INSTRUCTIONAL BOOKLET

insysted
Integrated System
for European Digital Learning

INSYSTED PEDAGOGICAL FRAMEWORK

An inspirational guide to foster soft and digital skills development and internationalisation in higher education through MOOCs, serious games and online learning communities

INSYSTED PEDAGOGICAL FRAMEWORK – INSTRUCTIONAL BOOKLET

This is the intellectual output 1 of the Erasmus+ KA2 project INSYSTED – Integrated System for European Digital Learning. Project number: 2019-1-DE01-KA203-005038

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Editorial information

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METID
LEARNING INNOVATION

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Aknowledgments

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POLITECNICO MILANO 1863
DIPARTIMENTO DI INGEGNERIA GESTIONALE

CentraleSupélec

Technische Universität Berlin

UCL

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EXECUTIVE SUMMARY

The booklet on the INSYSTED pedagogical framework provides practical advice on how to foster **soft and digital skills** and **internationalisation** in higher education by using **MOOCs, serious games and online learning communities** in a **blended learning** setting.

The overarching purpose is to **increase students' preparedness** for the challenges of a rapidly evolving labour market by promoting instructional approaches where they are active participants in their learning process, rather than passive recipients (student-centred approaches).

This booklet is for university teachers, especially from **industrial and management engineering** faculties, but also **non-academic staff** within operational units in higher education institutions and anybody interested in education processes.

The booklet can be used to support both the (re)design of lessons and courses and the training of pre-service and in-service teachers.

This publication takes a **bite sized approach with in-depth info cards** to meet the needs of an audience with various levels of experience in teaching innovation; although it is targeted towards industrial and management engineering education, it is meant to be transferable to any other university context.

To achieve these aims, the handbook is organised as follows.

The **first part** (Teaching innovation & blended learning) outlines the value proposition of the INSYSTED approach and the pillars that support it: MOOCs, serious games and online learning communities.

The **second part** (Intended Learning Outcomes – ILOs) covers the purposes for which learning outcomes are used and discusses aspects related to the definition and use of ILOs.

The **third part** (Assessment tasks) sets out the basic steps to be taken into account when designing assessment tasks and provides examples.

The **fourth part** (Teaching and Learning Activities – TLAs) describes how teaching and learning activities can be redesigned; uses examples to illustrate how the pillars (MOOCs, serious games and online learning communities) can be integrated into practice.

The booklet concludes with an **exploration of the peculiar value added** by each pillar.

Each part of the booklet provides an overview of, and a direct link to, **supporting research** in the topics covered.

THE BOOKLET CONTEXT

This booklet is the first output of the INSYSTED project (INtegrated SYSTem for European Digital learning http://www.alliance4tech.eu/insysted/), an Erasmus+ funded strategic partnership among Alliance4Tech universities:

- Technische Universität Berlin, Germany (coordinator);
- CentraleSupélec, France;
- Politecnico di Milano, Italy;
- UCL University College London, United Kingdom.

The INSYSTED project aims to unleash the potential of the integrated use of MOOCs, serious games and learning communities in a blended learning setting to support internationalisation and to foster soft and digital skills.

INTRODUCTION

WHO IS THIS BOOKLET FOR?

University teachers, especially in industrial and management engineering courses and related departments [PRIMARY TARGET AUDIENCE]

Non-academic staff within operational units in higher education institutions such as teaching and learning centres and library services

Anybody interested or involved in education processes

WHAT DO I FIND IN THE BOOKLET?

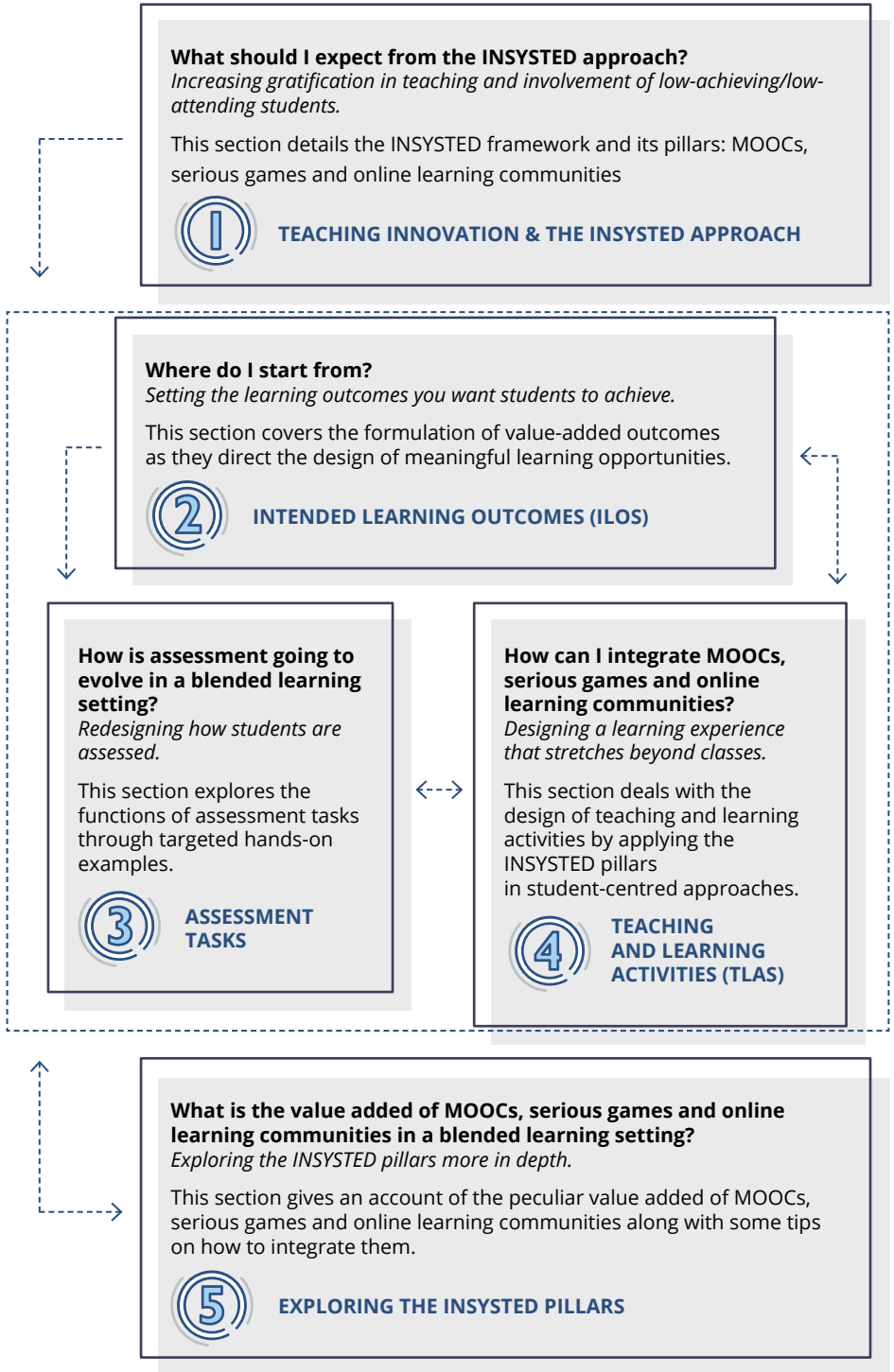
Whether you are about to start or you already have experience in teaching innovation, you will find **info cards** with both basic and advanced tips and a focus on **industrial and management engineering education** with targeted, hands-on examples.

Two distinctive features of the booklet are: **low-hanging fruit ideas** which describe tips that are relatively easy to implement; **supporting research and additional resources** which explore topics more in depth.

The booklet takes a bite sized approach, so that diverse reading options are available according to your needs: you may cherry-pick the content most beneficial to you, or you may peruse content following the suggested path.

You can print this booklet out...

...or you can read it on your digital device.



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BEFORE THE INSYSTED APPROACH

Anna

Engineering university teacher

"I am a university teacher in the study programme in Industrial Engineering and Management and I am reflecting on how to make the most of my courses.

I would like the students to engage in the classes more actively and gain practice in digital tools, in addition to just listening and taking notes."

Anna

Engineering university teacher

"I decided to use a small steps approach and to focus on one critical topic within my course, blending face-to-face and online activities."

1. TEACHING INNOVATION & THE INSYSTED APPROACH

WHAT IS THE VALUE PROPOSITION OF THE INSYSTED APPROACH?

The 3 INSYSTED pillars: MOOCs, serious games and online learning communities and the ProTUCE game.

WHY INNOVATE MY TEACHING?

Reflections on the motivation drivers and expectations for teaching innovation.

1. TEACHING INNOVATION & THE INSYSTED APPROACH

WHAT IS THE RATIONALE OF THE INSYSTED APPROACH?

More than ever, students in higher education will be working in jobs that may not yet exist. The Erasmus+ INSYSTED project aims to increase their preparedness for the challenges of a rapidly evolving labour market by promoting instructional approaches where students are active participants in their learning process, rather than passive recipients. These are known as student-centred approaches.

The overarching objectives of INSYSTED are:

- to foster **soft and digital skills** in learners, hence complementing their disciplinary knowledge;
- to support **internationalisation** by extending mobility and exchange opportunities through online tools and resources.

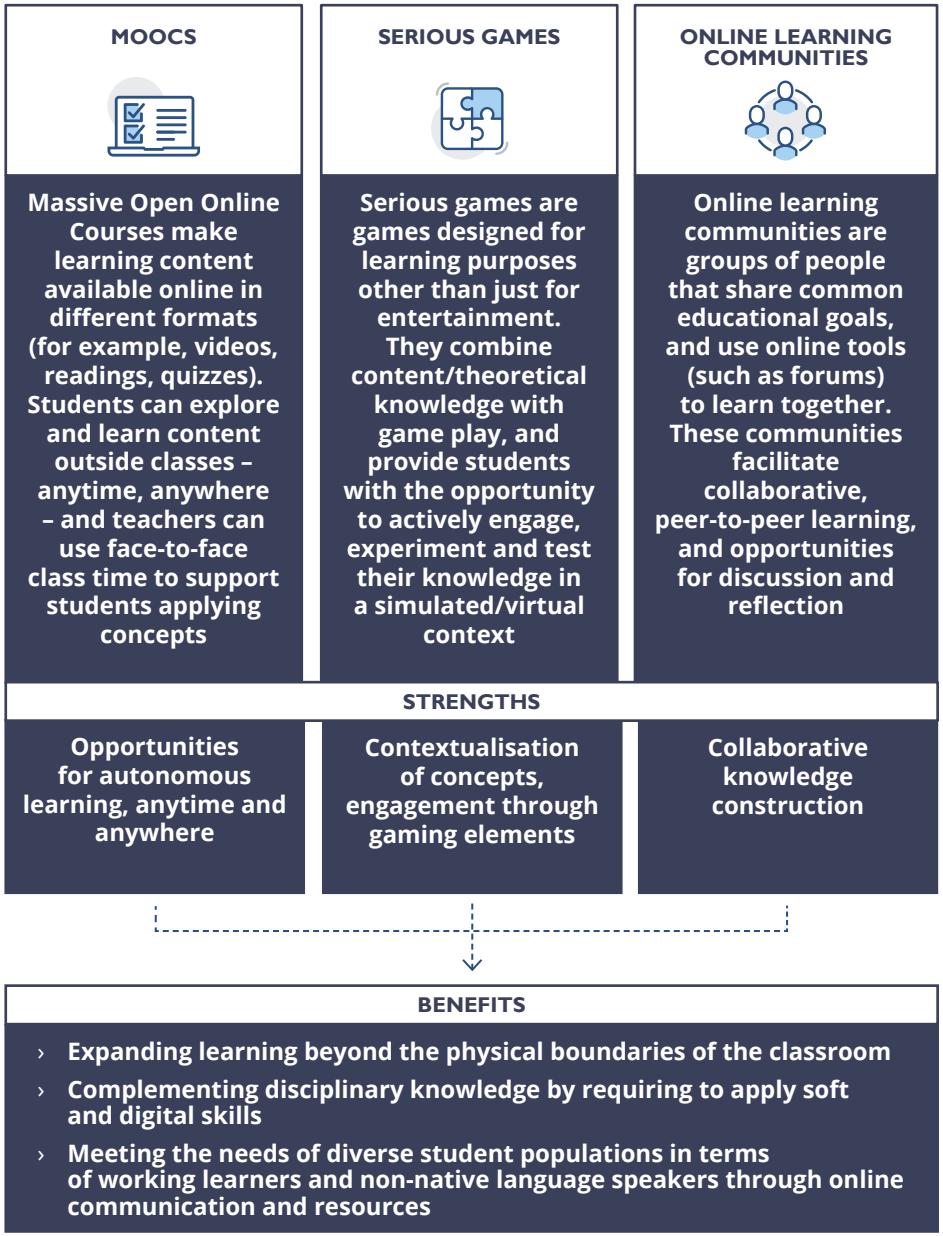
The INSYSTED approach is targeted primarily towards industrial and management engineering education, but it is meant to be **transferable** to any other university context.

This booklet aims to promote and inspire students-centred innovation through the integration of Massive Open Online Courses (MOOCs), serious games and online learning communities into curricular higher education (see the picture on the right). It can be used to support and guide:

- the **(re)design of learning opportunities** at various levels, from lessons, to courses, to programmes;
- the **training of both pre-service teachers (teachers in training) and in-service teachers (practising teachers).**

The booklet provides a step-by-step guide of how to design from scratch, or redesign, your lesson/course/programme by **blending face-to-face instruction** with online activities. Blended learning is "the planned integration of online and face-to-face instructional approaches in a way that maximises the positive features of each respective delivery mode" (Ragan, 2007).

The following figure summarises a key aspect related to each of the pillars and their combined benefit to blended learning approaches.



Below you can explore some selected insights from research.

- Using high quality MOOC content in a blended setting with a structured team-based approach can produce significant benefits for student learning and success (Ghadiri et al., 2013)
- Games and/or simulations may have a positive impact on learning goals in terms of cognitive, behavioural, and affective outcomes (Vlachopoulos, 2017).
- Forum activity in an online learning community seems to be a reliable predictor of academic performance (Dawson, 2010; Morris et al., 2005).

What fostering soft and digital skills means

Students can acquire new digital and soft skills such as:

- the **learning to learn ability** in terms of complementing their instruction by using MOOCs;
- the **ability to contextualise** their disciplinary knowledge and solve problems by using serious games;
- the **ability to collaborate** through digital tools by using forum-based online learning communities.

What supporting internationalisation means

MOOCs, serious games and online learning communities in a blended setting can be used to:

- prepare students for, support and follow up physical mobility;
- foster the exchange of pedagogical practices across EU Countries and beyond;
- extend educational opportunities and flexibility for all students, including working students.

The online accessibility of MOOCs allows learners to engage with other institutions programmes and content. MOOCs have also the advantage of accommodating, in principle, an unlimited number of students, in contrast with the restrictions imposed by physical classrooms. MOOCs can be used as an accelerator of some forms of internationalisation, where students interact with **learners from all over the world** and are exposed to materials and practices from **higher education institutions around the globe**, hence enriching their brick-and-mortar curriculum with the skills needed to operate in an international context.

An example of MOOC-supported internationalisation

The **Virtual Exchange Program** (https://www.tudelft.nl/studenten/onderwijs/virtual-exchange/) allows students from partner institutions such as a Technische Universiteit Delft – TU Delft to access MOOCs from high-ranking universities from Switzerland to the USA, whilst remaining at their home university and gaining credits for their study programme. In this context students can develop cross-boundary and cross-cultural awareness and knowledge, an educational exchange without the need to travel.

All courses involve online engagement with the curriculum and formal assessments; written exams take place at the learner's home university. Benefits for students include a wider choice of electives from courses from partner universities, experimenting with varied course activities and content formats, access to diverse expertise, studying at the time and place that suits them with no extra costs, being part of a global student community.

GIVING VALUE TO BLENDED LEARNING: THE PILLARS IN PRACTICE

The INSYSTED approach integrates the strengths of the **3 pillars** to unleash their potential; an important aspect of this approach is that it draws on the hands-on experience of Alliance4Tech partner institutions in this field.

MOOCs in a nutshell

Many high-ranking higher education institutions and other kinds of organisations share their expertise in the form of **online courses open to all** and able to accommodate an in principle **unlimited number of participants** (MOOCs).

MOOC content can be in various formats including, but not limited to, video lectures. In some cases MOOC material is made available under a Creative Commons licence which clearly states what the instructor is allowed to do with the learning content. This streamlines the process of reusing content in curricular education within or outside the institution which is offering the MOOC.

Some hints for integrating MOOC(s) into your teaching practice:

- you may use MOOC material **to complement your course activities,** e.g. assigning video lectures that convey concepts, so that students watch videos at home and you leverage classes to make students apply concepts under your guidance, also known as flipped classroom. To this end you can also use stand-alone Open Educational Resources (OER) available under a Creative Commons licence;
- you may ask your students **to participate in discussions and collaborative activities on MOOCs,** so that they can interact with larger and international learning communities to improve a wide range of soft skills such as written communication and teamwork.

Serious games in a nutshell

Serious games can be defined as computer games that are used for the purpose of learning, training, and instruction. In other terms, **serious games are games with more than just entertainment as a goal**, as they are designed to train a broad series of tasks using real life examples:

- the online application combines significant content with **motivation levels of game design** (e.g. competition, collaboration, challenge);
- learning typically occurs through **challenges** that require the learner to actively explore, experiment, compete or cooperate with other learners.

In the booklet you can find examples of use of a specific serious game (ProTUce), developed by the INSYSTED project to tackle production management problems.

Interdisciplinary subjects, where students need to combine knowledge and technical skills beyond their own discipline with soft skills such as communication, lend themselves well to serious games.

Some hints for integrating serious game(s) into your teaching practice:

- you may use serious games to make students **experiment with authentic tasks,** hence developing soft skills (e.g. problem solving) and applying knowledge (e.g. producing written and oral statements describing the interaction of complex variables and critical reasoning through simple and complex problems);
- you may use serious games to make students **engage in failure scenarios,** maximizing on-task learning and **reflective practice.**

Online learning communities in a nutshell

Online learning communities are groups of people that share **common goals and activities** and interact using online tools such as forums, blogs, videoconferencing applications. Here we focus on **course forum-based learning communities,** as the **forum** is one of the most commonly available tools in web-enhanced courses.

Some hints for integrating an online learning community into your teaching practice:

- you may use the forum to make students **develop course-related knowledge** through mutual interactions to produce assignments;
- you may require students to **discuss and exchange ideas in the forum** in flexible times and locations, hence extending opportunities outside the normal contact hours of the classroom. Learners engage in meaningful ways, especially those students who are less likely to participate, or are not comfortable to share their contributions in traditional classroom settings.

Integrating MOOCs, serious games and online learning communities into curricular education can enhance student's outcomes in terms of cognition, soft and digital skills. This is what this booklet aims to support.

WHAT IS THE VALUE PROPOSITION OF THE INSYSTED APPROACH?

The first of its kind, the INSYSTED booklet:

- **explores the potential** of the combined use of MOOCs, serious games and online learning communities in European higher education;
- **covers the challenges** of integrating these 3 pillars to develop soft and digital skills and to support internationalisation in terms of both physical and virtual exchange mobility;
- **provides targeted examples for using the ProTUce serious game**, which was specifically developed in the INSYSTED project to tackle production management problems;
- **integrates the feedback of partners from the industrial sector** to enrich its perspective on stakeholders.

The feedback of partners from the industrial sector

Partners from the industrial sector gave their feedback about the most demanded soft and digital skills that can support effectiveness at the workplace, especially in an international context:

- soft and digital skills seem to be equally important, but "methodological" soft skills in terms of **learning to learn and problem solving** might be more important as they provide a foundation to develop social and personal skills;
- digital skills all seem to be somewhat of the same importance and can help apply one's own "methodological" soft skills; **content creation skills** seem to be what lacks most in terms of generating meaningful, valuable new contents beyond the technical sense of knowing how to handle video production tools and multimedia;
- "**social**" **soft skills** are crucial to master any (non-trivial) project or task, especially in an international context. They can also help to mitigate ineffectiveness and frictions due to heterogeneity of people's objectives, incentives and backgrounds, which may happen in national as well as international contexts.

WHY INNOVATE MY TEACHING?

Do you want to attain better results in terms of students' achievements in crucial areas?

Do you want to reach out to low-achieving/ low-attending students?

Do you want to experiment with more gratifying teaching practices?

Do you want to improve the efficiency of your teaching in terms of achieving more with less effort/resources, and in terms of scalability/transferability/reuse?

Innovating teaching is no zero cost option at the very beginning, but it may be worth devoting some effort once you identified **your main motivation and expectations.**

What the research says

Technology is a means to an end, not an end in itself, and innovating teaching does not equal using digital resources and technologies. However, the use of MOOCs, serious games and online learning communities can support active learning strategies that help students learn. Active learning refers to any instructional method where **learners are actively or experiencing involved in the learning process**, beyond passive listening. Influential papers from the end of last century (Hestenes et al., 1992; Hacke, 1998) and more recent ones (Deslauriers et al. 2011), show the **effectiveness of active learning in STEM** and suggest it **imparts deep understanding of concepts** (Freeman et al., 2014).

Despite supporting evidence, research on university learning and teaching can very seldom give simple and straightforward answers, because phenomena are complex (Lindblom-Ylänne & Breslow, 2017) and empirical evidence often reveals complicated interrelationships which need to be taken into account. Some selected references you can explore are listed at the end of this section.

WHERE DO I START?

When trying a new approach in your course/lesson, you will need to act not only as a content expert, but also as a **designer of the overall learning experience**: reworking your teaching requires to define in advance what you want to achieve and how.

If you are about to start, this booklet provides you with a primer on the basic elements to support you in designing your course; if you already experimented with innovative pedagogies, you can find tips and more in-depth information that could inspire you.

You can then start thinking if you want to experiment with the INSYSTED approach **in your whole course, in a course section or in a single lesson** by integrating MOOCs, serious games and online learning communities.

A "Small Steps" approach is often instrumental to innovation: you may innovate a lesson or a small group of lessons.

> **The first step is to set the outcomes you want students to achieve, and then to design the assessment tasks and teaching activities in which students are involved. The constructive alignment, as devised by Biggs (2003) will support you in doing that.**

This booklet does not mean to go into detail on pedagogical theory, yet it adopts Biggs' constructive alignment as it gives an account of how the three key educational elements (intended learning outcomes, assessment tasks, and teaching and learning activities) connect and interact, hence providing the operational underpinning to guide the (re-)design of learning opportunities.

