CTwoSEAS

Climate Change: Science, Ethics & Society

Climate Change:
From Science to Society

METHODOLOGICAL GUIDE

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Climate Change: From Science to Society

Methodological Guide

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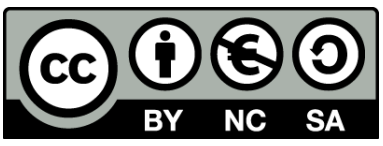

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1. Teaching methods and modalities in higher education

1.1 Models

This methodological guide aims to support the teaching of the course *Climate Change: From Science to Society* in terms of the organisation of students' learning, the development of these learnings, and their evaluation. All of this will be focused on the competences that the students must acquire during their learning process.

We are aware that, sometimes, the pedagogical training of university faculty staff outside the branches of education is scarce and, therefore, this guide will offer a myriad of methodological tools and strategies that can overcome some of these possible shortcomings.

In the development of this methodological guide, we are mindful that the proposed methodologies to be used in each specific case are limited by the context of the course and the organisational context of each educational institution. Given the diverse nature of each educational institution and its conditions (physical resources, teacher training, budget, among others) it will be the task of the teachers of the course in each of the institutions to select the most appropriate methodology to their reality. The challenge of this methodological guide is to design working modalities and methodologies for both teachers and students that are appropriate for a standard student in the European Higher Education Area (EHEA) to achieve the skills that are proposed.

The EHEA focuses the teaching-learning process on the student; in this context, the emphasis is not on what the teacher conveys but on what the student learns and acquires. Therefore, the teaching plan of a course should not be limited to the temporary distribution of content but should sequentially

expose the set of activities and tasks that teachers must carry out to guide students in the experiences they will have during their teaching-learning process to acquire the necessary skills.

The concept of competency was defined in 2002 by the OECD (Organisation for Economic Co-operation and Development) as the ability to answer the demands or carry out tasks successfully. These tasks are related to cognitive and non-cognitive dimensions (Rychen and Salganik, 2003).

In a higher education environment, competencies are defined as the combination of knowledge, skills (intellectual, manual, and social), attitudes, and values that will enable a graduate to deal with problem solving or intervention in a particular academic, professional or social context.

From a pedagogical point of view, the competencies are classified around two areas, subdivided into three sub areas (Table 1).

Table 1. Classification of competencies. Modified from Rodríguez-Jaume, M.J. (2009)

		Tuning project	ICE[1]	Spanish legislation (RD 55/2005)
Areas of Competence	Cognitive	Cognitive instrumentals	Know	Knowledge
	Non-cognitive	Instrumental-procedural	Know-how	Skill
		Interpersonal and synthesis	How-to-be	Aptitude

[1]Source: ICE: Instituto de Ciencias de la Educación

Cognitive skills (know) refer to the theoretical knowledge of the course, i.e., course contents. Table 2 shows the description of these competencies according to Bloom's taxonomy (Figure 1).

Figure 1. Three-dimensional representation of Bloom's taxonomy (Bloom and Krathwohl, 1956) revised by Anderson and Krathwohl (2001). Learning objectives are defined as the intersection of the knowledge and cognitive process dimensions. The statement of the learning objective contains an action (in red) related to the cognitive process (recall, classify, provide, etc.), and a knowledge that students are expected to acquire (in blue). Modified from Heer (2018).

Table 2. Examples of Knowledge Competencies

Categories	Description
Knowledge	Being able to remember words, ideas, events, data, classifications, theories
Comprehension	Being able to integrate and extrapolate from certain knowledge
Application	Being able to use knowledge or principles to solve a problem, or concrete and real situations
Analysis	Being able to break down a set of information into its parts and its aspects
Synthesis	Being able to compose, with elements and part, a whole or set of information
Evaluation	Being able to make critical judgments based on internal and external criteria

Skills or skill competencies (know-how) refer to those related to the student's ability to transfer knowledge from one context to another, infer data and ideas from others, modify cognitive strategies to address problems, and promote decision-making based on cognitive operations such as relating and analysing. In Table 3 we show a summary of these skills.

Table 3 Know-how competencies (capabilities and skills)

Academic	Read, see, listen, note down, plot, being able to interpret graphical documents, being able to design, create diagrams
Research	Observe, hypothesise, analyse, evaluate, document, use of research instruments, manipulate materials
Social	Cooperate, argue, work in teams, have leadership spirit, dispute resolution, stand up for one's own ideas, lead discussions

Finally, competencies in values and attitudes (how-to-be) aim to develop values that society considers necessary for professional development. Our project aims to take a step beyond, as we believe that these skills should work in the direction of raising awareness of European citizenship in students. Such a conscience is necessary to the extent that this course about climate change raises an issue that cannot be addressed from a local level, because it is a phenomenon that crosses borders. Explicitly, and as we focus on the specific problems affecting the Mediterranean region, we aim to develop in students the awareness that, at least at the climatic level, we live in a global space. In table 4 we summarise some of these aims.

Table 4. Aims for the 'how-to-be' competencies

Value	Appreciate the value and be willing to do things in a certain way
Curiosity and compromise	Lifelong learning
Initiative	Learning how to learn
Involvement	Play a part, strive

Once we have described in a general manner the competencies, the next step is to determine which competencies should be selected for the successful student training in our course. We have organised the competencies in generic and specific ways. In the following section, we will look at the generic ones, whereas the specific competences will be developed in the teaching guide.

1.1.1. Generic competencies

According to the Tuning project (González and Wagenear, 2003) generic or transversal competencies are shared by all knowledge areas and can be divided into instrumental, interpersonal and systemic.

Instrumental competencies include cognitive skills, methodological abilities, technological skills, and language skills. They are considered necessary for the understanding, construction, handling and critical use in

different professional practices. “Capacity for analysis and synthesis” and “Ability to manage information” are two examples of competencies considered in this group.

Interpersonal skills include individual capacities and social skills, such as “Interdisciplinary teamwork”, “Recognition of diversity and multiculturalism”, “Critical thinking”, and “Ethical commitment”.

Systemic competencies are the skills and abilities of the individual relative to the understanding of complex systems. Some examples of this group include “Autonomous learning”, “Adaptation to new situations”, “Leadership”, “Sensitivity towards environmental issues”, “Use of the internet for communication and information”, “Ability to communicate with lay people in the field”, and “Ability to understand the language and proposals of other specialists”.

The approach followed in this methodological guide is based on Biggs' constructive alignment (Biggs, 2005), according to which teaching modalities (organisational component), teaching methods (technical component) and evaluation (evaluative component) are defined in a parallel and integrated manner with the competencies to be achieved.

In the next section, we provide a brief description of the teaching modalities and teaching methods used in the university environment.

1.2 Teaching modalities

The modalities are defined as the ways of organising and carrying out the teaching-learning process. They are closely related to the objectives set out by the teaching staff and the institutional environment (facilities and resources available).

In Table 5 we summarised the main organisational modalities along with their description.

Table 5. Main organisational teaching modalities

Space	Modality	Description
Face-to-face	Theoretical class	Explanatory, exhibition and/or demonstrative sessions of the content by an expert
	Seminars and workshops	Supervised monographic sessions
	Practical class	Any type of classroom practices (labs, visits, study case)
	External internship	Training in external entities.
	Tutoring	Direct relationship between one or more students and the teaching in which the teacher guides and supports the teaching process
Blended	Study in groups and group work	Presentation of seminars, readings, works, reports developed through group work
Blended	Student self-study and self-work	Self-study and the activities described in the previous section carried out individually

It is noteworthy that face-to-face teaching can be totally or partially replaced by online teaching.

From the seven modalities shown in Table 5, we will not address the external internship as we decided to eliminate this modality in the design of the course.

Although the EHEA does not recommend the use of theoretical classes as the main modality, since it does not promote autonomous learning, the fact

remains that this is the most common modality in university education mainly due to the high number of students in a classroom and lack of space. Ideally, the use of several modalities that enrich the students' learning process is encouraged. Given the transverse nature of this course, we estimate that around 20 students will enrol in the course. If the number of students interested in the course is higher, it will be a good idea to fix a maximum enrolment quota. This will allow the use of a combination of different modalities.

In this project, the development of a learning platform will allow the teachers to combine face-to-face activities with online teaching. It will boost both the group and self-study work with the access to additional material (further reading, study cases, and so on).

2. Theoretical learning

2. 1 Introduction and objectives

The masterclass is the most characteristic teaching and learning method of the face-to-face theoretical modality (De Miguel, 2006). Historically, it has been the most widely used method at all education levels and, in particular, at the University level. It is based on a one-way relationship in which the teachers are in the exclusive possession of knowledge and use an expository method to transmit their knowledge to students.

Due to the multidisciplinary nature of the course and the different backgrounds of the students that will enrol it, we consider that this methodology is essential at the beginning of the teaching of this course. The aim is to establish a general basic knowledge that allows certain homogenisation in the acquisition of fundamental theoretical content, its processing, and the motivation of the students towards the learning process.

Nevertheless, the use of this methodology also needs an active and participatory role of the students. The use of technologies and tools (maps, images, video, etc.) is essential in a masterclass, along with the commitment of the students to their own learning process.

2.2 Competencies

Active masterclasses allow students to acquire three types of skills:

1. Training competences, the students will acquire knowledge of a theoretical-practical course that also has a broad and innovative professional projection in social, economic and scientific sectors. The student will learn to process the information received through different resources and to link it with the professional world. For example, this skill is fundamental for the use of geographic information systems, in order to know facts and data on climate change through Sentinel images, a part of the European satellite programme (Copernicus).

2. Competences linked to the development of intellectual and organisational skills that will allow the student to manage the information he receives, analyse it, reflect on it, synthesise it, evaluate it, and interpret it. The students will also develop communication and argumentative skills.

3. To develop essential attitudes and values, both professional and personal. This competence is of crucial importance in the proposed course given that climate change compromises the very existence of our environment. Therefore, the development of tolerance, responsibility and personal commitment on the part of the students will have multiplying advantages over their community.

