UNIVERSITAT POLITÈCNICA
DE CATALUNYA
BARCELONATECH

CATALOGUE OF TEACHING METHODS

LECTURE

BRIEF DESCRIPTION: In lectures, the professor makes an oral presentation of the content, which may be accompanied by graphic resources on a blackboard or screen.

SPACE REQUIREMENTS: A lecture hall with comfortable seating for students and room to use a computer or notebook. Sockets for laptops. High-quality multimedia and audio systems that should allow remote broadcasting. Good soundproofing.

NUMBER OF STUDENTS PER GROUP: Between 100 and 200.

OTHER REQUIREMENTS: The professor must be a point of reference in the field, have good public speaking skills, have a good command of the language in which the class is taught and have good stage management skills to attract and retain students' attention.

DURATION: 45 min.

TECHNOLOGICAL FACILITATORS: Multimedia presentation and/or capture systems, broadcasting systems, programs for interacting with the audience (real-time questionnaires, digital whiteboard, etc.).

BIBLIOGRAPHY:

- Gatica-Saavedra, M., & Rubí-González, P. (2020). La clase magistral en el contexto del modelo educativo basado en competencias. Revista Electrónica Educare, 25(1), 1-12. https://doi.org/10.15359/ree.25-1.17.
- Sánchez-Carracedo, F. & Barba Vargas, A. (2019). Cómo impartir una clase magistral según la neurociencia. Actas de las JENIU, 4, 87-94. https://upcommons.upc.edu/handle/2117/166394.

PROBLEM-BASED LEARNING (PBL)

BRIEF DESCRIPTION: Problem-based learning (PBL) is an active learning method that encourages students to direct their own learning process with the help of their peers and a teacher who plays the role of learning facilitator.
PBL is based on real problems or problems students are likely to encounter in their future careers that start off a process of enquiry that is aimed at finding possible solutions. By working collaboratively in small groups with the support of a tutor, they identify what they need to learn to solve the problem, generate hypotheses, look for information and discuss it, apply their new knowledge to the problem, draw conclusions and reflect on the learning acquired. During the process, they develop specific and cross-disciplinary competencies.

SPACE REQUIREMENTS: Small classrooms for working in groups, with a blackboard, computer and projector to accompany teamwork. If various groups work in the classroom at the same time, the classroom must be large, with modular tables for group work where computers can be connected and that make it easy for the teacher to reach all the groups, and have good sound design to prevent excessive noise.

NUMBER OF STUDENTS PER GROUP: The ideal scenario is working in groups of 6 - 10 students with a tutor. Alternatively, the groups may be of 20 - 30 students divided into groups of 5 - 6 students working together and the professor guiding the various groups at the same time.

OTHER REQUIREMENTS: The professor must have been trained in PBL and be qualified to act as a learning facilitator.

DURATION: 1 h 30 min - 2 h.

TECHNOLOGICAL FACILITATORS: Collaborative work tools.

BIBLIOGRAPHY:

- Carrió, M., Branda, L., and Baños, JE. El aprendizaje basado en problemas en sus textos. Fundació Dr. Esteve. Available at this link.
- Dolmans, D., Loyens, S., Matcq, H. & Gijbels, D. (2015). Deep and surface learning in problem-based learning: a review of the literature. Adv in Health Sci Educ, doi: 10.1007/s10459-015-9645-6.
- Savery JR. Overview of problem-based learning : definitions and distinctions. Interdiscip J Probl Learn. 2006;1(1):9–20.
- Schmidt, H. G., Rotgans, J. I., & Yew, E. H. J. (2011). The process of problem-based learning: What works and why. Medical Education, 45(8), 792–806. https://doi.org/10.1111/j.1365-2923.2011.04035.x.

PROJECT-BASED LEARNING

BRIEF DESCRIPTION: Project-based learning consists in organising the learning of a subject or topic around a project. The project is based on a real-life situation related to students' future careers and is generally worked on as a group. Projects may be of different types, such as investigating a complex question, solving a real problem or making a product. They are generally long-term (from weeks to months) and interdisciplinary in their approach. Learning is practical and inductive, and the professor introduces concepts as difficulties and needs arise. A specific form is the product development project (PDP), in which teams design and implement the functional prototype of a product whose requirements have been provided by an external agent.

