UNIVERSITÀ DI TORINO

DBMSS
Dipartimento di Biotecnologie Molecolari e Scienze per la Salute

Innovative methodologies and design of didactic activities

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With the patronage of

PUPKEWITZ FOUNDATION

Innovative methodologies

2

Adaptive Teaching

Multicultural classrooms

International mobility

Learning diseases

"to apply different instructional strategies to different groups of learners so the natural diversity prevailing in the classroom does not prevent any learner from achieving success"

(Borich, 2011)

Individual attitudes and inclinations

Common learning objectives

Different learning styles

Formative assessment

"Practice in a classroom is formative to the extent that ***evidence about student achievement is elicited, interpreted, and used*** *by teachers, learners, or their peers,* ***to make decisions about the next steps*** *in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was elicited."*

(Black & Wiliam, 2009)

Strategies of formative assessment

- clarifying and sharing learning intentions and **criteria for success**
- engineering **learning tasks** that elicit evidence of student understanding
- providing **feedback** that moves learners forward
- **activating students** as instructional resources
- activating students as the **owners of their own learning**

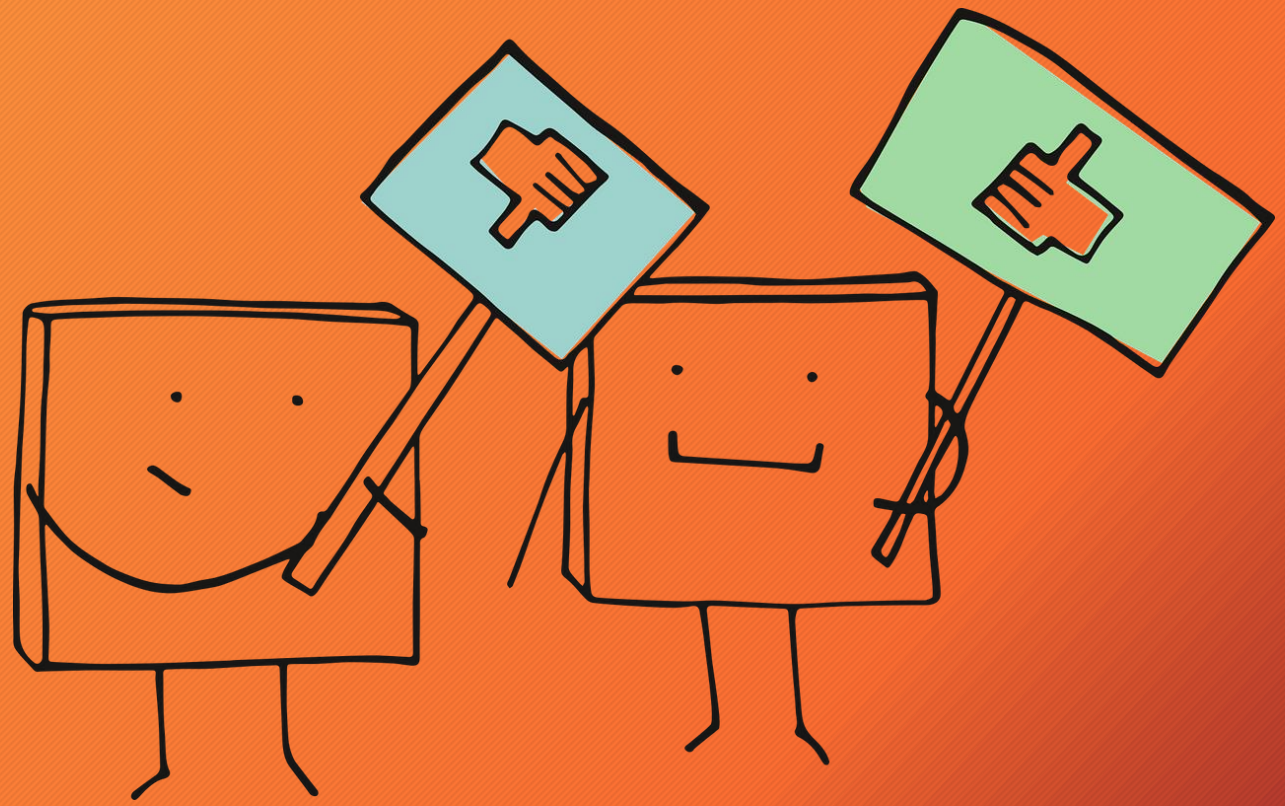
Feedback

"information provided by an agent (e.g., teacher, peer, book, parent, self, experience) regarding aspects of one's performance or understanding"