2.3 Methods

The expository method has some advantages since it allows us to teach a larger number of students. Students' curiosity can be stimulated and their cognitive skills improved by using techniques that the teacher can adopt in conjunction with the students. This expository technique has aims which allow us to achieve very diverse educational purposes:

a) To present the basic contents of the course. It is possible to resort to glossaries of scientific terms, examples of specific cases on climate change considering the geographical area we address, and so on. This strategy should be very useful because of the academic training differences between the students.

b) To explain the relationship between phenomena, as well as the cause-effect relationship in all its dimensions. This aim is fundamental given the course topic which is directly linked to the action and the relationship of humankind with the natural environment. To accomplish this objective it is necessary to develop different steps in an explanation, work with hypotheses, or evaluation of opposing theories. For example, the study of the causal link allows us to determine the relationship between climate change and migratory processes.

c) To prove hypotheses. This aim allows us to contrast the scope of the different hypotheses and argumentative or denial theories of climate change. In that sense, the use of geographic information systems and images from Sentinel satellites could be very relevant.

d) To present experiments and practical tests that can serve to illustrate a theoretical explanation.

The organisation of the lecture, although it has the teacher as the main protagonist, increasingly requires joint planning with the students, since the use of other resources, such as ICT (information and communication technologies), allows students to access content before the classes. In this way, specific techniques can easily be incorporated, such as maps, short videos, satellite images, argumentative debates, work in teams, critical reflection, personal analysis, etc., in which the students are the most active and protagonist part.

Additionally, according to Atkins and Brown (1988), theoretical classes (Figure 2) generally seek three fundamental objectives: to provide information to students, to promote understanding of knowledge, and to stimulate their motivation.

1. To provide information so that the teacher uses transmission formulas, a traditional strategy and means of communication in academic settings.

2. To generate processes of understanding of the transmitted knowledge that allow the teacher to consider how the students process that information.

3. To stimulate motivation towards learning by showing the student the scientific relevance and practical application of the exposed knowledge. In this way, motivation towards learning is stimulated.

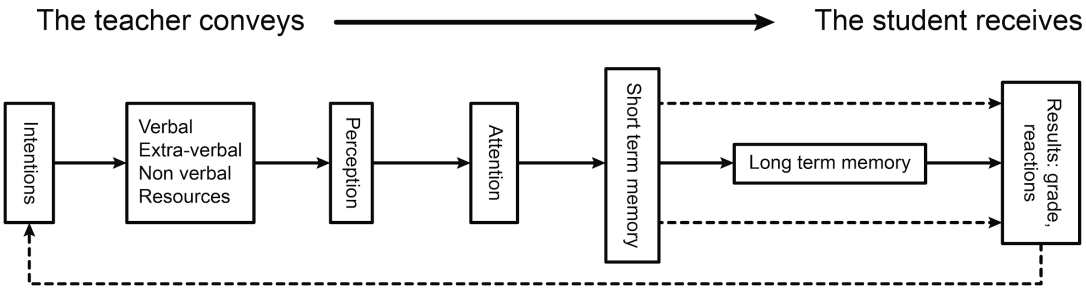

Figure 2. Theoretical framework of a lecture class, after Atkins and Brown (1988).

2.4. Strategies for teacher and student roles

The teacher's task as a stimulating agent and transmitter of learning is crucial in this methodology. Therefore, regardless of the resources that can be used, which we will approach later, the teacher must have a deep understanding of different teaching strategies that can be used throughout the different parts of the class (Figure 3).

Thus:

- In the introduction to the class, the teacher uses resources that allow him from the first moment to capture the attention and awaken the interest and curiosity of the students. This challenge can be overcome following some strategies such as making a solid and realistic outline of the content of the class, conveying their enthusiasm about the subject, engaging students through well-directed questions, allowing the students to perceive the practical utility of the knowledge that they are going to transfer, and organising the contents in a logical and sequential way

- During the development of the class, which must occupy the central and most extensive part of it, the teacher must facilitate the acquisition and processing of the contents. This goal can be achieved making use of clarity and rhythm in the exhibition, posing rhetorical questions, facilitating the collection of notes, following the content structure that has been marked at the beginning, summarising content with a certain frequency, which can also be

used to repeat the most important and complex concepts, using examples to explain the more complex content, and encouraging students to participate in the whole process.

- In the closing phase of the class, the teacher must help the students to develop their own thinking from the knowledge transmitted. Initiatives to achieve this include the use of outlines that facilitate the summary of the class, emphasising those most relevant turning points, presenting in a comprehensive way all the knowledge taught during that session, encouraging participation and discussion in class, raising questions or issues about the practical application of the contents that must be resolved to the next session as a formula to give continuity, relate and integrate the contents that are being discussed, avoiding that they are presented as isolated blocks for the students.

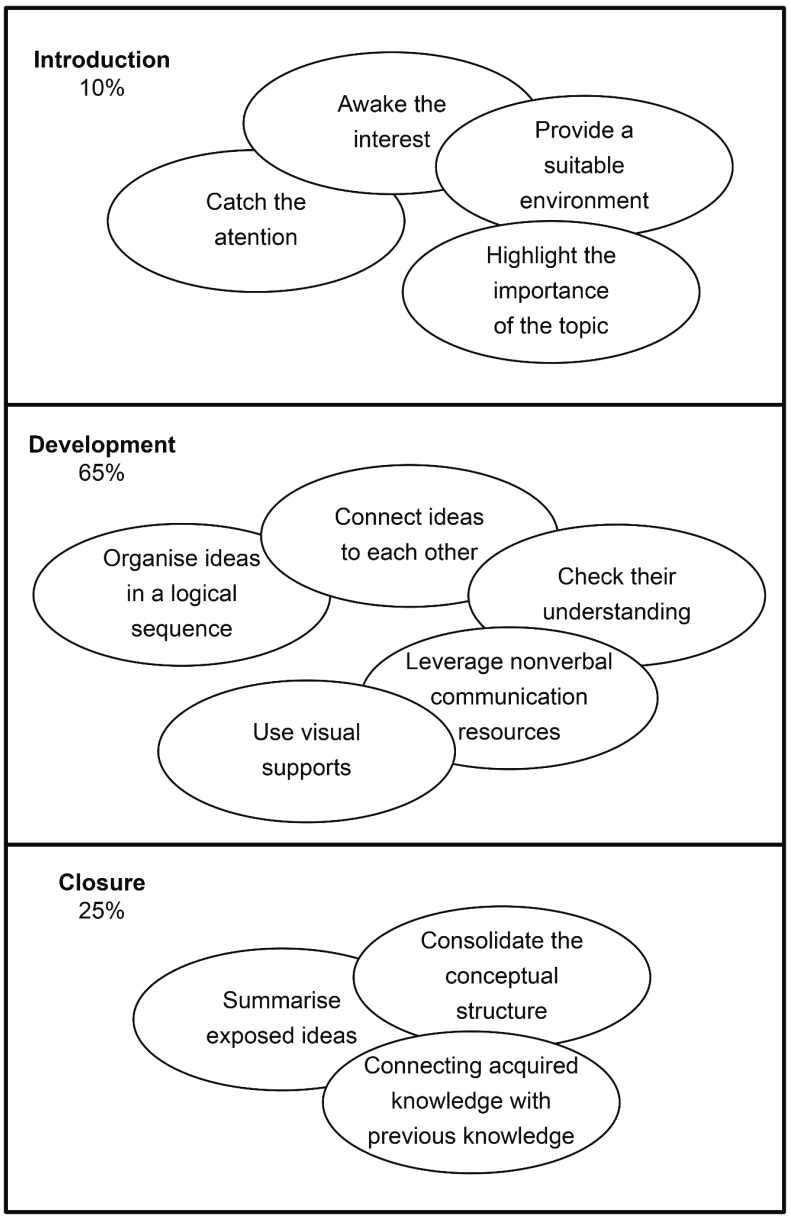

Figure 3. Structure of a lecture class. After Instituto Tecnológico de Estudios Superiores de Monterrey (2018), cited by Ferrón Zarraute (2019).

- In the masterclass, the tasks that the students must carry out, before the classes, during and after them, are also essential.

Before the class, students should review information and knowledge from the previous class and carry out the tasks that the teacher has assigned them as continuity work between classes, as well as to prepare the materials that the teacher has assigned them, along with all the doubts that may have arisen in these processes.

During the class, students should pay attention and take notes, but also interact with the teacher and with classmates in the activities that require it. It is also important that students raise doubts and aspects that they consider that have not been sufficiently clear in the previous presentation of the teacher.

Finally, after the class, students should carry on an autonomous work, through the activities and readings that the teacher has established as well as complement the information received. Moreover, they should work the contents in a way that develops the capacity for relationship and integration of knowledge.

2.5 Resources

Depending on the teaching purposes, objectives and the competencies to be developed in the masterclasses of this course, we can set the following resources:

- Physical and spatial resources: to have a classroom according to the number of students who will participate in the class. The classroom must have the proper equipment: furniture, blackboard/whiteboard, computer, overhead projector, internet access.

- In order to create an active learning environment, the teacher must use different ways/resources to communicate with the students: oral, video, computer.

- Virtual resources: the course will be virtualized on its own platform or that of the university centre where the activity is organised and to which the students belong. In this virtual space, the teacher can organise other types of interactions with students: forum, chats, etc. Students can also access all the materials provided by the teacher in this area: videos, presentations, articles, maps, interactive resources, notes, tasks to be carried out, questionnaires, resources of geolocation, etc.

2.6 Evaluation

In classes an evaluation will be carried out to test the accomplishment of the proposed competencies. The timing of this task is short and it may include the following items:

- Assistance and attention
- Active participation and generating ideas
- Objective tests: which will include two types:
  - Short answer
  - Preparation of a short report / essay on a research question.

2.7 Pros and Cons

The active masterclass has many advantages in order to organise the information, especially in this course which can be attended by students from different fields of study. In this sense, this methodology allows the attendance by a large number of students, as stated above.

Furthermore, planning of the information, knowledge, time and materials is easier to organise and implement in active masterclasses. In addition, this method is very well known by every student, and it is very easy to create a participative environment and a group spirit.

Moreover, this methodology allows the development of other competences in the classroom, such as leadership, communication skills or conflict resolutions.

Thus, the main challenge of this methodology may well be to obtain a permanent feedback and commitment from the students; that is to create a really active masterclass. Several drawbacks can be found in this teaching method if it is not a participative process, such as:

- passive attitude of students
- problems in recognising the real knowledge of the students and create a gap between them and the teacher
- lack of commitment of the students in their learning process
- lack of feedback and team spirit.

