LMS (and/or additional Learning Management Systems) as an additional feedback element on the final performance of the students.

Table 33 shows some basic information regarding the course.

Table 33. e-Government – Basic information

Target Group	Subject	Time/Duration	Overall Objective	Success metrics
☒Undergraduate	e-Government	13 weekly lectures	Learn about e-Government, Open	Assignment marks

university students ☐Postgraduate university students ☐Secondary education students ☐Primary education students ☐Professionals	e-Participation		Government Data and Linked Open Data	Final exams

In the new re-design of the course, students will be encouraged to access and study the learning material outside of the classroom, by providing content within the game as well as in the course's LMS platform.

Students will then learn the basic concepts of the course and can execute group assignments or individual tasks within the classroom in the following FLIP2G model stages. Table 34 shows a representation of the activities, tasks and tools relevant to this stage of the course.

Table 34. e-Government course – Concept exploration Stage

Concept exploration: Pre – class (educator-led part of the process that introduces learners to learning material. This is traditionally the presentation part of a course outside the classroom (by e.g. video lectures) **PBL step**: Problem formulation **Flipped Classroom**: Outside of the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☐ Discussion		☐Launch game elements for studying ☐Provide external tools	☐ Websites ☐ Slides ☐ Literature ☐ Video lectures / tutorials ☐ Audio lectures	
☒ Accessing learning material	Learn about open data	☒Launch game elements for studying	☒ Slides ☒ Literature	Understand what open data is and the basic

				principles
☐ Concept maps				
☐ Group game				
☐ Simulation				
☒ Quiz/test	Answer questions on open data	☒Launch mini-games	☒ Game quizzes	Comprehend the basic concepts of the subject
☐ Develop an infographic about the subject				
☐ Keywords on post-It notes				
☐ Watching videos				

Engagement with students
☒ Monitor students' online interactions ☒ Provide additional content ☐ Change activities (e.g. more or different quizzes)

Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
Discussion	☐ Individual performance ☐ Group performance	☐ Online interactions ☐Number of posts	☐Engagement patterns ☐Clustering ☐Social network analysis ☐Discourse analysis
Material accessed	☒ Individual performance	☒ Material accessed ☒ Number of materials	☒ Access frequency of material
Concept maps	☐ Individual performance ☐ Group performance ☐Structure of the map	Final product (i.e. map)	

	and how elaborate it is		
Group game	☐ Individual performance ☐Group's ability to communicate and work together	Outcome/performance in the group game	
Simulation	Degree of interaction with the simulation	Outcome/performance in simulation	
Intervention			
Redesign materials ☒Provide feedback ☐Plan additional activities ☐Send email reminders to disengaged students ☐Scaffolding			

Table 35. e-Government course – Meaning making stage

Meaning making: Pre – class (Students make meaning out of the information they have been exposed to by engaging in various assessment or reflection activities. Students show their mastery over the concept exploration content by producing their own content that reflects upon their acquisition in a meaningful way) **PBL step**: Problem analysis **Flipped Classroom**: Outside of the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒Content		☒Launch game elements for studying ☒Provide external tools (links of technologies)	☒ Websites ☒ Slides ☒ Literature ☐ Video lectures ☐ Audio lectures	☒Learn how to review available information
☒Discussion	Find and exchange open	☐ Chat room	☒Links of e-government data	☒ Exchange

	data repositories	☒ Forum	sites, apps	information
☒Game quiz	Answer question	☒ Quiz mini game	☒ Questions within game	☒ Understand concepts
Game			☐ Slides ☐ Literature ☐ Video lectures ☐ Audio lectures	
One-minute presentations				
Blog/vlog/social media posts				
Debate				
Producing a short podcast or a video on the subject				

Engagement with students
☒ Monitor students' ongoing progress during the problem analysis phase ☒ Provide additional content if students seem to not have understood part of the subject ☒ Change the activities to ensure more participation for the students that have not understood the material or seem to not collaborate with their team ☐ Challenge/motivate students/groups who understand to dig deeper into the learning material

Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
Discussion	☒ Individual performance ☐Group performance	☒Self-reported perception ☐Academic results ☐Engagement	☐ Participation ☐ Performance ☐Content analysis
Quiz	☒ Individual performance	☒ Answers (correct, incorrect, frequency or incorrect answers)	☒ Statistics (more commonly wrong answer, average grades) ☒ Likelihood to fail – prediction

			based on answers patterns
Game	☒ Individual performance ☐Group performance	☒Task completion time ☐Navigation paths	☒In-game statistics like completion time, completion rate ☒in-game engagement
Intervention			
☒Recommendations ☒Feedback ☐Send email reminders to disengaged students ☐Pop-up tips after a prolonged stay at one level/checkpoint ☐A notification to the teacher that a pupil is stuck and has not progressed.			

The next phase of the course will regard the problem solving PBL step and the Demonstration and application stage of the FLIP2G learning model. Groups of students will present their work done and the different ways they created applications and/or analysed "hidden" Open-Data and published a relevant data story.

Table 36 shows examples of how students will work during this phase.

Table 36. e-Government – Demonstration and application stage

Demonstration and application (Occurs in the classroom. Students analyse, evaluate and create and engage in peer learning activities or projects, while educators evaluate and offer additional support where needed) **PBL step**: Problem solving **Flipped Classroom**: Inside the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒Group work	Collectively exploit open data		☒ External tools	
Development and testing of a prototype				
Journal or				

portfolio				
Focus groups				
Individual reports				
Develop cases studies				
☒ Oral presentations	Present different apps, data stories, e-gov data		☒ Slides ☒ External tools	☒Learn how to present and justify an informed position

Engagement with students
☒ Monitor the problem solved ☒ Provide multiple learning pathways if problem solution is insufficient ☐ Provide multiple ways for students to assess their solution

Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
Group work	☒ Individual performance ☒Group performance	☒Self-reported perception ☐Number of solution versions ☒Engagement ☐Experience points	☐ Clustering ☒ Engagement ☐Content analysis
Development and testing of a prototype			
Journal / portfolio / wiki			
Focus groups			

Intervention
☐Scaffolding hints ☒Formative feedback ☒ Reminders

The last part of the course will regard students' reflection on the work done and the material that they were taught. Students will be required to show how they applied their knowledge in the activities (group and individual) they executed.

Table 37 shows examples of learning activities to be performed during the Experiential engagement stage of the course.