SPACE REQUIREMENTS: Large, flexible and versatile classroom, with mobile modular tables or shovel chairs, in which groups of students can work simultaneously, computers can be connected and the teacher can reach all the groups easily, and good sound design to prevent excessive noise. The project can also be worked on in small classes and group tutorials, but this requires more teachers. In the case of PDPs, laboratories in which to work on the prototypes are needed.

NUMBER OF STUDENTS PER GROUP: Students work on projects in small groups (5 - 10 students). Work can be done in groups of 20 - 30 students divided into 4 - 5 groups or groups of 5 -1 0 students for each professor.

OTHER REQUIREMENTS: The projects must be stimulating for the students, the project development process must be well planned by the professor, space for reflection and feedback must be built into the process and, whenever possible, the projects must transcend the classroom, that is, the final products must be of interest outside the classroom and beyond the subject.

DURATION: 1 or 2 hours. In the case of PDPs, longer sessions lasting 3 or 4 hours may be useful.

TECHNOLOGICAL FACILITATORS: Collaborative work tools.

BIBLIOGRAPHY:

- Žerovnik, A., Nančovska Šerbec, I. (2021). Project-Based Learning in Higher Education. A: Vaz de Carvalho, C., Bauters, M. (eds.) Technology Supported Active Learning. Lecture Notes in Educational Technology. Springer, Singapore. https://doi.org/10.1007/978-981-16-2082-9_3.
- Guo, P., Saab, N., Post, LS., Admiraal, W. 2020. A review of project-based learning in higher education: Student outcomes and measures. International Journal of Educational Research, 102, 101586. https://doi.org/10.1016/j.ijer.2020.101586.
- Cobb, C. L., Hey, J., Agogino, A. M., Beckman, S. L., & Kim, S. (2016), What alumni value from new product development education: A longitudinal study, Advances in Engineering Education, Vol. 5, No. 1, pp. 1-37.

SERVICE LEARNING

BRIEF DESCRIPTION: Service learning is an educational approach that combines learning and service to the community in a single, well-defined project. Students acquire knowledge, competencies, skills and/or values in a subject by working on a civic responsibility project within a real service to society, whether that is an institution or a business.

SPACE REQUIREMENTS: Generally, most of the activity takes place outside the University, in collaboration with external entities, so the facilities required will depend on the way each project develops.

NUMBER OF STUDENTS PER GROUP: This depends on the type of project and community service.

OTHER REQUIREMENTS: Collaboration with entities external to the University whose work relates to the subject being taught.

DURATION: Sessions in which there is interaction with the recipients of the service are generally longer than standard classes and may not coincide with the set timetable. Planning may need to be a bit flexible.

TECHNOLOGICAL FACILITATORS: Collaborative work tools.

BIBLIOGRAPHY:

- Xarxa d'Aprenentatge Servei de les Universitats Catalanes. 2019. Guia 0: Fer aprenentatge servei a la universitat.
- Xarxa d'Aprenentatge Servei de les Universitats Catalanes. 2020. Guia 1: Aprenentatge servei i pràctica reflexiva.
- Xarxa d'Aprenentatge Servei de les Universitats Catalanes. 2022. Guia 4: Aprenentatge servei i inclusió social.
- Guies i recursos per a l'Aprenentatge-Servei. Red española aprendizaje-servicio.
- Salam, M., Awang Iskandar, D.N., Ibrahim, D.H.A. et al. Service learning in higher education: a systematic literature review. Asia Pacific Educ. Rev. 20, 573–593 (2019). https://doi.org/10.1007/s12564-019-09580-6.

CHALLENGE-BASED LEARNING

BRIEF DESCRIPTION: Challenge-based learning (CBL) is a method based on solving challenges in the real world. Learning in one or various subjects is organised around a real external challenge. Students work in groups in collaboration with businesses and/or members of the community to solve a specific problem in the territory, and they explore options for improvement, propose solutions, put these solutions into practice and assess them. In comparison to a product development project, the challenge in CBL must be quite open-ended and emphasise the social impact. The teams must identify concrete needs within the scope of the challenge through interaction with external experts and end users and choose one in a reasoned manner. Then they have to come up with several conceptual solutions, choose one based on the feedback they received when they showed representations or rapid prototypes to users, and finally develop a proof-of-concept prototype. Because of the time it takes to complete the previous stages, this prototype tends to be lighter than the one obtained in the PDP type. A business model is also formulated and sustainability and ethical aspects are analysed. Learning outcomes are more in the realm of innovation than technology. It is customary to work in multidisciplinary teams; each member contributes their own knowledge and experience in analysing the challenge and formulating the final proposal. The professor must be more of an expert in the method than in the subject being discussed and act as the team's facilitator and the link between the students and the entity providing the challenge to be solved; this can be a private company, a public institution, an NGO or any entity that has close ties to the territory.