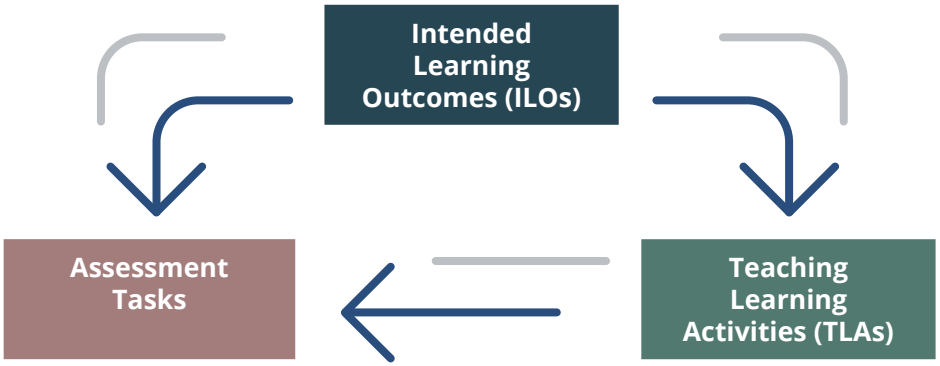


Image elaborated from Biggs (2003)

An example from an Operations management semester-based course at MSc level

This is how the course combines the 3 pillars.

MOOC

MOOC content and especially videos (both in English) are used to align disciplinary knowledge, as students come from diverse study courses and there are many international students.

Serious game

The serious game complements lectures and theory application. Students are required to play in teams to develop communication skills through group discussions. Students are provided with a case description + a mathematical model software + the serious game (simulation + data input interface) to apply and experiment with the theoretical concepts and methods in a realistic setting over a week.

Online learning community

Student groups of the serious game are required to deliver a presentation and a report discussing the final outcomes of the serious game session (disciplinary knowledge) and to cite supporting references and evidence (soft and digital skills). Reports are peer-evaluated according to criteria that take into account disciplinary knowledge and aspects related to soft and digital skills. The final grade of the course takes into account graded activities in terms of participation in the MOOC, in the serious game and in the online learning community.

SUPPORTING RESEARCH

Reference	Main information
Biggs, J. (2003). Aligning teaching for constructing learning. https://www.heacademy.ac.uk/sites/default/files/resources/id477_aligning_teaching_for_constructing_learning.pdf	The teacher's job is to create a learning environment that supports the learning activities appropriate to achieving the desired learning outcomes.
Boelens, R., De Wever, B., & Voet, M. (2017). Four key challenges to the design of blended learning: A systematic literature review. *Educational Research Review, 22*, 1–18. https://doi.org/10.1016/j.edurev.2017.06.001	This study identifies and explores four key challenges to the design of blended learning: incorporating flexibility, stimulating interaction, and facilitating students' learning processes.
Bowyer, J., & Chambers, L. C. (2017). Evaluating blended learning: Bringing the elements together. *Research Matters: A Cambridge Assessment Publication,* (23), 17–26. https://www.cambridgeassessment.org.uk/Images/375446-evaluating-blended-learning-bringing-the-elements-together.pdf	This article explores the benefits and factors to consider when implementing a blended learning programme, along with describing a number of frameworks to evaluate a blended learning programme.
Boyle, A., & Goffe, W. L. (2018). Beyond the Flipped Class: The Impact of Research-Based Teaching Methods in a Macroeconomics Principles Class, *AEA Papers and Proceedings, 108*, 297–301. https://doi.org/10.1257/pandp.20181052	Boyle and Goffe explore evidence-based techniques and important teaching principles from cognitive science research.
Dawson, S. (2010). 'Seeing' the learning community: An exploration of the development of a resource for monitoring online student networking. *British Journal of Educational Technology, 41*(5), 736–752. https://doi.org/10.1111/j.1467-8535.2009.00970.x	The paper shows how online technologies (in particular the ones aims at supporting networks and communities creation), can support the evaluation process of a course or teaching intervention offering educators data and information on students behaviour and network evolution over time.
Deslauriers, L., McCarty, L. S., Miller, K., Callaghan, K., & Kestin, C. (2019). Measuring actual learning versus feeling of learning in response to being actively engaged in the classroom. *PNAS, 116*(39), 19251–19257. https://doi.org/1 0.1073/pnas.1821936116	Measuring actual learning versus feeling of learning in response to being actively engaged in the classroom. This study in physics subjects shows that, though students felt as if they learned more through traditional lectures, they actually learned more when taking part in classrooms that employed so-called active-learning strategies.
Deslauriers, L., Schelew, E., & Wieman, C. (2011). Improved Learning in a Large-Enrollment Physics Class. *Science, 332*(6031), 862–864. https://doi.org/1 0.1126/science.1201783	The paper compares the amounts of learning achieved using two different instructional approaches under controlled conditions.

Reference	Main information
Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H. & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *PNAS, 111*(23), 8410–8415. https://doi.org/10.1073/pnas.1319030111	The paper presents evidence that active learning methods enhance the effectiveness of teaching and instruction in a way that imparts deep understanding of concepts.
Ghadiri, K., Qayoumi, M. H., Junn, E., Hsu, P., & Sujitparapitaya, S. (2014). *The Transformative Potential of Blended Learning Using MIT edX's 6.002x Online MOOC Content Combined with Student Team-Based Learning in Class.* San Jose State University. https://www.edx.org/sites/default/files/upload/ed-tech-paper.pdf	This paper presents a pilot experimentation of blended learning with MOOC content. This program, in which projects and quizzes were included following a flipped learning approach, achieved "a high success rate with 90% of the students passing the final exam, as compared with 55% in the traditional class of the previous year".
Henderson, C., Khan, R., & Dancy, M. (2018). Will my student evaluations decrease if I adopt an active learning instructional strategy? *American Journal of Physics, 86*(12), 934–942. https://doi.org/1 0.1119/1.5065907 (Full article at https://drive.google.com/file/d/179ejdWZNrb6FsKZvtpBRSipDpeLdtIDh/view)	The paper presents data from a survey of US physics instructors that attempted to incorporate active learning into their introductory course.
Hestenes, D., Wells, M., & Swackhamer, G. (1992). Force concept inventory. *The Physics Teacher, 30*(3), 141–158. https://doi.org/1 0.1119/1.2343497	The article aims to supply some of that technical knowledge about how students think and learn and an instrument to help teachers probe and assess the common sense beliefs of their students about how the physical world works.
Holmes, N. G., Wieman, C. E., & Bonn, D. A. (2015). Teaching critical thinking. *PNAS, 112*(36), 11199–11204. https://doi.org/10.1073/pnas.1505329112	This study reports the results of applying a learning framework that employs cycles of decisions about making and acting on quantitative comparisons between datasets or data and models in an introductory physics laboratory course. This structure led to significant improvement in students' critical thinking behaviours and can be applied in any instructional setting that involves the acquisition of data and relating that data to scientific models.
Jager, S., Nissen, E., Helm, F., Baroni, A., & Rousset, I. (2019). *Virtual Exchange as Innovative Practice across Europe: Awareness and Use in Higher Education: EVOLVE Project Baseline Study*. https://www.rug.nl/research/portal/nl/publications/virtual-exchange-as-innovative-practice-across-europe-awareness-and-use-in-higher-education(de9b9f72-b11b-4f28-9a17-eea6b76c62c4).html	Baseline study on awareness and use of virtual exchange in Higher Education in Europe (output of the Erasmus+ EVOLVE project).

Reference	Main information
Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why Minimal Guidance During Instruction Does Not Work: An Analysis of the Failure of Constructivist, Discovery, Problem-Based, Experiential, and Inquiry-Based Teaching. *Educational Psychologist, 41*(2), 75–86. https://doi.org/10.1207/s15326985ep4102_1	The paper explains evidence indicating that minimally guided instruction are less effective and less efficient than instructional approaches that place a strong emphasis on guidance of the student learning process in the context of our knowledge of human cognitive architecture, expert-novice differences, and cognitive load.
Lindblom-Ylänne, S., & Breslow, L. (2017). The Importance of Evidence-Based Enhancement of the Quality of Learning and Teaching in Research-Intensive Universities. In B. Stensaker, G. Bilbow, L. Breslow, R. van der Vaart (Eds.), *Strengthening Teaching and Learning in Research Universities* (pp. 187–213). Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-319-56499-9_8 (Full chapter at https://helda.helsinki.fi//bitstream/handle/10138/310602/Lindblom_Breslow_Final_01_09_17.pdf?sequence=1)	This chapter explores the role of research in improving teaching and learning in research-intensive universities and presents four case studies from the University of Helsinki and from the Massachusetts Institute of Technology.
Morris, L. V., Finnegan, C., & Wu, S. (2005). Tracking student behaviour, persistence, and achievement in online courses. *The Internet and Higher Education, 8*(3), 221–231. https://doi.org/10.1016/j.iheduc.2005.06.009	The paper presents results of an empirical analysis in which emerged that the time spent on tasks and frequency of participation are important factors for being successful in online learning.
Vlachopoulos, D., & Makri, A. (2017). The effect of games and simulations on higher education: a systematic literature review. *International Journal of Educational Technology in Higher Education, 14*, Article 22. https://doi.org/10.1186/s41239-017-0062-1	This paper highlights, through a literature review, how games and simulations may have a positive impact on learning goals in terms of cognitive, behavioural, and affective outcomes.
Von Korff, J., Archibeque, B., Gomez, K. A., Heckendorf, T., McKagan, S. B., Sayre, E. C., Schenk, E. W., Shepherd, C., & Sorell, L. (2016). Secondary analysis of teaching methods in introductory physics: A 50 k-student study. *American Journal of Physics, 84*(12), 969–974. https://doi.org/10.1119/1.4964354	The paper suggests that interactive engagement teaching techniques are significantly more likely to produce high student learning gains than traditional lecture-based instruction; interactive engagement instruction works in many settings, including those with students with a high or low level of prior knowledge, at liberal arts and research universities, and enrolled in both small and large classes.

Anna

Engineering university teacher

"Looking at exam results I concluded that students struggle with applying inventory control policies. I would like them to understand the importance of mastering this topic also for future use at the workplace.

To this end I would like to experiment with more hands-on, digitally enhanced teaching practices to improve effectiveness. I think I might revise the outcomes I want students to achieve, so that they are more aware of my expectations."

Anna

Engineering university teacher

"I revised the ILOs of this topic and I saw that they might be rephrased to explain more precisely the learning that I'm seeking to promote.

In addition to that, I found out that if I use a blended learning approach these ILOs might imply additional ILOs in terms of soft and digital skills that can help develop students' ability to act in ways that resemble those of experts in the engineering field."

Original formulation

- Students will learn about the characteristics of inventory systems.
- Students will know about costs incurred by inventory.

Revised formulation

- Students will be able to describe the characteristics of inventory systems.
- Students will be able to evaluate costs incurred by inventory in different industrial contexts.
- Students will be able to solve problems on the basis of a specified approach in an industrial context.
- Students will be able to collect, clean and use databases.

2. INTENDED LEARNING OUTCOMES (ILOS)

TAKE INNOVATION ON BOARD: BLENDING ONLINE AND FACE-TO-FACE

Reflection on the impact and main approaches in redesigning a course or part of it.

WHY ARE ILOS IMPORTANT?

Setting the outcomes students are expected to achieve to direct student learning along with the design of meaningful assessment tasks and teaching and learning activities.

ANATOMY OF VALUE-ADDED ILOS

How to practically develop and express Intended Learning Outcomes.

SYLLABUS AND LESSON PLAN

Focus on syllabus and lesson plans as tools to support the design of instruction and to direct students' learning.

2. INTENDED LEARNING OUTCOMES (ILOS)

TAKE INNOVATION ON BOARD: BLENDING ONLINE AND FACE-TO-FACE

Once you have identified your main motivation for transforming your teaching, it is crucial to reflect on the effort you want to devote to blending face-to-face instruction with online activities underpinned by the INSYSTED pillars: MOOCs, serious games and online learning communities. You may consider which of these approaches (Alammary et al., 2014) suits you best:

- **low-impact blend**: adding extra activities to an existing course, such as asking students to post some contributions in the forum-based online learning community and to provide critiques of their peers' submissions, with discussions then transferred into the physical classroom;
- **medium-impact blend**: replacing activities in an existing course, such as partially substituting in-class demonstrations with MOOC-based video demonstrations, or switching some face-to-face application exercises to online serious game sessions where students apply theoretical concepts in a realistic setting, or using the forum-based online learning community instead of classes to have learners discuss case studies under the instructor's supervision;
- **high-impact blend**: building the blended course from scratch, that is, looking at each single course learning outcome and determine the best delivery option of that outcome, whilst integrating the INSYSTED pillars accordingly.

WHY ARE ILOS IMPORTANT?

ILOs (Intended Learning Outcomes) express **what the learner is expected to know after the completion of a learning opportunity**, for example "Students will be able to explain the role of operations management and discuss the key challenges posed in operations management".

No matter what effort you are envisioning, the first step is to **set the outcomes you want students to achieve**, as they direct the design of meaningful, value-added assessment tasks and teaching and learning activities. **Constructive alignment** (Biggs, 2003) may support you in ensuring the consistency among intended learning outcomes, assessment and teaching and learning activities.

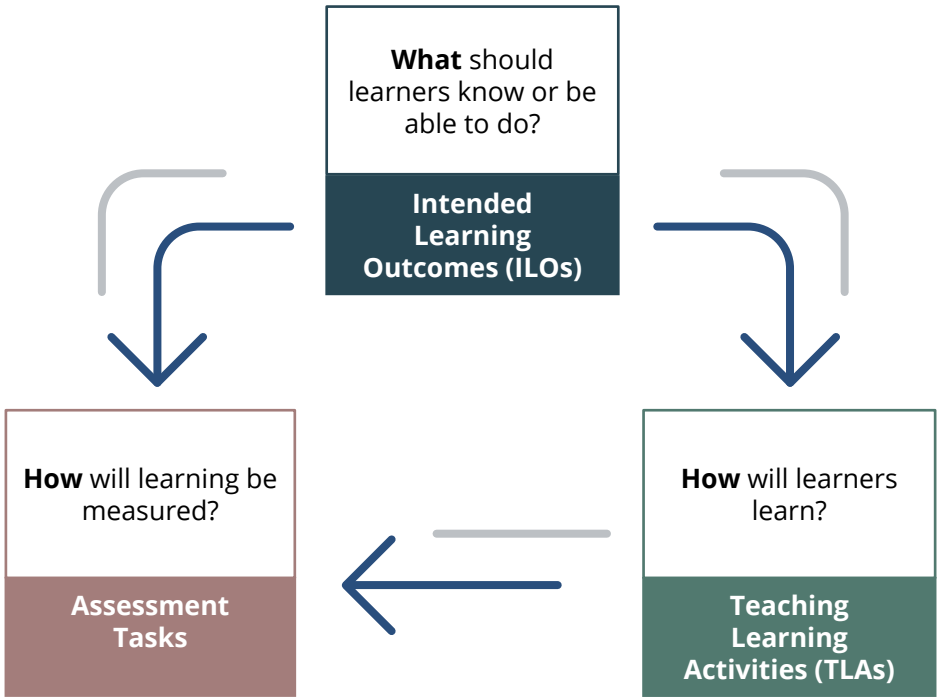


Image elaborated from Biggs (2003)

ILOs flow from course aims and have to be consistent with them. Ideally, **the Learning Outcomes of a course form a road map** to the final learning destination: in other terms, taken together, ILOs should present a very clear picture of the purpose of the course and what the learners will be able to do at the end of it.

ILOs can refer not only to the knowledge and skills concerning course topics (**disciplinary knowledge and subject-specific skills**), but also to **soft and digital skills** that are somewhat implied. MOOCs, serious games and online learning communities can make students engage more actively, hence fostering the development of soft and digital skills such as those related to teamwork and communication. Consider all kinds of skills to boost course effectiveness and make the most of the INSYSTED approach.

ILOs can be defined at **different levels of granularity**, from curriculum to course, to unit, to lesson level. A learning outcome is a statement of achievement that defines the results of a learning process, and ILOs should fit the scope of the learning process they refer to. ILOs should align with one or more outcomes at the next highest level: in other terms, ILOs of a curriculum are broader than ILOs of its courses, and ILOs of a course are broader than ILOs of its lessons: the higher the level, the broader ILOs are. The number of ILOs at course level varies according to course features; for some courses 4 to 6 ILOs might be a reasonable number.

Soft and digital skills

The INSYSTED approach suggests to use the skills of the eLene4work skills framework (http://og.elene4work.eu/en/soft-skills.html), that you find here. The eLene4work skills framework identifies the **soft and digital skills most demanded in the EU by employers, graduates and novice workers**.

DISCIPLINARY KNOWLEDGE

Course/section/lesson topics

SOFT SKILLS

Skills that are cross-cutting across jobs and sectors and relate to personal competences and social competences (Cedefop)

SOCIAL SKILLS	PERSONAL SKILLS	METHODOLOGICAL SKILLS
		
Communication Teamwork Conflict Management Negotiation	Adaptability and flexibility Leadership Self-evaluation	Learning to learn Analytical skills Creativity and innovation Problem solving

DIGITAL SKILLS

A range of abilities to use digital devices, communication applications, and networks to access and manage information (UNESCO)

COMMUNICATION	INFORMATION AND DATA-PROCESSING	PROBLEM-SOLVING	CONTENT CREATION
			
The ability to communicate in digital environments, share resources through online tools, link with others and collaborate through digital tools, interact with and participate in communities and networks, cross-cultural awareness	The ability to identify, locate, retrieve, store, organise and analyse digital information, judging its relevance and purpose	The ability to identify digital needs and resources, make informed decisions on most appropriate digital tools according to the purpose or need, solve conceptual problems through digital means, creatively use technologies, solve technical problems, update own and other's competence	The ability to create and edit new content (from word processing to images and video); integrate and re-elaborate previous knowledge and content; produce creative expressions, media outputs and programming; deal with and apply intellectual property rights and licences

ANATOMY OF VALUE-ADDED ILOS

ILOs should be understandable to students and expressed from their point of view, using "students will be able to":

a verb (the action expected, that is what kind of activity students will be able to perform);

an object (the content of the action);

if needed: **the context** (where the student will perform the action, that is where students are going to apply the acquired competence);

if possible: **the criterion** for achieving proficiency or, in other terms, how you will know that a student has met the objective.

Students will be able to select and evaluate reference materials and incorporate them appropriately into written assignments by providing citations and/or an annotated reference list including both academic and credible non-academic sources.

It is important to fine-tune each ILO by using a meaningful verb that describes what students will be able to do as a result of the learning process: ideally an **action verb that can be observed and measured**. If you are formulating an ILO, try to ask yourself: "How would I assess it?". If the ILO suggests to you a clear assessment, that probably means that your ILO is an effective one.

The suggested verbs for the revised Bloom's taxonomy (Anderson & Krathwohl, 2001) can support you in rephrasing value-added ILOs (see the table on the following page).

Less effective example

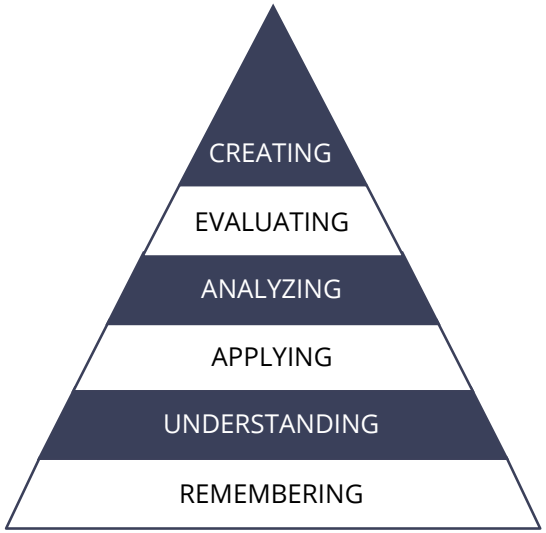
Students will learn about the characteristics of inventory systems.

More effective example

Students will be able to describe the characteristics of inventory systems.

The revised **Bloom's taxonomy** classifies the different kinds of learning with an increasing degree of complexity, starting from simple recall of knowledge.

Note that Bloom's taxonomy refers to the cognitive domain, that is things you can "know" such as disciplinary topics, hence it can not be applied to soft and digital skills as other taxonomies relate to affective and psychomotor domains. That said, also for soft and digital skills it is important to accurately choose the verb that describes what you expect students to be able to do upon completion of the learning opportunity.



Revised Bloom's taxonomy. Image elaborated from Anderson and Krathwohl (2001)

Examples of value-added ILOs

Disciplinary knowledge

Students will be able to describe the characteristics of an inventory system. [REMEMBERING]

Students will be able to formulate an analytical model for the performance analysis of specific industry setting based on Little's law and the Kingman approximation. [APPLYING]

Soft skills

Students will be able to communicate and work in team by means of targeted activities in groups.

Students will be able to use data storytelling in order to explain complex analytical results.

Digital skills

Students will be able to modify provided models to run the analyses in data analysis software.

Students will be able to collect, clean and use databases.

Low-hanging fruit tip

It can be useful to specify in the lesson plan the bridge-in, that is the "hook" to interest the learner.

Inspiration box

Have a look of some examples of ILOs that also include soft skills ILOs, mentioned under the umbrella term of transversal skills.

- Course: Production management, Ecole polytechnique fédérale de Lausanne – EPFL (MSc) https://edu.epfl.ch/coursebook/en/production-management-ME-419
- Course: Financial econometrics , Ecole polytechnique fédérale de Lausanne – EPFL (MSc) https://edu.epfl.ch/coursebook/en/financial-econometrics-FIN-407?cb_cycle=bama_cyclemaster&cb_section=if

Suggested verbs for Bloom's Taxonomy

Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
• Citing	• Clarifying	• Constructing	• Classifying	• Assessing	• Categorizing
• Defining	• Comparing	• Demonstrating	• Comparing	• Concluding	• Constructing
• Describing	• Describing	• Determining	• Explaining	• Determining	• Developing
• Identifying	• Discussing	• Discovering	• Identifying	• Interpreting	• Formulating
• Outlining	• Explaining	• Expressing	• Investigating	• Predicting	• Incorporating
• Recalling	• Predicting	• Investigating	• Outlining	• Supporting	• Reconstructing
• Recognizing	• Summarizing	• Predicting	• Relating	• Validating	• Summarizing

There are plenty of verbs you can use to write meaningful Learning Outcomes, but there are also verbs that it is better to avoid even though they are very common in learning outcomes, because they convey an internal state and/or are unobservable, such as:

- become familiar with;
- know about;
- appreciate;
- become aware of.

Potter and Kustra (2012) with the Sinister Sixteen verbs identified more verbs to be avoided.