Table 37. e-Government course – Experiential engagement

Experiential engagement (occurs when students consolidate their knowledge or explore further. It may occur before the concept exploration stage, when educators engage students in activities with the aim to pique their interest in a topic (e.g. play a game). It may also occur after the meaning-making stage, where students have to apply what they have learned (e.g. practice a skill, work on a project, etc.). At this stage, the educator has a chance to support students in applying their knowledge) **PBL step**: Evaluation and Reporting **Flipped Classroom**: After the class				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒Group work	Work together towards an application			Collaborative work towards a common objective
☒Individual work	Contribute to application			Individual contribution of knowledge learned
☒Development and testing of a prototype	Create an application relevant to e-gov			Application that adds value to a sector
Journal or portfolio				
Engagement with students				
☐ Configure the students' project / tasks based on their interactions in the game				
Reflection				
Learning activity	**Evaluation**	**Data**	**Learning analytics**	

	method		
Group work	☒ Individual performance ☒Group performance	☒Self-reported perception ☐Number of solution versions ☐Engagement	☐ Clustering ☐ Engagement ☐Content analysis
Development and testing of a prototype	☒ Individual performance	☒Self-reported perception	
Journal or portfolio			
Focus groups			
Intervention			
☒Scaffolding hints ☒Formative feedback ☒ Reminders ☒ Final marks			

3.3.3 Innovative e-Business Systems– MSc Programme: stream of specialization "Business Computing"

Innovative e-Business Systems is offered as an elective course within the second stream of specializations available in the Applied Informatics Department's MSc Programme, called "Business Computing". The main objective of this course is to familiarise students with innovative e-business systems with an emphasis on exploiting open data (e.g. visualization, analytics, development of innovative applications). Upon successful completion of this course students will be able to:

- visualize and analyse open data to support business decisions
- publish data as linked open data
- develop value-added applications using open data.

Table 38 shows some basic information regarding the course.

Table 38. Innovative e-business Systems – Basic information

Target Group	Subject	Time/Duration	Overall Objective	Success metrics
☐Undergraduate	Open data	13 weekly lectures	Learn about	Assignment marks

university students ☒Postgraduate university students ☐Secondary education students ☐Primary education students ☐Professionals	e-business systems		innovative e-business systems with exploiting open data	Final exams

Initially, students are introduced to the subject matter of open data, open government data and open data principles. They will be required to explore these concepts before class during the Concept exploration stage, as shown in Table 39.

Table 39. Innovative e-Business Systems – Concept exploration Stage

Concept exploration: Pre – class (educator-led part of the process that introduces learners to learning material. This is traditionally the presentation part of a course outside the classroom (by e.g. video lectures) **PBL step**: Problem formulation **Flipped Classroom**: Outside of the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☐ Discussion		☐Launch game elements for studying ☐Provide external tools	☐ Websites ☐ Slides ☐ Literature ☐ Video lectures / tutorials ☐ Audio lectures	
☒ Accessing learning material	Learn about open data	☒Launch game elements for studying	☒ Slides ☒ Literature	Understand what open data is and the basic principles
☐ Concept maps				
☐ Group game				

☐ Simulation				
☒ Quiz/test	Answer questions on open data	☒Launch mini-games	☒ Game quizzes	Comprehend the basic concepts of the subject
☐ Develop an infographic about the subject				
☐ Keywords on post-It notes				
☐ Watching videos				

Engagement with students
☒ Monitor students' online interactions ☒ Provide additional content ☐ Change activities (e.g. more or different quizzes)

Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
Discussion	☐ Individual performance ☐ Group performance	☐ Online interactions ☐Number of posts	☐Engagement patterns ☐Clustering ☐Social network analysis ☐Discourse analysis
Material accessed	☒ Individual performance	☒ Material accessed ☒ Number of materials	☒ Access frequency of material
Concept maps	☐ Individual performance ☐ Group performance ☐Structure of the map and how elaborate it is	Final product (i.e. map)	
Group game	☐ Individual performance ☐Group's ability to communicate and work	Outcome/performance in the group game	

	together		
Simulation	Degree of interaction with the simulation	Outcome/performance in simulation	
Intervention			
Redesign materials ☒Provide feedback ☐Plan additional activities ☐Send email reminders to disengaged students ☐Scaffolding			

Once students understand the basic principles of open data, they will endeavour to make sense of the concepts by visualizing, analysing, retrieving and publishing existing open data. Groups of students will be formed, and they will explore innovative technologies such as Tableau, RapidMiner, RDF, Turtle and OpenRefine. Within these technologies students will exploit and publish open data from existing repositories in order to make sense of ways that open data can improve a variety of sectors, such as business and computer science. An internal LMS will also be used for announcements of the course and communication between the teacher and the students.

Table 40 provides information on the different activities and tasks relevant to the meaning making stage of the course.

Table 40. Innovative e-Business Systems – Meaning making stage

Meaning making: Pre – class (Students make meaning out of the information they have been exposed to by engaging in various assessment or reflection activities. Students show their mastery over the concept exploration content by producing their own content that reflects upon their acquisition in a meaningful way) **PBL step**: Problem analysis **Flipped Classroom**: Outside of the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒Content		☒Launch game elements for studying ☒Provide	☒ Websites ☒ Slides ☒ Literature	☒Learn how to review available information

		external tools (links of technologies)	☐ Video lectures ☐ Audio lectures	
☒Discussion	Find and exchange open data repositories	☐ Chat room ☒ Forum	☒Links of open data and repositories	☒ Exchange information
☒Game quiz	Answer question	☒ Quiz mini game	☒ Questions within game	☒ Understand concepts
Game			☐ Slides ☐ Literature ☐ Video lectures ☐ Audio lectures	
One-minute presentations				
Blog/vlog/social media posts				
Debate				
Producing a short podcast or a video on the subject				☐Learn how to interpret appropriate information

Engagement with students

☒ Monitor students' ongoing progress during the problem analysis phase

☒ Provide additional content if students seem to not have understood part of the subject

☒ Change the activities to ensure more participation for the students that have not understood the material or seem to not collaborate with their team

☐ Challenge/motivate students/groups who understand to dig deeper into the learning material

Reflection

Learning activity	Evaluation method	Data	Learning analytics
Discussion	☒ Individual performance ☐Group	☒Self-reported perception ☐Academic results	☐ Participation ☐ Performance

	performance	☐Engagement	☐Content analysis
Quiz	☒ Individual performance	☒ Answers (correct, incorrect, frequency or incorrect answers)	☒ Statistics (more commonly wrong answer, average grades) ☒ Likelihood to fail – prediction based on answers patterns
Game	☒ Individual performance ☐Group performance	☒Task completion time ☐Navigation paths	☒In-game statistics like completion time, completion rate ☒in-game engagement
Intervention			
☒Recommendations ☒Feedback ☐Send email reminders to disengaged students ☐Pop-up tips after a prolonged stay at one level/checkpoint ☐A notification to the teacher that a pupil is stuck and has not progressed.			

The next phase of the course will regard the problem solving PBL step and the Demonstration and application stage of the FLIP2G learning model. Groups of students will present their work done and the different ways they exploited open data towards providing added value to the business sector.

Table 41 shows examples of how students will work during this phase.

