SPREADING VIRTUAL REALITY

Virtual Reality Labs:
From Theory to Practice

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METID
LEARNING INNOVATION

SPREADING VIRTUAL REALITY

Virtual Reality Labs: From Theory to Practice

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For a wider dissemination this manual was translated from Italian into English using Artificial Intelligence software. Therefore, it may contain inaccuracies.

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INTRODUCTION

INTRODUCTION

Politecnico di Milano has developed two Virtual Reality laboratories, with similar characteristics, located respectively on the Leonardo and Bovisa campuses.

Designing a teaching and learning experience in a very specific context such as a Virtual Reality laboratory requires taking into account certain aspects: technical, organizational, and methodological.

The purpose of this manual is to provide instructors with a tool designed to support the planning of lessons in a Virtual Reality laboratory. These lessons involve carrying out activities useful for achieving specific Intended Learning Outcomes.

The manual was designed based on the two laboratories at Politecnico di Milano, but it can be used as a basis for designing activities for any Virtual Reality simulator.

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VR LABORATORIES

The classrooms identified for the installation of the laboratories are two, with similar characteristics, located on the Leonardo and Bovisa campuses.
The classrooms were selected based on the following constraints:

Capacity of at least 14/15 fixed workstations;

Space for movement during the use of headsets and simulations of 4 square meters;

Availability of **minimum technical equipment** (power outlets and LAN network sockets);

WIFI network coverage;

Flat floor with no steps.
The configuration of the two classrooms therefore involves creating workstations adaptable to different usage scenarios:

Autonomous work: each group works on a single simulation; students take turns using the headset while the others can intervene directly in the simulation with mouse and keyboard or simply observe what happens on the monitor;

Cluster work: groups of workstations collaborate on a single simulation.
In this case as well, the person who will use the headset rotates within the groups.

The actions that can be carried out in a VR simulator can be grouped into 4 main areas:

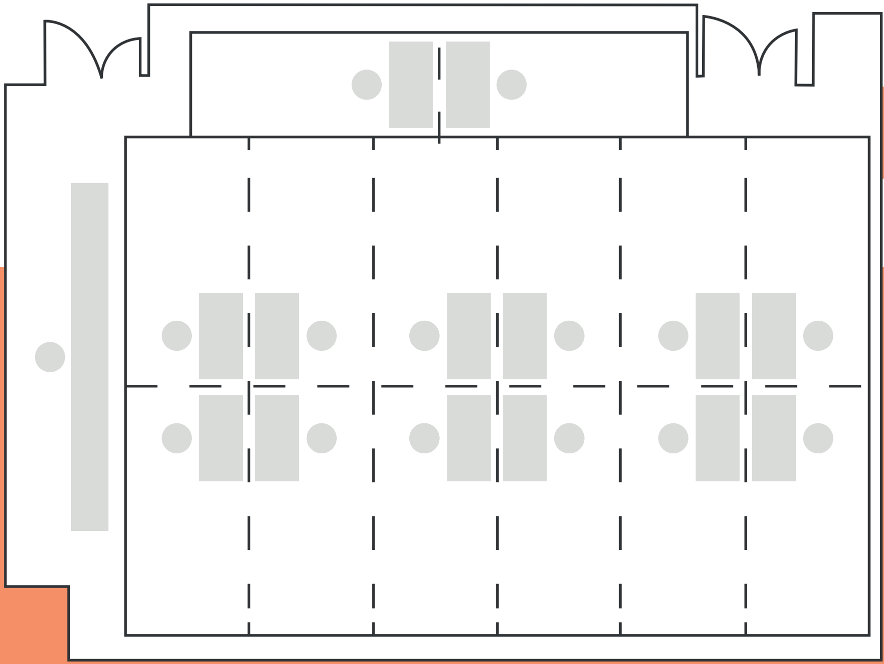
Training: carrying out a series of instructions provided by the instructor (checklist). The purpose is training, that is, learning and remembering the performance of actions that lead to a final result.

Exploration/analysis of an environment: exploration and analysis of a specific environment in order to understand its key points. Verification between theory and practice and identification of differences.

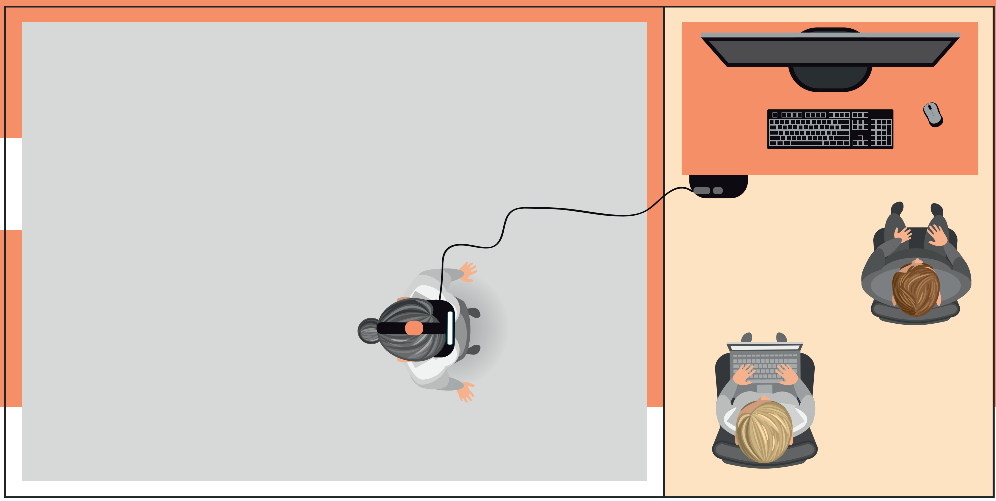
Solution development: searching for the solution to a problem through observation, its deconstruction, and the analysis of contents useful for understanding it and subsequently solving it.