3. Case study

3.1 Concept and use

The case study is a methodological tool that is included in the teaching modality of workshops and seminars. Its goal is to deepen into a specific topic through exchanges among the students and teacher. Therefore, the main characteristic of this methodology is the interactivity. This methodology allows the experience interchange, use of critical thinking and the implementation of communicative processes that involve dialogue, reflection and discussion.

Due to the multidisciplinary nature of our course, we consider that this is one of the most appropriate methodologies to approach the topic of climate change within a wider context. This methodology will allow our students to observe carefully the truth we face with regard to climate change thanks to the work on real examples.

The case study will help our students to understand the relevant phenomena related to climate change from different perspectives (technical, ethic, and social, among others). It will encourage students' commitment in their own learning process. It will train their ability to make decisions and it will provide to the students the experience of working in cooperative multidisciplinary team-works.

3.2 Objectives and competences

This methodology has three main objectives:

1) Development of communicative skills

This objective implies the ability to show, in an effective manner, data, opinions, experiences, hypotheses and so on. The ability to support facts and opinions in a rigorous manner. The abilities of active listening (listen to understand and not to answer), the critical analysis and the incorporation of other opinions in our discourse.

2) Development of intellectual and professional competences

This objective implies the ability to use the theoretical knowledge acquired during the course in a practical manner and in real context. Here, it is crucial to show our students that in a professional environment the approach to problems must be multidisciplinary with the contribution of staff from different sensibilities and backgrounds.

3) Personal growth

This objective implies the students' ability to manage social skills such as tolerance, empathy, listening or dialogue. The ability of self-motivation (to discover what is their driving force), self-evaluation (ability to assess the quality of their work, personal commitment)

From the point of view of competencies, this methodology allows us to work the ones related to know, know-how and how-to-be. In the case of intellectual and skill competencies addressed in this methodology, they can include the search and selection for relevant information related to the case presented during the class. After this step, the analysis and synthesis of the gathered data will be necessary, and the interpretation of the whole information to elaborate a written and informed report with a solution to the studied case. In the case of values and attitudes managed in this methodology, they are varied

and cover critical thinking, reasoning skills, tolerance and respect to other cultures and ways of thinking, development of self-motivation, and improvement of self-learning ability.

3.3. Teacher and student roles

In this methodology both the student and the teacher play specific roles that are described in the following lines.

3.3.1 Teacher's role

a) Before starting the case study

The teacher must clearly establish the topic and goals of the case study. Due to the multidisciplinary point of view of this course, we recommend the use of multidisciplinary case studies that can be approached from different perspectives.

The teacher must search and organise the material needed to support the case study. In the virtual platform created for the CTwoSEAS project (https://ctwoseas.eu/cop-portal), it is possible to download some case studies that can be used in the class and/or as inspiration for the creation of new material.

The teacher must establish how the student is going to participate in the course both in and out the classes. As an example, the following tools can be found in the platform (forum, tests, etc.). The instructor must propose both activities for individual (autonomous work) or group work (cooperative groups, collaborative groups).

The teacher must carry out the methodological design of the case study by elaborating a script, selecting crucial questions to stimulate student's reflection and lead to debate and decision making.

The teacher must establish the criteria and indicators to carry out the evaluation (more details are shown in section 3.5).

We recommend that the teacher will be highly familiarised with the case study or even will be involved in its elaboration. Moreover, due to the multidisciplinary point of view of the course, it is highly recommended that the case study will be created by teachers from different subjects.

b) During the case study

During the development of the case study, the teacher must focus on clearly transmitting the students what is expected from them and how their work will be evaluated. Special attention must be given to keeping a proper environment for the debate and decision-making processes. If necessary, the teacher must clarify concepts, open new discussions, and focus the topic to avoid end-lines and dispersion. During this process, the teacher can take notes for the evaluation of the student.

It is recommended the use of group dynamics to select the group members if working with small groups (e.g., using the Phillips 66 technique) or to boost the idea exchange (e.g., by means of brainstorming or free debate).

c) At the end of the case study

The teacher must evaluate the case study not only in terms of student performance but also in terms of degree of goals fulfilment, session management, and possible improvement for future case studies.

Regarding student evaluation, both the academic progress and competence achievement should be considered.

3.3.2 Student's role

a) Before starting the case study

The student must review the theoretical and practical knowledge acquired during the course and complete the previous work assigned by the teacher (complementary reading, watch videos, complete tests, etc.).

b) During the case study

The student must actively participate in the discussion and decision-making process with active listening, keeping their speaking time and with respect to other opinions.

c) At the end of the case study

If the teacher considers it of interest, the student must write a report about the work carried out, the decision-making process and the conclusions.

3. 4 Resources

As this methodology includes a great deal of work group activities, the use of flexible spaces is highly recommended. The case study can be presented using different tools such as video, PowerPoint or *prezi* presentations (or similar tools), paper documents, and so on. Therefore, ICT classrooms are highly recommended.

3.5 Evaluation procedures

The evaluation criteria must be aligned with the competencies developed during the learning activities. According to Alfaro (2009), the degree of completion in these competencies can be weighted through the quality of the student participation during the seminar, additional work (such as a portfolio) or oral presentations on the studied case.

Evaluation in this methodology is usually continuous and it is important to make criteria available for students in advance.

3.6 Pros and cons

Case studies are one of the most used teaching methodologies in social sciences because it favours the ability to get an in-depth vision of real life, so the student is able to suggest recommendations to tackle the proposed problems. Furthermore, they promote student engagement in the subject of providing solutions for the problems provoked by climate change and help him/her to build communication abilities.

However, this methodology works better if the formulated situations are simple and have definite solutions, the number of students is small, and it relies on the ability of the teacher to generate participative dynamics.

4. Flipped learning / Flipped classroom

4.1. Introduction and objectives

Flipped learning is a pedagogical model that changes the focus of teaching, the knowledge transition system, and the classroom model. It is defined as *"a* pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the course matter*"* (Flipped Learning Network, 2014).

The main objective of flipped learning is that the students become the protagonists of their own learning. For this, the students will study the theoretical concepts by themselves outside the classroom using resources and tools (i.e., podcast, videos, publications) provided by the teacher who will merely act as a guide; this education material will be available on a virtual platform. The time in the classroom will be dedicated to answering questions, delving into concepts and creating debates (Galway et al., 2014; Hwang et al., 2015).

Flipped learning is based on four pillars: flexible environment ("F"), learning culture (L"), intentional content ("I") and professional educator ("P"):

- **Flexible environment** ("F"). In a traditional classroom (such as a masterclass), the learning process is reduced to the physical space of the classroom. However, in the flipped learning model, the students decide when and where to learn creating adaptable spaces. Online platforms are a crucial pillar of this model.
- **Learning culture** ("L"). In the traditional mode, the teacher is the main source of information and transmits the knowledge. The students are mere passive courses in their learning process. They attend class, take notes, carry out the tasks indicated by the teacher and study the course. However, in the

flipped learning mode the teacher acts as a guide of the student's learning process. Teachers provide material (video, scientific papers, notes, books and so on) before the class so the students build their own knowledge and the class-time is transformed in an exploring time to deepen into the topics. Students are now active subjects of the learning process, and a more personalised learning is achieved.

- **Intentional content** ("I")**.** It is crucial to appropriately select the contents and materials that will be provided to the students to build their own learning.
- **Professional educators** ("P")**.** Professional teachers must observe and analyse how the students build their own learning and be ready to give them relevant feedback when needed. Moreover, the evaluation must be a continuous process.

4.2. Competencies

The competencies that can be taken on through the flipped learning methodology include the following:

1. To acquire the capacity for independent work and autonomous learning.
2. To master the use of digital resources and tools for personal and professional development.
3. To master oral and written communication strategies to interact with other students and the teacher.
4. To appreciate the importance of individual and teamwork.
5. To value the importance of leadership, self-work and entrepreneurship in personal and professional development.
6. To be able to understand and master basic concepts of the course to go deeper into the course and actively participate in debates inside the class.

4.3. Methods

Flipped Learning learning steps

1. Before the class. The work at this stage is focused on Bloom's taxonomy levels of remembering, understanding, and applying (Anderson and Krathwohl, 2001).

Specifically, **the teacher** must clearly define learning goals, and must create and select contents and materials. Additionally, the teacher should elaborate activities with different degrees of difficulty so the students can evaluate their knowledge and upload all the contents in an educational platform from which students can work.

For their part, **students** must read and work with the contents and materials, watch the videos prepared by the instructor, complete the assigned tasks and take notes of their doubts (Figure 4).

2. During the class. The previous preparation of the learning contents and materials permits a more detailed approach so more complex Bloom's taxonomy levels can be processed, such as analysing, evaluating and creating.

At this moment, the **teacher** is able to address the students' doubts, and identify difficulties and gaps in the comprehension of the topic by the students. Furthermore, the instructor can explore topics in more detail and propose different didactical techniques to achieve the aforementioned objectives, as for instance: problem-based learning, cooperative learning, group dynamics, case study or debates.

The **students** will be able to address the doubts that arose during the class preparation, and they can actively participate during the class.

3. After the class. All levels of the revised Bloom's learning taxonomy can be worked.

The **teacher** can provide students with additional materials and contents, addressing their doubts. She/he can also reinforce and promote students' learning by proposing cooperative projects and works and, at the end, evaluate the acquired knowledge.

The **students** will be able to deepen their learning and carry out the collaborative projects or works suggested by the teacher.