Table 41. Innovative e-Business Systems – Demonstration and application stage

Demonstration and application (Occurs in the classroom. Students analyse, evaluate and create and engage in peer learning activities or projects, while educators evaluate and offer additional support where needed) **PBL step**: Problem solving **Flipped Classroom**: Inside the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒Group work	Collectively		☒ External tools	

	exploit open data			
Development and testing of a prototype				
Journal or portfolio				☐Learn how to construct a portfolio of evidence
Focus groups				
Individual reports				
Develop cases studies				
☒ Oral presentations	Present different visualizations / open data exploitations		☒ Slides ☒ External tools	☒Learn how to present and justify an informed position
Engagement with students				
☒ Monitor the problem solved ☒ Provide multiple learning pathways if problem solution is insufficient ☐ Provide multiple ways for students to assess their solution				
Reflection				
Learning activity	**Evaluation method**	**Data**	**Learning analytics**	
Group work	☒ Individual performance ☒Group performance	☒Self-reported perception ☐Number of solution versions ☒Engagement ☐Experience points	☐ Clustering ☒ Engagement ☐Content analysis	
Development and testing of a prototype				
Journal / portfolio / wiki				

Focus groups			
Intervention			
☐Scaffolding hints ☒Formative feedback ☒ Reminders			

The last part of the course will regard students' reflection on the work done and the material that they were taught. Students will be required to develop applications using all the knowledge learned outside and inside the classroom and show how these applications provide added value.

Students will be required to use innovative technologies such as R, Javascript etc. Table 42 shows examples of learning activities to be performed during the Experiential engagement stage of the course.

Table 42. Innovative e-Business Systems – Experiential engagement

Experiential engagement (occurs when students consolidate their knowledge or explore further. It may occur before the concept exploration stage, when educators engage students in activities with the aim to pique their interest in a topic (e.g. play a game). It may also occur after the meaning-making stage, where students have to apply what they have learned (e.g. practice a skill, work on a project, etc.). At this stage, the educator has a chance to support students in applying their knowledge) **PBL step**: Evaluation and Reporting **Flipped Classroom**: After the class				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒Group work	Work together towards an application			Collaborative work towards a common objective
☒individual work	Contribute to application			Individual contribution of knowledge learned
☒Development and testing of a	Create an application with open data			Application that adds value to a sector

prototype				
Journal or portfolio				
Engagement with students				
☐ Configure the students' project / tasks based on their interactions in the game				
Reflection				
Learning activity	**Evaluation method**	**Data**	**Learning analytics**	
Group work	☒ Individual performance ☒Group performance	☒Self-reported perception ☐Number of solution versions ☐Engagement	☐ Clustering ☐ Engagement ☐Content analysis	
Development and testing of a prototype	☒ Individual performance	☒Self-reported perception		
Journal or portfolio				
Focus groups				
Intervention				
☒Scaffolding hints ☒Formative feedback ☒ Reminders ☒ Final marks				

3.4 Mandoulides Schools

The pilots organised at Mandoulides Schools include 3 courses in the areas of Mathematics, Physics and Informatics in the Primary Education. All three courses are basic courses of the curriculum and the students are familiar with solving practical exercises to apply the relevant theory. Mathematics run for 4 hours each week, Physics for 3 hours each week, while Informatics run for 2 hours each week.

Mandoulides Schools will also organize a hackathlon, a student competition where each student will have three tries to achieve the best score answering correctly as many questions as they can in a specific amount of time. The three students with the best score will be awarded a special prize.

3.4.1 Mathematics

The students learn to recite, read, write and order natural, class and decimal numbers as well as to perform all their operations. Students of this class also learn which numbers are divisible by 2, 3, 4, 5, 9, 10 and 25 and become familiar with the analysis of natural numbers into first factor factors and number forces. Other topics of the course include a) consolidating knowledge of conventional units of length, range, time, area and capacity, b) familiarizing with the usage of measurements in everyday life and c) formulating a rule for a simple arithmetic or geometric pattern. Students also practice in the design of straight shapes and circles with a rule (ruler) and diabetes, calculate the cycle length and area of a circular disk, the layers and volumes of basic solid shapes, reproduce, construct and compare angles, draw the symmetry of a shape with respect to an axis and perform transfers, magnifications and reductions.

Students also practice in the collection and recording of data of a problem, in the construction of data tables and graphs (bar graphs), in the conversion of oral or written descriptions of data into graphs and vice versa and in the formulation of predictions for the development of a phenomenon. They familiarize themselves with the concept of ordered pair and learn to calculate the average, perform the simple method of three, understand and apply the concepts of ratio, proportion and percentage. Finally, students solve simple equations with the help of the definition of operations.

Table 43. Mathematics - Basic information

Target Group	Subject	Time/Duration	Overall Objective	Success metrics
☐ Undergraduate university students ☐ Postgraduate university students ☐ Secondary education students ☒ Primary education students ☐ Professionals	Mathematics	3 x 45 minutes	Learning basic mathematical operations and complex calculations. Application in geometric shapes and area and volume calculations.	Assignment marks Student feedback

Table 44. Mathematics – Concept exploration stage

Concept exploration: Pre – class (educator-led part of the process that introduces learners to learning material. This is traditionally the presentation part of a course outside the

classroom (by e.g. video lectures) **PBL step**: Problem formulation **Flipped Classroom**: Outside of the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒ Discussion	Read/explore the learning content	☒Launch game elements for studying ☒Provide external tools	☒ Websites ☒ Slides ☒ Literature ☒ Video lectures / tutorials ☐ Audio lectures	☒Solving complex calculation problems.
☒Accessing learning material		☒Launch game elements for studying ☒Provide external tools	☒ Websites ☒ Slides ☒ Literature ☒ Video lectures / tutorials	☒Solving complex calculation problems.
☐ Concept maps				
☐ Group game				
☐ Simulation				
☒ Quiz/test		☒Launch game elements for quiz	☒ Quiz questions	☒Understand concepts
☐ Develop an infographic about the subject				
☐ Keywords on post-It notes				
☐ Watching videos				
Engagement with students				
☒ Monitor students' online interactions				

☒ Provide additional content ☒ Change activities (e.g. more or different quizzes)			
Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
Discussion	☒ Individual performance ☐ Group performance	☒ Online interactions ☐Number of posts	☒Engagement patterns ☐Clustering ☐Social network analysis ☐Discourse analysis
Material accessed	☒ Individual performance	☒ Material accessed ☒ Number of materials	
Concept maps	☐ Individual performance ☐ Group performance ☐Structure of the map and how elaborate it is	Final product (i.e. map)	
Group game	☒ Individual performance ☐Group's ability to communicate and work together	Outcome/performance in the group game	
Simulation	Degree of interaction with the simulation	Outcome/performance in simulation	
Intervention			
Redesign materials ☒Provide feedback ☒Plan additional activities ☒Send email reminders to disengaged students ☒Scaffolding			

Students try to understand the different mathematical concepts by analysing the material taught and trying to make sense of the rules that are applied and how they can apply them in different cases.