SPACE REQUIREMENTS: Large, flexible and versatile classroom, with mobile modular tables or shovel chairs, in which groups of students can work simultaneously, computers can be connected and the teacher can reach all the groups easily, and good sound design to prevent excessive noise. Groups spend a lot of time talking amongst themselves. Whiteboards on walls are useful for representing ideas and encouraging discussion. Other classrooms or small auxiliary spaces for group tutorials are useful, as it is good for tutorials to involve different supervisors. This requires more teachers even though tutorials take place while other students are working in a group. An additional space may also be necessary for devising simple prototypes, as well as, depending on the solution's technology, an electronics or electromechanical laboratory or a fab lab-type manufacturing facility.

NUMBER OF STUDENTS PER GROUP: Teams in CBL are relatively small, comprising 4 - 6 students; if the teams are interdisciplinary, 2 students per discipline. The advantage of them being interdisciplinary is that different perspectives can be brought to bear in identifying needs and generating ideas. In the final prototyping stage, students do contribute their own discipline-specific competencies.

OTHER REQUIREMENTS: An important part of CBL is interaction with external agents. Students must invest time in managing this interaction. One option is to have working sessions every two weeks so that there is time to organise meetings and hold interviews.

DURATION: Long sessions lasting 3 - 4 hours, in which most of the time is spent working as a team, are very useful. Capsules on methodology lasting half an hour at most are typically presented, students give short (5 min) presentations on the state of the project and tutorials are held team by team.

TECHNOLOGICAL FACILITATORS: Collaborative work tools.

BIBLIOGRAPHY:

- Silvia Elena Gallagher & Timothy Savage (2020) Challenge-based learning in higher education: an exploratory literature review, Teaching in Higher Education, doi: 10.1080/13562517.2020.1863354.
- S. Willis, G. Byrd and B. D. Johnson, "Challenge-Based Learning," in Computer, vol. 50, no. 7, pp. 13-16, 2017, doi: 10.1109/MC.2017.216.
- G. Charosky, L. Leveratto, L. Hassi, K. Papageorgiou, J. Ramos-Castro and R. Bragós, "Challenge based education: an approach to innovation through multidisciplinary teams of students using Design Thinking," 2018 XIII Technologies Applied to Electronics Teaching Conference (TAEE), La Laguna, Spain, 2018, pp. 1-8, doi: 10.1109/TAEE.2018.8476051.
- Papageorgiou, K. [et al.]. Prototyping the future of learning: reflections after seven iterations of Challenge-Based Innovation (2014-2020). "CERN IdeaSquare Journal of Experimental Innovation", 30 Juny 2021, vol. 5, núm. 1, p. 5-10. doi: 10.23726/cij.2021.1290.
- Kohn Rådberg, Kamilla; Lundqvist, Ulrika; Malmqvist, Johan; Hagvall Svensson, Oskar (2020). From CDIO to challenge-based learning experiences – expanding student learning as well as societal impact?. European Journal of Engineering Education, 45 (1), 22-37. doi: 10.1080/03043797.2018.1441265.

BLENDED TEACHING AND FLIPPED CLASSROOM

BRIEF DESCRIPTION: Blended teaching consists in combining on-site and online activities to use technology to improve learning. A wide range of activities may be included, from recording classes so that students can watch them whenever they like to holding asynchronous online classes or organising a seminar featuring international speakers via videoconference. The flipped classroom is a combined form of teaching in which part of the theory is provided via digital resources such as videos or readings. Students work on them before a class, and the experience in class is used to consolidate the knowledge acquired via classroom dynamics and practical cases in which the professor and the students interact. In this way, the traditional model in which the professor explained the theory in class and students then did the exercises at home without help is inverted.