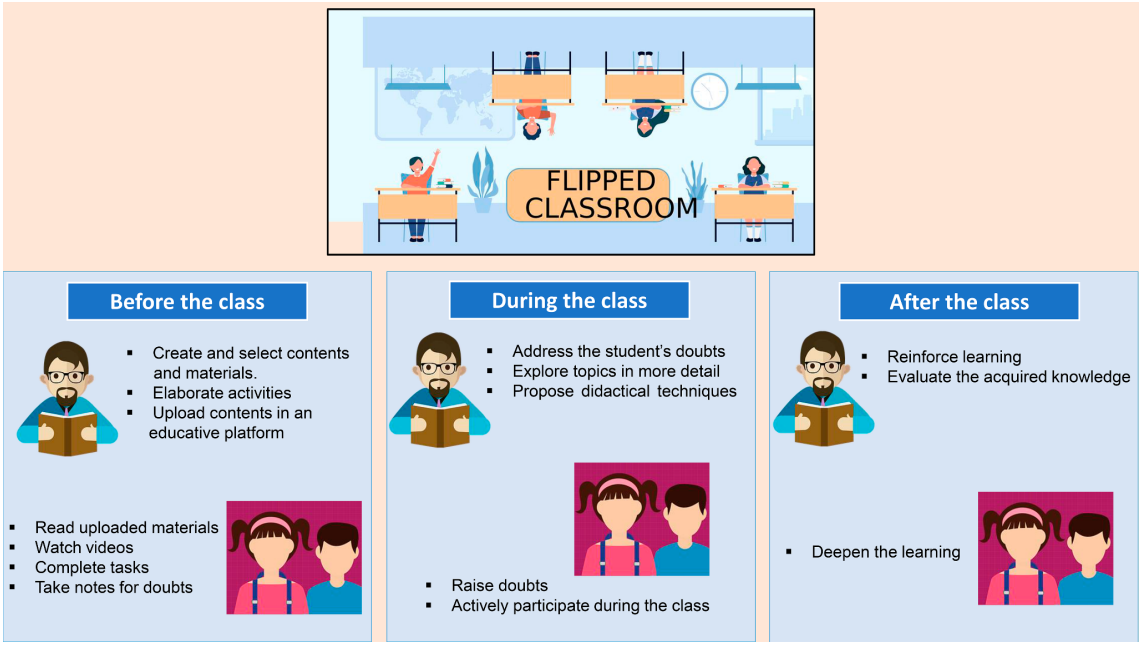

Figure 4. Methodologies implemented by teachers and students before, during and after a flipped class.

Below are some of the teaching resources that can be developed, and the most adequate software programmes and tools to create them. Unfortunately, some of them can have a very short lifespan, but up-to-date software programmes can be easily found through a simple web search.

Videos

- *Free access videos. Platforms such as YouTube and Ed-TED provide free access to audiovisual content. It is recommended that videos used in the Flipped Learning model should be no longer than 10-15 minutes.*
- *Video creation. If we do not find videos for the content that we need, we can create them by ourselves using some of these programmes and applications:, EDpuzzle, Screencast, Panopto.*

Presentations

- *There are several tools that allow teachers to create presentations such as PowerPoint, FreeOffice Presentations, Prezi, PhotoPeach, Canva, Genially.*

Publications

- *Databases such as Pubmed and Google Scholar allow the teachers to search for specialised literature that can be used as an educational resource in the Flipped Learning model.*

Murals

- *Programmes such as Padlet, Glogster and Mural allow teachers to create and share digital murals and posters with text, images, video and audio.*

Questionnaires

- *The creation of questionnaires through various programmes (Google Forms, Quizlet, QuizWorks, Socrative), allows the evaluation of the knowledge of the students in the different phases of the Flipped Learning model.*

Collaborative documents

- *Google Drive, Evernote and Edmodo* allow for the sharing of documents among students, thus facilitating collaborative work.

4.4. Evaluation

In the evaluation of flipped learning, work outside and inside the classroom will be considered. Thus, work outside the classroom can be evaluated through personal and group tasks and work. Regarding the evaluation within the classroom, attention, active participation, ability to generate ideas and link concepts will be taken into account. Likewise, taking a final exam will make it possible to assess the global knowledge acquired through this methodology.

4.5. Pros and cons

The advantages of the flipped learning methodology can be summarised in five points. In the first place, the method adapts to the student's learning pace, since

the resources and tools provided by the teacher on virtual platforms can be viewed whenever they want, from where they want, and as many times as they want. In the second place, it improves not only individual and team work, but also skills such as digital, communicative and organisational. In the third place, the classroom becomes a dynamic space to create debates on the issues learned, deepen concepts and detect deficiencies. In the fourth place, it increases teacher-student interactions. Finally, it promotes the development of critical thinking.

The flipped learning methodology also has disadvantages. Firstly, it requires more time and work than theoretical learning. On the one hand, the teacher must prepare more resources and tools that will be virtualised and made available to students on the corresponding virtual platform. On the other hand, students need to invest a lot of time in their learning outside the classroom to make notes and understand and learn the contents. Secondly, the student is required to be self-motivated, work autonomously and actively participate in the learning process for this methodology to be a success. Thirdly, another possible limitation of this methodology is that it can only be applied in advanced digital environments. It is required to have a computer/tablet and a fairly good internet connection.

5. Tutorials

5.1. Concept and use

The concept of tutoring is one of the most widely used in the context of university education. However, this concept is ambiguous because it includes very different meanings. Traditionally, tutorials have been understood as the time that the professor dedicates to the students outside of class in order to solve their doubts about the course, clarify questions that arise for the student in his or her study, delve into some aspects of the course in which the student is especially interested, or even deal with more personal matters that affect the student in his or her learning process. In recent years, the concept has also been used to describe other activities, such as the mentoring that some university institutions provide to their incoming students to assist them in their process of integration into university life. This function can be developed by a professor or by students in higher education. These very different activities, which we can call "teaching support" and "guidance", only have in common the fact that they involve a more personalised relationship with the student than that which is given in other university activities, typically theoretical or practical classes.

In this guide, we will not use the term in either of these senses but rather with regards to a teaching modality, a distinctive didactic strategy that it only shares with the senses of "tutoring" to which we have referred to. In fact, an activity that involves the teacher and the student in a very individualised way. Understood in this way, it constitutes a fundamental instrument to establish a follow-up and supervision of the students' work in an individualised way.

5.2. Objectives and competences

In this sense, what we could call “academic tutoring” (de Miguel Díaz 2006) can be developed at an individual level or in small groups, a choice that depends, among other criteria, on the number of students enrolled. In either of these two forms, tutoring has the following fundamental objectives: to identify and help to solve problems in the student's learning, to seek the development of good strategies and habits on the part of the student, to encourage autonomous study and the student's responsibility towards his or her own work, and to encourage the student to go deeper into the course.

In view of these objectives, tutoring is the indicated modality to develop a series of competences at different levels, such as:

- Related to knowledge and academic skills:
    - Development and deepening of knowledge, procedures and methodologies specific to the course.
    - Understanding of abstract concepts essential to the course.
- Related to the development of complex reasoning, problem solving and decision-making skills:
    - Transfer, extrapolate and apply knowledge to new situations.
    - Understanding and analysing information and texts.
    - To pose and solve problems.
- Related to communication skills and abilities:
    - Oral and written expression.
    - Planning and structuring the speech.
    - Managing and contrasting different sources of information.
- Skills related to organisation and self-management:
    - Knowing how to set up a realistic work plan.
    - Reflecting on your own work.
    - Planning, organising and managing time and resources.
- Skills related to personal commitment:
    - Willingness to know new things and go deeper into them.

- Responsibility.
- Attention to the ethical aspects of the work.
- Discipline.

5.3. Roles and tasks of the teacher and students

As it is a specific teaching modality, the roles and tasks of teachers and students within the tutoring can be clearly defined.

It is convenient that, from the beginning of the course, and according to the characteristics of the students, the teacher establishes and communicates to the students in a clear way the functioning and specific characteristics of the tutorials. In particular, he or she will establish whether the tutorials will be individual or in group (in this case, it is recommended that the groups have a maximum of 4 people), as well as the number of tutorials that will be carried out and their duration.

During the course the number of sessions and their duration may be altered, since tutorials are a very personalised type of teaching and, therefore, depend a lot on the specific characteristics of the students, which typically the teacher does not know at the beginning of the course. However, this initial planning is important so that both the teacher and the student can organise their work well and estimate the time they have to dedicate to the tutorial action, and also to avoid an informal and improvised feeling in the students, a risk that is run without this planning, especially if the students are not very used to the tutorial tool that we have called academic. It is therefore essential that these data are provided to the students from the beginning, as well as the possible flexibility in number and duration of sessions.

The place where the tutoring sessions will take place will also be announced at the beginning of the course.

The role of the teacher when acting as a tutor is always one of help and support, both in the development of skills and work strategies and in the resolution of problems faced by the student in the course matter. Therefore, and necessarily, it is a very flexible activity. This role can vary depending on whether it is individual or group tutoring. In individual tutoring, the teacher's task will be to supervise the student's work and must be based on the specific needs of the student. In view of them, the teacher will establish a work plan for the student, indicating tasks that the student must perform and will ask for evidence of the work done for the next session. In this type of tutoring, the teacher's role should include the ability to lead and coordinate the work of the students in the group.

During an individual tutoring, the tasks to be performed are even more diverse and we will treat them separately in the next section.

5.3.1. Individual Tutorials: Tasks to be performed by the tutor

Following the objectives to be achieved in academic tutoring, the teacher has different tasks, which will be developed in a flexible way and adapted to the individual needs of each student. These are:

- To resolve doubts and the expansion of information on basic concepts of the course.
- To advise on complementary activities of the courses (information on readings, bibliographic information, advice on commissioned work, etc.).
- To review and explain the results of exercises and grades.
- To stimulate in the student the responsibility of the students learning and their formation.
- To detect problems and deficiencies of an academic nature.

For the good accomplishment of these tasks, it is convenient that the teacher uses certain techniques. One of them, which acquires great importance in a transversal course like the one we propose, is the initial questionnaire. In this questionnaire, which is advisable to carry out during the first tutorial, the teacher will collect fundamental and particular aspects of the student's previous academic experience and his/her expectations in relation to the course. An example of this kind of initial survey can be found at the end of this document and on the project's web page (www.ctwoseas.eu).

5.3.2. Individual tutorials: tasks to be performed by the student

Since this type of tutoring is of the utmost importance for the student to develop autonomous learning, in many cases students must take the initiative so that the teacher can develop his tasks (for example, in the raising of questions). He must take responsibility for his work and adapt it at his own pace.

5.3.3 Group tutoring and project development

The group tutorials are the ideal framework for the development of projects and, given the nature of the course that we propose, this modality is very appropriate. The course we propose involves the integration of different areas and disciplines, both scientific and humanistic and social, and the development of projects in the method perhaps best suited to perform this type of integration.