(Hattie & Timperley, 2007)

Feedback can work at 4 levels:

- **task** level
- **process** level
- **self-regulation** level
- **self**-level



Self-regulated learning

*"self-regulated learning is an active constructive process whereby **learners set goals for their learning and monitor, regulate, and control their cognition**, motivation and behaviour, guided and constrained by their goals and the contextual features of the environment"*

(Pintrich & Zusho, 2002)

Good feedback practice to enhance self-regulation

helps clarify what **good performance** is

facilitates the development **of self-assessment**

delivers **high quality information** to students about their learning

encourages teacher and peer **dialogue around learning**

encourages **positive behaviours** and motivation

provides **opportunities to close the gap** between current and desired performance

provides **information to teachers** that can be used to help shape the teaching

Problem Posing in Mathematics

Context

Real

Rich

Linked to everyday life

Situation

Challenger

Coherent

Clear

Understandable

With more possible interpretations

Request

Contextualized

Adequate difficulty

More solution strategies

Requires math skills

Problem

Multiple resolutions possible

It suggests meaningful reflection

Generalization of the resolution

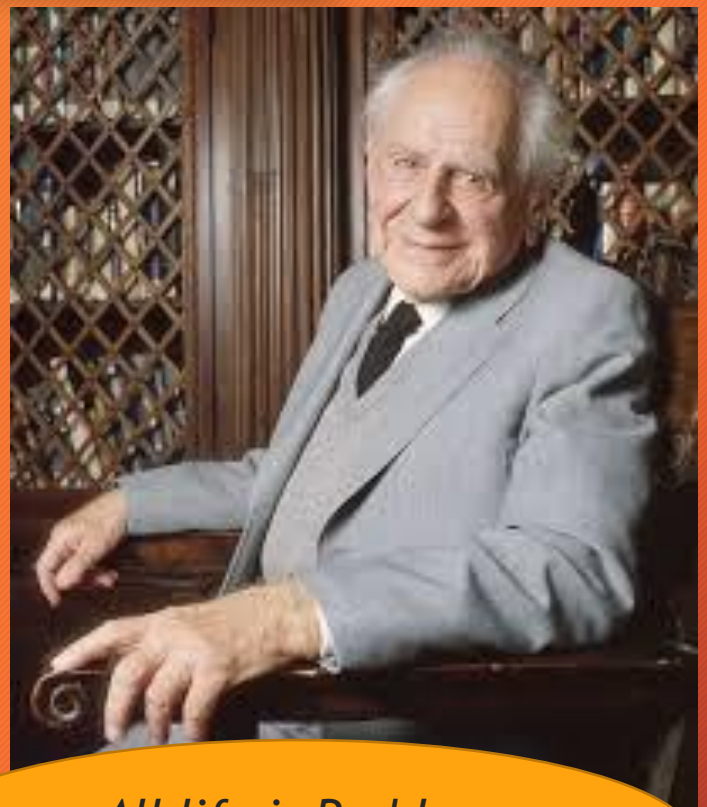
Problem solving in Mathematics

"The term “problem solving” refers to all mathematical tasks that have the ability to provide intellectual challenges to improve students' understanding and development of mathematical concepts, especially in dynamic real-world situations."

(National Council of Teachers of Mathematics, 2000)

Problem Solving

- To learn new ideas, new approaches
- To work in team
- To apply knowledge in daily life
- To face changes
- To model a problem situation



All life is Problem Solving (Karl Popper)