SUPPORTING RESEARCH

Reference	Main information
Alammary, A., Sheard, J., Carbone, A. (2014). Blended learning in higher education: Three different design approaches. *Australasian Journal of Educational Technology, 30*(4). https://doi.org/10.14742/ajet.693	This paper identifies and presents characteristics, benefits, challenges and recommendations of the three different approaches that can be adopted when designing a course in blended format: low, medium and high impact blend.
van Puffelen, E. (2017). Designing blended engineering courses. In J. C. Quadrado, J. Bernardino, & J. Rocha (Eds.), *Proceedings of the 45th SEFI Annual Conference 2017 – Education Excellence for Sustainability* (pp. 1308–1312). European Society for Engineering Education (SEFI). https://www.4tu.nl/cee/en/publications/sefi2017-designing-blended-engineering-courses.pdf	The paper describes how to design blended learning courses based on literature; it also reflects the experience of Wageningen University & Research, the Netherlands and its approach, starting with a well-constructed curriculum and properly formulated Intended Learning Outcomes.
Zhao, S. (2016). The Problem of Constructive Misalignment in International Business Education: A Three-Stage Integrated Approach to Enhancing Teaching and Learning. *Journal of Teaching in International Business, 27*(4), 179–196. https://doi.org/10.1080/08975930.2017.1301233	The paper first reviews some common problems associated with constructive misalignment in prior literature; then it proposes a three-stage integrated approach, encompassing the use of threshold concepts complemented by problem-based learning using simulation games.

ADDITIONAL RESOURCES

Reference	Main information
Anderson, L. W., & Krathwohl, D. R. (Eds.). (2001). *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. Longman.	The revision of Bloom's taxonomy is designed to help teachers understand and implement standards-based curricula.
University of Alberta Centre for Teaching and Learning. (2018). *A Guide to Learning Outcomes at the University of Alberta*. https://doi.org/10.7939/R3JD4Q569	Some additional, more in-depth hints and suggestions for developing effective ILOs.
Maastricht University Institute for Education Innovation (EDLAB). (2016). *The UM Handbook for Constructive Alignment*. https://constructivealignment.maastrichtuniversity.nl/wp-content/uploads/2017/04/Constructive_Alignment_Handbook_EDLAB.pdf	The handbook of the Maastricht University Institute for Education Innovation provides, among other things, guidance on (re-)designing ILOs at course level.
Potter, M., & Kustra, E. (2012). A primer on Learning Outcomes and the SOLO taxonomy. *Course Design for Constructive Alignment, Winter 2012,* 1–22. https://www.uwindsor.ca/ctl/sites/uwindsor.ca.ctl/files/primer-on-learning-outcomes.pdf	A primer on Learning Outcomes and the SOLO taxonomy.

SYLLABUS AND LESSON PLAN

ADVANCED INFO CARD

Once you have decided to blend face-to-face instruction with online activities and you have set the outcomes you want students to achieve, it is very important **to rework course organisation**. That means detailing the parts you will design from scratch or modify (e.g. one or more lessons) in terms of features, required resources and planning as well as defining how they connect to the whole. Course syllabus and lesson plans are very important not only because they support the redesign and rescheduling of your teaching, but also because they produce information that is crucial for students to know, in terms of what they are expected to do during the course and during the lesson. Integrating the INSYSTED approach into your course implies that learners' activities go beyond passive listening, hence **students need to be inducted** into them.

SYLLABUS

How does a reworked syllabus look like? Let's see the crucial information a syllabus should contain. Please remember that **syllabus elements can be adjusted** not only according to your course needs, but also according to possible external elements, such as the course level, (e.g. BSc and MSc) and the overall approach of the curriculum the course belongs to (e.g. Dublin Descriptors in terms of competence levels at the end of a cycle). Syllabus information can be circulated through several documents/web pages instead of being on one page, depending on the personal practices of the instructor and/or the policies the higher education institution might have in terms of spreading course information.

The essentials you might focus on are listed below.

- **Course information**: include course title and webpage address, and if applicable prerequisites and language(s) in which activities are carried out; remember to mention teaching staff information, and preferred contact channels.
- **Intended learning outcomes**: detail what you want students to achieve not only in terms of knowledge and skills concerning course topics (disciplinary, disciplinary knowledge), but also in terms of relevant soft and digital skills. If you revise learning outcomes in this perspective, remember that the INSYSTED approach fosters the development of students' soft and digital skills such as those related to teamwork and communication.

In this view revising an ILO may lead you to split the original one into more ILOs to "unpack" its component elements or to highlight soft and digital soft skills acquirement.

An example of a reworked ILO in an Inventory control MSc course:

Students will become familiar with different inventory control models.
Original ILO

Students will be able to incorporate different inventory control models depending on the context: the newsvendor model, the (r,Q) and the (T,S) policies. **Soft skills:** students will be able to work together in teams in the online learning community in order to tackle complex inventory control problems. **Digital skills:** students will be able to use digital tools based on a serious game in order to share, analyze and exchange data.
Reworked ILO + ILOs in terms of soft and digital skills

- **Course activities**: describe and explain the approach you plan to use (for example flipped learning and/or problem-based learning), list activities accordingly; mention if you are going to use e.g. a forum to support the online learning community of course students and/or a specific MOOC and/or a serious game).
- **Expectations of students:** if applicable provide guidelines about minimum required course attendance, participation and plagiarism.
- **Course resources:** specify e.g. textbooks, reference material, supporting content and tools.
- **Course schedule/calendar**: a blended learning approach implies diverse activities, both online and face to face; make sure that students know which kind of activities to expect and when, including due dates for assignments.
- **Grading policy and assignments:** make sure to list each kind of assignment and activity that is going to be graded and briefly describe it.

Inspiration box

Have a look at these examples to see how a reworked syllabus may look like.

- Course: Fundamentals of Systems Engineering, MIT (MSc) https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-842-fundamentals-of-systems-engineering-fall-2015/syllabus/
- Course: Engineering Mathematics, University of Sheffield (BSc) http://engmaths.group.shef.ac.uk/common/?staff_view=1
- Gannon, K. (2018, September 12). *How to Create a Syllabus Advice Guide*. The chronicle of Higher Education. https://www.chronicle.com/interactives/advice-syllabus

LESSON PLAN

The lesson plan should provide you with a practical outline to organise and deliver your lesson:

- **session** title, date and time;
- **aims and learning outcomes** you want to achieve in the class;
- **teaching content** you will cover throughout the lesson;
- **resources** in terms of reference materials, tools and items to bring or to set up at the start of the session;
- **lesson sub-sections** with respective timing guidelines;
- **details of activities**/how the students will learn, including pedagogical approaches (e.g. flipped learning);
- possible informal or formal **assessment methods** you will use in your classroom (e.g. surveys and online quizzes).

Please note: whether you are planning to innovate only a portion of your course or your whole course, remember that the lesson plan is useful to support you!

Inspiration box

Have a look at these templates and hands-on tips to formulate a lesson plan.

- Lesson plan template. Algonquin college, Canada https://www.algonquincollege.com/profres/files/2013/11/Lesson-Plan-TemplateD.pdf
- Brigham Young University-Idaho, USA Lesson plans instructional tool http://www.byui.edu/Documents/instructional_development/Instructional%20Tools%20Page%20PDFs/Lesson%20Plans.pdf (retrieved from https://www.byui.edu/instructional-development/resources/instructional-tools)

Anna

Engineering university teacher

"As I have changed the ILOs of the inventory control topic, maybe I should rethink how students are assessed against these ILOs.

In my opinion, students tend to learn what they think they will be tested on, hence assessment tasks should enable students to learn through preparing for and undertaking the assessment and from the feedback on their performance."

Anna

Engineering university teacher

"After being exposed to concepts underpinning inventory systems, I will upload a series of short texts in the course forum that describe different industrial contexts and I will ask students in groups to define the characteristics of inventory systems in each context and publish them in the forum.

I will ask each group of students to assess another group's output by identifying a positive aspect and an aspect that needs to be improved, in addition I will add my feedback.

After having explored inventory costs during the exercise session, the same groups of students will receive in the forum a case study related to the previous industrial context and will be asked to calculate the different inventory costs based on a big unstructured data set and to develop on the previous assessment task to outline a problem and a solution relevant to the case study and the provided data."

3. ASSESSMENT TASKS

EXAMPLES OF TECHNOLOGY-ENHANCED ASSESSMENT TASKS

Hands-on assessment tasks according to different kinds of learning with an increasing degree of complexity.

FUNCTIONS OF ASSESSMENT

The functions of assessment tasks through targeted hands-on examples.

RUBRICS

The importance of the rubric for assessment and its main features.

PEER ASSESSMENT

How to take advantage of this technique while taking into consideration some of the challenges.

3. ASSESSMENT TASKS

BACK TO CONSTRUCTIVE ALIGNMENT

Once you have set the outcomes you want students to achieve (Intended Learning Outcomes), **you may consider redesigning how students are assessed** accordingly. Again, the constructive alignment will support you in ensuring the consistency among assessment tasks and the other main elements of your teaching. In a constructively aligned approach, assessment needs to be thought out before the teaching and learning activities because it influences what students think is important: in other terms, **students tend to learn what they think they will be tested on**.

In the INSYSTED approach MOOCs, serious games and forum-based online learning communities underpin **authentic assessment tasks** that demonstrate students' increasing ability to think and solve problems in ways that resemble those of experts in the engineering field.

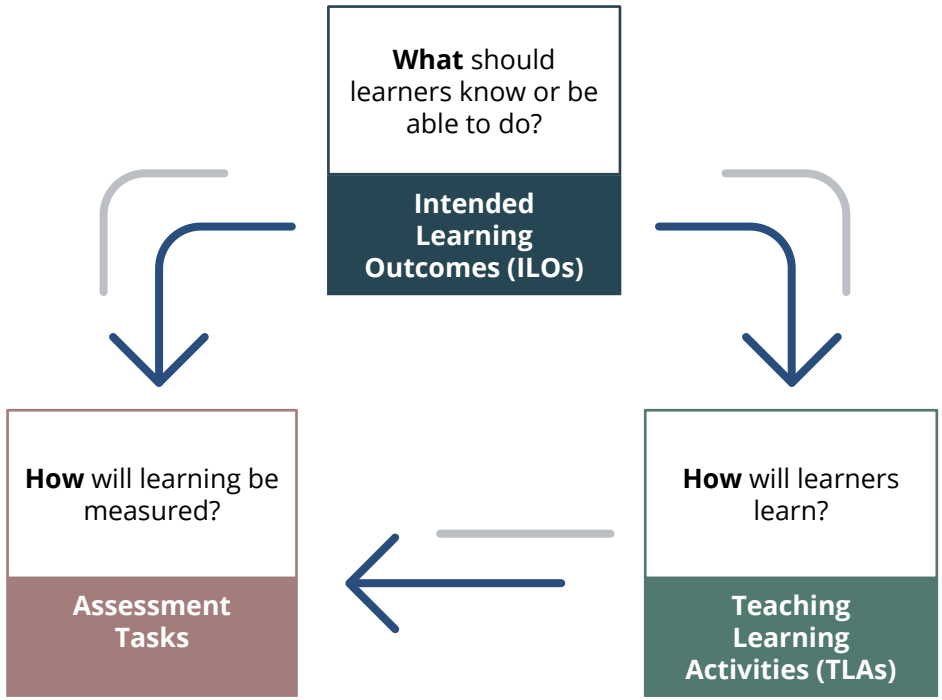


Image elaborated from Biggs (2003)

WHY IS ASSESSMENT IMPORTANT?

Assessment is crucial to support student learning in addition to measuring it. Fit-for-purpose **assessment is able to test what has been learnt and taught** or, in other terms, it is able to determine whether a student has achieved the ILOs set in terms of disciplinary knowledge, soft and digital skills. In addition to that, assessment can provide the instructor with meaningful **input data to improve teaching**.

Attributes of fit for purpose assessment

Fit for purpose assessment entails some attributes with respect to teachers and to students:

With respect to teachers	With respect to students
It applies **methods that measure students' achievement** of assessment criteria in order to check how well actual learning matches with ILOs.	It enables students to **learn through preparing for and undertaking the assessment** and from feedback on their performance in the assessment.
It enables instructors to understand **how students are responding** to their teaching.	It enables students to **benchmark their current level** of knowledge or skills and to identify areas for improvement and the overall progress made.
It is **explicit and accessible** to staff and students involved in the process (e.g. the teacher shares the purpose and requirements of each assessment task and the standards expected).	It provides students with focused, relevant and guiding **feedback** so that they recognise how future performance can be improved.

EXAMPLES OF ASSESSMENT TASKS

Below you can explore some hands-on **examples of constructively aligned assessment tasks** that can be applied depending on the Intended Learning Outcome the instructor wants students to achieve.

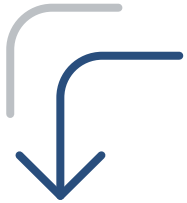
ILOs referring to disciplinary knowledge feature the corresponding verb relating to **Bloom's taxonomy**, that classifies the different kinds of learning with an increasing degree of complexity.

Tasks described can be part of formative assessment or implemented as elements of summative evaluation that contribute to course grade.

Level of Bloom's taxonomy: REMEMBERING

Students are required to recognise and recall information such as facts, concepts, terms, methods and procedures.

Hands-on example of a constructively aligned assessment task



Disciplinary knowledge: students will be able to describe the characteristics of an inventory system.

Intended Learning Outcome

Quiz

Pillar(s): MOOC

Soft/digital skills developed: no specific skills are expected to be developed with this task

The teacher prepares a quiz with an online tool and administers it in class at the beginning of the lesson to verify that students remember the MOOC content about inventory systems they were previously exposed to at home. Students are asked to access the quiz from their smartphones with their own identification numbers so that the instructor can award points upon successful completion.

Low-hanging fruit tip: different groups of students can be involved in producing questions and answers for different course topics; this task might contribute to the final grade awarded to each student.

Assessment Task

Types of questions and online quizzing

Diverse types of questions can be implemented depending on the features of each online quizzing tool. The table below gives an overview of some types of questions you can implement online and which types of learning objective they are best suited for. It is worth remembering that open questions have to be marked manually when reviewing the quiz.

Type of question	Type of learning objectives
Multiple/Forced Choice (MC/FC)	Recognising terms, understanding concepts, recognizing connections
Hot spot	Recognising visual structures, mentally rotating objects
Classification	Putting concepts in relation, associating concepts, recognising hierarchies
Ordering	Analysing processes, reproducing historical developments
Short text	Reproducing concepts, indicating mathematical results, reproducing dates and numbers
Long text	Describing problem solutions, arguing a standpoint
Text subset question	Reproducing concepts or names
Cloze question (e.g. containing input boxes for free-text or missing text suggestions)	Understanding the structure of a sentence, reproducing concepts, completing words (often used in language learning)

(Adapted from the E-Klausur Wiki of the Universität Gießen)

Wrap-up: online quizzes

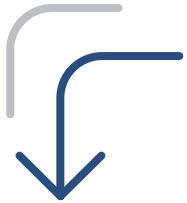
Online quizzes administering various types of questions like true/false, multiple choice, fill-in-the-blanks and matching questions with answers can make students recall and recognize knowledge. Online quizzes can be used for example at the beginning of a lesson to **check students' knowledge** of a topic they were previously exposed to, so that the instructor can reiterate the most critical concepts accordingly. They can also be used for **ongoing summative assessments**, that contribute to the final mark or as part of the final exam: in this case it is important that students access the quiz through their identification number. Classroom response systems and quizzing tools can administer online quizzes via clickers or other handheld devices such as smartphones. These tools can be open-source like YACRS by the University of Glasgow (https://learn.gla.ac.uk/yacrs/software/yacrs.pdf) or commercial products. The table on the right summarises some examples with free options (please always check for updated information).

Tool name	Typology	Cost
Top Hat https://success.tophat.com/s/	Classroom response system	Free option
Arsnova https://arsnova.thm.de/blog/en/homepage/	Classroom response system	Free option
Socrative https://socrative.com/	Classroom response system	Free for a limited number of students (up to 50)
Poll everywhere https://www.polleverywhere.com/	Classroom response system	Free option for a limited number of students (up to 25)
Poll Maker's Quiz Maker http://www.poll-maker.com/QuizMaker	Quiz	Free option for max 25 responses
Class markers https://www.classmarker.com/	Quiz	Free option for a max of 1,200 tests graded/year
Google Forms + Flubaroo https://sites.google.com/a/vols.utk.edu/google-apps-for-classroom/products-services/flubaroo	Quiz + grading tool	Free option
MOODLE quiz https://docs.moodle.org/38/en/Quiz_activity	Quiz	Free option. Requires Moodle on institution servers
Hot potatoes https://hotpot.uvic.ca/wintutor6/tutorial.htm	Quiz	Free option
Formative https://goformative.com/	Quiz	Free option with basic features

Level of Bloom's taxonomy: UNDERSTANDING

Students are required to interpret knowledge and translate it into a new context.

Hands-on example of a constructively aligned assessment task



Disciplinary knowledge: students will be able to define the key performance indicators of queuing systems and their relationship based on Little's law.

Intended Learning Outcome

Concept maps

- **Pillar(s)**: online learning community
- **Soft/digital skills developed**: teamwork, content creation

Students start working in teams of 2–3 people at end of the lesson where the topic was covered and finalise their concept map at home by using online tools (e.g. Coggle https://coggle.it/, Bubbl.us https://bubbl.us/). This task is useful to verify the comprehension of connections, such as the relationship of key performance indicators of queuing systems based on Little's law. Links to maps are shared in the online learning community, i.e. the course forum. Teams provide feedback on others' concept maps using the "two stars and a wish" technique; each team identifies two positive aspects of the map and expresses a wish about what could be improved.

Low-hanging fruit tip: the instructor could select and publish peer-assessed mindmaps in a specific section of the course forum, so that students can use them to review the material for the final exam.

Assessment Task

Another example of a task that can be used to assess understanding: one-minute paper

- **Soft/digital skills developed**: communication

It works very well for large classes: students at the end of the lesson have 1 to 3 minutes to reply to two questions posed through a survey tool like Google forms, e.g.: "What was the most important thing you learned?" and "What important question remains unanswered?". The teacher has an overall perception of what has been understood and what needs to be resumed in the following lesson; targeted information can be clarified in the course forum (online learning community).

Another example of a task that can be used to assess understanding: presentation

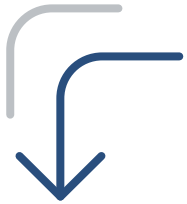
- **Soft/digital skills developed**: content creation, content communication in digital environments

In the forum the teacher asks students to explore the topic covered in the previous lesson by developing a self-sustaining presentation, individually or in groups. The presentation is delivered to the online learning community (course forum). Learners assess the presentation of another individual/group (here you find an example of rubric that may be used to this end https://www.rcampus.com/rubricshowc.cfm?code=M2X2B34&sp=true&nocache=1588578505542). An alternative version of this task is asking students to give an oral presentation of the deliverable via a videoconferencing system or to complement their presentation with an explanatory audio/video file. In both cases the forum supports the following peer-assessment phase.

Level of Bloom's taxonomy: APPLYING

Students are required to apply knowledge such as principles, rules, methods, laws, and theories in similar, new or real-life situations.

Hands-on example of a constructively aligned assessment task



Disciplinary knowledge: students will be able to examine the long-term performance of existing queuing systems based on Little's law.

Intended Learning Outcome

Report

- **Pillar(s)**: online learning community
- **Soft/digital skills developed**: self-evaluation, teamwork

Students have one week to develop, in small teams, a targeted report that gives an account of the 1-week challenge session on the ProTuce serious game (once it is over). After the follow-up in the classroom, reports are uploaded in the course forum and each team is asked to assess the output of another group on the basis of the rubric shared by the teacher (see a possible example here http://ecee.colorado.edu/~mathys/ecen2250/pdf/ReportRubric.pdf) by answering to the initial post. The teacher assigns a final mark to the report and a bonus to peer assessment feedback that meet the requirements.

Assessment Task

Another example of a task that can be used to assess applying: problem solving task

- **Soft/digital skills developed**: self-evaluation, problem solving

At the end of a critical learning unit or topic the teacher features a context-rich problem that students are asked to solve in groups. The deliverable is a document that is posted on the forum. The teacher gives feedback in the forum, either to each group, or summarising the main recurring issues and ways to improve in one post: in this way each group can self-assess its deliverable.

Level of Bloom's taxonomy: ANALYZING

Students are required to break down information into smaller constituent parts and determine how these parts relate to one another and to an overall structure or purpose.

Hands-on example of a constructively aligned assessment task

Disciplinary knowledge: students will be able to formulate an analytical model for the performance analysis of a specific industry setting based on Little's law and the Kingman approximation.

Intended Learning Outcome

Case Study

- **Pillar(s)**: online learning community
- **Soft/digital skills developed**: self-evaluation, learning to learn

Each group of students is required to formulate an analytical model for the performance analysis of a different specific industry setting. In class student groups gather relevant information about their given case study. Before being assessed by the instructor for the final mark, a first version of the deliverable document of each group is reviewed by another group in the forum and improved accordingly.

Low-hanging fruit tip: assessment based on evaluation of written assignments works well in combination with peer assessment supported by the online learning community (course forum).

Assessment Task

Another example of a task that can be used to assess analyzing: document analysis

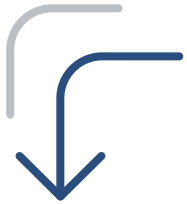
- **Soft/digital skills developed**: self-evaluation, teamwork

Students are required to take a descriptive text for a specific topic/situation and break it apart into sections, analyzing each one, and reaching an overall conclusion. Pairs are made for assessing outputs by applying explicit criteria (e.g. by using a rubric – see advanced infocard at page 42), so that students improve their own assignment before the teacher does a final summative assessment.

Level of Bloom's taxonomy: EVALUATING

Students are required to critically examine information, e.g. making judgements based on criteria and evidence and to express their own opinion based on evidence.

Hands-on example of a constructively aligned assessment task



Disciplinary knowledge: students will be able to propose system configuration to minimize costs in specific industry setting.

Intended Learning Outcome

Developing criteria to evaluate a product or a solution

- **Pillar(s):** online learning community
- **Soft/digital skills developed**: self-evaluation, analytical skills

Students are asked to develop criteria and descriptors; criteria related to different aspects are assigned to different groups. Groups work on online shared spreadsheets and use the course forum as a hub to share for review and the rationale behind their work. The outputs are refined in 1 or more iterations of peer assessment before the final evaluation by the teacher.

Assessment Task

Another example of a task that can be used to assess evaluating: literature review

- **Soft/digital skills developed**: self-evaluation, analytical skills

The instructor identifies subtopics and assigns them to groups of students who produce a literature review by searching and evaluating the available literature in this specific subtopic. Before being assessed by the instructor, the output of each group is reviewed by another group in the forum (see an example of rubric at https://ar.cetl.hku.hk/am_literature_reviews.htm#6) and improved accordingly.

Level of Bloom's taxonomy: CREATING

Students are asked to put elements together to form a new consistent whole or to reorganise elements into a new pattern or structure e.g. by compiling or producing information.