Table 45. Mathematics – Meaning making stage

Meaning making: Pre – class (Students make meaning out of the information they have been exposed to by engaging in various assessment or reflection activities. Students show their mastery over the concept exploration content by producing their own content that reflects upon their acquisition in a meaningful way) **PBL step**: Problem analysis **Flipped Classroom**: Outside of the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒ Content	Read/explore the learning content.	☒Launch game elements for studying ☒Provide external tools (e.g. links with books / articles)	☒ Websites ☒ Slides ☒ Literature ☐ Video lectures ☐ Audio lectures	☒Learn how to review available information
Discussion		☐ Chat room ☐ Forum		
☒Quiz		☒ Quiz tool		
Game			☐ Slides ☐ Literature ☐ Video lectures ☐ Audio lectures	
One-minute presentations				
Blog/vlog/social media posts				
Debate				
Producing a short				☐Learn how to

podcast or a video on the subject				interpret appropriate information

Engagement with students
☒ Monitor students' ongoing progress during the problem analysis phase ☒ Provide additional content if students seem to not have understood part of the subject ☐ Change the activities to ensure more participation for the students that have not understood the material or seem to not collaborate with their team ☐ Challenge/motivate students/groups who understand to dig deeper into the learning material

Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
Discussion	☐ Individual performance ☐Group performance	☐Self-reported perception ☐Academic results ☐Engagement	☐ Participation ☐ Performance ☐Content analysis
Quiz	☒ Individual performance	☒ Answers (correct, incorrect, frequency or incorrect answers)	☒☐ Statistics (more commonly wrong answer, average grades) ☒ Likelihood to fail – prediction based on answers patterns
Game	☐ Individual performance ☐Group performance	☐Task completion time ☐Navigation paths	☐In-game statistics like completion time, completion rate ☐in-game engagement

Intervention
☐Recommendations ☒Feedback ☐Send email reminders to disengaged students ☐Pop-up tips after a prolonged stay at one level/checkpoint ☐A notification to the teacher that a pupil is stuck and has not progressed.

Students are given tasks and assignments that they have to complete by applying the concepts learned in the previous two course stages. During demonstration and application (Table 46), students show how they completed their tasks, argue the way they worked to achieve their goals and apply the knowledge learned in different ways.

Table 46. Mathematics – Demonstration and application stage

Demonstration and application (Occurs in the classroom. Students analyse, evaluate and create and engage in peer learning activities or projects, while educators evaluate and offer additional support where needed) **PBL step**: Problem solving **Flipped Classroom**: Inside the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
Group work				
Development and testing of a prototype				
Journal or portfolio				☐Learn how to construct a portfolio of evidence
Focus groups				
☒Individual reports	☒ Create assignment report			
Develop cases studies				
Oral presentations				☐Learn how to present and justify an informed position
Engagement with students				
☒ Monitor the problem solved ☒ Provide multiple learning pathways if problem solution is insufficient				

☐ Provide multiple ways for students to assess their solution			
Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
Group work	☒ Individual performance ☐Group performance	☒Self-reported perception ☐Number of solution versions ☐Engagement ☐Experience points	☐ Clustering ☐ Engagement ☐Content analysis
Development and testing of a prototype			
Journal / portfolio / wiki			
Focus groups			
Intervention			
☐Scaffolding hints ☒Formative feedback ☐ Reminders			

Once students learn in depth different mathematical concepts and rules, they are assigned different tasks in order to engage with and practice the learned material.

Table 47. Mathematics – Experiential engagement stage

Experiential engagement (occurs when students consolidate their knowledge or explore further. It may occur before the concept exploration stage, when educators engage students in activities with the aim to pique their interest in a topic (e.g. play a game). It may also occur after the meaning-making stage, where students have to apply what they have learned (e.g. practice a skill, work on a project, etc.). At this stage, the educator has a chance to support students in applying their knowledge) **PBL step**: Evaluation and Reporting **Flipped Classroom**: After the class

Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
Group work				
☒Individual work	☒Solve exercises	-	Assignment brief	To assess whether the learning goals of the module have been achieved.
Development and testing of a prototype				
Journal or portfolio				
Engagement with students				
☐ Configure the students' project / tasks based on their interactions in the game				
Reflection				
Learning activity	**Evaluation method**	**Data**	**Learning analytics**	
Group work	☒ Individual performance ☐Group performance	☐Self-reported perception ☐Number of solution versions ☒Engagement	☐ Clustering ☐ Engagement ☐Content analysis	
Development and testing of a prototype				
Journal or portfolio				
Focus groups				
Intervention				
☒Scaffolding hints ☐Formative feedback				

☐ Reminders ☐ Final marks

3.4.2 Physics

Students form a first perception of the fundamental forms of energy, realize that energy is transformed from one form to another and that it is stored. Students know the main modern energy sources and realize that their rational use reduces the energy problem. Students also appreciate the importance of mild forms of energy for the environment, understand the relationship between electricity and magnetism as a process of energy transformation and appreciate the importance of electromagnetism in the development of technological culture. Finally, students recognize the ways of heat dissipation, connect them to the states of matter and appreciate the importance of the ways of heat dissipation in phenomena of everyday life.

Table 48. Physics course – Basic information

Target Group	Subject	Time/Duration	Overall Objective	Success metrics
☐ Undergraduate university students ☐ Postgraduate university students ☐ Secondary education students ☒ Primary education students ☐ Professionals	Physics	3 x 45 minutes	Learn the fundamentals form of energy and how to transform energy from one form to another.	Assignment marks Student feedback

Initially, the teacher provides students with learning material that helps them explore all the different concepts they will learn in the course. Such material can be PowerPoint slides, literature links, quiz, and games.

Table 49. Physics – Concept exploration

Concept exploration: Pre – class (educator-led part of the process that introduces learners to learning material. This is traditionally the presentation part of a course outside the

classroom (by e.g. video lectures)

PBL step: Problem formulation

Flipped Classroom: Outside of the classroom

Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒ Discussion	Solving exercises	☒Launch game elements for studying ☒Provide external tools	☒ Websites ☒ Slides ☐ Literature ☐ Video lectures / tutorials ☐ Audio lectures	To understand the concepts introduced in the lectures/slides.
☒ Accessing learning material	Read theory.	☒Provide external tools	☒ Websites	To solve exercises.
☐ Concept maps				
☐ Group game				
☐ Simulation				
☒ Quiz/test	Answer questions in quizzes on the material read	☒Launch game elements for quizzes		Identify possible misconceptions
☐ Develop an infographic about the subject				
☐ Keywords on post-It notes				
☐ Watching videos				
Engagement with students				
☒ Monitor students' online interactions ☒ Provide additional content ☐ Change activities (e.g. more or different quizzes)				

Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
Discussion	☒ Individual performance ☐ Group performance	☒ Online interactions ☐Number of posts	☒Engagement patterns ☐Clustering ☐Social network analysis ☐Discourse analysis
Material accessed	☒ Individual performance	☒ Material accessed ☐ Number of materials	
Concept maps	☐ Individual performance ☐ Group performance ☐Structure of the map and how elaborate it is	Final product (i.e. map)	
Group game	☐ Individual performance ☐Group's ability to communicate and work together	Outcome/performance in the group game	
Simulation	Degree of interaction with the simulation	Outcome/performance in simulation	
Intervention			
Redesign materials ☒Provide feedback ☒Plan additional activities ☐Send email reminders to disengaged students ☒Scaffolding			