Scenario evaluation: evaluation of a scenario or of a specific situation through observation and exploration. In some cases, it is useful to consider acting within the scenario by imagining oneself as a particular professional figure.

LABORATORY FLOOR PLAN



WORKSTATION DETAILS



METHODOLOGY

1. START:

The starting point for defining the activities presented in this manual was the identification of the Intended Learning Outcomes (ILOs) deriving from the use of a Virtual Reality system.

REMEMBER [RE]
UNDERSTAND [UND]
APPLY [APP]
ANALYZE [AN]
EVALUATE [EV]
CREATE [CR]

2. ACTIVITY DESIGN: Some activities were designed both to achieve the ILOs and to make the most of the Virtual Reality environment.
The activities were structured following the step-by-step logic of the pedagogical frameworks.

PROBLEM-BASED LEARNING
INQUIRY-BASED LEARNING
KOLB' CYCLE
GAGNÉ LEARNING EVENTS

3. DIVISION OF ACTIVITIES INTO THREE ORGANIZATIONAL MODES:

The activities were then divided into three organizational modes, seeking to enhance not only the individual work dimension, but also the collaborative work dimension.

INDIVIDUAL ACTIVITIES
PAIR ACTIVITIES
GROUP ACTIVITIES

INTENDED LEARNING OUTCOMES

The starting point for the design of the activities was to imagine what the Intended Learning Outcomes (ILOs) could be that an instructor might set when having students use a Virtual Reality system. The initial question was therefore:

why is it useful for students to use a Virtual Reality simulator?

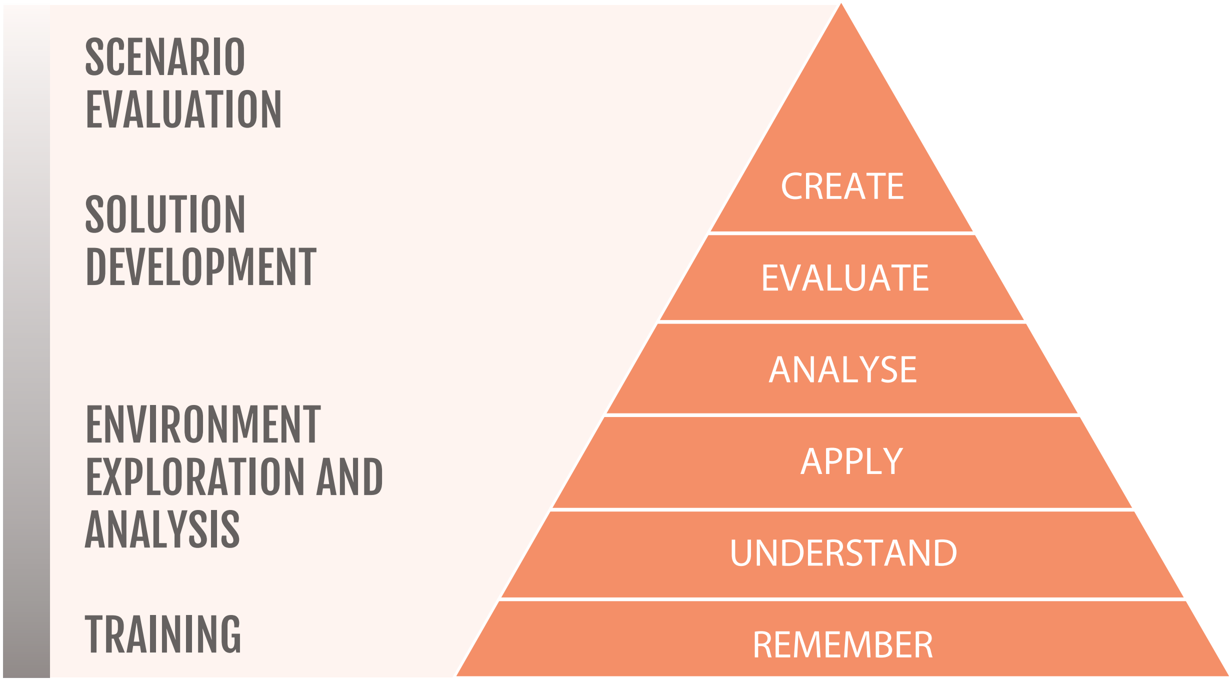
The general answer can certainly be found in the assumption that there is a great advantage in being able to have students apply theoretical concepts immediately in a virtual environment that faithfully replicates the real one.

Bringing theoretical concepts just learned directly into a practical context is undoubtedly the main purpose. We therefore identified 4 main overarching objectives: training, exploration and analysis of an environment, solution development, and scenario evaluation.

However, these are not the only ones. In order to map and detail as effectively as possible the ILOs that an instructor might assign to students, Bloom's Pyramid was used.

In this context, learning is conceived as a sequential and linear process that proceeds through a series of well-defined stages, each of which is a prerequisite for accessing the next.