Hands-on example of a constructively aligned assessment task

Disciplinary knowledge: students will be able to develop new ideas and solutions to redesign the current procedures and tools of the purchasing process, and to improve the overall performance.

Intended Learning Outcome

Outline a strategic plan

- **Pillar(s)**: serious game and online learning community
- **Soft/digital skills developed**: self-evaluation, learning to learn

Students in groups are given a case study and required to outline a strategic plan with a solution based on the concepts covered in the course and from a relevant serious game simulation. Before being assessed by the instructor during the final exam, the output of each group is reviewed by another group in the course forum and improved accordingly.

Assessment Task

Another example of a task that can be used to assess creating: contribution to a knowledge sharing website like Wikipedia

- **Soft/digital skills developed**: content creation, information and data processing

Individual students are asked to add targeted modifications to a selection of existing articles (e.g. to improve the explanation of a concept), that are then assessed by the knowledge sharing website community; the teacher can check the outputs of the individual contributions. The other course students may be engaged in the review.

WRAP-UP: ASSESSMENT AND BLENDED LEARNING

Here you can find some considerations regarding assessment tasks underpinned by the INSYSTED pillars.

Teacher's and peers' role

Provide students with valuable **information about what is being assessed and how** in order to direct learning. Consider using a rubric to list the criteria by which an assignment will be assessed and describe the levels of quality for these criteria (see advanced infocard at page 42). Assessment can be carried out not only by instructors, but also by peers. **Peer assessment** is the assessment of students' work by their peers against a set of assessment criteria (see advanced infocard at page 45).

Rules

Depending on course features, you might consider specifying to students which behaviours are acceptable and which are not in order to **prevent misconduct** such as cheating/plagiarism. Take also into account that some assessment designs tend to prevent academic dishonesty, for example assignments that require students to work together, open-book assignments and assignments that require the submission of intermediate drafts.

Context

While (re)designing assessment, it is important to consider if what you are designing fits with your **contextual factors** (e.g. number of students, equipment, etc.) and if it is manageable in terms of student and instructor workload.

Students' feedback

Informal feedback from students after classes can provide meaningful input. In large classes traditional backchannel communication is difficult due to the number of students. **Classroom response systems** can also be used for **collecting students' feedback**, hence creating options for learners who would otherwise avoid interacting during group discussions.

OUTLINE OF ASSESSMENT TASKS WITH PRACTICAL ADVICE

The table summarizes **remarks and rules of thumb** to implement the assessment tasks explained in the previous pages. You will find also **additional examples** of assessment tasks underpinned by the INSYSTED pillars that might inspire you. Bear in mind that the same element might be used both as an assessment task and as a Teaching and Learning Activity depending on how you design it.

Bloom's verb	Assessment task	Description	Remarks/rules of thumb
 **REMEMBERING**	Quiz	See page 26.	Works well with large classrooms. Suitable for both Bachelor's and Master's level students.
 **UNDERSTANDING**	Short answers	Open-ended questions that require a short answer (from one word to a few lines); answers can be of various types, including short descriptive or qualitative answers, diagrams with explanations etc.	Demanding in large classrooms as answers have to be corrected manually (peer assessment might help reduce instructor's workload). Suitable for both Bachelor's and Master's level students.
	10 Questions, 10 Answers	Students are assigned 4–7 assigned scientific papers to find answers to 10 questions.	Demanding in large classrooms as answers have to be corrected manually (peer assessment might help reduce instructor's workload). Suitable for both Bachelor's and Master's level students.
	Collaborative quizzes	Students attempt a quiz independently and then work in pairs or triplets to re-attempt the same quiz.	Collecting and organising quizzes delivered during the course to be used in its following iterations might help reduce instructor's workload. Suitable for both Bachelor's and Master's level students.

Bloom's verb	Assessment task	Description	Remarks/rules of thumb
UNDERSTANDING	Concept maps	See page 28.	More suitable for Master's level students.
	One-minute paper	See page 28.	Suitable for both Bachelor's and Master's level students.
	Presentation	See page 28.	Demanding in large classrooms (peer assessment upon criteria/rubric might help reduce instructor's workload). Suitable for both Bachelor's and Master's level students.
APPLYING	E-portfolio	It is a collection of sample student work, demonstrations, and artefacts that showcase student's learning progression, achievement, and evidence of student's capabilities (Berkeley Center for Teaching & Learning).	Appropriate for a wide scope/time frame (e.g. a whole course/a series of modules). Suitable for both Bachelor's and Master's level students.
	Open-ended question(s)	In this type of question, students are asked to solve problems in situations by applying acquired knowledge, facts, techniques, and rules. Such kind of questions can be proposed at the end of theoretical explanations, supporting knowledge recall and understanding.	Demanding in large classrooms as answers have to be corrected manually (peer assessment might help reduce instructor's workload). Suitable for both Bachelor's and Master's level students.
	Report	See page 29.	More suitable for Master's level students.
	Problem solving task	See page 29.	More suitable for Master's level students.

Bloom's verb	Assessment task	Description	Remarks/rules of thumb
 **ANALYZING**	Review paper	Students are asked to work in teams to develop their own paper and then each team reviews another team's paper. Peer evaluation will contribute to the final mark. The review process can be carried out on other outputs than a paper.	More suitable for Master's level students.
	Open-ended question(s)	When working with Analysing, questions focus on identifying patterns and relations among what students have learnt. For example this method can be used as introduction to an application or a new topic.	Demanding in large classrooms as answers have to be corrected manually (peer assessment might help reduce instructor's workload). Suitable for both Bachelor's and Master's level students.
	Case study	See page 29.	More suitable for Master's level students.
	Document analysis	See page 29.	Quite time consuming for students, it can be carried out partially or totally online (e.g. on the course forum). Demanding in large classrooms; a round of peer assessment might help reduce instructor's workload. Suitable for both Bachelor's and Master's level students.
 **EVALUATING**	Argumentative or persuasive essay	Students in groups are required to explore and critically review evidence coming from literature, MOOC-based case studies and outcomes from a relevant serious game simulation. The first draft of the argumentative essay is assessed by another group through the rubric shared from the beginning of the assignment. The work will be revised before the summative assessment conducted by the teacher.	Medium-long term scope (min 1 week). More suitable for Master's level students.
	Peer Review	Feedback on outputs produced by other peers, individually or in groups.	Suitable for both Bachelor's and Master's level students.

Bloom's verb	Assessment task	Description	Remarks/rules of thumb
EVALUATING	Outline alternative solutions	Students are asked to peruse case studies to deduce strategies on the basis of theories and models introduced in the course and then to identify 2–3 alternative solutions by assessing risks and benefits of each of them.	More suitable for Master's level students.
	Open-ended question(s)	Asking student to construct a representation of an event, observation, or phenomenon and to provide the reasoning that links the representation to its explanation or prediction.	More time consuming than the same activity in the immediate lower level of the Bloom's taxonomy. More suitable for Master's level students.
	Developing criteria to evaluate a product or a solution	See page 30.	Works well if carried out by students in groups Suitable for both Bachelor's and Master's level students.
	Literature Review	See page 30.	More suitable for Master's level students.
CREATING	Outline a strategic plan	See page 30.	More suitable for Master's level students.
	Contribution to a knowledge sharing website like Wikipedia	See page 30.	Suitable for both Bachelor's and Master's level students depending on the contribution required to students.

SUPPORTING RESEARCH

Reference	Main information
Adams, W. K., & Wieman, C. E. (2010). Development and Validation of Instruments to Measure Learning of Expert-Like Thinking. *International Journal of Science Education, 33*(9), 1289–1312. https://doi.org/10.1080/09500693.2010.512369	This paper describes the process for creating and validating an assessment test that measures the effectiveness of instruction by probing how well that instruction causes students in a class to think like experts about specific areas of science.
Barber, W., King, S., & Buchanan, S. (2015). Problem Based Learning and Authentic Assessment in Digital Pedagogy: Embracing the Role of Collaborative Communities. *Electronic Journal of E-Learning, 13*(2), 59–67. https://eric.ed.gov/?id=EJ1060176	The paper qualitatively examines the relationship between problem-based learning, authentic assessment and the role of community in fostering learning in digital contexts.
Bursic, K. M. (2012). Does the Use of Clickers Increase Conceptual Understanding in the Engineering Economy Classroom. https://pdfs.semanticscholar.org/ffe9/134af41115a873117331bcfc2ff748eeccaa.pdf	The paper reports on an experiment in which several sections of an engineering economy course at the University of Pittsburgh are compared.
Bursic, K. M. (2017, June 24–28). *Work in Progress – An Engineering Economy Concept Inventory* [Paper presentation]. 2017 ASEE Annual Conference & Exposition, Columbus, Ohio. https://peer.asee.org/29138	The paper discusses the work in progress on the Engineering Economy Concept Inventory which can be used to assess learning in any introductory engineering economy course.
Dick-Perez, M., Luxford, C. J., Windus, T. L., & Holme, T. (2016). A Quantum Chemistry Concept Inventory for Physical Chemistry Classes. *Journal of Chemical Education, 93*(4), 605–612. https://doi.org/10.1021/acs.jchemed.5b00781	The paper features a 14-item, multiple-choice diagnostic assessment tool, the quantum chemistry concept inventory or QCCI.
Jorion, N., Gane, B. D., James, K., Schroeder, L., DiBello, L. V., & Pellegrino, J. W. (2015). An Analytic Framework for Evaluating the Validity of Concept Inventory Claims. *Journal of Engineering Education, 104*(4), 454–496. https://doi.org/10.1002/jee.20104	The paper proposes an analytic framework for evaluating the validity arguments of concept inventories.
Madsen, A., McKagan, S. B., & Sayre, E. C. (2017). Best Practices for Administering Concept Inventories. *The Physics Teacher, 55*(9), 530–536. https://doi.org/10.1119/1.5011826 (also available at https://www.researchgate.net/profile/Eleanor_Sayre/publication/261914576_Best_Practices_for_Administering_Concept_Inventories/links/53e68c730cf2fb74871ed9b3.pdf)	The article addresses common questions from interviews with physics faculty and provides a summary of best practices for administering concept inventories.

Reference	Main information
Norris, M. (2019). University online cheating – how to mitigate the damage. *Research in Higher Education Journal, 37*, 1–20. https://files.eric.ed.gov/fulltext/EJ1233121.pdf	The article examines products available to assist students in ways that compromise academic integrity and solutions to enforce academic integrity and to prevent online cheating.
Purzer, S., Douglas, K. A., Folkerts, J. A., & Williams, T. V. (2017). An Assessment Framework for First-Year Introduction to Engineering Courses. https://docs.lib.purdue.edu/enepubs/16/	The evidence-based practice paper describes an assessment framework that applies to first-year introductory engineering courses.
Reddy, Y. M., & Andrade, H. (2010). A review of rubric use in higher education. *Assessment & Evaluation In Higher Education, 35*(4), 435–448. https://doi.org/10.1080/02602930902862859	This paper critically explores literature on the use of rubrics at higher education level.
Sadler, D. R. (2005). Interpretations of criteria-based assessment and grading in higher education. *Assessment & Evaluation in Higher Education, 30*(2), 175–194. https://doi.org/10.1080/0260293042000264262	The article is based on a review of the most common grading policies that purport to be criteria-based. The analysis shows that there is no common understanding of what criteria-based means or what it implies for practice.
Sands, D., Parker, M., Hedgeland, H., Jordan, S., & Galloway, R. (2018). Using concept inventories to measure understanding. *Higher Education Pedagogies, 3*(1), 173–182. https://doi.org/10.1080/23752696.2018.1433546	The paper focuses on the Force Concept Inventory (FCI) in physics and asks how useful concept inventories are for evaluating learning gains. Finally, it reports on recent work to extend conceptual testing beyond the multiple-choice format.
Simkins, S. P., & Maier, M. H. (2008). Learning from physics education research: Lessons for economics education. https://mpra.ub.uni-muenchen.de/9314/	The paper highlights four specific examples of successful pedagogical innovations drawn from physics education – context-rich problems, concept tests, just-in-time teaching, and interactive lecture demonstrations – and illustrate how these practices can be adapted for economics education.
Vaughan, N. (2014). Student Engagement and Blended Learning: Making the Assessment Connection. *Education Sciences, 4*(4), 247–264. https://doi.org/10.3390/educsci4040247	The article focuses on how collaborative learning applications and a blended approach to learning can be used to design and support assessment activities that increase levels of student engagement.
Wiggins, G. (2012). Seven Keys to Effective Feedback. *Educational Leadership, 70*(1), 10–16. http://www.ascd.org/publications/educational-leadership/sept12/vol70/num01/Seven-Keys-to-Effective-Feedback.aspx	The article explores the concept of true feedback and how it can improve learning.

ADDITIONAL RESOURCES

Reference	Main information
Center for Innovation in Research and Teaching. (n.d.). *Effective feedback in the classroom*. Retrieved September 21, 2020, from https://cirt.gcu.edu/teaching3/tips/effectivefeed	Grand Canyon University, USA provides some food for thought about operational aspects and variables of giving feedback.
Examples of resources on Academic Integrity by University College London – UCL › https://www.ucl.ac.uk/students/exams-and-assessments/academic-integrity › https://www.ucl.ac.uk/ioe-writing-centre/reference-effectively-avoid-plagiarism/plagiarism-guidelines › https://www.ucl.ac.uk/academic-manual/sites/academic-manual/files/chapter_6_student_casework_framework_2019-20.pdf (especially pages 34–36) Examples of Honor Code abstracts by the University of Denver, USA for use in syllabi to address the topic of academic integrity › https://www.du.edu/studentlife/studentconduct/media/documents/hc-abstract-faculty.pdf	Examples of resources at university and course level to prevent misconduct.
Hood, L. (2011). *Examples of Classroom Assessment Techniques for Larger Classes.* http://www.schreyerinstitute.psu.edu/pdf/2011-10-13-10430-CATs_for_Large_Classes.pdf	The document features some examples of assessment techniques along with their respective main phases.
Kulkarni, C., Wei, K. P., Le, H., Chia, D., Papadopoulos, K., Cheng, J., Koller, D., & Klemmer, S. R. (2013). Peer and self assessment in massive online classes. *ACM Transactions on Computer-Human Interaction, 20*(6), Article 33. https://doi.org/10.1145/2505057	This article reports on experiences with two iterations of the first large online class to use peer and self-assessment in MOOCs in global classrooms; it reports also on experiments to improve grading accuracy.
Education Technology Office. (2020, January 08). *Overview of Backchanneling Tools and Techniques*. Retrieved September 21, 2020, from https://ito-engineering.screenstepslive.com/s/ito_fase/m/84234/l/988096-overview-of-backchanneling-tools-and-techniques	The University of Toronto provides an overview of popular backchanneling tools and techniques.

Reference	Main information
Panadero, E., Jonsson, A., & Strijbos, J.-W. (2016). Scaffolding Self-Regulated Learning Through Self-Assessment and Peer Assessment: Guidelines for Classroom Implementation. In D. Laveault, & L. Allal (Eds.), *Assessment for Learning: Meeting the Challenge of Implementation* (pp. 311–326). Springer, Cham. https://doi.org/10.1007/978-3-319-39211-0_18	The paper presents strategies for the implementation of peer assessment in the classroom along with guidelines on teachers' mediating and modeling role and on how to use tools such as rubrics.
PhysPort. *Browse Assessments*. Retrieved September 21, 2020, from https://www.physport.org/assessments/	The PhysPort webpage features a series of assessments, not only in physics. Here there is a list of 95 Research-Based Assessments.
Purzer, S., Douglas, K. A., Folkerts, J. A., & Williams, T. V. (2017). An Assessment Framework for First-Year Introduction to Engineering Courses. http://docs.lib.purdue.edu/enepubs/16	Evidence-based practice paper describing an assessment framework that applies to first year introductory engineering courses at Purdue University, USA.
The Sheridan Center, Brown University. (n.d.). *Use of Clickers in the Classroom*. Retrieved September 21, 2020, from https://www.brown.edu/sheridan/teaching-learning-resources/teaching-resources/course-design/enhancing-student-learning-technology/clickers	The Brown university, USA provides some strategies and examples for using clickers effectively.

THE FUNCTIONS OF ASSESSMENT

ADVANCED INFO CARD

If you are considering (re)designing your assessment tasks, you might explore the functions of assessment in more depth. The table below summarizes the functions of assessment.

Function	Timing	Aim	Outcome/Decision
Diagnostic	Before learning (before course/ unit/topic)	Determining the level	Planning teaching
Formative	During learning	Reflecting how far the learning outcomes have been achieved	Orienting learning, adjustment of teaching
Summative	After learning	Assessing the achievement of learning outcomes	Performance assessment, grading
Quality-promoting	After course/lesson	Improvement of teaching	Appraisal of teaching, adapting to suggestions

Adapted from Krüger & Schmees (2013)

DIAGNOSTIC ASSESSMENT

It is aimed at **collecting data on what students already know about the topic at the beginning** of the course or of the unit/topic (e.g. multiple choice questions to assess a learner's current knowledge base or previous collaborative experiences with a view to designing a group work session).

Diagnostic assessment is useful to find out not only students' prior knowledge before your course/unit/topic starts, but also **learners' misconceptions about what you are planning to teach**. Misconceptions in particular may prevent students from building correct understanding because some foundational ideas they have are incorrect. Some disciplines like physics have developed a set of diagnostic tests such as concept inventories.

Concept inventories

In its most typical form, a concept inventory is a low-stakes test with multiple choice questions designed to test students' conceptual understanding. Based on a number of key concepts from the subject (Jorion et al., 2015; see page 36), each question, or item, has one correct answer and a number of incorrect answers, known as distractors, based on common student misconceptions. The key to constructing an effective concept inventory lies in the selection of good questions with appropriate distractors (Dick-Perez et al., 2016; see page 36).

Concept inventories are often administered in large classes and their most common use is to **test the effectiveness of a pedagogical practice** in altering conceptions. Students are tested on the concept inventory before

instruction (pre-test) and again after misconceptions have been addressed (post-test). The pre-test and post-test scores from across the student body are then compared to determine whether there has been an improvement.

Madsen et al. (2017) argue strongly for the assessment to be taken in some supervised setting, to avoid students using outside resources.

Concept inventories can also be used to compare students' background knowledge on a topic across different course sections, which can be useful especially in the case of courses with many students with diverse backgrounds, like in the case of international students.

Concept inventories do not include all the possible misconceptions that students may have about a topic, hence it is useful to combine them with formative assessments to test students' conceptual understanding.

The Technische Universität Hamburg (TUHH) provides a list of concept inventories articulated in subject areas, without any judgement about quality (https://cgi.tu-harburg.de/~zllwww/fachdidaktik/ci/?lang=en).

FORMATIVE ASSESSMENT

It is aimed at **monitoring student learning by providing ongoing** (usually non-graded) **feedback** that students can use to improve their learning e.g. by identifying their strengths and weaknesses. Formative assessments throughout the course make students aware of their performance in relation to the course's learning outcomes. To this end they need to be timely administered, so that students are able to correct their learning deficiencies and misconceptions and the instructor can adapt teaching.

SUMMATIVE ASSESSMENT

It is aimed at **evaluating student learning at the end of an instructional unit** by comparing it against some standard or benchmark (e.g. through a midterm exam or a final project). Summative assessment after the end of a course or of a course section enables students to determine if they achieved the learning outcomes and if their study strategies were effective.

QUALITY-PROMOTING ASSESSMENT

Assessment can also provide information to support instructors in improving their teaching practices: this is a large and complex topic that goes beyond the aims of the INSYSTED booklet, hence we provide here some food for thought in case you want to go more in depth.

Measurement implies to **make a choice about what data to collect and analyse** (e.g. quantitative data and their statistical analyses such as final exam and course grades, and qualitative data such as open ended and descriptive responses to how the course might be improved). While designing/re-designing a course you might use your own perceptions along with evidence as input data to fine tune your teaching in a **cyclical design process** in which you make and test gradual adjustments across subsequent course iterations. For example, data from summative assessments can be aggregated for each learning outcome to provide an indication of overall student success in achieving them and to determine which course learning outcomes are most problematic for students. For these outcomes, it may be necessary to redesign some instructional aspects.

Comparing data from past offerings of the course with data from the actual course can be challenging, if the main course elements such as ILOs (hence the content that was covered in the course) and assessments were redesigned. For example, you may decide to require students to create a group project instead of a written exam, hence assessing skills e.g. teamwork and communication in addition to content knowledge. In addition to that, some teachers entertain the possibility that requiring from learners in class other behaviours beyond listening and taking notes may have an impact on scores in teaching evaluation questionnaires filled in by students.

Having **summative assessments aligned with learning outcomes** might tell you whether the changes you planned to achieve in your students actually occurred. Again, depending on how different these assessments are from the previous editions of your course, you may not be able to compare them, but you can compare them to the future iterations of the course.

RUBRICS

ADVANCED INFO CARD

WHAT IS A RUBRIC?

A rubric is a tool that articulates the **expectations for assignments and performance tasks** by listing criteria, and for each criterion, describing the levels of quality. The rubric can be developed for assessing both disciplinary knowledge and soft and digital skills.

WHAT ARE THE MAIN FEATURES OF A RUBRIC?

A rubric is formed by the following essential parts:

- the **list of the criteria** to be used for assessing the performance, ideally linked to the ILOs to be assessed;
- a **scale** (and scoring) that describes the level of mastery (e.g., exceed expectation, meets expectation, doesn't meet expectation or basic, proficient, advanced);
- the description of the different **levels of performance quality** (performance descriptors) of the components/dimensions at each level of mastery. This element should be as detailed as possible in order to facilitate self and peer assessment by students.

A rubric is usually defined as a document with a list of assessment criteria, a scoring strategy and quality definitions normally stated on a scale that describe what students need to take into account to demonstrate a particular level of performance (Reddy & Andrade, 2010). Rubrics can be used both for summative and formative assessment:

- for **summative assessment**, to grade students' work;
- for **formative assessment**, to make students' actively use and internalize assessment criteria, resulting in improved learning and performance.

WHY CAN IT BE VALUABLE?

A rubric is a very useful tool to share with students the assessment criteria that are going to be adopted, and it becomes even crucial when the assessment is conducted among peers (peer assessment). A rubric can help to provide **meaningful feedback**; if you share the rubric at the start of the course/an assignment, it guides students in reaching learning outcomes. In addition to that, a rubric can reduce subjectivity of marks, especially when there is more than one instructor/grader.

Advantages for teachers	Advantages for students
Reduce the time spent grading and help to give students feedback.	Understand teachers' expectations and standards.
Help instructors more clearly identify strengths and weaknesses across an entire class and adjust their instruction appropriately.	Use teacher feedback to improve their performance.
Help to ensure consistency across time and across graders.	Monitor and assess their progress as they work towards clearly indicated goals.
Reduce the uncertainty which can accompany grading.	Recognize their strengths and weaknesses and direct their efforts accordingly.
Discourage complaints about grades.	In case of peer assessment activity, have a valid and consistent tool to be used as guide.
Support peer assessment activity.	Improve self and peer assessment competence.