Table 50. Physics – Meaning making

Meaning making: Pre – class (Students make meaning out of the information they have been exposed to by engaging in various assessment or reflection activities. Students show their mastery over the concept exploration content by producing their own content that

reflects upon their acquisition in a meaningful way) **PBL step**: Problem analysis **Flipped Classroom**: Outside of the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒ Content		☒Launch game elements for studying ☒Provide external tools (e.g. links with books / articles)	☒Websites ☒ Slides ☒ Literature ☐ Video lectures ☐ Audio lectures	☒Learn how to review available information
Discussion		☐ Chat room ☐ Forum		
☒Quiz	Answer questions on theory taught	☒ Quiz tool	☒ Quiz questions in game / Kahoot	Understand the relevant theory and solve the exercises successfully
Game			☒ Slides ☒ Literature ☐ Video lectures ☐ Audio lectures	To consolidate learning/test knowledge
One-minute presentations				
Blog/vlog/social media posts				
Debate				
Producing a short podcast or a video on the subject				☐Learn how to interpret appropriate information
Engagement with students				

☒ Monitor students' ongoing progress during the problem analysis phase ☒ Provide additional content if students seem to not have understood part of the subject ☐ Change the activities to ensure more participation for the students that have not understood the material or seem to not collaborate with their team ☒ Challenge/motivate students/groups who understand to dig deeper into the learning material

Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
Discussion	☒ Individual performance ☐Group performance	☒Self-reported perception ☐Academic results ☒Engagement	☒ Participation ☐ Performance ☐Content analysis
Quiz	☒ Individual performance	☐ Answers (correct, incorrect, frequency or incorrect answers)	☒ Statistics (more commonly wrong answer, average grades) ☐ Likelihood to fail – prediction based on answers patterns
Game	☒ Individual performance ☐Group performance	☒Task completion time ☐Navigation paths	☒In-game statistics like completion time, completion rate ☒in-game engagement

Intervention
☒Recommendations ☒Feedback ☒Send email reminders to disengaged students ☐Pop-up tips after a prolonged stay at one level/checkpoint ☒A notification to the teacher that a pupil is stuck and has not progressed.

Table 51. Physics – Demonstration and application stage

Demonstration and application (Occurs in the classroom. Students analyse, evaluate and create and engage in peer learning activities or projects, while educators evaluate and offer additional support where needed)

PBL step: Problem solving

Flipped Classroom: Inside the classroom

Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
Group work				
Development and testing of a prototype				
Journal or portfolio				☐Learn how to construct a portfolio of evidence
Focus groups				
Individual reports				
Develop cases studies				
☒ Oral presentations	☒ Present each diagram created and its rationale		☒ Slides	☒Learn how to present and justify decisions made during system design

Engagement with students
☐ Monitor the problem solved
☐ Provide multiple learning pathways if problem solution is insufficient
☐ Provide multiple ways for students to assess their solution

Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
Group work	☐ Individual performance ☐Group performance	☐Self-reported perception ☐Number of solution versions ☐Engagement	☐ Clustering ☐ Engagement ☐Content analysis

		☐Experience points	
Development and testing of a prototype			
Journal / portfolio / wiki			
Focus groups			
Intervention			
☐Scaffolding hints ☐Formative feedback ☐ Reminders			

Table 52. Physics – Experiential engagement

Experiential engagement (occurs when students consolidate their knowledge or explore further. It may occur before the concept exploration stage, when educators engage students in activities with the aim to pique their interest in a topic (e.g. play a game). It may also occur after the meaning-making stage, where students have to apply what they have learned (e.g. practice a skill, work on a project, etc.). At this stage, the educator has a chance to support students in applying their knowledge) **PBL step**: Evaluation and Reporting **Flipped Classroom**: After the class				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
Group work				
☒ Individual work	Solving Exercises	-		To assess whether the learning goals of the course have been achieved.
Development and testing of a prototype				

Journal or portfolio				
Engagement with students				
☐ Configure the students' project / tasks based on their interactions in the game				
Reflection				
Learning activity	**Evaluation method**	**Data**	**Learning analytics**	
Group work	☒ Individual performance ☐Group performance	☐Self-reported perception ☐Number of solution versions ☒Engagement	☐ Clustering ☒Engagement ☐Content analysis	
Development and testing of a prototype				
Journal or portfolio				
Focus groups	Provide feedback regarding the experience with the course			
Intervention				
☐Scaffolding hints ☒Formative feedback ☒ Reminders ☒ Final marks				

3.4.3 Informatics

Students that complete the Informatics course should be able to analyse complex tasks in individual simpler projects, choose the appropriate ICT tools for implementation of the work it undertake, use various ICT tools effectively to complete their work and to select, organize and sort information. Students should also be able to compose, create and transform information and material, apply criteria evaluation of sources and information, and present and communicate their ideas.

Table 53. Informatics course – Basic information

Target Group	Subject	Time/Duration	Overall Objective	Success metrics
☐ Undergraduate university students ☐ Postgraduate university students ☐ Secondary education students ☒ Primary education students ☐ Professionals	Informatics	3 x 45 minutes	Learn how to code and how to transform the solution of a problem to simple steps forming an algorithm.	Students' feedback.

Table 54. Informatics – Concept exploration

Concept exploration: Pre – class (educator-led part of the process that introduces learners to learning material. This is traditionally the presentation part of a course outside the classroom (by e.g. video lectures)

PBL step: Problem formulation

Flipped Classroom: Outside of the classroom

Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒ Discussion		☒Launch game elements for studying ☒Provide external tools	☒ Websites ☒ Slides ☒ Literature ☐ Video lectures / tutorials ☐ Audio lectures	
☐ Accessing learning material				

☐ Concept maps				
☐ Group game				
☐ Simulation				
☒ Quiz/test		☒ Launch game for quiz	☒ Quiz questions	☒ Understand the learning material
☐ Develop an infographic about the subject				
☐ Keywords on post-It notes				
☐ Watching videos				

Engagement with students
☒ Monitor students' online interactions ☒ Provide additional content ☒ Change activities (e.g. more or different quizzes)

Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
Discussion	☒ Individual performance ☐ Group performance	☒ Online interactions ☐Number of posts	☒Engagement patterns ☐Clustering ☐Social network analysis ☐Discourse analysis
Material accessed	☒ Individual performance	☒ Material accessed ☐ Number of materials	
Concept maps	☐ Individual performance ☐ Group performance ☐Structure of the map and how elaborate it is	Final product (i.e. map)	

Group game	☒ Individual performance ☐Group's ability to communicate and work together	Outcome/performance in the group game	
Simulation	Degree of interaction with the simulation	Outcome/performance in simulation	
Intervention			
Redesign materials ☒Provide feedback ☐Plan additional activities ☐Send email reminders to disengaged students ☐Scaffolding			

Table 55. Informatics – Meaning making stage

Meaning making: Pre – class (Students make meaning out of the information they have been exposed to by engaging in various assessment or reflection activities. Students show their mastery over the concept exploration content by producing their own content that reflects upon their acquisition in a meaningful way) **PBL step**: Problem analysis **Flipped Classroom**: Outside of the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
Content	Solve Exercises	☒Launch game elements for studying ☐Provide external tools (e.g. links with books / articles)	☒ Websites ☒ Slides ☒ Literature ☐ Video lectures ☐ Audio lectures	☒Learn how to review available information
Discussion		☐ Chat room ☐ Forum		