On a practical level, this translates into a teaching strategy that progresses from simple to complex and reserves objectives related to higher-level skills for later stages of the student's education and development. Bloom therefore divides his Pyramid into six levels of knowledge: remember, understand, apply, analyze, evaluate, and create.



REMEMBER [RE] What is the process/procedure/ steps that students must remember in order to correctly carry out the activities within the simulation? What prior knowledge must students be able to recall and use?	**Be able to recognize/identify** the components of the system Describe the components of the system (in qualitative and quantitative terms) **Define** the relationships between the components of the system (cause–effect, independence…) **Arrange** the operations to be carried out in the system according to a temporal logic **Correctly repeat** a process (from theory to practice / from practice to practice) **Match** the various components to the correct parts of the system **Choose** the appropriate tools to perform specific operations **Trace** the correct path to connect two different areas of the system
UNDERSTAND [UND] What are the crucial aspects that students must understand when carrying out the operations? What are the cause-and-effect relationships within the process that students must be able to interpret and explain? What practical aspects must the student be able to interpret in relation to the theory?	**Estimate** the time required to reach an area of the system **Compare** identical processes/operations with different outputs **Demonstrate** the correct process for achieving an output **Discuss** the best working strategies for achieving an objective **Discuss** the possibility of an anomaly occurring **Explain** the process that leads to achieving an output **Explain** the functioning of the system components **Explain** a particular observed scenario/situation **Interpret** the occurrence of an unexpected event **Justify** the occurrence of a particular event

APPLY [APP]

In what ways must students be able to apply/choose their knowledge in order to arrive at the correct solutions?
What differences are there in the practical application of a procedure?

Choose the best way to carry out a process/operation
Choose, in a particular context, to activate component “x” rather than component “y”
Use a specific tool to activate a given component of the system
Demonstrate that, in order to achieve an output, process/operation “x” is better than “y”
Build a component of the system
Operate a component of the system or multiple components considering temporal and cause-and-effect relationships
Write down the values obtained from calculations carried out within the system
Calculate and **measure** the value of “x”

ANALYSE [AN]

What are the main characteristics of a process/problem/scenario that students must be able to examine?
What actions must the student plan before starting the activities in the simulator?

Analyze a particular situation and scenario by identifying the most relevant aspects / any anomalies
Simplify the operations of a process in order to achieve an objective more quickly
Examine the conditions of the system components in order to verify their state
Examine a particular process highlighting the differences found between practice and theory
Compare different processes in order to understand their differences and qualitative and quantitative characteristics
Inspect a specific area of the system to verify its conditions and ensure that all necessary operations have been carried out
Plan the operations to be performed in order to carry out a complex process

EVALUATE [EV]

How do students classify the actions performed in order to interpret the experience carried out?
How do students interpret the actions performed in order to explain the process?

Judge/interpret the work carried out by a colleague
Advise a colleague to perform one operation rather than another and how to carry it out
Evaluate the feasibility of a process or an operation within a situation or scenario
Examine a situation or scenario in order to assess the implications within the system
Classify the level of danger of situations or scenarios
Propose solutions to problems
Propose ways of carrying out complex processes
Demonstrate the correctness of one's arguments based on the actions performed within the system
Justify the choices made within a situation or scenario

CREATE [CR]

How do students develop a solution to a problem?
What aspects of a process must the student be able to plan in order to formulate a solution?

Create creative and innovative solutions to solve a problem
Propose innovative processes to reach the solution to a problem or achieve an output in ways different from those generally proposed
Plan the actions to be carried out in order to formulate a solution
Prepare everything necessary in order to carry out a process under the best conditions
Compose new processes to achieve the set objectives more effectively
Develop a personal process or workflow that leads to achieving an output

PEDAGOGICAL FRAMEWORKS

PEDAGOGICAL FRAMEWORKS

FRAME WORK

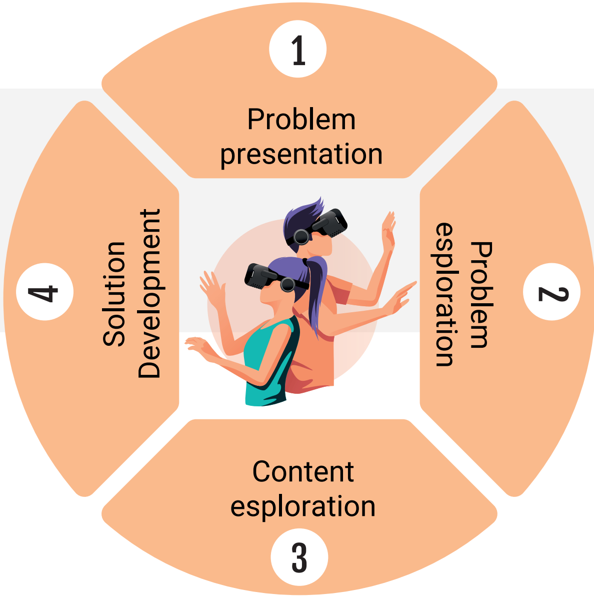
Pedagogical frameworks are tools that describe the general principles through which a pedagogical theory can be applied to the practice of learning and teaching.

They are practical tools that provide a methodological guide useful for instructors to design and structure the content of their lessons effectively, aligning them with the Intended Learning Outcomes.

We therefore decided to use the frameworks as guidelines in the design of the activities presented in this manual. Since each activity can be adapted and modified by the instructor according to their needs, we consider it useful to include a brief introduction to these pedagogical approaches.