EXAMPLE – ASSESSMENT TASK INSTRUCTIONS WITH INTEGRATED RUBRIC

Assessment task: reflect upon your learning

- Reflect upon the concepts you learned in this course section, choose a concept that appealed most to you, and write a short discussion post about how this concept might be applied in a workplace context. If possible, research this application and support your viewpoint with examples of real-life applications and relevant articles. Suggested word limit: 200-300 words. Complete this task by dd/mm/yyyy hh:mm
- Comment on two posts of other students by answering with the Rose and Thorn technique, that is specifying what do you like (Rose) and what should be improved (Thorn). Your reply has to contain at least 50 words. Complete this task by dd/mm/yyyy (+ 1 week) hh:mm

Incomplete contributions and/or postings delivered more than 7 days late will not be graded.

Evaluation criteria

Your contribution will be evaluated upon the criteria in the rubric on the right.

Criterion	Definition	Levels of performance		
		Does not meet expectations	Meets expectations	Exceeds expectations
Relevance	Relevance and pertinence to the required task.	The post is off-topic/not supported by any related evidence/ no references to readings or research.	The central message is clear and consistent.	The central message is clear, consistent and gives a substantive contribution that advances discussion.
Quality	Argumentation and sources supporting the post.	The post expresses largely personal opinions without specific real-life application/ supporting research.	The post expresses consistent information supported by basic references properly cited.	The post is precisely stated and strongly supported by specific real-life applications, references and arguments that stimulate reflection on one's own reasoning; sources are properly cited.
Engagement	Written comments on 2 others' contributions by specifying for each a strong point (Rose) and an improvement margin (Thorn).	Postings do not respond to peers' postings/do not enrich reflection.	Elaborates on existing postings with further comment or observation but does not add substantive information to the reflection.	Demonstrates analysis of others' posts; extends meaningful reflection by building on previous posts.

Types of rubrics

- **An analytic rubric** articulates different dimensions of performance and provides ratings for each dimension: see an example of an analytic rubric (Association of American Colleges and Universities (AAC&U). (2009). *Inquiry and analysis VALUE rubric*. Retrieved from https://www.aacu.org/value/rubrics/inquiry-analysis).
- **A holistic rubric** describes the overall characteristics of a performance and provides a single score: see the example of a holistic rubric (Facione, P. A., & Facione, N. C. (1994). *Holistic Critical Thinking Scoring Rubric*. California Academic Press.).

Analytic vs holistic

Holistic rubrics are most appropriate when the assessment criteria have significant overlap or when making broad judgments of quality, while analytic rubrics help instructors and students better identify areas needing improvement but are more time consuming (Putzer et al., 2017).

Adapting the rubric example

The rubric mentioned above can be adapted and used for other assessment tasks such as those below.

Assessment task: research and discuss an article on topic X

- Find an article from a reputable source on an application of topic X that inspires or interests you. Write a short summary of the article and why it inspires you and post it on the course forum. Remember to include the link to the article in your post. Suggested word limit: 200–300 words.
- Write a short reply to at least one of your peers' posts, adding substantially to the conversation. Read the article and the post, and make at least one new point in your reply.

Assessment task: describe a decision using the topic X

Module 1 provided you with an overview of topic X and four major tasks of decision-making:

1. understanding data;
2. predicting what will happen;
3. determining what to do;
4. determining what caused the outcome.

For this exercise, pick one problem or decision that would benefit from topic X. Write a discussion post that describes the problem or decision, and how you might approach it using each of the four major tasks. Make sure you include the challenges you might face and any questions you have. Suggested word limit: 200–400 words.

INSPIRATION BOX

Have a look at these examples to see how a rubric may look like.

Disciplinary knowledge

- McGill – Faculty of Engineering. *Graduate Attribute Indicator Rubrics*. https://www.mcgill.ca/engineering/files/engineering/rubrics.pdf
- B. Kanmani. *Outcomes and Assessment of Engineering Projects: An Example*. http://wosa.nbaind.org:8081/proceedings/Web%20page/articles/025.pdf

Soft skills

- Rhodes, T. (2010). *Assessing outcomes and improving achievement: Tips and tools for using rubrics*. Association of American Colleges and Universities. https://www.aacu.org/publications-research/publications/assessing-outcomes-and-improving-achievement-tips-and-tools-using
- Centre for Enhancing Teaching & Learning. (2014, August 11). *Facilitating Online Discussions*. University of New Brunswick. Retrieved September 21, 2020, from https://www.unb.ca/fredericton/cetl/tls/resources/teaching_tips/tt_instructional_methods/online_discussion.html
- UMass Lowell. Oral Communications Graduate Programs. https://www.uml.edu/docs/MBA%20Oral%20Communication%20Skills%20Rubrics_tcm18-291121.pdf
- Wentworth Institute of Technology. Directions for instructor use of the Teamwork assessment rubric. https://wit.edu/sites/default/files/learning-innovation/lit-PDFs/Teamwork-Assessment-Rubric.pdf

Digital skills

- Carretero Gomez, S., Vuorikari, R., & Punie, Y. (2017). D*igComp 2.1: The Digital Competence Framework for Citizens with eight proficiency levels and examples of use.* Publications Office of the European Union. https://doi.org/10.2760/38842
- University of Delaware. Rubric for Asynchronous Discussion Participation. http://www1.udel.edu/janet/MARC2006/rubric.html

PEER ASSESSMENT

ADVANCED INFO CARD

WHAT IS PEER ASSESSMENT?

Peer assessment is the **assessment of students' work by their peers** against a set of assessment criteria. Falchikov (1995) defines peer assessment as the process through which groups of individuals rate their peers.

Depending on the cases, the **instructor may moderate peer grade and feedback**. In some cases, a combination of instructor and peer grading is used.

Peer assessment can be conducted on a variety of outputs developed by students, from essays, to presentations, to student's replies to a discussion on the course forum.

In the INSYSTED approach, peer assessment is underpinned by the online learning community pillar.

WHY CAN IT BE VALUABLE?

Peer assessment can be valuable as it:

- offers an opportunity to **scale assessment** to large classrooms;
- **engages students** in the learning process by making them apply the assessment criteria set, hence developing their capacity to reflect on and evaluate their own learning;
- makes learners **practice and provide evidence of soft skill development** in terms of communication and self-evaluation.

WHAT ARE THE MAIN FEATURES OF PEER ASSESSMENT?

Peer assessment can happen in the following combinations:

- **individuals** assessing individual or group work;
- **students in each group** assessing the individual work of other students in their group (generally a group is made by 2 to 4 people) or assessing group work;
- **students collaborating** within their group to assess the work of other groups;
- **students assessing** their own work (self-assessment).

If the forum is the supporting tool of the peer assessment, this generally happens by replying to a post in text format and/or by uploading a file (in the case of groups assessing the work of other groups, each group often chooses one student who will submit on behalf of their group).

Peer assessment practices may differ in terms of:

- **purpose** (summative vs. formative);
- **format** (marking/rating with or without comments/feedback);
- **contribution** (e.g. peer assessment of individual performance vs. peer assessment of fellow group members' contribution to group work);
- **mode** (e.g. in class students use computers or mobile devices to provide each other with feedback vs out of class students use computers or mobile devices to provide each other with feedback as a homework activity).

Teacher's intervention is generally necessary to introduce formal peer assessment as part of the overall learning experience.

Panadero et al. (2016) identify some **recommendations for teachers** to implement peer assessment; among them:

- **clarify the purpose** of peer assessment, its rationale and expectations to the students;
- **involve students** in developing and clarifying assessment criteria;
- **define the peer assessment format** (e.g., rating with or without comments) and mode of interaction (e.g., face-to-face or online);
- **provide rubrics and examples** of peer assessment feedback to prevent misunderstandings and to ensure reliable and consistent outcomes;
- **specify peer assessment activities** and timescale;
- **monitor** the peer assessment process and coach students.

CHALLENGES OF PEER ASSESSMENT

- **Students may feel uneasy** about assessing their peers or may not trust that their peers are able to assess them.
- Depending on the context, **students may not be able to provide evaluative feedback** (e.g. feedback that judges their peers' critical thinking or whether or not peers' work is a unique contribution to the field). Asking students questions that call for evaluative responses may be appropriate where the questions are linked to course goals and students have had preparation in addressing such questions.

Even if peer assessment practices can differ:

- generally it is advisable to **ensure that all students** have the opportunity to both provide feedback on one another's work and to receive feedback on their own work. Assigning students the task of providing feedback to 3–4 peers allows for sustained reflection and a variety of perspectives without the task becoming overwhelming;
- for electronically-submitted feedback (e.g. on the course forum), the instructor should **periodically review a selection of the comments** provided to ensure that they are constructive and relevant;
- peer assessment can be done **openly**, encouraging comparison and discussion, **or anonymously** depending on the assessment task and context. In general not anonymizing the feedback may encourage students to be accountable to each other for their feedback, thus providing opportunities to discuss their feedback with their peers;
- **assigning students a grade for participation** in the activity fosters a more productive participation of assessors in the task.

INSPIRATION BOX

Have a look at these resources to get additional hands-on insights.

- Teaching and Learning Services – McGill University. (2018). *Designing Peer Assessment Assignments: A Resource Document for Instructors*. https://www.mcgill.ca/tls/files/tls/pa-resource-doc-rev-aug-2018.pdf
- Teaching and Learning Services – McGill University. (n.d.). *Examples of PA assignments*. McGill University. Retrieved September 17, 2020, from https://www.mcgill.ca/tls/instructors/assessment/peer/examples
- Reis, R., Kokernak, J., & Pei, L. (n.d.). *Ways to Teach Peer Writing and Response, in Any Course and Any Size Class*. Tomorrow's Professor Postings. Retrieved September 21, 2020, from https://tomprof.stanford.edu/posting/940
- Egodawatte, G. (2010). A rubric to self-assess and peer-assess mathematical problem-solving tasks of college students. *Acta Didactica Napocensia, 3*(1). http://dppd.ubbcluj.ro/adn/article_3_1_8.pdf
- Moodle. (n.d.). *Workshop activity*. Moodle Docs. Retrieved September 17, 2020, from https://docs.moodle.org/38/en/Workshop_activity
- City University London. (n.d.). *Facilitating Peer Assessment using Forums*. Educational Technology Guidance. Retrieved September 17, 2020, from https://sleguidance.atlassian.net/wiki/spaces/Moodle/pages/35815436/Facilitating+Peer+Assessment+using+Forums
- van der Westhuyzen, C. (2017). *Implementing peer assessment in online group projects*. Research Hub by GetSmarter. https://www.getsmarter.com/blog/wp-content/uploads/2017/07/GS_WHITEPAPER_IMPLEMENTING-PEER-ASSESSMENT-IN-ONLINE-GROUP-PROJECTS-1.pdf

Anna

Engineering university teacher

"When I explain the topic in class many students struggle with the quantitative parts and lack motivation in the following exercise activity."

Anna

Engineering university teacher

"I redesigned how I teach the topic by adding value using online activities to extend the lesson beyond class time, so that activities can support the achievement of ILOs and are aligned with assessment tasks.

For this reason, I decided to expose students to content by assigning them targeted MOOC videos to watch before class. In class I'm going to briefly summarize the topic by outlining the pivotal questions and ask them to work in groups under my supervision on an application exercise with real-life scenarios supported by a serious game.

After the lesson the groups of students are asked to deliver a summary of the work done in the course forum including decision-supporting data."

4. TEACHING AND LEARNING ACTIVITIES (TLAS)

WHICH METHOD TO CHOOSE TO (RE)DESIGN TLAS?

Targeted instructional methods that support student-centred learning in the INSYSTED approach: flipped learning, inquiry-based learning, problem-based learning, project-based learning.

EXAMPLES OF TECHNOLOGY-ENHANCED TLAS

Hands-on blended learning activities according to different kinds of learning with an increasing degree of complexity.

TEACHING INNOVATION AND LEARNING SPACES

Classroom configurations that are conducive of active learning strategies.

FLIPPED LEARNING

How flipped learning articulates, tips to run a flipped classroom smoothly and hands-on practice examples.

4. TEACHING AND LEARNING ACTIVITIES (TLAS)

CONSTRUCTIVELY ALIGNED ACTIVITIES

Once you have set the outcomes you want students to achieve and defined how students are assessed, the constructive alignment can support you in designing the Teaching and Learning Activities (TLAs): they are crucial to **enable students to develop their capacity to meet assessment criteria** and thereby achieve the Intended Learning Outcomes.

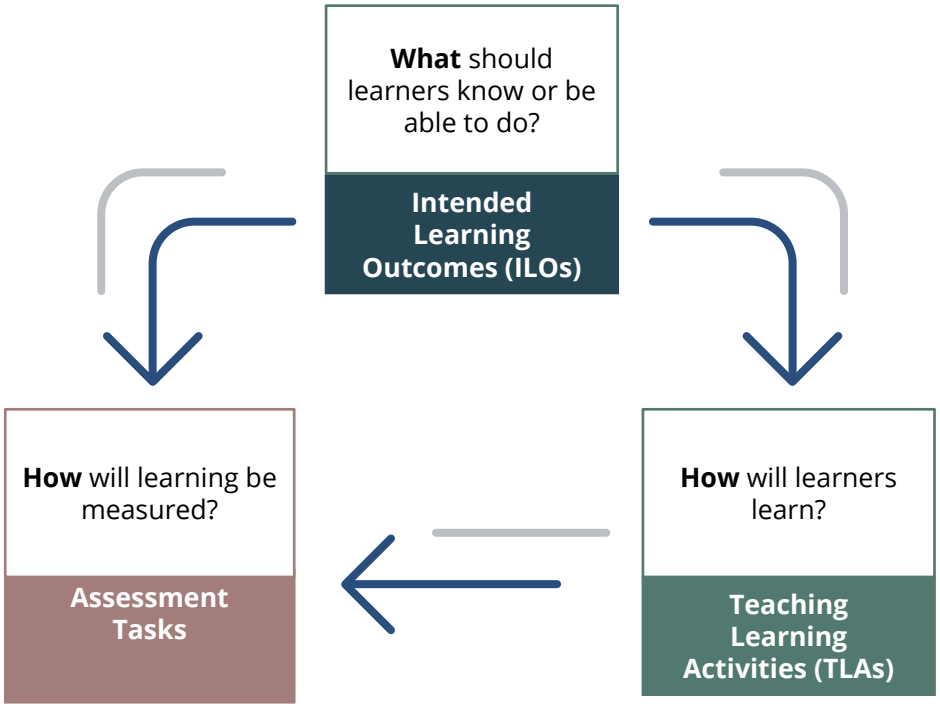


Image elaborated from Biggs (2003)

In the INSYSTED approach, part of TLAs are carried out online and underpinned by the pillars that enable access to educational content (MOOC), social interaction (online learning community) or both (serious game). These activities generally **replace a portion of direct instruction** (e.g. lecture, demonstration): face-to-face and online components are integrated, hence the term blended.

WHICH METHOD TO CHOOSE TO (RE)DESIGN TLAS?

You might focus on a new instructional method to (re)design your TLAs or a portion of them: that does not mean that lectures do not have a place: they do, but their use concentrates on what suits best the outcomes you want to achieve. The INSYSTED approach supports **student-centred learning**, which implies the flexibility of individual learning paths and an outcome-based perspective in the context of the Bologna Process. Student-centred learning encompasses new instructional methods where **learners engage in the learning process beyond passive listening** (active learning) and have greater agency in their learning: it is not necessarily technology-supported, but developments in educational technology and the online availability of an unprecedented quantity of content enable a blended instruction where students are actively engaged.

In the INSYSTED approach, flipped learning can provide valuable opportunities in itself, but can be also combined with other instructional methods. In flipped learning, students are instructed to engage with learning content and materials prior to a lesson, and to work through these independently. This leaves **more time for teachers to provide support more effectively** when back in the classroom. With this in view, inquiry-based learning, problem-based learning and project-based learning were identified among the instructional methods that can be used in the classroom to complement flipped learning, as they lead students to **develop skills** such as problem-solving and communication skills and to **engage in authentic TLAs**, applying knowledge and skills to contexts that mirror those faced by professional engineers in the workplace.

You might apply one of these instructional methods or a combination thereof to a lesson, a portion of your teaching or to a whole course using the INSYSTED pillars: MOOCs, serious games and online learning communities.

Flipped learning

Instructional method description

Flipped learning refers to a pedagogical model in which **the typical lecture and homework elements are reversed**: prior to a lesson, student engage with new learning content for the first time, in video, text or any other format in their individual spaces (e.g. at home); in the classroom, the educator guides students in applying the concepts they learned independently.

How the INSYSTED pillars might support it

MOOCs can be used to deliver the transmissive content students are exposed to before the lesson. As MOOCs are accessible to any learner in the world and can be offered by organisations other than the students' home university, they can support internationalisation in terms of fostering **cross-boundary cultural awareness and knowledge**.

EXAMPLE

Physical chemistry of materials course – Prof. Gimenez (Engineering BSc curriculum at Universitat de Barcelona)

Suitable for up to 100 students (20 groups of 5 students), and one instructor.

ACTIVITY

Objective: addressing medium-and low-achieving students that may drop any work to be done in advance with the typical flipped classroom setting, due to difficulties in conceptual understanding. To this end "SABER 2.0 in STEM" was adopted – a practical implementation of the so-called synchronous flipped classroom (SFC), where students do not work on any material in advance, but rather start working in the classroom under direct teacher supervision. More at http://diposit.ub.edu/dspace/bitstream/2445/141102/1/686299.pdf.

- Students use **activity sheets**, prepared by the teacher, with specific tasks (ruling) and instructions (data acquisition, initial modelling, contrast, refining, reinforcement practice). An example of activity sheet structure:
  a. initial, motivational case;
  b. reading summary;
  c. conceptual question;
  d. application exercise;
  e. bibliographic sources.
- During the lesson (2-hour sessions), students work and comment on what they are doing, which was proved to be effective for learning. Groups are freely made of 2–5 people that change every lesson.
- In-class **question solving**: the teacher provides targeted answers to specific questions of each group; recurring questions are answered in plenary.
- Students deliver assignments on the activity sheet online and then revise work and analyse errors according to teacher's feedback, improving their initial version (learning through error self-analysis). Such activity promotes **self-assessment**, **analytical skills** and **learning to learn competence**.

If you want to adapt/reproduce this activity in your teaching: you might use the INSYSTED online learning community and create a forum where you share with students the answers you gave in class.

Inquiry-based learning

Instructional method description

Inquiry-based learning promotes student learning through an increasingly **independent investigation of complex questions, problems, and issues:** rather than teaching the results of others' investigations, which students learn passively, the instructor poses one or more meaningful questions and assists students in learning through an active investigation of the topic.

How the INSYSTED pillars might support it

In class, the instructor asks students to investigate a question or an issue in groups by starting from initial literature and resources made available in the **course forum and by using a serious game** to experiment with real-world scenarios. The forum becomes a learning community supporting the production of results that have a certain degree of novelty, hence fostering soft and digital skills in terms of **analytical skills**, **creativity and innovation** and **information and data processing**.

EXAMPLE

Economics and computation course (Engineering MSc curriculum at PoliMI)

In the classroom about 40 students, in a total of 110 enrolled students, few international students.

ACTIVITY

Objectives:

› encouraging students to tackle scientific research problems;
› enhancing course effectiveness and efficiency.

Course articulates into 4-week modules (4 course modules in total).

- **1st and 2nd week – at home**: students watch video lectures + do self-assessment quizzes on Socrative.
- **3rd week – in the classroom**: instructor and teaching assistants explain problematic topics emerged from quizzes on Socrative.
- **4th week – in the classroom**: 30-minute assignment about video lectures + 2-hour scientific **challenge** in groups with a series of exercises; students have to complete the previous exercise to unlock the following one.
- Completion of activities during 4-week modules is included in grading.
- PoliMI web-enhanced platform is used to deliver teaching material.
- Not sustainable in classrooms with 150 students or more.

If you want to adapt/reproduce this activity in another context: you might use the INSYSTED MOOC pillar to make students watch video lectures made available by other teachers.

Problem-based learning

Instructional method description

Problem-based learning is an instructional method where relevant problems lacking a well-defined answer are introduced at the beginning of the instruction cycle and **students learn about the subject through the experience of solving an open-ended problem**.

How the INSYSTED pillars might support it

Students work in groups to research the problem given by the instructor in class and explore content in various formats, including **MOOC-based content**. The teacher instructs students to use a **serious game to apply knowledge and explore solutions**; work groups are asked to **share resources and outputs on the course forum**, that enacts the online learning community. This approach fosters soft and digital skills such as **learning to learn** and **information and data processing** skills; in addition to that, using the serious game can help engage more international students, especially in courses that are offered in English and in another European language.

EXAMPLE

Strategies for environmental challenges (Engineering Bachelor of Science degree at PoliMI)

About 100 students.

ACTIVITY

Objectives: making students able to tackle problems and find solutions by engaging with diverse stakeholders across disciplinary fields.

A real case study/problem is used as a guiding thread of the whole course; role play activities and simulations are used to explore and solve the case study in teams.

- First phase focuses on institutional stakeholders. Through interviews, material analysis and context exploration, students simulate the process of guidelines definition these stakeholders have to conduct.
- In a second phase, students in teams play the role of an engineering studio who has to develop an innovative proposal based on what emerged from the guidelines.

If you want to adapt/reproduce this activity in another context: you might use the INSYSTED Serious game to support role play activities beyond class time and the INSYSTED Online learning community pillar to share input material on the course forum.

Project-based learning

Instructional method description

Project-based learning is a teaching method in which students are challenged to **develop a plan and create an output, a product or artefact that addresses a complex question, issue, problem, or challenge**; learners gain knowledge and skills by working on the project and by integrating theory and practice.

How the INSYSTED pillars might support it

The teacher assigns projects to groups of students and track their participation as well as their contributions by using an **online learning community** implemented through a course forum. Exchanges among community members and work groups foster soft skills in terms of **communication** and **collaborative problem solving**.

EXAMPLE

River hydraulics for flood risk evaluation (Engineering MSc curriculum at PoliMI)

About 55 students in the classroom, 80% international students.

ACTIVITY

Objective: making students understand how a real system works.

- Theory studied at home with handouts.
- In-class time devoted to revision of homework assignments and to apply theory by solving problems of increasing complexity in groups using Matlab, Excel, commercial software.
- Cautious introduction of an inductive approach proved to be adaptive in a multicultural, non-uniform context.
- PoliMI web-enhanced platform to share both teaching material and homework assignments.
- Not feasible for more than 15 ECTS.