In the completion of projects, students have the possibility to approach concrete problems and in a creative way to integrate and apply the knowledge acquired and developed in other modalities and methods of teaching used in the course (theoretical classes, case studies, etc.). Through the completion of projects the student faces real problems that require a creative and novel proposal of solution, which is of the greatest importance in our course because it intends not only that students master certain theoretical and practical knowledge, but also that they acquire a practical commitment in the fight against climate change and become effective agents capable of offering solutions to concrete problems and/or contributing in a critical and positive way to the proposals of other agents.

It also allows students to take responsibility for their work and develop their autonomy to the maximum, planning and organising their own work and becoming the true protagonist of their learning.

On the other hand, although it is certainly possible to carry out individual projects, in the case of our course, which will be enrolled by students who are in different years of their respective grades, it is much more appropriate to carry out projects in groups. This will allow students from different backgrounds to be involved in a process in which they can learn from each other. Finally, the development of group projects develops and strengthens in students the habits and attitudes necessary for group work.

5.3.4 Tasks to be performed by the teacher

The teacher's role in this type of tutoring is fundamentally to mentor students during the process of developing their projects, while facilitating and respecting the autonomy, initiative and protagonism of the students in relation to the projects. The teachers must be available to solve the doubts that arise during the development of the project, from its beginning to its conclusion, serving as a guide and motivation without ever acquiring excessive prominence. We can express the rest adequately when we say that the teacher must guide the students in the development of their projects.

This role is specified in the different tasks that the teacher must perform:

- To help in the definition of the project, always starting from the initiative and/or specific interests of the students.
- To provide basic indications about the methodological procedure to follow in the development of the project.
- To review the work plan of each group.
- To hold meetings with each group to discuss and guide the progress of the project.
- To review the progress of the project.

5.3.5 Tasks to be performed by the student

The main role of the students can be specified in the following tasks:

- To form the group with which the project will be carried out
- To define the objective of the project.
- To define the work plan (individual activities, meetings, etc.).
- To search, collect and review the information.
- To develop the project and meetings with the teacher.
- To deliver a first report or proposal of results.
- To present results obtained and of the lessons learned.

5.6. Necessary resources

For the development of the tutorials, it is convenient to have a space that facilitates the face-to-face interaction either between teacher and student or, in the case of group tutorials, between the teacher and a small group of students. Usually, a suitable space is the teacher's office, but other spaces can be used

as long as they have that feature or can be accommodated to it, for example a classroom where the furniture can be moved in a way that allows this type of personalised interaction.

5.7. Evaluation

Individual academic tutoring, insofar as it aims to offer personalised help to the student in their learning process, is inextricably linked to the use of other methodologies (theoretical classes, etc.) that have their own means of evaluation. In the case of being related to project development, the final project itself constitutes a means of evaluation.

But the competencies to be developed through tutorials can and should also be evaluated through ongoing assessment. For this, the teacher must keep a written record of the development of each session, the tasks to be carried out by the student, their achievements and progress. It is convenient to have a portfolio for each student in which to file the different tasks carried out as this will help us to check their progress.

6. Study in groups and group work

6.1. Concept and use

The 1990s could be called the prodigious decade from the point of view of technological advances related to information and knowledge technologies, more commonly recognised as ICT (Information and Communications Technology).

If we move our memories to that moment, or better yet, if we consult the newspaper library, we will find a few years that began to point towards new training needs, because ICT, for the general public – at that time the Internet essentially – were being standardised and the number of users grew exponentially each week.

Many traditional manufacturing processes began to be replaced in those years, as the use of computers lowered and accelerated many processes, while providing them with new forms, new methods, etc., and above all the handling of large volumes of information, unthinkable until then. One of the most affected sectors was that of graphic arts, which happened in a few years, from the 90s, from working with chemicals for the generation of photoliths and galleys of photo component machines, to being replaced by computers and completely eliminating the conventional process, to the point of sending text and image directly to new plate filmers, which generate these directly for printing machines, rotary machines, etc. This is how newspapers, magazines and all kinds of publications are produced today.

Logically, technology created many new, well-qualified jobs, but destroyed all the manuals that existed in the conventional system, leaving a ratio of 1/4, that is, a new position qualified by traditional characteristic that disappeared (plate pins, tweakers, scanners, dark laboratory technicians, all kinds of bondage posts, etc.).

Castells (1997) defined this phenomenon of the 1990s as the network society, which was also referred to as the knowledge and information society

(IS), as did many other authors of the time and more recently (Almenara, 2001; Burch, 2005; Sacristán, 2010; Grijalva and Tapia, 2018; among others).

It is essential to know the technological evolution of IS since its consolidation back in 2001 (Castells, 2006), when e-commerce began to reach business volumes that rival the traditional ones, and that became the catapult of technological changes that society would experience in that decade and in the next decade, and also in which we have just started in 2020. It was in that year of 2001 that group work would be claimed as a new mode of learning, imposed by the times and advancement of technology.

Concept

The consolidation of e-commerce represented that of IS, and from that moment, everything began to flow at breakneck speed. There is still not sufficient explanation; however, we can say that it was both the stability of the Internet and its availability, that is to say, the ease of transmitting information instantly, safely and in large quantities, that brought at the very same time a new need to society: immediacy.

Without a clear cause-and-effect relationship, when the transmission of information ceased to be a problem of difficult solution and high cost, society became more demanding with response times as, previously, when the Internet was not used, it was necessary to always take into account very flexible margins of time for the transport of information (García Tartera, 2017).

Thus, without a really satisfactory explanation, many companies went on to work 24 hours in shifts, not because of the need for great production but because of the immediacy of the orders that customers now required. To all this, we must add the effect of globalisation, as a result of the evolution of ICT, so that the world became a kind of spider web where everything is connected. Any movement at one end of the network is transmitted to the other end immediately. This, transferred to business and commerce, represented that decision-making became extremely immediate and based on information that continuously runs through the bushy network and causes immediate

bankruptcies and brilliant successes, depending on the decisions taken in accordance with the information received.

Let us give an ordinary example of today's world:

If Apple decides to introduce a new phone model, it keeps the promotion date secret until the last moment. Its most direct competitor, Samsung, goes hand in hand, and if Apple pulls out a new model, Samsung has already prepared its own to counter, and vice-versa. It is sufficient for one of us to anticipate the opposite within 24 hours to start sales and turn the presentation of the competition into a failure.

This would be a typical case of decision-making based on the information that is received in the board of the company. Thus, decisions of immediacy according to the information received.

There is a lot that companies play in this new immediate decision market. Therefore, it is not a matter of the president of the company deciding and of him being responsible. It no longer depends on a single person, but on a very well-trained and very competent team that collects information, purifies it, processes it, analyses it and immediately transmits to the director the best option to act, also immediately.

The concept of study and group work has its cause in the need of modern society to have multifaceted and multidisciplinary teams that can provide ideas and solutions to problems that must be fully covered.

6.1.1. From group work to cooperative learning. An essential transition

The concept of study and group work has its cause in the need of modern society to have multifaceted and multidisciplinary teams that are very complemented and accustomed to working with technological tools, which are those that provide agile access to information and allow its processing to turn it into knowledge, which is nothing but value for the company.

Group work, in a conventional way, has traditionally consisted of leadership of this group and the sharing of tasks among members, as well as monitoring compliance with commitments. However, today's society needs a deeper concept of collaboration in the group, as the immediacy of the response forces much greater blending, as if it were a single member in the group. This way of working also implies a new way of learning, which is what we can now define as cooperative learning.

Technology Enhanced Learning Tools are technological tools that can be found on the Internet in hundreds. The vast majority have a common feature: they work in the cloud. The new concept of cloud was created by Apple (iCloud) and was quickly followed by all prestigious companies. Currently talking about the cloud has become absolutely normal in Europe and has become a daily expression.

These tools, even before working in the cloud, were already high-value learning tools, while scientifically proven to enhance learning (e.g., Prilla and Blunk, 2015; Esteve, 2016). That means, indeed, that students learn more, and in less time, with their use, than when they follow conventional teaching-learning procedures.

Cooperative learning, therefore, is a necessity that is part of modern society, of the IS, to respond to the immediacy of solutions that current working groups must provide in globalised companies. This learning is based on the power and flexibility that technological tools allow, i.e. TEL (Technology Enhanced Learning) tools.

The support through which cooperative learning is generated and flowed are these tools, so there is great reciprocity between the two expressions. In fact, the connectivistic pedagogical model (Siemens, 2004), the most innovative to date, bases learning on the connectivity offered by the Internet and all the technological tools that allow users to cooperate in research, even in real time. All this rests, of course, on the cloud.

To get from group work to cooperative learning there has been a technological process of constant evolution to which the user has had to adapt. In the first case, there was no cloud and the main means of communication was email, an asynchronous medium from which no immediate response can be expected because, among other things, there is also no security that the recipient has received the mail, or if they have read it. Therefore, although it still has a very high use today, it has been losing weight in favour of social networks that offer the immediacy that companies need in IS, that is, in a globalised world.

In short, cooperative work implies a great knowledge of the technological tools that we find on the Internet, since it is based on work in the cloud. Examples include e-learning platforms like Moodle, but also all the tools that allow the work of several people in real time, such as Google Drive, Office 365 and a long etcetera of programs that allow synchronous work and even video conferencing.

6.1.2. Convergences and divergences with other organisational strategies

Organisational strategies in education seek the best way to organise students through the creation of more ergonomic and motivating spaces, the use of the means, the organisation of the schedules, the structure of the contents, etc., to make the teaching-learning process optimal and to get the maximum performance.

We could argue that the cooperative work strategy encompasses the best characteristics of the rest of strategies because:

- It concentrates all resources into a virtual space, making them immediately available.
- It empowers learning "from each other" with simple and fun tools that enable real-time interaction of students.
- Most are synchronous and do not require timeouts to receive the information.

- Every student, in co-op work, is seeing what peers do and has the option to comment and correct the work of others. The end result is not the work of a person, as with other strategies, but the product of the effort, talent and creativity of all the members of the group.

On the other hand, cooperative work must overcome some disadvantages:

- The user must have an advanced level of digital competence.
- You must have the material means required for Internet and cloud access at all times.
- Working in the cloud is, in most cases, a mode of remote work, in which there is no physical contact between users. This can cause some students to leave the activity early for lack of motivation.