Problem Solving

Comparison

- with situations contextualized

Invention

- of new procedures thinking outside the conventional schemes

Creation

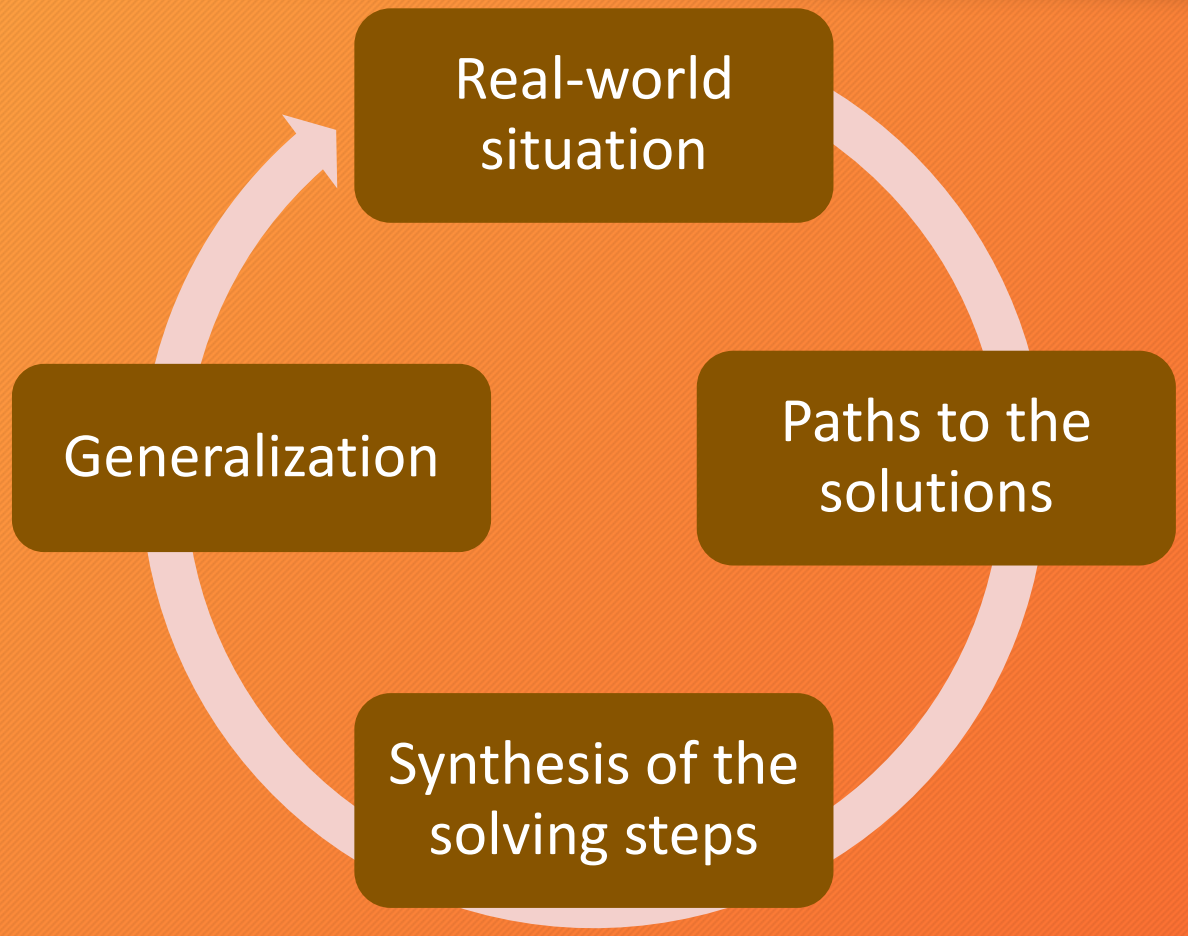
- of solutions with an original contribution, designing a strategy

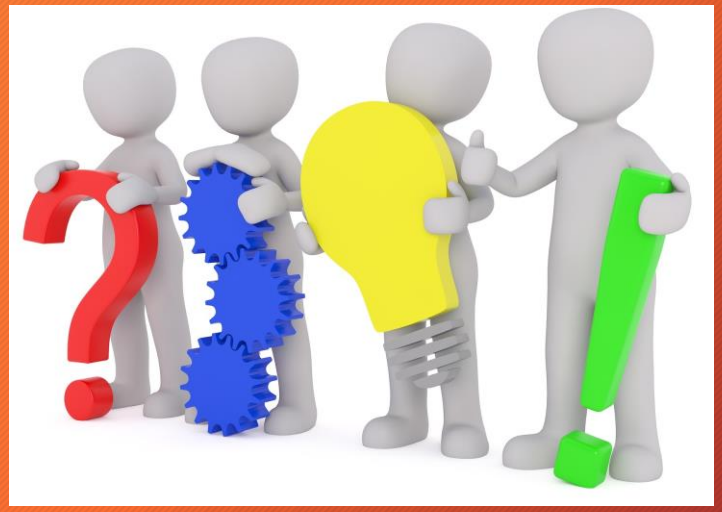
Description

- argumentation of the solution process using different representations

(Samo et al., 2017)

The problem solving process





Mathematical Modelling

*The **process of translating** between the real world and Mathematics* in both directions, where reality means the "rest of the world" outside Mathematics, including nature, society, everyday life, and other scientific disciplines