If you want to adapt/reproduce this activity in another context: you might use the INSYSTED Online learning community pillar to share the phases and main outcomes of the revision of assignments through the course forum.

EXAMPLES OF TECHNOLOGY-ENHANCED TLAS

Level of Bloom's taxonomy: REMEMBERING

Students are required to recognise and recall relevant information such as facts, concepts, terms, methods and procedures.

Hands-on example of a constructively aligned activity

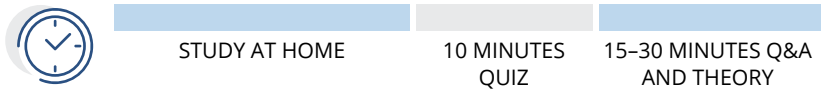
Quiz

Assessment Task

Disciplinary knowledge: students will be able to describe the characteristics of an inventory system.

Intended Learning Outcome

Previous Knowledge test

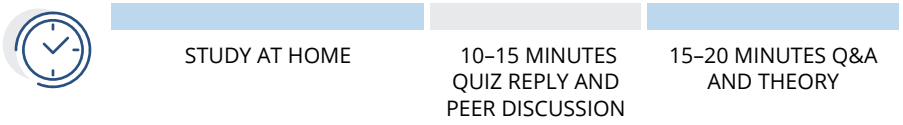


- **Pillar(s)**: MOOC
- **Instructional method**: flipped learning
- **Soft/digital skills developed**: no specific skills are expected to be developed with this activity

The activity starts with an online activity: at the end of the previous lesson the teacher assigns students selected MOOC materials such as videos to be watched at home, so that they are exposed to content before the following lesson. After the in-class quiz (assessment) the instructor focuses on the concepts that were less clear to students, based on quiz results.

Teaching and Learning Activity

Another example of activity that can be used: small group game



- **Pillar(s)**: MOOC
- **Instructional method**: flipped learning
- **Soft/digital skills developed**: self-assessment, communication

Students are asked to explore the contents (videos or text material) of a selected MOOC at home. While in class, the teacher administers a short quiz (e.g. 3–5 multiple choice questions) that students answer individually. No solution is given. Instead, students discuss their answers in pairs or small groups of three (peer discussion). Following this, students take the quiz again. Finally, the teacher shares solutions and explains concepts that were not consolidated or less clear to students.

NB

These examples of hands-on activities are by no means exhaustive but may inspire you. If you want to design technology-enhanced TLAs, the starting point is to determine what cognitive processes are involved in the corresponding intended learning outcome: Bloom's taxonomy can support you in that. The focus is on the experiences that help students to learn or, in other terms, the means by which students achieve learning outcomes.

Level of Bloom's taxonomy: UNDERSTANDING

Students are required to interpret knowledge and translate it into a new context.

Hands-on example of a constructively aligned activity

Concept Maps

Assessment Task

Disciplinary knowledge: students will be able to define the key performance indicators of queuing systems and their relationship based on Little's law.

Intended Learning Outcome

Highlight keywords

20–30 MINUTES ACTIVITY IN CLASS | 1 WEEK COLLABORATIVE CONCEPT MAP DEVELOPMENT

- **Pillar(s)**: online learning community
- **Instructional method**: inquiry-based learning
- **Soft/digital skills developed**: learning to learn, self-evaluation

This activity can be used for introducing a new topic or to deepen the understanding of a concept after the theoretical explanation/ consolidation. The teacher circulates printed copies of a text explaining the topic (or a few excerpts from different sources/ textbooks); students in pairs or triplets are asked to highlight keywords on paper or on a collaborative online space (e.g. a wiki, an online board or a spreadsheet). All the relevant links and resources are shared on the forum. Then, students are asked to work collaboratively outside classroom time, and demonstrate the understanding of performance indicators and their relationship by producing a concept map (assessment).

This activity can support a more in-depth understanding of concepts. It can be particularly useful for international students.

Teaching and Learning Activity

Another example of activity that can be used: misconceptions

5 MINUTES POLL | 20 MINUTES THEORY | 15 MINUTES RECALLING IN CLASS | 10 MINUTES GUIDED DISCUSSION

- **Pillar(s)**: MOOC
- **Instructional method**: flipped learning
- **Soft/digital skills developed**: learning to learn, self-evaluation

At the end of the lesson the teacher administers 3 or 4 polls about common misconceptions students have about the forthcoming learning topic, and asks students to agree or disagree with a set statements about these concepts. Then, students are assigned MOOC material to watch at home. In the following lesson, the instructor recaps key concepts and gives additional explanations. Then, the teacher shares an online spreadsheet with the wrong statements of the polls: students are asked to briefly explain why those statements are incorrect.

Level of Bloom's taxonomy: APPLYING

Students are required to apply knowledge such as principles, rules, methods, laws, and theories in similar new or real-life situations.

Hands-on example of a constructively aligned activity

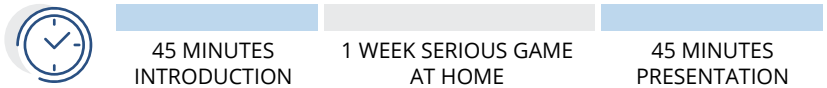
Report

Assessment Task

Disciplinary knowledge: students will be able to examine the long-term performance of existing queuing systems based on Little's law.

Intended Learning Outcome

Serious game – ProTUce

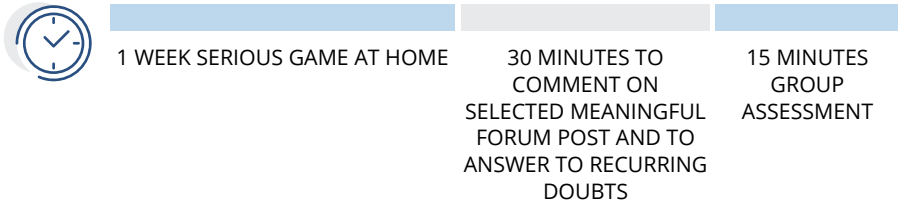


- **Pillar(s)**: serious game and MOOC
- **Instructional method**: problem-based learning
- **Soft/digital skills developed**: teamwork, negotiation communication

The instructor launches the game challenge. Students are organized in teams and start to work at the first level of the game, using data provided by the instructor; simulation and data input features support students in applying knowledge. Each team has 1 week to play in the first level of the game. Team members have to collaborate in taking the right decisions to reach the highest possible profit. Students are encouraged to search and study online material (MOOC). Before the end of the week, teams have to finalize their report (assessment). In the next lesson, each team presents a summary of the key points of their report (3 minutes). The teacher comments on each presentation and adds theoretical elements when needed.

Teaching and Learning Activity

Another example of activity that can be used: simulation



- **Pillar(s)**: serious game + MOOC + online learning community
- **Instructional method**: project-based learning
- **Soft/digital skills developed**: analytical skills, communication skills

The teacher introduces the new topic at the end of the lesson and instructs groups of students to work with different variables/conditions and predict results to a certain problem/situation with the support of both serious game and MOOC material. Groups are asked to share their answers in the forum prior to the next lesson. Once in class, the teacher shares groups' answers and adds an explanation about recurring doubts related to the corresponding theoretical background. Before the end of the lesson, groups have to complete the assessment task.

Level of Bloom's taxonomy: ANALYZING

Students are required to break down information into smaller constituent parts and determine how these parts relate to one another and to an overall structure or purpose.

Hands-on example of a constructively aligned activity

Case study

Assessment Task

Disciplinary knowledge: students will be able to formulate an analytical model for the performance analysis of specific industry setting based on Little's law and the Kingman approximation.

Intended Learning Outcome

Role play

15 MINUTES THEORY IN CLASS | 1 WEEK SERIOUS GAME AT HOME

- **Pillar(s)**: serious game
- **Instructional method**: problem-based learning
- **Soft/digital skills developed**: information and data processing, negotiation, problem solving

The teacher presents a specific industry setting (case study) and the related theoretical concepts. Then, students are asked to tackle a trigger situation (1 different situation for each group) involving the work of 3–4 industry professionals. Groups of 3–4 students are assigned to role-play the work of these professionals. Students are provided with a job description for each role within the project team, and video interviews with professionals. Each team plays all the characters in an online serious game. This role play starts in class and continues for one week, requiring students to work together out of class. One student per group is in charge of taking notes to produce the output of the assessment.

Teaching and Learning Activity

Another example of activity that can be used: analytic text

15–20 MINUTES THEORY IN CLASS | 1 WEEK FOR EXPLORING CASE STUDY | 30–45 MINUTES PRESENTATION

- **Pillar(s)**: online learning community and MOOC
- **Instructional method**: project-based learning
- **Soft/digital skills developed**: negotiation and conflict management, team communication, public speaking

The instructor shares in the forum an online spreadsheet with a list of specific industry case studies. Students are divided into small groups and each one is assigned a different case to work on. The teacher explains the related theoretical background. Outside class, students are asked to explore the case, look for references including targeted OER and/or MOOC content, and create a short presentation using a **PechaKucha** format, that is a fast-paced presentation in which 20 slides of information are shown for exactly 20 seconds each. During the next lesson, one spokesperson per group has 6 minutes and 40 seconds to present its work.

Level of Bloom's taxonomy: EVALUATING

Students are required to critically examine information, e.g. making judgements based on criteria and evidence and to express their own opinion based on evidence.

Hands-on example of a constructively aligned activity

Developing criteria to evaluate a product or a solution

Assessment Task

Disciplinary knowledge: students will be able to propose system configuration to minimize costs in specific industry setting.

Intended Learning Outcome

Activity sheets

STUDY AT HOME

45 MINUTES TO FILL IN THE ACTIVITY SHEET

- **Pillar(s)**: MOOC
- **Instructional method**: problem-based learning
- **Soft/digital skills developed**: analytical skills, teamwork, communication

During pre-class time, students are exposed are exposed to supporting learning content (MOOC); in class, students in free groups of 2–5 people are instructed to define a system configuration that minimises costs, and complete online activity tasks prepared by the teacher which include instructions and industry scenario (application exercise). The teacher provides targeted answers to specific questions of each group while recurring questions are answered plenary. Following this, groups work on the assessment task.

Teaching and Learning Activity

Another example of activity that can be used: gaming session

30 MINUTES THEORY IN CLASS

15 MINUTES TO FORM THE GROUPS AND LAUNCH THE WORK ON THE SERIOUS GAMES

1 WEEK SERIOUS GAME AT HOME

45 MINUTES TO PRESENT

- **Pillar(s)**: serious game
- **Instructional method**: inquiry-based learning
- **Soft/digital skills developed**: analytical skills, communication

The teacher answers to pivotal questions about minimising costs to cover the related theoretical content. After that, students are asked to work in teams, and start from a specific industry setting. Each group has to play on ProTUce for 1 week and take/make the most effective decisions to find the system configuration that minimizes costs. During the next lesson, each team has 3 minutes to present their decisions/solutions to the whole class. Following this, the teacher comments on each presentation and clarifies any misconceptions and doubts. Finally, students complete the assessment task.

Level of Bloom's taxonomy: CREATING

Students are asked to put elements together to form a new consistent whole or to reorganise elements into a new pattern or structure e.g. by compiling or producing information.

Hands-on example of a constructively aligned activity

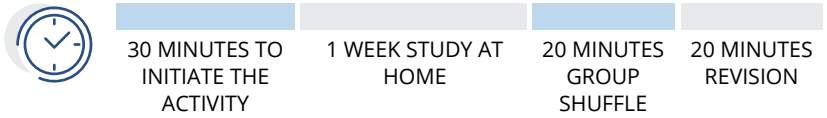
Outline a strategic plan

Assessment Task

Disciplinary knowledge: students will be able to develop new ideas and solutions to redesign the current procedures and tools of the purchasing process, and to improve the overall performance.

Intended Learning Outcome

Jigsaw revised



- **Pillar(s)**: online learning community and MOOC
- **Instructional method**: inquiry-based learning
- **Soft/digital skills developed**: analytical skills, teamwork, negotiation, information and data processing, content creation

The instructor selects different scenarios presenting pivotal questions regarding the current processes and tools of the purchasing process. Students are split into small groups and provided with some initial resources. Each group's task is to develop expertise on its particular scenario, by conducting research, and to produce a report presenting its solutions. The activity starts in class and continues online in the forum. During the next lesson, groups are reshuffled so that the members of each new group have a different area of expertise to share within the group. Before the end of the lesson, the original groups rejoin and revise their initial work on the basis of the previous peer discussion.

Teaching and Learning Activity

Another example of activity that can be used: crib cards

- **Pillar(s)**: online learning community
- **Instructional method**: inquiry-based learning
- **Soft/digital skills developed**: problem solving, creativity, innovation

In class, the teacher explains a context-rich problem. A context-rich problem is a problem that allows the student to connect the discipline to reality, and answers challenging questions that cover the related foundational concepts. Students are instructed to work in pairs outside classroom and develop a card (study resource) including information that could be used to redesign a specific aspect of the purchasing process. The card template is given in the forum.

Low-hanging fruit tip: cards developed during course iterations can be shared as Open Educational Resources.

WRAP-UP: TLAS AND BLENDED LEARNING

The INSYSTED pillars support active learning pedagogies where learners engage in the instructional process beyond listening and taking notes; no matter which instructional method you choose, digitally-enhanced TLAs pose some challenges.

Teacher's role

- Elucidate the mutual agreement between teacher and students in terms of expectations (**classroom pact**) and make sure that your students are aware of it: you can use e.g. course syllabus to convey this information.
- **Detail the resources and tools** that you are going to use in you teaching, such as the INSYSTED pillars (e.g. the course forum on the university LMS for the online learning community, the specific MOOC and serious game that are going to be used and the function/aim of each of them).
- **Give feedback to students' messages and contributions** (e.g. in the course forum), to support learning and foster confidence in the approach you chose.

Student engagement and motivation

- Active learning requires students to have a greater sense of agency and autonomy. When adopting TLAs that ask students to carry out some sort of activity before the lesson, the teacher must be aware that some students may come unprepared to the class. **Providing an incentive** in terms of points for students to prepare for class could encouraging their pre-class engagement.
- Consider to use a **"hook" that introduces your lesson in an engaging way**, in order to interest learners at the beginning of your class or at the end of the previous one (e.g. a real world phenomenon or event to relay the relevance of the topic).
- **Short classroom activities** (<10 minutes) such as online quizzes and polls can prompt students' reflection and attention after a long theoretical explanation.

Learning spaces and technology

- Consider the **classroom setting**, as it has an impact on how an activity can be carried out (e.g. fixed vs movable furniture, Wi-Fi vs no Internet connection); if you are planning group activities in classrooms with fixed furniture, a generally smooth running solution is to ask students to turn to the 2–3 people behind (or in front) of them, instead of changing seats.
- **Some activities are only feasible with small and medium-sized classrooms**; there is no universally accepted definition of what a large class is, but in this booklet we consider classes that exceed 80 students to be large classes.
- **Set the rules for in-class technology use and share them**, e.g. in the course syllabus; sensitize learners to the distraction that off-task technology use (e.g. mobile phones) implies and to the negative impacts on their learning and academic performance.
- Devote some time to **check out in advance that the digital tools you chose are working properly**.

Design of activities

- The initial design of a TLA is not carved in stone: **ask regularly for students' feedback to identify problems** promptly (above all informally), so that you can fine-tune the design of your teaching and learning experience.
- If you require students to produce a deliverable for a TLAs individually or in groups, ask them to **define in advance objectives, deadlines, outputs, resources** etc. on an online shared spreadsheet (linked from the forum) that will support them and that you can review if necessary.
- In case you have students who support you in managing activities in class or in preparing material to be used for TLAs, consider **using special roles and/or rewards** for them.

WRAP-UP: MOOCS IN CURRICULAR EDUCATION

Selection of MOOC content

Identify accurately the MOOC content to be used. Basically, a MOOC is offered as a stand-alone online course, but if you are considering to use a MOOC in your teaching, **content should be targeted and meaningful** to the learning activity being carried out. MOOC features may vary considerably in terms of media formats for content. MOOCs should be selected from a reputable higher education institutions or from other kinds of organisation with complementary expertise, such as professional associations and companies.

Availability of the MOOC

Check the availability of desired content. **Content should be actually available online** when it is needed by your course schedule. Some MOOCs are offered on demand, other ones are available only within specific dates, and policies can change over time. It is worth noting that MOOC content often includes (but is not limited to) lectures in video format that might also be accessed on other channels: for example, the POK platform by Politecnico di Milano has a YouTube channel with a playlist for each MOOC.

Connection between MOOC and course

Detail how the MOOC relates to the course. **Which content students are expected to access** and what they are expected to do with it should be clearly defined. In addition to content, MOOC activities can be used as well: for example, you may require students to take part in MOOC activities, such as assignments, on the MOOC platform. Apparently trivial information (such as how to enrol in the MOOC, and language), should be clear to students. You can include this information on the syllabus.

Compliance with the MOOC licence

Verify the MOOC licence. Your use of the MOOC has to be compliant with its licence: it is important to **check the licence** related to each resource you are planning to use. If you lack information about licence and requirements, ask directly the MOOC provider.

WRAP-UP: MAKING THE MOST OF A SERIOUS GAME

Integrating the serious game into the overall learning experience

- Know the game well enough to be able to propose **value-added activities** that support the achievement of specific course learning outcomes.
- Provide **guidance to students** regarding the proper way of using the serious game and what to expect from it; provide information about what to do in case of any technical problems while using the game (e.g. synchronous support, email).

Onboarding students in the serious game

- Offer plenty of **explanatory support in advance**, such as a user guide of the game in the course forum. Consider delivering trial runs to expedite the start process that otherwise might be time consuming, as students not necessarily raise questions if they don't understand.
- Consider to **adapt the difficulty level**, as often high-performing students are, generally, more motivated while unprepared/low-achieving students may struggle.

Balancing activities

- Pay attention to the **criteria you use to form the groups of students** that play the game, as assigning teams arbitrarily poses challenges. Be aware that if you let students to form groups themselves, high-performing students tend to choose each other, and low-performing students may struggle.
- Provide **in-between classes** to deliver part of the solutions/explain the key concepts of interaction with the game.

Leveraging the other INSYSTED pillars

- Consider **follow-up activities supported by the other INSYSTED pillars**, such as exposing students to targeted MOOC content, selecting and discussing information that is relevant to the achievement of learning outcomes, launching discussion, consolidation and reflection activities in the forum-based online learning community.
- Use the **course forum** to make available supporting and introductory material.

WRAP-UP: BUILDING AN ONLINE LEARNING COMMUNITY IN A COURSE FORUM

Strengthening the linkage between face-to-face and online activities

- **Balance interactivity and instructor workload** by making more use of forum activities. Ideally, these activities should replace some face-to-face interactions rather than being an add-on; the teacher can be supported by collaborators in managing the forum.
- **Remind students** during classes of the tasks they are expected to carry out in the forum and make sure they are clearly written, e.g. in the course teaching material and/or in the syllabus.
- Create **assignments that require a forum post** in order to strengthen the forum's centrality to the class, and to promote the development of the online learning community.
- Use the forum as a **hub of resources** that are relevant to expected activities and tasks.
- Consider to send a **summarizing final comment** when closing a discussion in the forum, and advise students to make notes or save the most valuable content on their computers, so that they can come back to it later on.

Minding consistent communication patterns

- **Provide feedback** in the first weeks of use of the forum, e.g. replying to questions that need you contribution, asking "trigger questions" to prompt ideas, giving and asking for examples, acknowledging valuable students' contributions.
- **Redirect any relevant student's question** to the forum, so that all other students can benefit from your answer.
- **Remind students to interact with each other directly**, not through you as the instructor; your presence online should not dominate the discussion; everywhere possible, rather than providing answers, prompt debate by suggesting resources and ideas.
- **Re-focus/correct wrong students' answers** and off-topic evolutions of the forum.

Onboarding students in online activities

- **Consider to post** a first ice breaking message on the course forum to explain what it is aimed for.
- Detail **what you expect from students and what students can expect from you** (e.g. the instructor will reply to clarify errors and misunderstandings).
- **Provide clear instructions for forum tasks** (e.g. material to be read before answering, post format and length, language style, suggested thread/title formulation, task deadlines, quotation standards) and communication rules within the forum; consider providing examples to make your expectations clear.
- Think about implications for possible **international students**, as asynchronous forum communication allows them to reflect and elaborate their posts in another language.
- In the case of **large classes**, if you divide students into subgroups bear in mind that it has an impact on the dynamics of the overall learning community.

Scaffolding knowledge construction activities

- Consider assigning **participation points/grades for forum activities** to foster students' participation in the online learning community; a rubric explaining how participation will be evaluated (see example at https://www.purdue.edu/innovativelearning/supporting-instruction/portal/files/8.2_Sample_Discussion_Board_Rubric_LDT.pdf) might be crucial to provide clear assessment criteria.
- If a task implies you **posing a question**, design it carefully (the Stanford University's Designing Effective Discussion Questions provides some food for thought https://teachingcommons.stanford.edu/resources/teaching/student-teacher-communication/designing-effective-discussion-questions).
- **Monitor and track participation** either manually on an online spreadsheet or automatically through analytics, if available; that might prompt you to contact individuals/groups whose participation is very low to see if they are experiencing technical difficulties.

TEACHING INNOVATION AND LEARNING SPACES

The INSYSTED approach aims at supporting instructors in making the most with the **existing classroom equipment and resources**: that's why the majority of the suggested activities are feasible in a traditional, frontal classroom configuration and do not necessarily require movable tables or non-standard multimedia devices.

Nevertheless, it is worth mentioning that the shift towards active learning practices is fostering new classroom configurations in addition to the traditional arrangement[1] that optimizes instructor transmission and a "one-size-fits-all" approach.

Recent learning spaces are often **flexible in size and arrangement**[2] and equipped with **wireless Internet access** to accommodate interactions among students, such as discussion and teamwork.

New learning spaces can **support the use of personally owned devices** such as smartphones and tablets by students in the Bring Your Own Device paradigm – BYOD: that poses challenges as it is important that technology is used to fulfill specific educational goals, otherwise it can create a distraction (Richmond, A. S., & Troisi, J. D. (2018, December 12). *Technology in the Classroom: What the Research Tells Us.* https://www.insidehighered.com/digital-learning/views/2018/12/12/what-research-tells-us-about-using-technology-classroom-opinion).

Several higher education institutions, such as Technische Universiteit Delft – TU Delft and Politecnico di Milano, offer specific spaces where teachers can experiment with flexible, digitally-enhanced classroom settings and tools.

The convergence of an unprecedented quantity of online resources and educational technologies is shaping the synergies within the whole university ecosystem and especially among instructors, students, libraries and learning innovation units, whose role can be relevant to the uptake of new pedagogies and related skills such as digital skills.