Quiz		☒ Quiz tool		
Game			☒ Slides ☐ Literature ☐ Video lectures ☐ Audio lectures	
One-minute presentations				
Blog/vlog/social media posts				
Debate				
Producing a short podcast or a video on the subject				☐Learn how to interpret appropriate information

Engagement with students
☒ Monitor students' ongoing progress during the problem analysis phase ☒ Provide additional content if students seem to not have understood part of the subject ☐ Change the activities to ensure more participation for the students that have not understood the material or seem to not collaborate with their team ☒ Challenge/motivate students/groups who understand to dig deeper into the learning material

Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
Discussion	☒ Individual performance ☐Group performance	☐Self-reported perception ☐Academic results ☒Engagement	☒ Participation ☐ Performance ☒Content analysis
Quiz	☒ Individual performance	☒ Answers (correct, incorrect, frequency or incorrect answers)	☐ Statistics (more commonly wrong answer, average grades) ☐ Likelihood to fail – prediction based on answers patterns
Game	☒ Individual	☒Task completion	☒In-game statistics like

	performance ☐Group performance	time ☐Navigation paths	completion time, completion rate ☐in-game engagement
Intervention			
☒Recommendations ☒Feedback ☒Send email reminders to disengaged students ☐Pop-up tips after a prolonged stay at one level/checkpoint ☒A notification to the teacher that a pupil is stuck and has not progressed.			

Table 56. Informatics – Demonstration and application stage

Demonstration and application (Occurs in the classroom. Students analyse, evaluate and create and engage in peer learning activities or projects, while educators evaluate and offer additional support where needed) **PBL step**: Problem solving **Flipped Classroom**: Inside the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
Group work				
Development and testing of a prototype				
Journal or portfolio				☒Learn how to construct a portfolio of evidence
Focus groups				
Individual reports				
Develop cases studies				
Oral				☒Learn how to

presentations				present and justify an informed position
Engagement with students				
☒ Monitor the problem solved ☒ Provide multiple learning pathways if problem solution is insufficient ☐ Provide multiple ways for students to assess their solution				
Reflection				
Learning activity	**Evaluation method**	**Data**	**Learning analytics**	
Group work	☒ Individual performance ☐Group performance	☒Self-reported perception ☐Number of solution versions ☐Engagement ☐Experience points	☐ Clustering ☒ Engagement ☒Content analysis	
Development and testing of a prototype				
Journal / portfolio / wiki				
Focus groups				
Intervention				
☐Scaffolding hints ☒ Formative feedback ☒ Reminders				

Table 57. Informatics – Experiential engagement stage

Experiential engagement (occurs when students consolidate their knowledge or explore further. It may occur before the concept exploration stage, when educators engage students in activities with the aim to pique their interest in a topic (e.g. play a game). It may also occur after the meaning-making stage, where students have to apply what they have learned (e.g. practice a skill, work on a project, etc.). At this stage, the educator has a chance

to support students in applying their knowledge)

PBL step: Evaluation and Reporting

Flipped Classroom: After the class

Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
Group work				
☒Individual work	☒Solve the coding exercises	N/A	Assignment brief	To assess whether the learning goals of the module have been achieved.
Development and testing of a prototype				
Journal or portfolio				

Engagement with students
☐ Configure the students' project / tasks based on their interactions in the game
☒Provide formative feedback on draft reports prior to the online submission

Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
Group work	☒ Individual performance ☐Group performance	☒Self-reported perception ☐Number of solution versions ☒Engagement	☐ Clustering ☒ Engagement ☐Content analysis
Development and testing of a prototype			
Journal or portfolio			

Focus groups			
Intervention			
☒Scaffolding hints ☒Formative feedback ☒ Reminders ☒ Final marks			

3.5 Revheim School

Revheim School is a lower secondary school in Norway with pupils ranging from ages 14-16. The pilots at this school will run on the ninth grade of social sciences, having four classes consisting of 100 pupils.

We will be running our first pilot in one class during November/December to alpha test it, revise our approach if necessary, and then run the three remaining classes in January/February. This will also ensure that there are no technical problems for the main bulk, as well as that the course itself can be adjusted if necessary.

The theme of the course will be imperialism. The plan is to develop goals in accordance with our new curriculum plan.

The pupils after the tenth grade should be able to:

- Use didactical methods and digital resources in their own investigations and be able to present their findings with the use of digital tools whilst discussing the validity and relevance of their findings.
- Draft how different presentations of the past, e.g. events and groups have been affecting people's actions and attitudes to this day.
- Reflect upon how people who have been fighting for changes in society have been affected by geography and historical contexts.

This means that the pupils will develop a multi-perspective understanding of imperialism by focusing on the history, the societal impact and the geographical aspects around it. To achieve this, the curriculum's goals are perfect for a flipped classroom approach in that the pupils need to be doing the investigation of the topic themselves with scaffolding from the teacher. The pupils will present their findings in pairs or by themselves at the end of the 2 -week period. They can choose among a video presentation, a podcast or a PowerPoint presentation in front of the class.

3.5.1 Social Sciences on Imperialism

Table 58. Social Sciences on Imperialism – Basic information

Target Group	Subject	Time/Duration	Overall Objective	Success metrics
☐Undergraduate university students ☐Postgraduate university students ☒Secondary education students ☐Primary education students ☐Professionals	Imperialism	2 weeks	For pupils to learn about the imperialist time period and enable the pupils to reflect upon the underlying reasons for the imperialist expansion and how it affects the world today.	For a pupil to be successful it needs to be able to use history to explain and discuss how events after this time period has unfolded. This means that the presentation should include elements of discussion and not just presentation of a time period.

Table 59. Social Sciences on Imperialism – Concept exploration

Concept exploration: Pre – class (educator-led part of the process that introduces learners to learning material. This is traditionally the presentation part of a course outside the classroom (by e.g. video lectures)

PBL step: Problem formulation

Flipped Classroom: Outside of the classroom

Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒ Discussion	Homework activity to watch a video on imperialism, coupled with keywords on things they did not understand from the video, they are placed	☐Launch game elements for studying ☒ Provide external tools, www.padlet.com	☒Websites ☐ Slides ☐ Literature ☐ Video lectures / tutorials ☐ Audio lectures	Pupils scaffold their learning with each other and gain a social constructed understanding of the topic thus far. Produce a research question

	into groups where they explain to each other what they understood from the topic. Teacher will walk from group to group explaining and helping with things they do not understand.			they want to pursue the next two weeks.
☒ Accessing learning material	After homework and group discussions they are given different sources they can work with in the next step to learn more about the topic.			A select few good sources to start with helps the pupils understand what type of sources they should be consulting to learn more.
☐ Concept maps				
☐ Group game				
☐ Simulation				
☐ Quiz/test				
☐ Develop an infographic about the subject				
☒ Keywords on post-It notes	Whilst watching the video they are to write down keywords that they learn, want to learn more about or didn't understand.			This helps them be more aware of what they know and what they need to learn.
☒ Watching	Homework is to		☒ Video lectures	Everyone has the

videos	watch an introduction video on YouTube		/ tutorials	same starting point for the topic and know something about it.