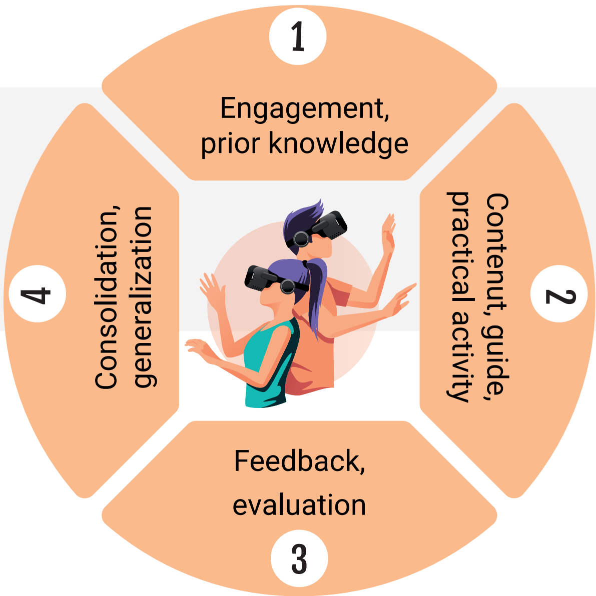
PROBLEM-BASED LEARNING

Problem-Based Learning (PBL), is a pedagogical framework in which learning is fostered through the solving of problems that become the opportunity to explore the content and methods needed to address them.



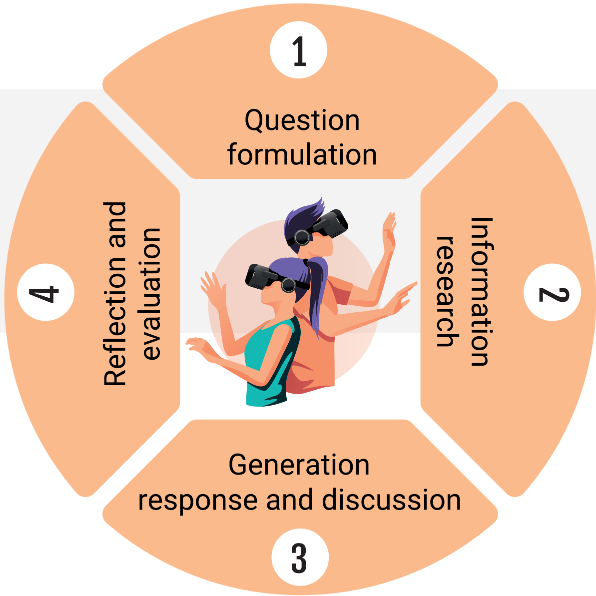
GAGNÉ LEARNING EVENTS

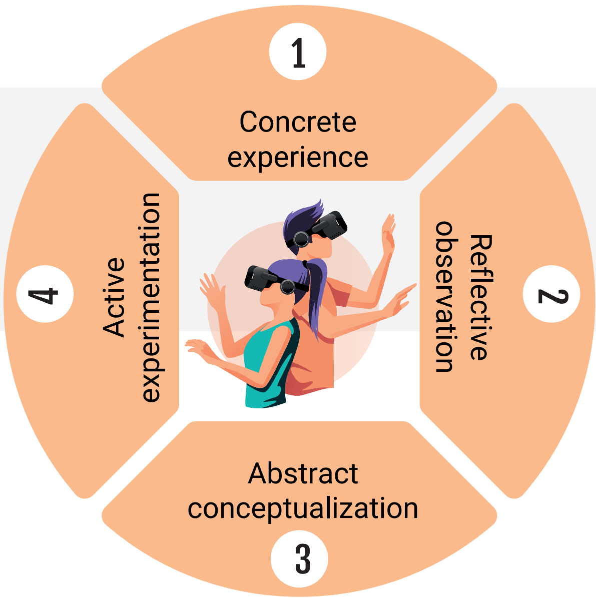
Gagné Learning Events are a pedagogical framework according to which learning takes place when a “stimulus” situation affects the learner in such a way that there is a change in their performance. The “instructional events” are identified as key moments in the learning activity.



INQUIRY-BASED LEARNING

Inquiry-Based learning (IBL), is a pedagogical method that emphasizes the role of students' independent inquiry, starting from the formulation of a question.





CICLO DI KOLB

Kolb's cycle is based on the assumption that learning is a process that creates knowledge through the transformation of experience. The development of new concepts is essentially provided by new experiences, and learning involves the acquisition of abstract concepts that can then be flexibly applied in a range of situations.

ORGANIZATIONAL FORMATS

ORGANIZATIONAL FORMATS

FOR MAT S

The activities to be carried out in the laboratory have been divided into three organizational formats: individual activities, pair work, and group work.

Individual activities include all tasks that can be completed by students on their own without interacting with others. The only form of dialogue takes place during the feedback session with the instructor. Interactions occur in plenary sessions or directly with the instructor.

Pair activities include all tasks that can be carried out by two students at a single workstation. In this way, learning also takes place through discussion and exchange, fostering the development of transferable skills.