Models

- **representations that can describe** and explain the phenomena of reality

Using models

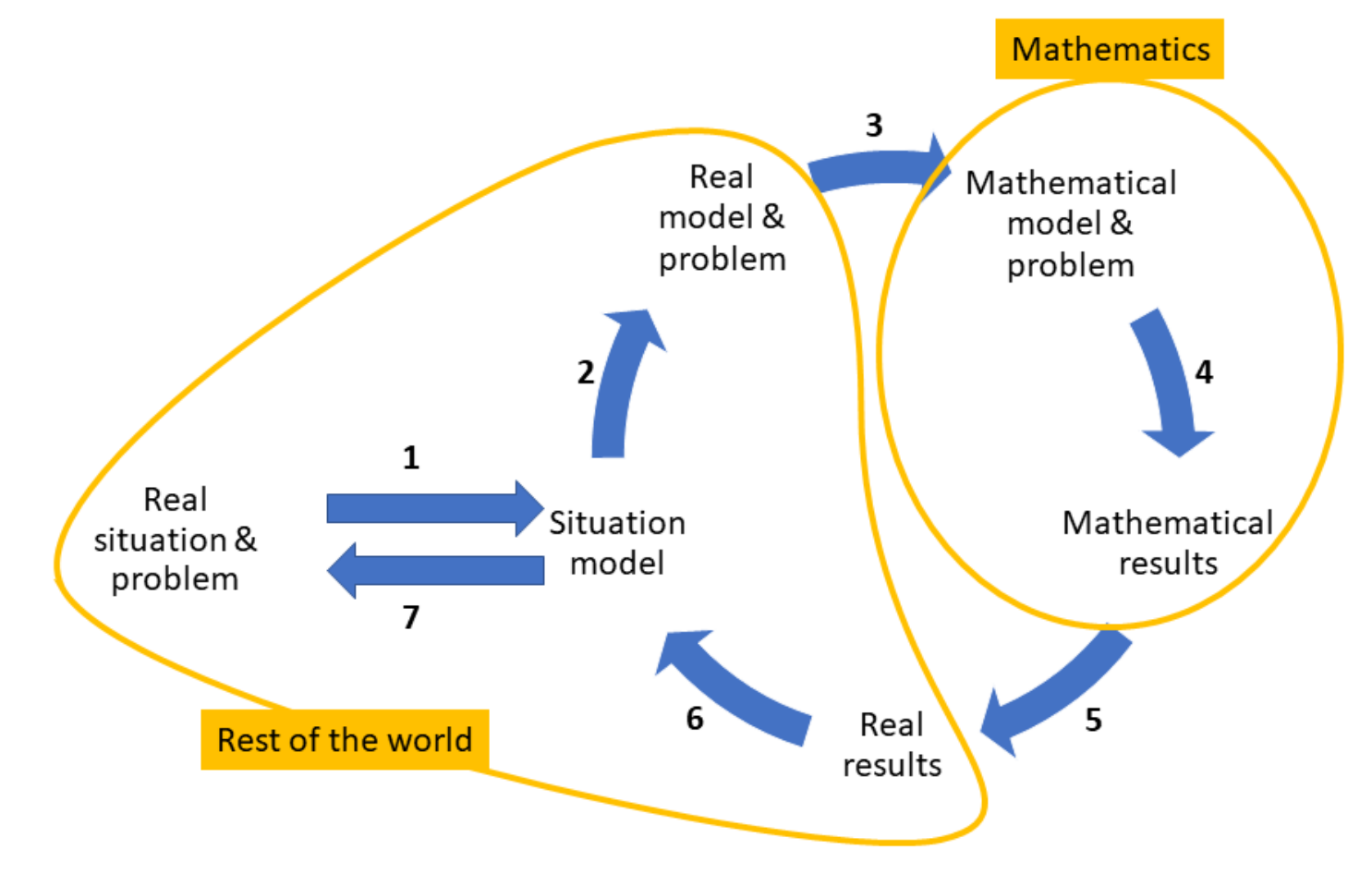
- to obtain **predictions** on the progress of experiments, mechanisms and processes

(Blum & Ferri, 2009; Pollak, 1979; Fazio & Spagnolo, 2006)

Mathematical Modelling

- Helping students to better **understand the world**
- **Supporting** Mathematics **learning** (motivation, concept formation, comprehension, retaining)
- Contributing to develop various **mathematical competencies** and appropriate attitudes
- Contributing to an adequate **picture of Mathematics**