Engagement with students
☐ Monitor students' online interactions ☒ Provide additional content ☐ Change activities (e.g. more or different quizzes)

Reflection			
Learning activity	**Learning activity**	**Learning activity**	**Learning activity**
Discussion	Discussion	Discussion	Discussion
Material accessed	Material accessed	Material accessed	Material accessed
Concept maps	Concept maps	Concept maps	Concept maps
Group game	Group game	Group game	Group game
Simulation	Simulation	Simulation	Simulation

Intervention
Redesign materials ☒Provide feedback ☐Plan additional activities ☐Send email reminders to disengaged students ☒ Scaffolding

Table 60. Social Sciences on Imperialism – Meaning making stage

Meaning making: Pre – class (Students make meaning out of the information they have been exposed to by engaging in various assessment or reflection activities. Students show their mastery over the concept exploration content by producing their own content that reflects upon their acquisition in a meaningful way) **PBL step**: Problem analysis **Flipped Classroom**: Outside of the classroom
Preparation

Learning activity	Tasks	Gamification / tools	Learning materials / media	Learning goals / outcomes
Content	Create a working sheet where they write down information they have found and reflect upon it in a written form. Use game elements for studying things they need to know about the topic.	☒ Launch game elements for studying ☐Provide external tools (e.g. links with books / articles)	☐ Websites ☐ Slides ☐ Literature ☐ Video lectures ☐ Audio lectures	☐Learn how to review available information
Discussion	Discussion in groups about what they have written on the subject and the question they try to answer.	☐ Chat room ☐ Forum		Peer review of the written assignment
Quiz		☐ Quiz tool		
Game	Creation of their own Q&A for the teacher to implement into the game.	Gamification of a quiz.	☐ Slides ☐ Literature ☐ Video lectures ☐ Audio lectures	
One-minute presentations				
Blog/vlog/social media posts				
Debate				
Producing a short podcast or a video on the subject	Using the worksheet to create a podcast or video where they present their			☒Learn how to interpret appropriate information

	findings.			
Engagement with students				
☒ Monitor students' ongoing progress during the problem analysis phase ☒Provide additional content if students seem to not have understood part of the subject ☒ Change the activities to ensure more participation for the students that have not understood the material or seem to not collaborate with their team ☒ Challenge/motivate students/groups who understand to dig deeper into the learning material				
Reflection				
Learning activity	**Evaluation method**	**Data**	**Learning analytics**	
Discussion	☒ Individual performance ☐Group performance	☒Self-reported perception ☐Academic results ☒ Engagement	☒ Participation ☒ Performance ☒ Content analysis	
Quiz	☐ Individual performance	☐ Answers (correct, incorrect, frequency or incorrect answers)	☐ Statistics (more commonly wrong answer, average grades) ☐ Likelihood to fail – prediction based on answers patterns	
Game	☒ Individual performance ☐Group performance	☒ Task completion time ☐Navigation paths	☒ In-game statistics like completion time, completion rate ☐in-game engagement	
Intervention				
☐Recommendations ☒ Feedback ☐Send email reminders to disengaged students ☐Pop-up tips after a prolonged stay at one level/checkpoint ☐A notification to the teacher that a pupil is stuck and has not progressed.				

Table 61. Social Sciences on Imperialism – Demonstration and application stage

Demonstration and application (Occurs in the classroom. Students analyse, evaluate and

create and engage in peer learning activities or projects, while educators evaluate and offer additional support where needed)

PBL step: Problem solving

Flipped Classroom: Inside the classroom

Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
Group work				
Development and testing of a prototype				
Journal or portfolio				☐Learn how to construct a portfolio of evidence
Focus groups				
Individual reports				
Develop cases studies				
Oral presentations	Present their findings and answer the question they made in the first task.			☒ Learn how to present and justify an informed position

Engagement with students
☒ Monitor the problem solved
☐ Provide multiple learning pathways if problem solution is insufficient
☒ Provide multiple ways for students to assess their solution

Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
Group work	☐ Individual performance	☐Self-reported perception	☐ Clustering ☐ Engagement

	☐Group performance	☐Number of solution versions ☐Engagement ☐Experience points	☐Content analysis
Development and testing of a prototype			
Journal / portfolio / wiki			
Focus groups			
Intervention			
☐Scaffolding hints ☐Formative feedback ☐ Reminders			

Table 62. Social Sciences on Imperialism – Experiential engagement stage

Experiential engagement (occurs when students consolidate their knowledge or explore further. It may occur before the concept exploration stage, when educators engage students in activities with the aim to pique their interest in a topic (e.g. play a game). It may also occur after the meaning-making stage, where students have to apply what they have learned (e.g. practice a skill, work on a project, etc.). At this stage, the educator has a chance to support students in applying their knowledge) **PBL step**: Evaluation and Reporting **Flipped Classroom**: After the class				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
Group work	Working on the podcast or movie.			
individual work	Working on the podcast or movie.			

Development and testing of a prototype				
Journal or portfolio				
Engagement with students				
☐ Configure the students' project / tasks based on their interactions in the game				
Reflection				
Learning activity	**Evaluation method**	**Data**	**Learning analytics**	
Group work	☐ Individual performance ☐Group performance	☒Self-reported perception ☐Number of solution versions ☒Engagement	☐ Clustering ☐ Engagement ☐Content analysis	
Development and testing of a prototype				
Journal or portfolio				
Focus groups				
Intervention				
☒ Scaffolding hints ☐Formative feedback ☐ Reminders ☒ Final marks				

3.5.2 Social Sciences on Imperialism (part 2)

Table 63. Social Sciences on Imperialism (part 2) – Basic information

Target Group	Subject	Time/Duration	Overall Objective	Success metrics
☐Undergraduate university students	Imperialism	2 weeks	For pupils to learn about the	For a pupil to be successful it needs

☐Postgraduate university students ☒Secondary education students ☐Primary education students ☐Professionals			imperialist time period and enable the pupils to reflect upon the underlying reasons for the imperialist expansion and how it affects the world today.	to be able to use history to explain and discuss how events after this time period has unfolded. This means that the presentation should include elements of discussion and not just presentation of a time period.

Table 64. Social Sciences on Imperialism (part 2)– Concept exploration

Concept exploration: Pre – class (educator-led part of the process that introduces learners to learning material. This is traditionally the presentation part of a course outside the classroom (by e.g. video lectures)

PBL step: Problem formulation

Flipped Classroom: Outside of the classroom

Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
☒Discussion	Homework activity to watch a video on imperialism, coupled with keywords on things they did not understand from the video, they are placed into groups where they explain to each other what they understood from the topic.	☐Launch game elements for studying ☒ Provide external tools, www.padlet.com	☒Websites ☐ Slides ☐ Literature ☐ Video lectures / tutorials ☐ Audio lectures	Pupils scaffold their learning with each other and gain a social constructed understanding of the topic thus far. Produce a research question they want to pursue the next two weeks.