Low-hanging fruit tip

To promote collaborative learning and team-based learning, the HES-SO (Haute École Spécialisée de Suisse Occidentale), Switzerland advises faculty members to ask each work group of students to have an extra, empty chair at their table, so that the instructor can share a moment with each group of students. When the teacher sits at the table, learners are engaging much more effectively and deeply than if they were just working by themselves, and have the opportunity to discuss concepts which haven't been understood clearly.

[1]Traditional classroom configuration

[2]Flexible classroom configuration

Inspiration box

Elkington, S., & Bligh, B. (2019). *Future Learning Spaces – Space, Technology and Pedagogy*. Advance HE. https://www.advance-he.ac.uk/knowledge-hub/future-learning-spaces-space-technology-and-pedagogy

Finkelstein, A., Ferris, J., Weston, C., & Winer, L. (2016). Research-Informed Principles for (Re)designing Teaching and Learning spaces. *Journal of Learning Spaces, 5*(1). https://files.eric.ed.gov/fulltext/EJ1152623.pdf

Experimenting with innovative learning spaces: Educafé

Politecnico di Milano – METID Learning Innovation designed and implemented the Educafé space that instructors can use to experiment with teaching and learning innovation for large and medium/small-sized classrooms. The Educafé space develops along two axes:

a long axis to **simulate large-sized classrooms** (from 80 to 250–300 students), mainly **aimed at integrating diverse sources**, whose equipment consists of:

a. projector with 2 screens (PC linked to projector, one of the screens can be connected to the smartboard), e.g. 1 source on one screen, e.g. slides + 1 source on the other screen e.g. videos, online surveys etc.;
b. blackboard;
c. smartboard (featuring online videos, presentations, special pen to comment/write; screens produced with the pen can be recorded); up to 2 people working on the same smartboard;
d. writable wall;

a short axis to **simulate medium- and small-sized classrooms** (up to 70–80 students), mainly **aimed at supporting sharing and collaboration**, whose equipment consists of:

a. flat floor;
b. mobile furniture for flexible workspaces;
c. tables with small whiteboards;
d. smartboard (up to 4 people working on the same smartboard), results can be recorded and shared on smartphones; people working on other devices can connect their smartphones to the smartboard e.g. to project results.

In both settings students can connect their laptops to the smartboards via Wi-Fi.

Sancassani, S., Marenghi, P., Baldoni, V., & Malan, S. (2019). *Spreading Educafé*. Milano, Politecnico di Milano – METID Learning Innovation. https://www.metid.polimi.it/en/spreading-educafe-spunti-e-idee-per-laula-attiva/

OUTLINE OF TEACHING AND LEARNING ACTIVITIES WITH PRACTICAL ADVICE

The table summarizes **remarks and rules of thumb** to implement the activities explained in the previous pages. You will find also **additional examples** of activities supported by the INSYSTED pillars that might inspire you. Bear in mind that the same element might be used both as an assessment task and as a Teaching and Learning Activity, depending on how you design it.

Bloom's verb	Activity	Description	Remarks/rules of thumb
 **REMEMBERING**	Previous knowledge test	See page 55.	Appropriate for classrooms with international students. Suitable for both Bachelor's and Master's level students.
	Small group game	See page 55.	Appropriate for classrooms with international students. Suitable for both Bachelor's and Master's level students.
 **UNDERSTANDING**	Give one/Get one	This activity is designed to help students recap prior knowledge. The teacher creates a google spreadsheet organized in 2 columns "Give one" and "Get one". Students write 2–3 things they already know about the topic under "Give One" column. Then, they work in pairs and "give one" of their ideas to their partner to comment and discuss. Students write any new information they get from these discussions in the "get one" column and exchange their roles in the pair. These pair discussions can be replicated. Finally, the teacher facilitates a plenary discussion on the main ideas and doubts in the online spreadsheet.	Appropriate for small classrooms with students with different background knowledge/from diverse study courses. More suitable for Master's level students.
	Think-pair-share	Students reply individually to a question. Then they pair up with their neighbour and discuss their responses/ thoughts. Finally, students volunteer to share their responses.	Also works well with large classrooms. Suitable for both Bachelor's and Master's level students.

Bloom's verb	Activity	Description	Remarks/rules of thumb
 **UNDERSTANDING**	Fish bowl discussion	Students are divided into groups of 10 people: 4 people form an inner circle, 6 form an outer circle. The 4 in the inner circle (the fishbowl) manage a sort of "round table": a first round, in which everyone gives their opinion in a limited period of time, is followed by a free discussion of the topic proposed by the teacher. The outer circle listens carefully, without interfering. The inner circle is then replaced by 4 people belonging to the outer circle. 2 people remain permanently in the outer circle, tasked with managing the times and keeping track of the most important points of the discussion; also, during the final phase, they will act as the spokespeople of the group, sharing the outcome with the class.	Appropriate for small classrooms of up to 40–50 students. Requires movable seats and tables. More suitable for Master's level students.
	Note-taking pairs	This activity enables explaining, providing feedback, understanding alternative perspectives. Students pair up with their neighbour and summarise, collaboratively, their notes on a lecture delivered in the previous part of the class (or on a video lecture watched at home) and deliver their output on the forum. Posts can be commented by the other pairs and/or a plenary discussion can be launched in class to clarify doubts.	Also works well with large classrooms. Suitable for both Bachelor's and Master's level students.
	Case study	Students in groups are given case studies; each group is required to agree on an answer by classifying elements introduced in the course in a conceptually meaningful way.	Appropriate for small classrooms of up to 40–50 students. Requires movable seats and tables. More suitable for Master's level students.
	Highlight keywords	See page 56.	Also works well with large classrooms. Suitable for both Bachelor's and Master's level students.
	Misconceptions	See page 56.	Also works well with large classrooms. Suitable for both Bachelor's and Master's level students.

Bloom's verb	Activity	Description	Remarks/rules of thumb
 **APPLYING**	Discussion board post	In class the instructor covers a topic and launches the activity to be completed in the forum after class: students are asked to produce a post to share their opinion on how the topic will be applied in a different context.	Works better if carried out in groups. More suitable for Master's level students.
	Serious game	See page 57.	More suitable for Master's level students.
	Simulation	See page 57.	Appropriate for up to 100 students. More suitable for Master's level students.
 **ANALYZING**	Context-Rich Problems	Context-rich problems are short realistic scenarios which give the students a plausible motivation for solving the problem. They support the development of expert-like behaviour as they require using and integrating more than one concept. These problems can be made available at the end of a module, when more concepts are covered.	Suitable for both Bachelor's and Master's level students.
	Jigsaw	It is a collaborative strategy in which students are organized in groups of 4–6 people. Each group member works on a specific sub-topic of the topic assigned. Once the sub-topic is explored and learnt, students who completed the same sub-topic meet in an "Expert group" to talk about and process the details of their sub-topic. Then students return to their original "Jigsaw" groups and take turns sharing the sub-topics they've become experts on. Outputs can be shared in the course forum.	Appropriate for application content in classrooms of up to 40 students. Requires movable seats and tables. More suitable for Master's level students.

Bloom's verb	Activity	Description	Remarks/rules of thumb
 **ANALYZING**	Three-stay, one-stray	Students, in groups, periodically take a break from their work (often at key decision making points) and send one group member to another group to describe their progress. The role of the group is to gain information and alternative perspectives by listening and sharing. The number of times the group sends a representative to another group depends on the level of complexity of the problem.	Appropriate for workshops/application content in classrooms of up to 40 students. Requires movable seats and tables. More suitable for Master's level students.
	Roundtable writing	Students pass a paper around and add an item according to the criteria designated by the instructor. This activity can be implemented through a spreadsheet linked in the course forum.	Appropriate for small classrooms. More suitable for Master's level students.
	Role play	See page 58.	Appropriate for small classrooms. Suitable for both Bachelor's and Master's level students.
	Analytic text	See page 58.	Also works well with large classrooms (mind: the organization of the presentation phase). Suitable for both Bachelor's and Master's level students.
	PechaKucha	See page 58.	Works better with max 10 groups of 3–4 people each. Suitable for both Bachelor's and Master's level students.

Bloom's verb	Activity	Description	Remarks/rules of thumb
 **EVALUATING**	Pros and cons list	Students are divided in teams and asked to discuss a complex issue and to fill an online spreadsheet with pros and cons to be later commented by the instructor. This activity can also be modified proposing a pair discussion among 2 teams: one that sustains pros and one cons.	Appropriate for small classrooms. Suitable for both Bachelor's and Master's level students.
	Activity sheets	See page 59.	Works well with classrooms with up to 100 students. Suitable for both Bachelor's and Master's level students.
	Gaming session	See page 59.	Suitable for both Bachelor's and Master's level students.
 **CREATING**	Brainstorming	It is a large or small group activity that encourages students to focus on a topic and contribute to the free flow of ideas.	Appropriate for small classrooms and workshops/application topics. More suitable to Master's level students.
	Think-aloud-pair-problem solving	The teacher organizes students in pairs. Each pair has a series of problems to solve. Each member of the pair alternate between being the problem solver and the listener. The problem solver thinks aloud, talking through the problem, while the partner listens, following the steps and attempting to understand the reasoning, and offering suggestions.	Also works well with large classrooms. Suitable for both Bachelor's and Master's level students.
	Jigsaw revised	See page 60.	Appropriate for small classrooms. Depending on the Learning Outcome defined, it can be suitable for both Bachelor's and Master's level students.
	Crib cards	See page 60.	More suitable for Master's level students.

SUPPORTING RESEARCH

Reference	Main information
Acton, R. (2019). Mapping the Evaluation of Problem-Oriented Pedagogies in Higher Education: A Systematic Literature Review. *Education Sciences, 9*(4), 269. https://doi.org/10.3390/educsci9040269	The article explores the ways problem and inquiry-based pedagogies are currently evaluated in universities.
Arico, F., Gillespie, H., Lancaster, S., Ward, N., & Ylonen, A. (2018). Lessons in learning gain: insights from a pilot project. *Higher Education Pedagogies, 3*(1), 249–265. https://doi.org/10.1080/23752696.2018.1454845	Learning gain can be defined as the learning achieved by a student between two points in time, which could be the start and end of a course or programme: this paper presents preliminary findings from a project at the University of East Anglia (UEA) on identifying and measuring learning gain. It builds upon self-efficacy assessments, concept inventories and student marks.
Bergfjord, O. J., & Heggernes, T. (2016). Evaluation of a "Flipped Classroom" Approach in Management Education. *Journal of University Teaching & Learning Practice, 13*(5). https://ro.uow.edu.au/jutlp/vol13/iss5/17	The paper suggests a small improvement in average grades, the reduced frequency of low grades (D and E) and a probable link between higher student satisfaction in the second year than in the first year of flipped learning experimentation due to fine-tuned practice.
Boyle, A., & Goffe, W. L. (2018). Beyond the Flipped Class: The Impact of Research-Based Teaching Methods in a Macroeconomics Principles Class. *AEA Papers and Proceedings, 108*, 297–301. https://doi.org/10.1257/pandp.20181052	A key finding from STEM education research is that students can often solve problems with scant fundamental understanding of key concepts; asking students about fundamental concepts that underlie problem solving (conceptual rather than computational questions, higher on Bloom's Taxonomy) should help students develop richer schemas (networks of knowledge).
Fedesco, H. N., & Troy, C. (2016). *Why This Flip Wasn't a Flop: What the Numbers Don't Tell You About Flipped Classes* [White paper]. American Society for Engineering Education. https://doi.org/10.18260/p.27203	The paper details how a large Civil Engineering fluid mechanics course has been converted into a more student-centred, active learning-oriented course through the flipping of one lecture per week.
Hartikainen, S., Rintala, H., Pylväs, L., & Nokelainen, P. (2019). The Concept of Active Learning and the Measurement of Learning Outcomes: A Review of Research in Engineering Higher Education. *Education Sciences, 9*(4), 276. https://doi.org/10.3390/educsci9040276	The article provides an overview of arguments and possible outcomes of using active learning.
Jarvis, C. L. (2020). The flip side of flipped classrooms. *Chemical & Engineering News, 98*(3). https://cen.acs.org/education/undergraduate-education/flip-side-flipped-classrooms/98/i3	The article argues that literature tends to ignore flipped-classroom failures and that flipped classrooms, when poorly implemented, can even disadvantage vulnerable students.

Reference	Main information
Jenkins, M., Bokosmaty, R., Brown, M., Browne, C., Gao, Q., Hanson, J., & Kupatadze, K. (2017). Enhancing the Design and Analysis of Flipped Learning Strategies. *Teaching & Learning Inquiry, 5*(1), 65–77. https://doi.org/10.20343/teachlearninqu.5.1.7	The paper presents a Flipped Learning Matrix to both analyse existing flipped learning strategies and design the flipped classroom.
Joksimović, S., Gašević, D., Kovanović, V., Riecke, B. E., & Hatala, M. (2015). Social presence in online discussions as a process predictor of academic performance. *Journal of Computer Assisted Learning, 31*(6), 638–654. https://doi.org/10.1111/jcal.12107	The study examines the relationship between indicators of student ability to socially engage with an online learning community and academic performance. The results suggest that certain indicators of social presence are significant predictors of final grades in a master's level computer science online course; in addition to that, course design that increases the level of meaningful interactions among students has a significant impact on the development of social presence, and thus could positively affect students' academic performance.
Karabulut-Ilgu, A., Jaramillo Cherrez, N., & Jahren, C. T. (2018). A systematic review of research on the flipped learning method in engineering education. *British Journal of Education Technology, 49*(3), 398–411. https://doi.org/10.1111/bjet.12548	The paper features flipped learning challenges in terms of workload and technical issues.
Kestin, G., Miller, K., McCarty, L. S., Callaghan, K., & Deslauriers, L. (2020). Comparing the effectiveness of online versus live lecture demonstrations. *Physical Review Physics Education Research, 16*(1). https://doi.org/10.1103/physrevphyseducres.16.013101	The paper compares the effectiveness of live lecture demonstrations with online videos under controlled conditions in the first semester of an introductory physics (mechanics) course at Harvard University.
Miller, K., Lukoff, B., King, G., & Mazur, E. (2018). Use of a Social Annotation Platform for Pre-Class Reading Assignments in a Flipped Introductory Physics Class. *Frontiers in Education, 3*. https://doi.org/10.3389/feduc.2018.00008	The paper illustrates the successful implementation of pre-class reading assignments through a social learning platform that allows students to discuss the reading online with their classmates.
Nestojko, J. F., Bui, D. C., Kornell, N. & Ligon Bjork, E. (2014). Expecting to teach enhances learning and organization of knowledge in free recall of text passages. *Memory & Cognition, 42*, 1038–1048. https://doi.org/10.3758/s13421-014-0416-z	The paper reports on a research with US undergraduate students and a non-STEM text to assess the potential effects of expecting to teach on learning.

Reference	Main information
van Alten, D. C. D., Phielix, C., Janssen, J., Kester, L. (2019). Effects of flipping the classroom on learning outcomes and satisfaction: A meta-analysis. *Educational Research Review, 28*, 1–18. https://doi.org/10.1016/j.edurev.2019.05.003	The paper, written by researchers at the Universiteit Utrecht, analysed 114 studies which compared flipped and non-flipped classrooms in secondary and postsecondary education. Flipped learning emerged as a promising approach, but only when properly designed. Two features seem to be crucial to the effectiveness of a flipped classroom: the non-reduction of the face-to-face class time comparing to class time in the traditional approach and the use of quizzes.

ADDITIONAL RESOURCES

Reference	Main information
Inamorato dos Santos, A. (2019). *Practical Guidelines on Open Education for Academics: Modernising Higher Education via Open Educational Practices (based on the OpenEdu Framework).* Publications Office of the European Union. https://doi.org/10.2760/55923	Guidelines for the academic staff of higher education institutions, with the goal of helping them move towards the use of open educational practices (OEP) in order to widen participation in education.
Queen's University Centre for Teaching and Learning. (n.d.). *Inquiry-Based Learning: What is Inquiry-Based Learning?* Retrieved September 21, 2020, from https://www.queensu.ca/ctl/teaching-support/instructional-strategies/inquiry-based-learning	The Centre for Teaching and Learning of the Queen's University, Kingston (Canada) offers guidelines about pedagogical approaches for active learning.
Yelamarthi, K., Drake, E., & Prewett, M. (2016). An Instructional Design Framework to Improve Student Learning in a First-Year Engineering Class. *Journal of Information Technology Education: Innovations in Practice, 15*, 195–222. https://doi.org/10.28945/3617	The article proposes an instructional design framework utilized to strategically adjust flipped methodologies in a first-year engineering course in the USA, by using low-cost technology aids in a traditional classroom setting, with minimal additional resources (a trackpad to write and record problems and its solutions, such as a Bamboo Capture Pad and screen casting software, such as Camtasia).

FLIPPED LEARNING

ADVANCED INFO CARD

Flipped learning refers to a pedagogical model in which the typical lecture and homework elements are reversed.

Students gain exposure to new content in video, text or any other format in their individual spaces (e.g. at home), before the lesson; in the classroom, the educator guides students in applying the concepts they learned.

BEFORE CLASS	DURING CLASS	AFTER CLASS
		
Make sure that your students are aware that you are going to use flipped learning and what to expect from it. Choose the most relevant content to be assigned before class.	Guide students in applying the content they were previously exposed to. Assign new content to be read/watched by students before the following class and elucidate briefly why it is important.	Students consolidate learning in terms of both concepts and their application in the previous class. Students read/watch material for the following lesson.

Research seems to suggest that a well-planned flipped approach can lead to some positive outcomes (van Alten et al., 2019; Bergfjord & Heggernes, 2016): this alone may not be a compelling enough reason for an instructor to invest in this approach. Nevertheless, it is worth considering that flipped learning can be beneficial beyond quantitative assessment, as it can enhance student collaboration skills and teacher awareness of students' difficulties.

HANDS-ON TIPS TO RUN A FLIPPED CLASSROOM SMOOTHLY

Introduce the new approach to students: make sure that your students are aware that you are going to use flipped learning in your course and explain the reasons behind your choice. Elucidate the classroom pact, as knowing what is expected from the very beginning can help shape students' behaviour positively. Devote some class time to that and make sure you add this information in the course supporting material as well. Remember to specify how student's participation in these activities is linked to their assessment.

Strengthen the connection among activities: choose the most appropriate content to be assigned before class, so that it is very relevant and closely connected to the following classroom activity. In addition to that, pairing lecture material with online self-assessment quizzes can increase students' preparedness for in-class activities. Feedback from quizzes is also useful so that the instructor identifies difficulties in lecture comprehension.

Set the workload carefully: particularly in the before and after lesson phases so that it is not too demanding, as students are required to both consolidate learning and read/watch material for the following lesson.

Guide passage from in-class to after class time: devote a short time at the end of each lesson, or in the course forum, to **raise interest for the following lesson**, and motivate students to read/watch the related material in the pre-lesson phase.

Ask students for informal feedback: it is valuable to fine-tune the design of flipped learning in your course (in person, after the lesson, or online e.g. online polls).

BEFORE CLASS TIME

Are you considering using a flipped learning approach? Do you need content you can assign to students before applying it in the classroom? You can adapt or produce material on your own but... Do not reinvent the wheel!

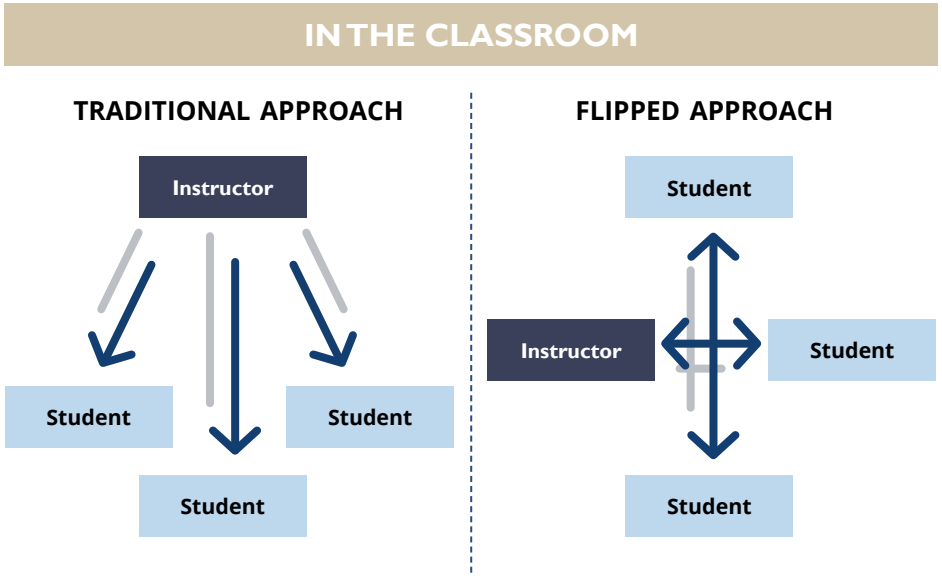
At page 81 you can find educational materials that are already available online, either in the form of MOOC content or stand-alone OER.

Not only videos

Content assigned to students is often a video lecture, but there are other options: for example, Miller, K. et al., 2018 illustrate the successful implementation of pre-class reading assignments through the Perusall.com social learning platform, that allows students to discuss the reading online with their classmates. Perusall.com technology was developed mostly at Harvard University and then became a commercial product.

IN-CLASS TIME

Flipped learning allows for more **peer interaction** in the classroom; **the teacher is a guide** to students (see figure below).



In-class time is **highly structured and thoroughly planned**.

In-class time generally includes learning activities that force students to **recap and apply** the material learned before the lesson; that includes giving students the opportunity to **teach their peers** about course content, which increases the degree to which they understand the material themselves.

In-class time often includes **small-group** learning activities such as:

- **group discussions**: the instructor gives students two or more types of problems that are difficult to distinguish, with several examples of each type; the teacher asks groups to identify which example fits which kind of problem and discusses their thinking;
- **think-pair-share**: the instructor asks students a question that may require them to apply knowledge and asks them to think or write down an answer for one minute, and then turn to a peer to discuss their responses for two minutes; following this, all groups share their responses and the instructor provides further explanation if needed.

Small-sized and medium classrooms (up to 80 students): what to take into consideration

Organise discussions: it is relatively easy to organize and manage discussions, especially if you ask students to present, sustain and defend their own opinions or ideas, for example in thought debate and pros & cons.

Promote formative feedback: plan frequent moments dedicated to offering rich formative feedback, from the teacher or from peers, for example commenting on quizzes or interactive activities conducted in class, reviewing assignments students are working on along the course.

Large-sized classrooms (from 80 to 250–300 students): what to take into consideration

Schedule questioning: asking questions is a relatively simple but beneficial form of interaction; develop key questions before class and plan when you're going to ask them. For example, questions at the beginning of the lesson can grab student's attention and assess their level of knowledge; class response systems like Socrative or Polleverywhere can be used for this activity.

Involve students as facilitators: some students can be engaged in classroom activities as facilitators. For example they can create questions and verify that other students send their as well; these roles can be rewarded.