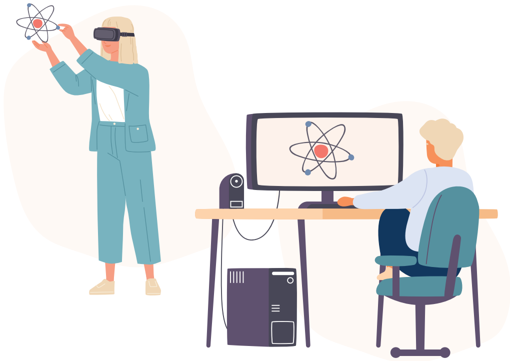
Group activities include tasks that require interaction among multiple workstations; this allows for the experimentation of more complex scenarios and/or the introduction of challenge dynamics and team-based competition.

INDIVIDUAL ACTIVITIES

These include all activities that the student carries out independently within the virtual environment.

PAIR ACTIVITIES

These include all activities that students carry out in pairs within a single virtual environment.



GROUP ACTIVITIES

These include all activities that involve interaction among multiple workstations within a single virtual environment.

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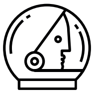
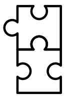
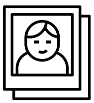
- ●● Pair activities
- ●●●● Group activities

PEDAGOGICAL FRAMEWORKS


Kolb's cycle


Inquiry-based Learning


Problem-based Learning


Gagné Learning Events

INTENDED LEARNING OUTCOMES

[RE]	Remember
[UND]	Understand
[APP]	Apply
[AN]	Analyse
[EV]	Evaluate
[CR]	Create

ACTIVITY INDEX

INDIVIDUAL

ACTIVITY	IMPLEMENTATION MODE	
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THE PROBLEM OF THE CENTURY	Problem-based Learning	[EV] [CR]
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ACTIVITY	IMPLEMENTATION MODE	
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IN GROUPS

ACTIVITY	IMPLEMENTATION MODE	
ALL FOR ONE	Gagnè Learning Events	[RE] [UND]
ROLE-PLAY	Kolb's cycle	[APP] [AN]
TEAM - BASED COMPETITION	Problem-based Learning	[EV] [CR]
SHARED GOALS	Inquiry-based Learning	[EV] [CR]

ACTIVITY SHEETS

ACTIVITY SHEETS

STEP BY STEP

ORGANIZATIONAL MODE	PEDAGOGICAL FRAMEWORK	KNOWLEDGE LEVEL
Individual	Gegné Learning Events	[RE] [UND] Remember, Understand

FRAMEWORK	ACTIVITY PHASES
Involvement Expectation Prior knowledge	The teacher **involves** the students by showing, through the live simulation or a recorded video, the context of the action. Then create **anticipation** by communicating that students will be the ones who will have to complete the activity. The teacher launches a quiz and proposes questions to recall **previous knowledge**.
Guide Content Practical activity	Through *feedback, it* explores the **contents** useful for carrying out operations. The teacher acts as a **guide** by showing the actions to be carried out in detail, live or through a video, and distributes any instructions on the procedure to be performed. It may be useful to provide a description of the procedure to be carried out and, if desired, a field in which to note the key steps and any difficulties encountered. Students carry out practical activities, repeating the actions shown by the teacher and/or listed in the instruction document.
Feedback Rating	The teacher guides students to carry out the activities also through **feedback** punctual. At the end of the activities, the teacher **evaluates** the operations carried out by the students and, also through an online tool, collects doubts and questions.
Consolidation Generalization	The teacher **consolidates what has** been learned during the exploration, recalling the theory behind the experience, possibly generalizing in a broader context.

FROM PRACTICE TO THEORY

ORGANIZATIONAL MODE	FRAMEWORK PEDAGOGICAL	[APP] [AN] LEVEL OF KNOWLEDGE
Individual	Kolb cycle	Apply, Analyze

FASI FRAMEWORK	ACTIVITY PHASES
Practical experience	The teacher assigns an activity (a series of steps, an experiment to be carried out, some measurements to be detected, etc.) to be carried out in the simulator. Students carry out **the experience** and take note of key passages/elements to reflect on.
Reflective observation	Students **observe** the key points that emerged through direct experience and share them with the class orally or in a shared sheet. The teacher **reflects** with the students on the experience carried out (retracing the activities, asking questions, etc ...).
Abstract conceptualization	The teacher **abstracts the process from the** practical experience just performed and creates a connection with the theoretical concepts. The conceptualization phase can also be carried out collaboratively, stimulating students to connect the key points of the emerged experience with theoretical concepts, possibly through a shared document or map.
Active experimentation	The students enter the environment again to **redo the experience**, in the light of what has been discussed.

THE PROBLEM OF THE CENTURY

ORGANIZATIONAL MODE	PEDAGOGICAL FRAMEWORK	[EV] [CR] LEVEL OF KNOWLEDGE
Individual	Problem-based Learning	Assess, Create

FASI FRAMEWORK	ACTIVITY PHASES
Understanding the problem	The teacher asks students to solve a **problem** that can be answered by navigating within the simulator.
Exploring the Problem	Students **deconstruct the problem** and articulate it into sub-problems to identify the information, concepts or methods necessary to solve it, possibly creating maps or documents that can be shared online.
Content Exploration	Students explore the simulator for **useful information** and connect it to the **previous contents**/knowledge.
Development of solutions	Students **develop the** most promising solutions, based on the information gathered. The teacher collects the solutions developed by the students in plenary and comments on them.