6.2. Objectives and competencies

General objectives:

- Generate shared knowledge.
- Develop social skills.

Specific objectives:

- Undertake problem solving from a group approach that would be individually unattainable.
- Learn to perform different roles in the group: coordinator, member, presenter, etc.

6.3. Theoretical framework

The Internet is present in our lives, in society, in the company, and also in the formation of all levels, both in the university and in the pre-university.

Just as technological development has brought with it the globalising phenomenon worldwide, the Internet has brought new forms of study and results. If we consider the cone of knowledge (Dale, 1969) - also known as the pyramid of knowledge (Figure 5) - we will see that the greatest degree of learning occurs when the student adopts an active attitude of learning and does so in a practical way, that is, practising what he is studying.

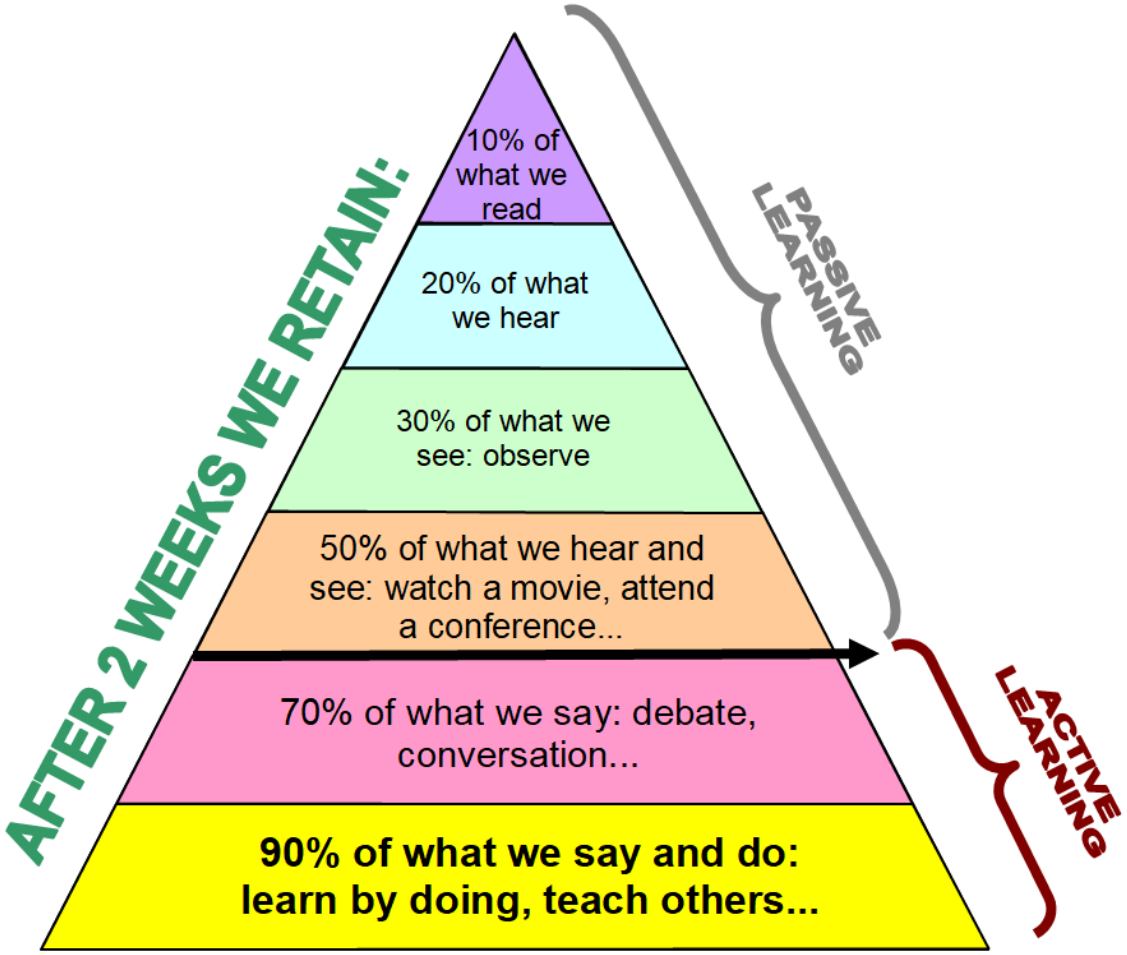

Figure 5. Pyramid of learning. Source: self-made.

The same results are also obtained when the student tries to teach another classmate the knowledge that he has previously memorised, without necessarily learning them yet.

Therefore, in both cases, joint work is referred to among several people, since "learning by doing" is implicit in requesting collaboration to develop the

practical aspect of what is being learned, while in "teaching another", collaboration between several people is directly evident.

Applications that have emerged in the Internet environment have evolved to materialise a new concept that previously existed on the Internet, which is to work at the same time, several people, on the same application. This idea arose from the very evolution of necessity in a globalised world: someone generates a document with protocols, a report, a presentation, any office work that requires supervision from another person. The system had even always consisted of sending it to you and waiting for the file back with the corrections. Applications on the Internet evolve to optimise that process and become online applications that allow the document, or any file, to be shared online by multiple people. Clearly, the improvement in time efficiency is drastic.

Apple was one of the first to develop this type of online work, a modality it gave its name: *iCloud* (in the 2000s).

Under this *modality of iCloud*, was a whole revolution that emerged from the concept of teamwork. From that moment on technology, associated with the Internet and online applications, provided affordable, inexpensive and effective tools for teamwork, an aspect that companies greatly favoured to reduce the downtimes waiting for decisions of the people in charge of giving the go-ahead to a development, presentation, brochure, etc.

The standardisation of something positive comes on its own in a short *time, so* Google, in its innovative desire and to become a global reference, developed group work tools that are currently under the name of Google Drive as a value-added service to the GMail account. In its first stages, for a small capacity it is free.

This is the true take-off of group work and cooperative work, because until then, the tools developed were based on expensive software and tailor-made solutions that specialised companies developed for their customers. Google standardised it and made it available to every user, for free. From there, there was the take-off of collaborative work.

A team of people focused on developing the same task are a very powerful unit that can diversify tasks to achieve the goal. It is obvious that a team will be able to solve, under normal conditions, any work more efficiently and effectively than working individually. Today's cooperative work emerges as a natural thing that human beings have been practising since before *homo sapiens.* Groups, clans and tribes were created to face dangers together and have a better chance of survival. In modern times, the group's spirit of collaboration has moved to the cloud, but the essence has not changed: together everything is easier, it goes much further, in less time and there is mutual and reciprocal help to achieve the goals.

6.4. Organisational and methodological strategies

There are no defined and standardised benchmarks of mandatory compliance to propose group work through the cloud, but there are experience-based recommendations endorsed by many public and private institutions. They could be summarised in the following:

6.4.1. Organisational strategies

- In any group of people, it is desirable that a coordinator or moderator be appointed and given the role of mediator in any controversy or interpretation of the tasks to be carried out. This coordinator must be respected by the other members, so that it must be the one who moderates the discussions and is responsible for initiating the word on organisational issues (Torres and Vallejo, 2018).
- Students must always respect other members, and moderator guidelines. It is very important that you learn to listen and intervene by requesting it in the form prescribed.
- Respect for the opinion of others must be present, at all times. It is appropriate that interventions are limited and agreed upon at the founding meeting of the group.

- Decisions taken with the group's majority consensus should also be respected by all, whether supported by a vote or not.
- Absence, for any reason, is not exempt from the fulfilment of the tasks that may have been assigned or the commitments made on behalf of the whole group, except for reasons of force majeure that should be agreed in advance.

6.4.2. Methodological strategies

The method (Figure 6) is the container under which strategies, techniques and tools needed to achieve a goal are in place (AduLeT, 2019).

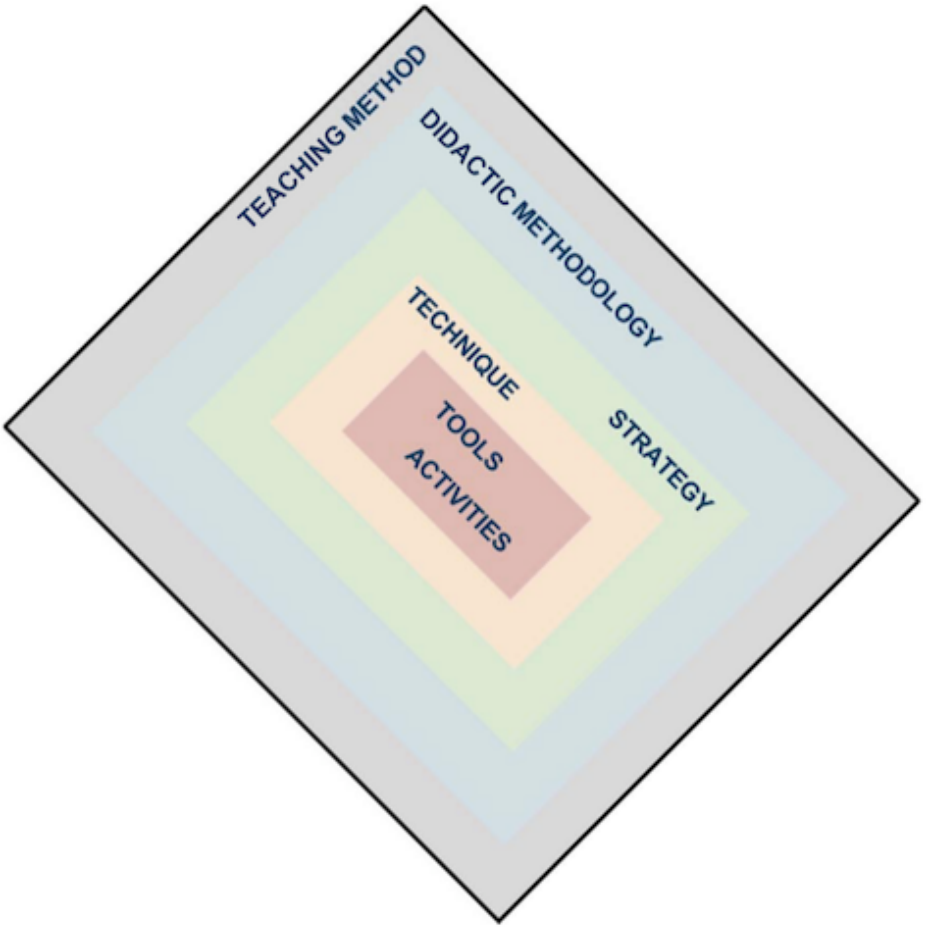

Figure 6. Teaching methodology. Source: AduLeT

Group work could be divided into two modalities:

1. Collaborative work
2. Cooperative work

In the first one, there is a natural flexibility and goodwill of the members of the group to collaborate to perform a task. In the second, the work is clearly divided into several tasks for which, each member, must be held effectively and accountable.