SPACE REQUIREMENTS: For the online activities, a well-structured digital platform (e.g. Atenea) is required. For the on-site activities, a flexible, versatile classroom in which students can work in groups and whose distribution can easily be changed is required.

NUMBER OF STUDENTS PER GROUP: Online activities may involve a large number of students (between 100 and 200). In on-site activities, working in groups of 30 - 50 students is recommended.

OTHER REQUIREMENTS: Software is required to record and edit the instructional videos that professors may want to produce, and ideally, an audiovisual support team to produce them. Students must prepare for classes beforehand, so the subject must be planned, the schedule communicated and strategies used to ensure work is done in advance.

DURATION: This depends on the classroom dynamics but generally between 1 and 2 hours.

TECHNOLOGICAL FACILITATORS: Multimedia presentation and/or capture systems, videoconferencing systems.

BIBLIOGRAPHY:

- Sams, A., & Bergmann, J. (2013). Flip Your Students' Learning. Educational Leadership, 70(6), 16–20.
- O'Flaherty, J., & Phillips, C. (2015). The use of flipped classrooms in higher education: A scoping review. The Internet and Higher Education, 25, 85–95.
- Blended and Hybrid Teaching Guide. Standford University, Teaching commons.

GAMIFICATION

BRIEF DESCRIPTION: This involves using features of game playing in a learning environment to capture students' attention, to motivate them and to promote their participation, as well as to improve problem solving. Gamification strategies include achievable challenges, quests, narratives, teams, feedback, reward systems, progress bars, etc. You can gamify an activity or an entire subject.

SPACE REQUIREMENTS:

NUMBER OF STUDENTS PER GROUP: The method can be applied to groups of all sizes: small, medium-sized and large.

OTHER REQUIREMENTS:

DURATION: Generally the duration of a conventional session lasting 1 or 2 hours.

TECHNOLOGICAL FACILITATORS: Reward management platform (Atenea), online surveys (Kahoot!, Atenea, etc.).

BIBLIOGRAPHY:

- Escamilla J, Fuerte K, Venegas E, Fernández K, Elizondo JM, Román R et. al. EduTrends: Gamificación. Monterrey: Observatorio de Innovación Educativa del Tecnológico de Monterrey. Available at the following link.
- Mora, A., Riera, D., González, C. et al. Gamification: a systematic review of design frameworks. J Comput High Educ 29, 516–548 (2017). https://doi.org/10.1007/s12528-017-9150-4.
- Sujit Subhash, Elizabeth A. Cudney. Gamified learning in higher education: A systematic review of the literature. Computers in Human Behavior, 87, 192-206 (2018). https://doi.org/10.1016/j.chb.2018.05.028.

COOPERATIVE LEARNING

BRIEF DESCRIPTION: Cooperative learning is a generic term that encompasses different procedures that are based on dividing students into small work groups for shared tasks. The teacher designs activities to create a highly structured and organised learning environment that requires everyone's active participation. Students collaborate to solve shared academic tasks and learn together. Cooperative learning activities generally have the following features: 1) tasks are set that work better as group work than as individual work, 2) groups are of 2 - 5 students, 3) a collaborative atmosphere is generated, 4) positive interdependence is fostered with activities that are organised so that group members need each other to carry out the shared tasks and 5) students take responsibility for their tasks and their learning. Cooperative learning strategies include think-pair-share, the collaboration pyramid and the jigsaw method.

SPACE REQUIREMENTS: Large, flexible and versatile classroom, with mobile modular tables or shovel chairs, in which groups of students can work simultaneously, computers can be connected and the teacher can reach all the groups easily, and good sound design to prevent excessive noise.

NUMBER OF STUDENTS PER GROUP: 20 - 30 students divided into small groups.

OTHER REQUIREMENTS: Tasks for students must be very well planned and the activity's aims and the group members' tasks must be clear.

DURATION: 1 - 2 h.

TECHNOLOGICAL FACILITATORS: Collaborative work tools.