THE KEY QUESTION

ORGANIZATIONAL MODE	PEDAGOGICAL FRAMEWORK	[EV] [CR] LEVEL OF KNOWLEDGE
Individual	Inquiry-based Learning	Assess, Create

FASI FRAMEWORK	ACTIVITY PHASES
Formulating a question	The teacher formulates and provides a question (or a list of questions), through a shared document or an *online tool*, which can be answered by navigating within the simulator.
Search for information	Students explore the environment in search of useful information to answer the question
Ideation of a response	Students reflect individually on the information that emerged from the exploration carried out, and try to elaborate an answer to the initial question.
Discussion	The teacher collects the answers elaborated, also through a shared document or an *online tool*, and stimulates discussion (possibly asking individuals to argue their answers also showing the exploration carried out)
Reflection and evaluation	Students reflect on what has been discussed. The teacher re-proposes the question and collects the solutions or further details on the solutions, also through an *online tool*, and evaluates them.

RELAY

ORGANIZATIONAL MODE	PEDAGOGICAL FRAMEWORK	LEVEL OF KNOWLEDGE
In pairs	Gegné educational events	[RE] [UND] Remember, Understand

FASI FRAMEWORK	ACTIVITY PHASES
Involvement Expectation Prior knowledge	The teacher **involves** students by showing the context of the action, in order to stimulate their curiosity and create **expectations** with respect to the activity to be carried out. The teacher proposes some questions in order to recall the **students' previous knowledge**. Students respond individually or in pairs.
Guide Content Practical activity	The teacher comments on the answers obtained and uses them as a starting point to introduce the **content** necessary for carrying out the activity. The teacher illustrates the process to be carried out and assigns the activities within the work pairs. The process should have two or more phases: the output of the first will be the starting point for the second, and so on. During all phases of the activity, the teacher supervises the operations and **guides** the students. - Start the **practical activity**: - The first student carries out the first phase. The other student observes and keeps track of the crux/most difficult passages/etc. - The second student carries out the second phase starting from the outputs of the first. The first student observes and in turn keeps track of what emerges. The students, in pairs, support each other in case of difficulty.
Feedback Rating	The teacher observes the students and intervenes with *timely feedback*. At the end of the activity, the teacher comments, together with the students, the outcome of the activity, **evaluating** what worked and which steps, on the other hand, were less understood.

Consolidation Generalization	The teacher summarizes the activity carried out, resuming the key points of the process. It recalls the theory behind the activity, in order to **consolidate** the students' knowledge.

PARTICIPATORY OBSERVATION

ORGANIZATIONAL MODE In pairs	FRAMEWORK PEDAGOGICAL Kolb cycle	[APP] [AN] LEVEL OF KNOWLEDGE Apply, Analyze

FASI FRAMEWORK	ACTIVITY PHASES
Practical experience	The teacher presents the activity and provides students with a guide (*checklist* or instruction document) that exposes, in more or less detail, the operations to be carried out in the virtual experience. The teacher divides the students into pairs and starts the activity. NB the teacher can decide to have both students repeat the same activity, or prepare two similar, but not identical activities (e.g. by varying the values of the triggers). Start the **experience** in the virtual space: - The first student moves in the simulation and carries out the operations; the second observes it, taking note and identifying any errors. - The roles are reversed: the second student acts in the simulation, while the first observes and notes any errors.
Reflective observation	The two students share their observations and **reflect** on their experience.
Abstract conceptualization	The teacher supports students in drawing **general conclusions** and explores the theoretical dimension of the topic.
Active experimentation	The teacher invites students to immerse themselves again in a virtual experience in which they can **actively experiment with** the concepts they have just acquired.

SHARED SOLUTIONS

ORGANIZATIONAL MODE	PEDAGOGICAL FRAMEWORK	[EV] [CR] LEVEL OF KNOWLEDGE
In pairs	Problem-based Learning	Assess, Create

FASI FRAMEWORK	ACTIVITY PHASES
Understanding the problem	The teacher presents the **problem** to be solved. He proposes that students divide into pairs and search for the solution to the problem, moving in the virtual space and consulting different materials selected by him (e.g. articles, websites, videos, chapters of a book...).
Exploring the Problem	Students **explore the problem**: in pairs, they briefly reflect on the key points of the problem, trying to identify what information to look for in order to solve it.
Content Exploration	Students **explore the content** individually: - The first student moves in the virtual environment, while the second student explores the material made available by the teacher. - Subsequently, the roles are reversed. Once the exploration is over, each student individually sketches out the possible solutions.
Development of solutions	The students, in pairs, discuss the solutions identified and **develop** the most promising. The teacher collects the solutions (orally or through a shared document) and comments on them. Finally, explain the correct solution(s) to the problem.

OPERATOR AND ASSISTANT

ORGANIZATIONAL MODE	PEDAGOGICAL FRAMEWORK	LEVEL OF KNOWLEDGE
In pairs	Inquiry-based Learning	[EV] [CR] Assess, Create

FASI FRAMEWORK	ACTIVITY PHASES
Formulating a question	The teacher formulates a **question** that students will be able to answer after exploring the virtual environment. The teacher explains the scenario within which they will move and divides the students into pairs, assigning the roles (assistant and operator). If necessary, the teacher provides: - assistants, theoretical and structural information on the plant being simulated. - to operators, practical information on the operation of certain elements of the plant itself.
Search for information	The student operator enters the virtual environment and, guided by the student assistant, **searches for useful information** to answer the teacher's question.
Ideation of a response	Once the exploration is over, the couple shares the information collected and **elaborates a response**. Each pair shares their answer with the class (orally or through a shared document).
Discussion	The teacher collects the answers and opens a moment of **discussion**, trying to guide the students towards a common **synthesis**.
Reflection and evaluation	The teacher concludes the activity by sharing the correct answer(s): starting from these, he can launch a brief **reflection**, useful for proposing new content or new questions, in view of the following lessons.