"I am considering using a flipped learning approach in my lessons, but in case many students do not read/watch the new content before class, is there a fallback solution to prevent the failure of the lesson?"

Start the lesson with a **quick recap** of the key points covered in the content assigned before class (alternatively this can be done also through an online quiz on Socrative or Kahoot with the teacher commenting on the quiz). In this way students that did not read/watch the new content before class are not completely stuck. Then you can either guide students in applying the concepts as you planned, or you can engage them in a **group activity in small groups** of about 3 people with the same purposes; **avoid lecturing**, as it can hinder future developments in terms of active learning.

To engage students in flipped learning, remember to devote some time at the end of the lesson or in the course forum to **raise interest for the following lesson** and for the related material (e.g. why is this lesson important in 5 points).

Peer instruction

Peer Instruction[1] is a specific form of flipped learning that was coined by the physics teacher Eric Mazur at Harvard University.

1. **Before class**, students gain first **exposure to content** and complete Web-based assignments designed to help them think about the reading.
2. **Class time** is structured around a series of topics of about 15 minutes each, where a **mini-lecture** is followed by a related **conceptual question** that all students have to answer individually.
3. Handheld personal response systems allow students to answer anonymously, so that the instructor can see and **display results** immediately.
4. Students then **reconsider the question with others** sitting around them while instructors and teaching assistants circulate to promote **productive discussions**.
5. After discussion, **students answer** the conceptual question **again**.
6. The instructor provides feedback, explaining the **correct answer** and moves on to the next topic.

HANDS-ON EXAMPLES OF FLIPPED LEARNING

EXAMPLE

Flipped classroom and blended learning in a Sustainable Multidisciplinary Design Process course (MSc curriculum in Building engineering and architecture at PoliMI)

About 70 students, including many international students.

ACTIVITY

- Before – at home: students study content using video lectures, presentations, texts.
- During – in the classroom: online test on content prepared at home + 15 min lecture + plenary activity + group activity and presentation + final test.
- After – at home: individual in-depth study on the basis of the feedback at the end of the lesson.

EXAMPLE

Flipped classroom and blended learning in an Introduction to Nanoscience course (Engineering MSc curriculum at PoliMI)

About 100 students, of which more than a half are international.

ACTIVITY

- Before – at home: students watch video lectures and take a quiz.
- During – in the classroom: 15 min recap of content delivered via video lectures + online quiz (individual or in pairs) + 15 min lecture (new content).

Low-hanging fruit tip

Consider "recycling" graded quizzes as self-assessment tests.

[1] *Back in 2001 Crouch and Mazur research demonstrated improved student mastery of conceptual reasoning and quantitative problem-solving and showed that after peer discussion the number of students giving correct answers to a concept re-test substantially increased (http://web.mit.edu/jbelcher/www/TEALref/Crouch_Mazur.pdf). Additional research suggests that, in order to maintain a pace that keeps everyone engaged, students should not be given too much time to respond (https://journals.aps.org/prper/abstract/10.1103/PhysRevSTPER.10.020113).*

Anna

Engineering university teacher

"While re-designing the course topic I would like to explore the potential of integrating MOOCs, serious games, and forum-based online learning communities into my teaching."

Anna

Engineering university teacher

"My idea is to fine-tune my teaching in a cyclical design process in which I introduce and test gradual adjustments across subsequent course iterations.

Depending on the results, I might also extend this approach to other course topics."

5. EXPLORING THE INSYSTED PILLARS

THE ADDED VALUE OF MOOCS, SERIOUS GAMES AND ONLINE LEARNING COMMUNITIES

The potential of integrating the INSYSTED pillars into curricular education.

HANDS-ON USE EXAMPLES OF MOOCS, ONLINE LEARNING COMMUNITIES AND SERIOUS GAMES

How MOOCs, serious games and forum-based online learning communities are used in curricular higher education.

5. EXPLORING THE INSYSTED PILLARS

THE ADDED VALUE OF MOOCS, SERIOUS GAMES AND ONLINE LEARNING COMMUNITIES

In this final part of the instructional booklet you can explore more in depth what is the unique added value of each pillar: content is complemented by practical examples and supporting research.

MOOCS

Integrating MOOCs into curricular education

The MOOC pillar can be integrated into curricular education with diverse aims, such as:

- **exposing students to content before class**, to free up time in class for students to pursue tasks and activities related to its application under the instructor's supervision (**flipped learning**);
- **increasing course preparedness** across diverse student populations – MOOC content and delivery can be used to align entry knowledge for face-to-face courses, like for example: in the case of prospective MSc students coming from other universities or BSc courses; and in the case of "Fundamentals of financial and management accounting" and "Fundamentals of economics" MOOCs of Politecnico di Milano;
- **enriching courses with complementary content** as MOOCs can be the output of synergies between higher education institutions and organisations with complementary expertise, like in the case of the "Designing and implementing effective entrepreneurship policies" MOOC, developed by Politecnico di Milano in collaboration with UNCTAD, the United Nations Conference on Trade and Development, which is used in a Business and Industrial economics course;
- **extending educational opportunities** – MOOCs on soft and digital skills can be used to complement traditional curricula, like in the case of the "Working in multidisciplinary teams" MOOC by Politecnico di Milano.

Not only MOOCs

The open education movement gave access to an unprecedented quantity of educational materials, not only in terms of Massive Open Online Courses (MOOCs), but also in terms of material released under an open licence, that is Open Educational Resources (OER) and Open Educational Practices (OEP), an umbrella term for practices that include the creation, use, and reuse of OER as well as open sharing of teaching practices.

Creative Commons licences provide the infrastructure that supports the creation and uptake of OER and OEP, as they help creators (licensors) retain copyright while allowing others to copy, distribute, and make some uses of their work (https://creativecommons.org/licenses/?lang=en).

OER are educational materials like lectures, lesson plans, textbooks; also MOOC content can be licenced under a Creative Commons licence.

Depending on the licence, commercial use and derivative works might be allowed or not; for example, under the OCW Creative Commons license, users are allowed to translate MIT OpenCourseWare materials into the language of their choice (https://ocw.mit.edu/courses/translated-courses).

Do not reinvent the wheel (unless it is value added)

If you are considering to use the INSYSTED approach in your teaching, you could leverage already available MOOCs and OER. Some resources are listed below.

MOOCs

- **Coursera** https://www.coursera.org

  American MOOC platform founded by Stanford professors Andrew Ng and Daphne Koller
- **edX** https://www.edx.org

  American MOOC platform created by MIT and Harvard university
- **FutureLearn** https://www.futurelearn.com

  UK-based MOOC platform
- **France Université Numérique** https://www.fun-mooc.fr

  French ministerial MOOC platform – Courses mainly in French
- **iMooX** https://imoox.at/mooc

  Austria-based MOOC platform – Online courses mostly in German and English
- **POK – Polimi Open Knowledge** https://www.pok.polimi.it

  Institutional MOOC platform of Politecnico di Milano – Online courses mostly in Italian and English

- **Selection of MOOCs on soft skills**
  http://og.elene4work.eu/en/browse-by-mooc.html

  Here you can find a targeted list of MOOCs on soft skills provided by the EU-funded eLene4work project

OER repositories

- **MIT OpenCourseWare** https://ocw.mit.edu/index.htm

  Web-based publication of virtually all course content of Massachusetts Institute of Technology; additional resources for instructors in the OCW Educator Portal section https://ocw.mit.edu/educator

- **TU Delft OpenCourseWare** https://ocw.tudelft.nl

  Open digital publication of university-level educational materials of Technische Universiteit Delft – TU Delft organized as courses

- **OER UCLouvain** https://oer.uclouvain.be/jspui

  OER repository of the Université Catholique de Louvain

- Open Educational Resources on the **Internet archive**
  https://archive.org/details/education

  Many resources also in French

- **AMSER** (the Applied Math and Science Education Repository)
  https://www.amser.org/index.php?P=AdvancedSearch

  Part of the US National Science Digital Library, created by the National Science Foundation to direct users to high-quality STEM resources

- **Media Portal Siemens Stiftung**
  https://medienportal.siemens-stiftung.org

  Mostly school level, materials also in German

- **ABLConnect (Harvard university)**
  https://ablconnect.harvard.edu/activity-database

  Database of activities that can be proposed to students

OER discovery sites/search tools

- **Mason OER Metafinder** https://mom.gmu.edu

  Launches a real-time, simultaneous search across 21 different sources of open educational materials

- **OER commons advanced search**
  https://www.oercommons.org/advanced-search

  Materials provided by a variety of providers

- **MERLOT advanced material search**
  https://www.merlot.org/merlot/advSearchMaterials.htm

  MERLOT is a program of the California State University that gives access to learning materials in a variety of formats

The MOOCs for teachers series

If you want to go more in depth with innovative pedagogies and practices, you can explore the MOOCs for teacher series of Politecnico di Milano – METID on POK (https://www.pok.polimi.it).

- Designing Learning Innovation
- Engaging Students in Active Learning
- New Assessment Strategies – The magic of feedback
- To Flip Or Not To Flip – Discover the flipped classroom methodology
- Using Open Educational Resources in Teaching
- Introduction to Debate (in Italian)

SERIOUS GAMES

Integrating serious games into curricular education

Serious games are designed to entertain users, individually or in groups, in an environment from which they can also learn and be educated and trained in well-defined areas and tasks. Serious games support active learning as they have a **learner-centred approach**, where the student feels in control of an interactive learning process.

Serious games have more than just entertainment as a goal, they **combine relevant content with motivation levers of game design** (e.g. competition, collaboration, challenge), keeping a balance between boredom and frustration.

Student engagement is a catch-all term that is often used to describe diverse elements, from committing individually to learning, to interactions with other students (e.g. cognitive engagement in terms of integrating ideas, justifying decisions, collaborative engagement in terms of supporting and encouraging peers). It can be referred to as flow, a highly energized state of concentration and focus while deeply engaged with experiential interactive learning environments (Paine in Lamb et al., 2017).

Serious game vs simulation

Serious games typically are about winning or achieving a competitive goal (for example, achieving as many points as possible) while educational simulations are about experimenting without competitive elements.

- **Serious game**: the learner is exposed to complex representations often requiring specific content knowledge and learning progressions to be completed in order to move the game forward toward the objective. Serious games have a system of rules and game mechanics for interaction between both the serious games and with other players, which is not required in educational simulations.
- **Simulation**: is generally task-based and aimed at developing specific skills in a limited domain (e.g. flying an airplane as a part of a flight simulator). Furthermore, educational simulations typically are narrowed-down interactive representations, including as few variables as possible.

The basics of the INSYSTED serious game ProTUce

- The aim of the serious game is to support students in solving production management problems in successive levels, through:
  a. priority techniques of performance analysis (queue theory) and inventory management (order quantity planning);
  b. a game procedure based on the dynamic emulation of a production company (1 real hour in the company = 1 day in the game), with students playing online for a pre-planned time, without interaction among teams, with the goal to achieve the highest possible profit.
- Game duration is basically of 1 week for each level.

What the research says

Competition and collaborative pedagogies seem to be effective techniques for enhancing learning performance in face-to-face learning environments, as students learn about the conditions under which the new knowledge can be applied; they are more prone to engage in problem-solving (Popescu et al., 2011).

Additional research explores which specific instructional techniques can further improve learning and increase motivation in serious games (content integration, context integration, assessment and adaptivity, level of realism, narration-based techniques, feedback, self-explanation and reflection, collaboration and competition, and modeling) (Wouters & van Oostendorp, 2017).

Games and simulations can contribute to cognitive learning outcomes, including knowledge acquisition, conceptual application, content understanding, and action-directed learning, and university instructors should take a more active role in using them in a blended learning setting (Vlachopoulos & Makri, 2017 – Research questions: how can the best practices/methods for designing and incorporating games and simulations in student learning be identified? How can games/simulations enhance Higher Education?).

ONLINE LEARNING COMMUNITIES

Integrating online learning communities into curricular education

The INSYSTED pillar refers to **forum-based online learning communities**. These are basically course forums, especially those developed within a relatively short period of time, usually a semester, with students enabling each other to understand some defined course content and developing soft and digital skills through the interaction with peers on tasks and activities (e.g. learning to learn skills, information and data processing skills – see the eLene4work skills framework http://og.elene4work.eu/en/browse-by-skill.html), and facilitated by the teacher or teaching assistant.

Forum types

There is no standard univocal classification of forum types, but operationally we might identify the following typologies.

Structured task-based forum for individual or group activities supporting sophisticated activities from providing and receiving explanations, to co-constructing ideas, to peer assessment.

A related concept is **scaffolding**, that is an umbrella term for any kind of teacher support within student-centred knowledge construction activities (e.g. breaking tasks into smaller pieces).

In this perspective, a **team collaboration forum** is a space for students to communicate about group projects, not only to support project

development, but also to allow the instructor to monitor the participation of group members.

- **Discussion forum** to discuss a pre-selected or open list of topics; this includes open forums where learners participate freely on a loosely-guided agenda, mostly by asking for information.
- **Q&A forum** with the initial thread post as a question, requesting responses.
- **Single simple discussion forum** with the teacher putting a targeted discussion topic and then students replying to it.

Forum communication is mostly text-based, but additional media can be used, e.g. images and documents as attachments.

Features of forum-based communities

Structured forum-based communities	Non-structured forum-based communities
Forum aimed at complementing face-to-face instruction	Forum as an extra to face-to-face instruction, so that students have free discussion on course-related topics
Teacher's (or teacher's collaborator) role as a designer and/or moderator	Teacher as supervisor (mainly student-led)
Some pre-set topics and activities	No pre-set topics and activities
Some forum activities graded, either on an individual or on a group basis	No graded forum activity
Forum introduced to students at the beginning of the course	Forum introduced to students at any time

HANDS-ON USE EXAMPLES OF MOOCS, SERIOUS GAMES AND ONLINE LEARNING COMMUNITIES

Let's explore some hands-on examples of how MOOCs, online learning communities and serious games, individually or in combination, can innovate Teaching and Learning Activities.

MOOCS

"Introduction to management engineering" **MOOC series** (Engineering MSc curriculum at PoliMI)

MOOCs designed to expose prospective MSc national and international students, from other BSc courses or from other universities, to the key fundamentals of Management Engineering. Upon successful completion of specific MOOCs, students can access the course exams. MOOCs can be used to implement flipped learning as well, hence applying active learning approaches in the classroom.

The MOOCs are available at https://www.pok.polimi.it/.

SERIOUS GAMES

Using an Escape game in a Security in apps course, 1st year engineering BSc at CentraleSupélec

Learners (25 students) are requested to participate in an Escape Game one afternoon at university before the corresponding lecture to get familiar with the security breaks in applications and know some of them; the teacher animates the escape game, then gives a lecture after the escape game.

Students have to solve some enigmas to escape a room, which imply finding security breaks in an application, through indices in the app, on the internet and in the room.

Resources: one room prepared for it, computer with internet access, smartphones for all the students.

Outcomes: students will know the techniques better, after applying them in this competition game.

SERIOUS GAMES

Integrating a serious game into a Telecommunication principles course, 2nd year engineering MSc at CentraleSupélec

The serious game was developed by 10 students and is currently used by 50 students every year. The serious game integrates traditional lecture style and aims at making students learn and practice the basics of telecommunication (2h per game level once a week), with the teacher answering possible questions.

See the poster in French (https://drive.google.com/file/d/1YNUA6dpxvj1QXHWmHqo-DA_DsBZdHttU/view).

SERIOUS GAMES

Complementing the "Sustainable Mobility: Technical and environmental challenges for the automotive sector" MOOC of the IFP School (ENSPM – École Nationale Supérieure du Pétrole et des Moteurs) with a **serious game**

The MOOC offered in English over a 4-week period is complemented by a serious game during 3 weeks, in order to enhance interaction and to make students practice the skills learnt during lessons. The overarching aim is to attract young students to the fields of energy and transport, and to improve the recruitment of excellent students from all over the world.

SERIOUS GAMES

Fostering resilience and risk management skills in a blended learning setting with the Beware **serious game** used in the Engineering MSc curriculum at the Universität Bremen

Multiplayer online game implemented in a workshop setting. The students have the possibility to apply risk assessment and risk management methods, and thus increase their awareness of risks in production networks as well as the complexity of decision making. Players can communicate using the inbuilt chat, phones or Skype, or also schedule physical meetings to discuss relevant issues.

LEARNING COMMUNITIES

Combining **forum and group tutorials** in Industrial Engineering and Software Engineering degree courses of the Universidad de Córdoba

Moodle forums and group tutorials were combined to improve students' academical performance and skills such as problem solving and teamwork by means of collaborative learning. Forum participation rose substantially once it has started to contribute to the overall course mark.

Salas-Morera, L., Arauzo-Azofra, A., & García-Hernández, L. (2011). Collaborative e-Learning by Means of Asynchronous Discussion Forums and Group Tutorials Combination. In A. Verbraeck, M. Helfert, J. Cordeiro, & B. Shishkov (Eds.), *Proceedings of the 3rd International Conference on Computer Supported Education – Volume 2* (pp. 367–374). SciTePress. https://doi.org/10.5220/0003441803670374

SUPPORTING RESEARCH

Reference	Main information
Barber, W., King, S., & Buchanan, S. (2015). Problem Based Learning and Authentic Assessment in Digital Pedagogy: Embracing the Role of Collaborative Communities. *Electronic Journal of e-Learning, 13*(2), 59–67. https://eric.ed.gov/?id=EJ1060176	The paper qualitatively examines the relationship between problem based learning, authentic assessment and the role of community in fostering learning in digital contexts.
Bralić, A., & Divjak, B. (2018). Use of MOOCs in Traditional Classroom: Blended Learning Approach [Special issue]. *European Journal of Open, Distance and E-Learning*. https://www.eurodl.org/?p=special&sp=articles&inum=9&article=766	The paper researches a blended learning model where a MOOC has been integrated in a traditional classroom in a Discrete Mathematics with Graph Theory course in a MSc at University of Zagreb.
Chen, B., deNoyelles, A., Zydney, J., & Patton, K. (2017). Creating a Community of Inquiry in Large-Enrollment Online Courses: An Exploratory Study on the Effect of Protocols within Online Discussions. *Online Learning, 21*(1). https://doi.org/10.24059/olj.v21i1.816	The research study explores a protocol developed and improved over two iterations in a very large undergraduate video-streaming business course. Findings suggest that protocols are potentially useful to manage online discussions in large classes.
Dorn, S., Schweiger, B., & Albers, S. (2016). Levels, phases and themes of coopetition: A systematic literature review and research agenda. *European Management Journal, 34*(5), 484–500. https://doi.org/10.1016/j.emj.2016.02.009	There is increasing interest among management scholars in "coopetition", which is simultaneous cooperation and competition between at least two actors. This study addresses the issue by means of a systematic literature review.
Ghadiri, K., Qayoumi, M. K., Junn, E., Hsu, P., & Sujitparapitaya, S. (2014). *The Transformative Potential of Blended Learning Using MIT edX's 6.002x Online MOOC Content Combined with Student Team-Based Learning in Class* [White paper]. San Jose State University. https://www.edx.org/sites/default/files/upload/ed-tech-paper.pdf	Research seems to suggest that adaptation of high quality MOOC content using a blended approach and in conjunction with a highly structured in-class team-based approach can produce significant benefits in transforming student learning and success.
Kestin, G., Miller, K., McCarty, L. S., Callaghan, K., & Deslauriers, L. (2020). Comparing the effectiveness of online versus live lecture demonstrations. *Physical Review Physics Education Research, 16*(1). https://doi.org/10.1103/PhysRevPhysEducRes.16.013101	The paper compares the effectiveness of live lecture demonstrations with online videos under controlled conditions in the first semester of an introductory physics (mechanics) course at Harvard University.
Lamb, R. L., Annetta, L., Firestone, J., & Etopio, E. (2017). A meta-analysis with examination of moderators of student cognition, affect, and learning outcomes while using serious educational games, serious games, and simulations. *Computers in Human Behavior, 80*, 158–167. https://doi.org/10.1016/j.chb.2017.10.040	This study suggests higher cognitive gains in learning from subjects using serious games; effects were calculated from 46 empirical experimental studies.

Reference	Main information
Ma, Y., Vallet, F., Cluzel, F., & Yannou, B. (2019). Analysing the Relevance of Serious Game Elements for Effectively Teaching Innovation Processes. *Proceedings of the Design Society: International Conference on Engineering Design, 1*(1), 439–448. https://doi.org/10.1017/dsi.2019.47	Among other topics, the article provides a literature review of the existing serious game evaluation methods.
Popescu, M., Arnab, S., Berta, R., Earp, J., de Freitas, S., Romero, M., & Usart, M. (2011). Serious Games in Formal Education: Discussing Some Critical Aspects. In D. Gouscos, & M. Meimaris (Eds.), *Proceedings 5th European Conference on Game-Based Learning, Oct 2011, Athens, Greece* (pp. 486–493). Academic Conferences and Publishing International. https://hal.archives-ouvertes.fr/hal-00985810/document	The paper reports some key challenges in the adoption of serious games within formal education, that are examined from different perspectives as part of a joint exploration into the topic conducted by a group of partners in the Games and Learning Alliance (GALA).
Seethamraju, R. (2014). Effectiveness of Using Online Discussion Forum for Case Study Analysis. *Education Research International, 2014*. https://doi.org/10.1155/2014/589860	The paper reports on a study of the effectiveness of a pedagogical approach that blends online discussion board and case study in a business school context.
Tan, M., & Hew, K. F. (2016). Incorporating meaningful gamification in a blended learning research methods class: Examining student learning, engagement, and affective outcomes. *Australasian Journal of Educational Technology, 32*(5), 19–34. https://doi.org/10.14742/ajet.2232	The article explores the concept of true feedback and how it can improve learning.
Vlachopoulos, D., & Makri, A. (2017). The effect of games and simulations on higher education: a systematic literature review. *International Journal of Educational Technology in Higher Education, 14*(1). https://doi.org/10.1186/s41239-017-0062-1	The research studies the impact of games and simulations with regard to achieving specific learning objectives. Results indicate that games and/or simulations have a positive impact on learning goals. The researchers identify three learning outcomes when integrating games into the learning process: cognitive, behavioural, and affective.
Wouters, P., & van Oostendorp, H. (2017). Overview of Instructional Techniques to Facilitate Learning and Motivation of Serious Games. In P. Wouters, & H. van Oostendorp (Eds.), *Instructional Techniques to Facilitate Learning and Motivation of Serious Games* (pp. 1–16). Springer, Cham. https://doi.org/10.1007/978-3-319-39298-1_1	The chapter explores which specific instructional techniques can further improve learning and increase motivation in serious games (content integration, context integration, assessment and adaptivity, level of realism, narration-based techniques, feedback, self-explanation and reflection, collaboration and competition, and modelling).