In the case of work involved in learning, because it is raised in a teaching framework, there are a number of methodological guidelines based on practice that lead to maximum academic performance depending on the circumstances in which the study is carried out:

- Initially, students are unaware of the mode of group work, and more so if it has to be accomplished through the cloud. Therefore, your learning should be progressive and value the advantages of this system of work.
- It can be more complicated for some students than for others for different reasons:
  - Skill in the handling of devices.
  - Internet access and adequate means.
  - Ability to understand the problem.
  - Personal initiative.
  - Adaptation to the environment and the working group.

- The group must together represent a positive value for the student, or the member, in the sense that it provides and solves those deficiencies that it possesses, while the user himself also contributes in what is capable of and, if possible, in the complete fulfilment of the distributed tasks.
- The user should see in the group a support, a form of proximity to solve their doubts, while with their contributions also makes the

group stronger and more compact, with the collaboration of all members.

- Group work does not necessarily mean that an exact distribution is established to members based on workload; rather the trend should be for everyone to contribute to the extent of their means. Those group members trained (globally) to contribute more should assume that role, while those who can contribute less should do so to the extent possible, without reaching exhaustion. The group must strike this balance among its members. An unequal balance in which each user contributes according to himself; thus, the group becomes consistent when it accepts these singularities and takes advantage of them for the benefit of the whole.

Cooperative learning

In this modality, the clear and objective division of tasks is essential. Also, the responsibility that each member of the group must assume for the commitment to execute and complete the assigned tasks.

There is a physical and detailed distribution of the work according to the criteria defined in previous sections, but once accepted they become the responsibility of each member.

It is common to draw up a kind of contract between the members of the group to establish the commitments, their implications and even what protocol to follow in the event of a breach by one or more members.

The members of the group agree on this document, are clearly identified and even signed, and are included as a part of the main work, either in the introduction or as an annex.

The main difference with regard to collaborative work is flexibility, being the cooperative much stricter and more rigid. Cooperative work is clearly focused on objectives that can only be achieved and undertaken by working as a group.

6.4.3. Other methodological variants

Group work is mostly limited to the development of a document, presentation, mental map, drawing, etc., using one of the technological tools provided by the Internet to carry out a shared work in real time.

In the case of a document, we can see how all, or several group members, connect at once, and each works in one of the sections of the document, once the tasks have been divided among the members. The result is in everyone's sight. They can usually make comments from each other, so that they are provisionally reflected in the document pending the resolution of these new one-off tasks being resolved with the recommended amendments to the commentary or resolution of the discussion in which all members can participate.

This example applies to the vast majority of shared work apps available on the Internet. Almost all with a permanent free service, or the first 30 days; any user has at their disposal tools that, a few years ago, were the privilege of a few companies which could pay the high costs of such implementations in the management and communication programme.

In the last decade, there has been a technology emerging strongly and making its way in the world of communications. It must be considered for its great potential and its clear destiny to lead the next steps of globalised modern societies, from enterprise to education, and through a large majority of social states: videoconferencing.

On the occasion of the global pandemic (COVID-19), which has already caused countless contagions and deaths, there has been a lockdown of people in their homes for several weeks, even months, in many countries. This has caused a halt and a likely economic disaster in the coming months. However, while many industries have closed their production down, as well as shops and any work environment described as "not essential" (agriculture, food, distribution, security forces, among others), not all sectors have completely

paralysed their daily work, because telework has become a reality that has greatly alleviated the ills of confinement.

Some value-added videoconferencing communication tools have thus become true pandemic totems, achieving worldwide fame overnight. For example:

- Google Meet
- Microsoft Teams
- Zoom

These tools allow you to maintain a video conference with many people at once (some with more than 100 people connected to webcam and microphone), who can actively participate in real time at any time that the moderator gives way to them. In addition, they incorporate the added value of being able to display the screen of the presenter's computer or any participant to which the moderator authorises at any time. Thus, this participant will be able to show their screen to everyone else and speak to all connected listeners, while also showing their image live through their webcam.

These applications also typically incorporate a whiteboard that the presenter can use to write, draw, insert an image or object, etc. They allow you to upload files, show presentations, chat with participants, pass them links through the chat, prepare private chatting with a specific participant...

The possibilities that open up with these tools are immense and they have demonstrated so in this confinement, having become the real stars of telework and indirect protagonists of a likely future in the fate of many sectors of modern societies. It is as if one before and after the coronavirus could be established and yet it is, by no means, one of the greatest pandemic that humanity has overcome.

These tools will probably have a lot to do with the awareness of society in the care of the environment, since their employment has shown that from home you can do a lot of the daily work that is carried out in companies.

If this reality is applied at some point, as it seems more than likely as a result of this experience, we will see social changes of great depth in a short time that, among other benefits, will bring:

1. Reduction of pollution in large cities by eliminating movements of private cars.
2. Savings on energy bills and oil consumption.
3. Reduction of environmental degradation.
4. Much healthier air for people.
5. It brakes on climate change as a result of the above.
6. Improving society's awareness of life and nature.

Surely, the advantages will be accompanied by other disadvantages. However, in view of the care of the planet, there will certainly be many more benefits than social disadvantages. Planet, as our house, we only have one today.

As can be inferred, group work is greatly reinforced and enhanced with these tools, so that the relationship between members becomes much more interactive and "physical" contact, at least facial expressiveness and voice, both extremely important elements of communication, are recovered.

Also, in the education sector, we can talk about a turning point after COVID-19, since administrations will undoubtedly enhance these tools and their implementation to prevent the effects of future pandemics, which will also lead to other forms of teaching, other methodologies and substantial social changes that are already seen when the gaze rises above the forest.

6.5. Roles and tasks of teachers and students

The pedagogical model that prevails today is *Constructivism*, which comprises a fairly important technological component. However, the model that is actually being used is *Connectivism* (Siemens, 2004), much more accurate to the practice used around the world, with an increasingly based and Internet-dependent teaching. Bearing in mind that the network anticipated by

Dale (1969), in this methodology group work becomes the essence of learning, as his cone of knowledge was to *"learn from each other, teach others"*.

In this model, the student takes on the leading role, leaving the teacher as a mere driver or moderator and being the Internet at the heart of the whole process.

The information is on the Internet. Working groups must develop the critical spirit to locate, filter and transform it into knowledge, and then return it to the network, to share with other users the progress made. It is an endless wheel in which humanity's progress is the goal.

6.6. Resources needed

It is all about technology. Pen and paper no longer have a place in *connectivism*. They are necessary elements in other disciplines, but not in modern group work for learning purposes.

Therefore, the following could be listed:

1. Smartphone
2. Tablet
3. Laptop
4. Broadband Internet
5. Virtual hard disk (Dropbox, Mega, etc.)
6. Social media
7. Cloud user account

6.7. Evaluation

A conventional evaluation seems not to have much sense when technology is present from the beginning, throughout the process, to its end. Technology delivers concrete results: it works or it does not work. Meeting the goal is the greatest proof that the result has been positive. However, the evaluation is not just the result; who else is better than group members

themselves to evaluate the work they have done? Or who else is better than another group -of similar characteristics- who knows the problem thoroughly and values the effort made (as you also know it) to evaluate another group?

In this sense, we can find evaluation methods such as "peer review" which, moved to the connected field, with slight modifications, can provide us with great objectivity in the application to this case. For example, the Workshop activity found on *Moodle*, a well-known platform for connected teaching, based on *free software.*

This activity allows us to generate collaborative or cooperative working groups, recommended for four members, which can then evaluate the work of others under specific criteria established by the moderator (teacher) based on a rubric, so that all users can evaluate under the same principles and parameters.

The application of "peer review" will consist of scheduling the workshop activity in *Moodle* and, instead of being evaluated one by one, it will be evaluated by groups. Each student will randomly be assigned between 3 and 5 works by their peers; the system will also condition that none of their same group members will be assigned to that student (there are several conditions available to the activity scheduler).

This process complies with several of the principles of neurodidactics, including those already mentioned above as “teaching others” or “learning by practising” (Dale, 1969).

6.8. Pros and cons

The promotion of the critical spirit is one of the greatest values highlighted in the education laws of any country; increasingly, the volume of information available is so high, and can be so contradictory depending on the source from which it comes, that the critical spirit is an essential value, especially in the Information Society.

The workshop activity-based assessment model enhances the critical spirit of the student (e.g., García Tartera and Gonçalves, 2018) as you can learn from your colleagues' work and you should evaluate them according to the same indicators that will apply to you in evaluating your work.

Consequently, critical thinking emerges from the moment the student establishes a comparison of what he has done with what he is evaluating, while comparing with the common indicators provided to all of them.

The only drawback is the essential use of the Internet and connection devices like those mentioned above.

7. Autonomous learning

7.1. Concept and use

In this century, we have witnessed a significant increase in the uncertainty of the kind of jobs that will be available in the coming years. This incertitude is due to the rapid changes that the Information Society in which we live is experiencing (see, for example, Bauman, 2007). In this context, the capacity of students to learn all by themselves will make a difference in the shaping of responsible citizens. The teaching activities for autonomous learning must be designed in a way that the students achieve continuous learning, in an autonomous way by the making of the adequate decisions on their part. In order to accomplish these goals, Lobato Fraile (2009) put the following conditions forward: learning must be put in context, students must carry out a personal reflection on their learning, the construction of knowledge should be progressive, and, finally, emphasis should be placed on the practical application of knowledge, as well as on the evaluation of the entire process.

The CTwoSEAS project maintains a web page which includes several materials, training courses and a Community of Practice, all of them allowing the possibility to learn autonomously.