ALL FOR ONE

ORGANIZATIONAL MODE	PEDAGOGICAL FRAMEWORK	[RE] [UND] LEVEL OF KNOWLEDGE
Group	Gegné educational events	Remember, Understand

FASI FRAMEWORK	ACTIVITY PHASES
Involvement Expectation Prior knowledge	The teacher **involves** the students by showing the context of the action. He introduces the activity by explaining how every system works effectively only with the union of all its parts. It therefore tries to stimulate the curiosity of the students and to create **expectations** with respect to the activity to be carried out. The teacher divides the students into groups, then proposes some questions to each group, in order to recall **previous knowledge**.
Guide **Content** **Practical activity**	The teacher collects the answers of each group: he starts from these to introduce the **content** useful for carrying out the simulation. The teacher gives each group a **guide** (*checklist* or shared document) containing instructions for carrying out specific operations in the virtual environment. Each group is assigned to carry out a different procedure, within the same simulation system: each group will therefore affect the same system. Start the **practical activity** in groups: - a student acts in virtual reality, - the others follow his movements through a screen and consult the guide, giving suggestions on how/where to move.
Feedback **Rating**	The teacher observes the various groups and intervenes with *timely feedback* when necessary. Finally, **he comments on** the outcome of the activity, pointing out that the overall modification of the system was only possible thanks to the integration of the various procedures carried out by each group. **Finally, it evaluates** the activity, focusing on strengths and weaknesses.

Consolidation Generalization	The teacher recalls the theory behind the various procedures just carried out, in order to **consolidate** students' knowledge.

ROLE PLAYING GAMES

ORGANIZATIONAL MODE	FRAMEWORK PEDAGOGICAL	[APP] [AN] LEVEL OF KNOWLEDGE
Group	Kolb cycle	Apply, Analyze

FASI FRAMEWORK	ACTIVITY PHASES
Practical experience	The teacher presents the activity and divides the students into *teams*. All *teams* operate in the same simulation, each completing their *task* through a VR workstation. Tasks are related: the activity therefore requires the various *teams* to coordinate. The teacher provides each *Team* with a specific guide (check list or instruction document) that sets out the *task* and the operations necessary to complete it. The teacher asks each *team to* organize itself internally. Each member of the *Team* must have a specific role (e.g. "operator" - moves in the virtual space, "observer" - controls movements in the virtual space and notes critical steps, "assistant" - consults the *checklist* and instructs the operator on how to move, "communications officer" - communicates with the other *Teams* to synchronize operations in virtual space...) NB the teacher decides how many and which roles to assign, depending on the number of students and the objective of the activity. Start the **experience** in the virtual space: - Team members work together to complete their *Task*. - The various *teams* coordinate to perform the operations in the correct order.
Reflective observation	The team **reflects** on the experience: each member comments on the operations from their own point of view, depending on the role held. The teacher collects the **students' reflections** and comments on them, paying particular attention to the dynamics that were created between the various *Teams* during the virtual experience.

ROLE PLAYING GAMES

Abstract conceptualization	The teacher supports students in drawing **general conclusions** and explores the theoretical dimension of the topic.
Active experimentation	The teacher invites students to immerse themselves again in a virtual experience in which they can **actively experiment with** the concepts they have just acquired. The experience is proposed in the *Team* dynamic, already explained above. NB the teacher can decide to repeat the previous experience, modifying or reversing the *Tasks* between the *Teams*, or can prepare a new activity similar to the first / that is based on the same theoretical concepts.

TEAM COMPETITION

ORGANIZATIONAL MODE	PEDAGOGICAL FRAMEWORK	[EV] [CR] LEVEL OF KNOWLEDGE
Group	Problem-based Learning	Assess, Create

FASI FRAMEWORK	ACTIVITY PHASES
Understanding the problem	The teacher presents a problem to the students and divides them into teams. He then explains the rules of the competition: each team will occupy a VR station and will have to solve the same problem by exploring the virtual space and analyzing the resources made available by the teacher (e.g. articles, websites, videos, chapters of a book...). The team that gives the correct answer in the shortest possible time will win.
Exploring the Problem	The teacher assigns a maximum time for the exploration phase of the problem. Each group **explores the problem**: the teacher can provide an outline (paper or *online* document) with some suggestions to deconstruct the problem effectively.
Content Exploration	The teacher assigns a maximum time for the **exploration phase of the contents**. The group independently manages the exploration of the contents, dividing itself between virtual space and content provided by the teacher.
Development of solutions	The real competition phase begins: each group tries to **develop the solutions** in the shortest possible time. The teacher collects the solutions orally or through an *online tool*. Finally, explain the correct solution to the problem and proclaim the winning team.