	Teacher will walk from group to group explaining and helping with things they do not understand.			
☒Accessing learning material	After homework and group discussions they are given different sources they can work with in the next step to learn more about the topic.			A select few good sources to start with helps the pupils understand what type of sources they should be consulting to learn more.
☐ Concept maps				
☐ Group game				
☐ Simulation				
☐ Quiz/test				
☐ Develop an infographic about the subject				
☒ Keywords on post-It notes	Whilst watching the video they are to write down keywords that they learn, want to learn more about or didn't understand.			This helps them be more aware of what they know and what they need to learn.
☒ Watching videos	Homework is to watch an introduction video on YouTube		☒ Video lectures / tutorials	Everyone has the same starting point for the topic and know something about it.
Engagement with students				

☐ Monitor students' online interactions ☒ Provide additional content ☐ Change activities (e.g. more or different quizzes)			
Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
Discussion	☒ Individual performance ☒ Group performance	☐ Online interactions ☐Number of posts	☐Engagement patterns ☐Clustering ☐Social network analysis ☐Discourse analysis
Material accessed	☒ Individual performance	☒Material accessed ☒ Number of materials	
Concept maps	☐ Individual performance ☐ Group performance ☐Structure of the map and how elaborate it is	Final product (i.e. map)	
Group game	☐ Individual performance ☐Group's ability to communicate and work together	Outcome/performance in the group game	
Simulation	Degree of interaction with the simulation	Outcome/performance in simulation	
Intervention			
Redesign materials ☒Provide feedback ☐Plan additional activities ☐Send email reminders to disengaged students ☒Scaffolding			

Table 65. Social Sciences on Imperialism (part 2) – Meaning making

Meaning making: Pre – class (Students make meaning out of the information they have been exposed to by engaging in various assessment or reflection activities. Students show their mastery over the concept exploration content by producing their own content that reflects upon their acquisition in a meaningful way)

PBL step: Problem analysis

Flipped Classroom: Outside of the classroom

Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
Content	Create a working sheet where they write down information they have found and reflect upon it in a written form. Use game elements for studying things they need to know about the topic.	☒ Launch game elements for studying ☐Provide external tools (e.g. links with books / articles)	☐ Websites ☐ Slides ☐ Literature ☐ Video lectures ☐ Audio lectures	☐Learn how to review available information
Discussion	Discussion in groups about what they have written on the subject and the question they try to answer.	☐ Chat room ☐ Forum		Peer review of the written assignment
Quiz		☐ Quiz tool		
Game	Creation of their own Q&A for the teacher to implement into the game.	Gamification of a quiz.	☐ Slides ☐ Literature ☐ Video lectures ☐ Audio lectures	
One-minute presentations				

Blog/vlog/social media posts				
Debate				
Producing a short podcast or a video on the subject	Using the worksheet to create a podcast or video where they present their findings.			☒Learn how to interpret appropriate information

Engagement with students
☒ Monitor students' ongoing progress during the problem analysis phase ☒ Provide additional content if students seem to not have understood part of the subject ☒ Change the activities to ensure more participation for the students that have not understood the material or seem to not collaborate with their team

Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
Discussion	☒Individual performance ☐Group performance	☒Self-reported perception ☐Academic results ☒ Engagement	☒ Participation ☒Performance ☒ Content analysis
Quiz	☐ Individual performance	☐ Answers (correct, incorrect, frequency or incorrect answers)	☐ Statistics (more commonly wrong answer, average grades) ☐ Likelihood to fail – prediction based on answers patterns
Game	☒ Individual performance ☐Group performance	☒ Task completion time ☐Navigation paths	☒ In-game statistics like completion time, completion rate ☐in-game engagement

Intervention
☐Recommendations ☒Feedback

☐Send email reminders to disengaged students ☐Pop-up tips after a prolonged stay at one level/checkpoint ☐A notification to the teacher that a pupil is stuck and has not progressed.

Table 66. Social Sciences on Imperialism (part 2)– Demonstration and application

Demonstration and application (Occurs in the classroom. Students analyse, evaluate and create and engage in peer learning activities or projects, while educators evaluate and offer additional support where needed) **PBL step**: Problem solving **Flipped Classroom**: Inside the classroom				
Preparation				
Learning activity	**Tasks**	**Gamification / tools**	**Learning materials / media**	**Learning goals / outcomes**
Group work				
Development and testing of a prototype				
Journal or portfolio				☐Learn how to construct a portfolio of evidence
Focus groups				
Individual reports				
Develop cases studies				
Oral presentations	Present their findings and answer the question they made in the first task.			☒ Learn how to present and justify an informed position
Engagement with students				
☒ Monitor the problem solved				

☐ Provide multiple learning pathways if problem solution is insufficient ☒ Provide multiple ways for students to assess their solution			
Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
Group work	☐ Individual performance ☐Group performance	☐Self-reported perception ☐Number of solution versions ☐Engagement ☐Experience points	☐ Clustering ☐ Engagement ☐Content analysis
Development and testing of a prototype			
Journal / portfolio / wiki			
Focus groups			
Intervention			
☐Scaffolding hints ☐Formative feedback ☐ Reminders			

Table 67. Social Sciences on Imperialism (part 2) – Experiential engagement

Experiential engagement (occurs when students consolidate their knowledge or explore further. It may occur before the concept exploration stage, when educators engage students in activities with the aim to pique their interest in a topic (e.g. play a game). It may also occur after the meaning-making stage, where students have to apply what they have learned (e.g. practice a skill, work on a project, etc.). At this stage, the educator has a chance to support students in applying their knowledge) **PBL step**: Evaluation and Reporting **Flipped Classroom**: After the class
Preparation

Learning activity	Tasks	Gamification / tools	Learning materials / media	Learning goals / outcomes
Group work	Working on the podcast or movie.			
individual work	Working on the podcast or movie.			
Development and testing of a prototype				
Journal or portfolio				

Engagement with students
☐ Configure the students' project / tasks based on their interactions in the game

Reflection			
Learning activity	**Evaluation method**	**Data**	**Learning analytics**
Group work	☐ Individual performance ☐Group performance	☑ Self-reported perception ☐Number of solution versions ☑ Engagement	☐ Clustering ☐ Engagement ☐Content analysis
Development and testing of a prototype			
Journal or portfolio			
Focus groups			

Intervention
☑ Scaffolding hints ☐Formative feedback ☐ Reminders ☑ Final marks

4 Conclusion

The above plans show that the FLIP2G model can incorporate a wide variety of learning activities and assessment types. Instructors that are interested in adopting the model, need to consider the learning goals of their courses, the level of study and the delivery mode of the course. The above plans are only indicative of how the model can be applied in different disciplines, so we encourage instructors to experiment with additional tools, learning activities, or whichever delivery modes would be deemed most appropriate each time.