BIBLIOGRAPHY:

- Aronson, E. (2002). “Building Empathy, Compassion, and Achievement in the Jigsaw Classroom.” Improving AcademicAchievement 209–225. ISBN 9780120644551.
- Gillies, RM. Cooperative Learning: Review of Research and Practice. Australian Journal of Teacher Education. 2016, 41(3). http://dx.doi.org/10.14221/ajte.2016v41n3.3.
- Jigsaw classroom (2021) https://www.jigsaw.org/.
- Loh, R.C.Y., & Ang, C. S. (2020). Unravelling cooperative learning in higher education: A review of research. Research in Social Sciences and Technology, 5(2), 22-39. doi.org/10.46303/ressat.05.02.2.
- Springer L, Stanne ME, Donovan SS. Effects of Small-Group Learning on Undergraduates in Science, Mathematics, Engineering, and Technology: A Meta-Analysis. Review of Educational Research. 1999;69(1):21-51. doi:10.3102/00346543069001021.

CASE STUDY

BRIEF DESCRIPTION: In this teaching method, the teacher presents a real case of a situation that is representative of students' future careers and that they must solve. Typically, students work on the case in small groups and the teacher guides them. Case studies allow general aspects of the profession to be worked on in the context of a specific case. It has a long tradition in medical, law and business schools and is becoming more and more common in other disciplines taught at universities. In comparison with problem-based learning, the approach is more directed and structured, the information needed to solve the cases is provided and the type of solution expected is not as open-ended. The case study method is very versatile and may involve medium-sized groups (20-30 members) and large groups (50-100 members) and short cases lasting 1-2 hours or long cases lasting weeks.

SPACE REQUIREMENTS: The ideal arrangement is a flexible classroom with tables for group work. A large classroom or lecture hall is also an option if the activity is combined with a lecture. Group work must therefore be organised in small groups (2-3 students) and feedback must be given with real-time questionnaires (Mentimeter, Socrative, Kahoot!, etc.).

NUMBER OF STUDENTS PER GROUP: 30 - 100.

OTHER REQUIREMENTS:

DURATION: 1 - 2 h.

TECHNOLOGICAL FACILITATORS: Collaborative work tools, multimedia presentation and/or capture systems.

BIBLIOGRAPHY:

- Case-Based Learning. Yale Poorvu Center for teaching and learning. Strategies for Teaching.
- National Center for Case Study Teaching in Science.
- Nkhoma M, Sriratanaviriyakul N. (2017). Using case method to enrich students' learning outcomes. Active Learning in Higher Education, 18(1):37-50.

CLINICAL SIMULATION

BRIEF DESCRIPTION: Simulation is a widely used teaching method in health sciences. It consists in creating a scenario representing a real healthcare situation and allows students to put their skills and knowledge into practice and to learn, evaluate and analyse their own actions in a safe environment. The aim of this method is to improve clinical decision making, teamwork and reflective practices and to increase the motivation to learn. This activity provides a safe environment for the "patient", who is a simulated patient, such as a manikin, or a standardised patient, such as a virtual patient or an actor, and for the student. Students therefore establish good practices and learn from their mistakes, with no consequences in the real world.

SPACE REQUIREMENTS: Simulation rooms equipped with the necessary materials are essential for simulating the scenarios (such as an external consulting room, an emergency department, etc.), as are the technicians needed for the operation and maintenance of the room and computer equipment. An adjacent room is also necessary so that participants who are not in the scene can observe the streamed simulation.

NUMBER OF STUDENTS PER GROUP: 10 - 20.

OTHER REQUIREMENTS: Professors must have received specific training in simulation practices. The method is well established and consists of three stages (prebriefing, simulation and debriefing) that professors must know how to lead.

DURATION: 1 - 2 h.

TECHNOLOGICAL FACILITATORS: Videoconferencing and broadcasting systems.

BIBLIOGRAPHY:

- Johnston S, Coyer FM, Nash R. Kirkpatrick's Evaluation of Simulation and Debriefing in Health Care Education: A Systematic Review. J Nurs Educ. 2018 Jul 1;57(7):393-398. doi: 10.3928/01484834-20180618-03. PMID: 29958308.
- McGaghie WC, Issenberg SB, Petrusa ER, Scalese RJ. A critical review of simulation-based medical education research: 2003-2009. Med Educ. 2010;44:50–63.
- Motola I, Devine LA, Chung HS, Sullivan JE, Issenberg SB. Simulation in healthcare education: a best evidence practical guide. AMEE Guide No. 82. Med Teach. 2013 Oct;35(10):e1511-30. doi: 10.3109/0142159X.2013.818632. Epub 2013 Aug 13. PMID: 23941678.