SHARED GOALS

ORGANIZATIONAL MODE	PEDAGOGICAL FRAMEWORK	LEVEL OF KNOWLEDGE
Group	Inquiry-based Learning	[EV] [CR] Assess, Create

FASI FRAMEWORK	ACTIVITY PHASES
Formulating a question	The teacher divides the students into groups, briefly presents the topic of the simulation and assigns each group a specific **question** related to the topic itself. Each group will have a VR station to navigate in. The teacher can provide each group with a personalized outline (paper or online document) with some ideas and suggestions.
Search for information	Each group explores the virtual environment in **search of useful information** . One student acts in virtual reality, while the others follow his movements through a screen and give suggestions on how/where to move.
Ideation of a response	Once the exploration is over, the group consults and, based on the information collected, **Develop a response**.
Discussion	Each group shares the developed response with the class, orally or through an online tool. Starting from the students' answers, the teacher stimulates discussion and tries to systematize all the answers obtained.
Reflection and evaluation	The teacher recalls the theoretical concepts underlying the answers received: starting from these, he stimulates a brief **reflection**, through which to propose new contents, in view of the following lessons.

TECHNICAL CHARACTERISTICS

Before designing laboratory activities, it is advisable for the instructor to verify the features of the Virtual Reality software.

The first aspect to consider when allocating time to activities is that prolonged use of the headset may cause nausea. It is therefore recommended that activities carried out using the headset do not exceed 10–15 minutes.

If more time is required, it is preferable to use the joystick and monitor, which still allow for the same dynamics as the headset. It is also useful to check whether two students—one using the headset and the other using the joystick—can interact within the same environment.e

Another essential aspect to consider when designing laboratory activities is whether **interaction and collaboration among multiple users** within the same virtual environment (including from different workstations) is possible.

It is also important to determine whether access to the **software** can be granted through a personal account, as this would allow activities to continue on different days without losing previously completed work.

It is equally useful to understand whether content can be recorded and projected. **Recording** can become an essential resource for bringing the laboratory experience back into the classroom and for reviewing and analyzing the steps taken at a later stage.

Projection, on the other hand, is useful for the instructor when explaining to all students how to carry out a specific activity within the simulator. It can also be equally important as a basis for the feedback session: students may be asked to project a recording of the actions they performed so that they can be discussed and analyzed by the entire class and the instructor.

HEADSET USE TIME

Prolonged use of the headset may cause nausea. Plan activities that do not exceed 10–15 minutes.

JOYSTICK INTERACTION

Check that it is possible to interact within the environment while using the headset and the joystick at the same time.

COLLABORATION

Check whether it is possible to carry out different actions simultaneously within the virtual environment and whether interaction with other students is possible.

ACTIVITY LOG

Check whether it is possible to access the virtual environment using a student's personal account.

RECORDING

Check whether it is possible to record the activities carried out with the headset within the virtual environment.

PROJECTION

Check whether it is possible to project the activities carried out with the headset or the results achieved.

TIPS FOR THE TEACHER

It is useful for the teacher not to overlook the fundamental steps in managing laboratory activities. Before the laboratory session, it is essential to prepare a lesson plan in order to have a clear understanding of the timing of the class. It is also important to provide an introductory summary that contextualizes the content, explains how the activities work (by giving instructions and outlining the key steps), and clarifies the objectives.

During the activities carried out by students, it is important for the instructor to always keep track of what is happening in the laboratory and to provide continuous feedback. To speed up the feedback collection process, it may be helpful to prepare a spreadsheet in which students can enter a summary of the work completed.

At the end of the laboratory session, it is useful to collect the materials produced (recordings and projections) in order to bring the laboratory experience back into the classroom.

BEFORE THE WORKSHOP

1

ACTIVITY PLANNING

Careful planning of the activities that students will have to carry out during the laboratory having in mind what are the objectives they will have to achieve.

2

LESSON PLAN

Always prepare a lesson plan, planning all the moments of the workshop, in such a way as to respect the scheduled times.

3

NUMBER OF STUDENTS

Always carefully evaluate the number of students who will participate in the workshop before choosing the activity.

4

REGISTRATION

Plan the moments of the laboratory to be recorded in anticipation of an in-depth study or a recall during the following theoretical lessons.

DURING THE WORKSHOP

5

PROPER OPERATION

Check that everything is working properly and that students do not have any difficulties using the workstation.

6

LABORATORY OBJECTIVE

Clearly state the objective of the workshop you are proposing, also in relation to the theoretical lessons already held.

7

MONITORING

It monitors the work of students, intervening if they encounter difficulties. You can use tools such as *online quizzes* (e.g. *Wooclap, Mentimenter, Socrative*...) and shared documents (e.g. *Google Spreadsheet, OneDrive...)* to keep participants aligned.

8

ONLINE QUIZZES AND SHARED DOCUMENTS

You can use online quizzes and shared documents at various points in the lab, to achieve specific goals, such as:
anticipatory quizzes: to stimulate reflection before entering the simulation;
intermediate "control" quizzes: to monitor the progress of the groups and intercept any difficulties by intervening in a timely manner;
final "recap" quizzes: to verify the level of understanding of the students at the end of the experience.

9

FEEDBACK

Feedback is a very important moment of the workshop: identify the phases in which it is appropriate to give *feedback* and in what ways:
intermediate phase: after checking the progress of the students, provide indications regarding the correct or incorrect performance of the actions, so that they can orient themselves in the performance of the subsequent ones;
Final phase: focus on the most common difficulties and mistakes, provide explanations, solve the most common doubts and comment on the results obtained by the students, evaluating their work when necessary/expected.

AFTER THE WORKSHOP

10

CONTENT SHOOTING

Collection of the material produced during the laboratory activities and preparation of useful content to be taken up during the classroom lessons.