The Community of Practice (CoP) will be a relevant aspect within the project consortium since it provides a platform not only to share knowledge on the main topics contained in the teaching guide and hence methodologically framed by this guide, but also to allow the possibility of contacting with other users, lecturers and experts, and share materials and experiences.

At this point, it might be reasonable to explain what a CoP is and what it means within the context of our project.

Initially, the term was used to describe learning through practice and Wenger (1998) described it as “an integral part of our daily lives. They are so informal and so pervasive that they rarely come to explicit focus, but for the same reasons they are also quite familiar. Although the term may be new, the experience is not”. As such, learning was deeply connected to social participation and therefore, a CoP is an organised group of people who have a common interest in a particular domain, who collaborate regularly to share information and experiences, improve competences and actively work on developing the knowledge of the domain. Later, the idea of a virtual community of practice, like this one, prevailed (Dubé, Bourhis & Jacob 2005).

This is indeed what happens in the CoP created for CTwoSEAS; we aim at expanding learning through the sharing of contributions and best practice on the several topics displayed on the corresponding platform. Our Community of Practice is available to everyone as a portal and comprises three main topics:

Science, Ethics and Society. These are correspondingly the organisational topics under which the several contributions will be arranged on the platform.

The CoP on climate change will also be permanently updated and enlarged through several contributions which are allocated to different tools and menus. The various contributors will be able to accommodate their materials under headings such as climate change forum, video conferencing tools and links to online teaching on climate change. The CoP will consequently embed climate change consequences, mitigation and adaptation, materials to learn, to teach, to share experiences and to do all of this in a better way.

The best practices will allow the whole participating community to provide materials and ideas that can be applied in the teaching/learning environment apart from critical thinking situations the many agents within the project may find themselves.

7.2. Objectives and competencies

The main objectives for this type of methodology are rather basic and are focused on understanding the essence of climate change in a global context. The learner going through the process of autonomous learning should be able to realise its position regarding climate change and view himself as a CO_2 generator, as such a participant in the process, mainly through the carbon footprint.

In this sense, both teachers and learners should be able to incorporate the main behaviours learned in his/her life. A consequence of learning this way should be to convince others that a change is possible, so being aware of the notions and concepts used throughout the courses taught (view Teaching Guide) is highly relevant.

It is well known that we approach the learning of new concepts using our own worldview, that is, our own biases. This becomes more apparent during autonomous learning, so skills related to organising and processing information, as well as skills related to critical thinking, are especially important.

Another type of competence of great importance in autonomous learning is related to the ability to carry out a metacognitive reflection on the learning process itself and the ability to motivate oneself to overcome possible difficulties during learning.

Autonomous learning also requires a great mastery in the use of new technologies, not only to search for and select information, but also to prepare audiovisual documentation on the course studied, in this case, climate change.

7.3. Evaluation procedure

Since the student is the centre of this learning process, there is a strong need for controlling his/her assessment. This can be achieved through the assessment materials made available through the training courses on the

platform. As such, students are required to fulfil these tests and assessment procedures with a high score. This will show his/her proficiency in the topics under study. For more suggestions of evaluation check the Teaching Guide. Nevertheless, a self-reflective evaluation is deemed necessary.

7.4. Pros and cons

The main advantage of this modality is that the student controls the process in terms of pace, time and contents. The drawback is that, with the permanent changes occurring scientifically, the course materials may be changing. As such, the students should access the course periodically for updates.

The fact that in this modality the student has full control of the learning process represents a significant advantage but also a considerable disadvantage. On the one hand, the student can control the learning pace, the study time and the contents, so she/he can reconcile other activities with learning. On the other, she/he is the only one responsible for her/his success (or failure). The student must work on her/his own motivation to keep her/his determination steely.

8. Infographics

8.1. Concept and use

Infographics are graphic visual representations of information, data or knowledge intended to present information quickly and clearly. They show complex ideas using combinations of elements such as illustrations, diagrams, charts, maps, text and so on. (Clarín, 1997; Smiciklas, 2012). We consider that infographics are a very useful learning method for our course due to the multidisciplinarity and complexity of the topic covered.

The use of infographics in education is relatively new and it can be considered from two different sides. In the first one, infographics are used as a tool to present information to the students in an appealing manner. In the second, the students create their own infographics. This option is the one that is going to be presented in this methodological guide since it covers different skills that we consider highly relevant for our students.

8.2. Objectives and competencies

Infographics is a very complete tool from the point of view of the competences and allow us to work all levels from the Revised Learning Taxonomy by Bloom (Figure 8.1). In order to prepare the infographic students must select what is the relevant information of the topic and organise this information in different levels. To do that, students need a deep knowledge of the topic and they need to be able to analyse and interpret information.

Infographics can be carried out in an individual manner or as group work, in the last situation extra benefits regarding competencies are gained. In particular, working in a group forces the students to face other ideas, to cooperate, to practise argumentative discussion and so on (see Section 6 for more details). Even when working separately, the presentation of the infographics is useful to work on the communicative skills of the students. Infographics are also particularly useful to improve technological skills since it requires the handling of different tools such as canva, vennage or visme, among others. Infographics seem to positively impact the students' learning, improving knowledge building, revision and content enrichment (Muñoz García, 2014).

8.3. Infographics learning steps

The use of infographics in the class demands an initial training of both students and teachers in the management of infographics tools.

Before the class, the levels of remembering, understanding, and applying from the revised version of Revised Learning Taxonomy by Bloom are worked.

The teacher must learn about the use of infographics in teaching (concepts and tools). For Spanish speakers, we recommend the following link. (https://www.ucm.es/infografias/videotutoriales).

Other teachers' duties include the definition of learning goals, the elaboration of elaborate activities with different degrees of difficulty so the students can evaluate their knowledge, the selection or creation of contents and materials available in an educative platform from which students can work.

Students have to read and work with the contents and materials, to watch videos regarding how to prepare infographics.(For example, students can use the following link https://www.ucm.es/infografias/videotutoriales, material in Spanish), to complete the tasks assigned by the teacher and to take notes of theirs doubts to be shared with the teacher.

During the class, the more complex levels of Revised Learning Taxonomy by Bloom are worked on (analysing, evaluating and creating).

Teacher duties include to address students' doubts, to identify difficulties and gaps in the comprehension of the topic by the students, to explore topics in more detail and to guide the students during the preparation of the infographic material

After the class, all levels of Revised Learning Taxonomy by Bloom will be worked.

The teacher must provide additional materials and contents, address students' doubts, guide the students during the preparation of the infographic material, reinforce learning and evaluate the acquired knowledge.

The students' duties include to deepen the learning and to complete the infographic material (Figure 7).

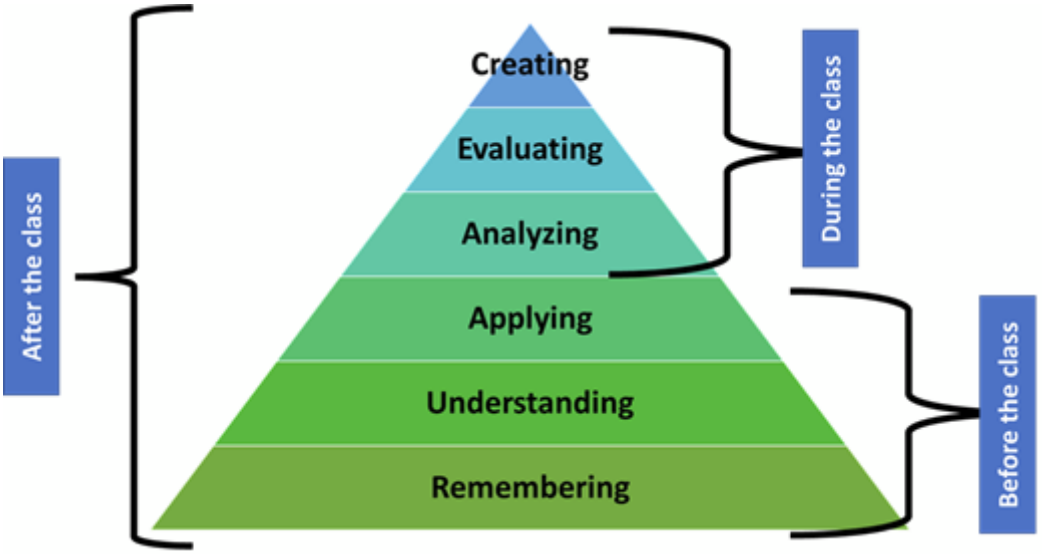

Figure 7. Infographics and the Revised version of Bloom's Taxonomy.

8.4. Evaluation procedure

The evaluation will be based on the quality of the infographic material prepared by the students taking into account different aspects that should include the development of technological skills (management of infographic tools, visual presentation of data, clarity of information and message), ability to summarise and analyse complex data and get to conclusions.

8.5. Pros and cons

Infographics is a very complete methodology regarding the work on the different students' competences.

It improves students´ technological skills with the use of different software to create the infographics and to convert data into figures. They learn about different open resources to collect images that can be useful in other activities. With infographics, all levels of Revised Learning Taxonomy by Bloom are worked. Since students must carefully select, analyse and present complex data in a reduced space, the more complex levels are particularly trained. Moreover, infographic allows working in groups adding all the advantages of this methodology as reviewed previously. The main disadvantage is the curve of learning since the needed time to manage the different tools to create infographics is large. Both teachers and students need a training period. In the case of the teachers, since they can use infographics in all their teaching, the learning period is easily amortised. In the case of students, this methodology is not very frequently used so they will have fewer opportunities to use it in the

future. However, we consider infographics a very interesting methodology that they can use in working environments. It also requires a class where the students ideally can use computers (from the faculty or their own) with an internet connection.

Some resources to prepare infographics:

https://www.ucm.es/infografias/aplicaciones-infograficas

https://www.ucm.es/infografias/repositorios

https://www.ucm.es/infografias/herramientas-de-diseno

9. Conclusions

This guide is the result of a cooperative work among the CTwoSeas project members to collect some of the different methodologies used in our institutions for teaching. It is not intended to be an exhaustive review of all possible methodologies, but a review of those that seem most appropriate for our course. It is not obligatory to use them and they are not exclusive. We just propose a pool of tools that can be used according to the characteristics of each student's group. Each teacher must select those methodologies that seem to be more appropriate in its particular context.

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