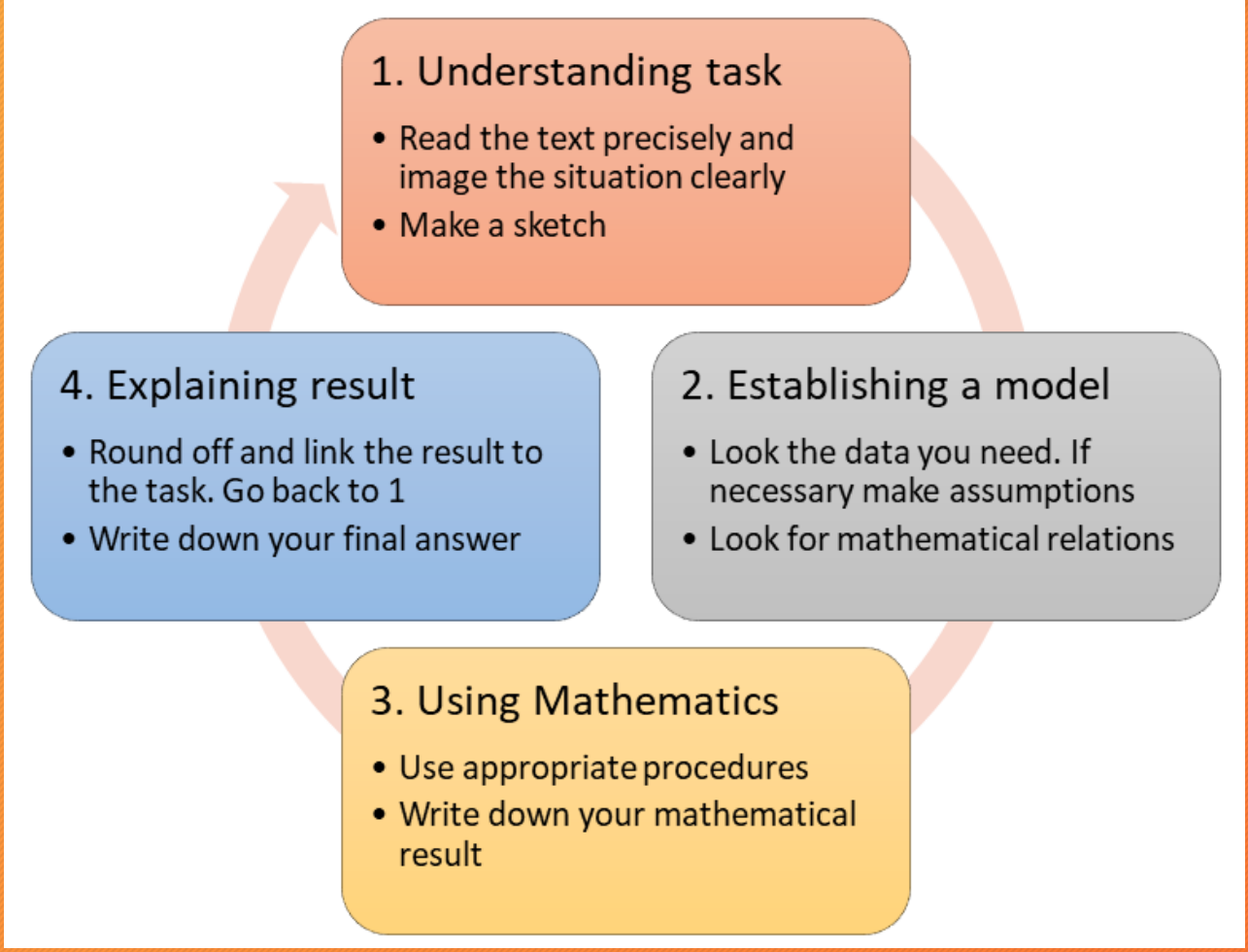
Seven-step model of the “modelling cycle” for research and teaching purposes



Modelling** is inseparably linked with other **mathematical competencies

(Blum & Leiß, 2007)

Four-step model of the “modelling cycle” for student’s activities



“modelling competency” is the ability to construct models by carrying out all the steps and to analyse or compare given models

Collaborative Learning

A didactic methodology to make two or more people learn together

Educational approach that the group uses to improve learning

Groups of two or more people working together to solve problems, complete goals, and learn new concepts

Collaborative learning keywords

Group	Cooperation	Competences	Active learners
• Leadership • Coordination • Peer • Responsibility	• Competition • Listening • Interaction • Instruments	• Express ideas • Defending ideas • Public Speaking • Soft skills	• Feedback • Self-esteem • Self evaluation • Integration

To prepare students for real situations of social life and the world of work

Collaborative learning for professional development

Collaboration
=
key factor for professional development

- Teachers learn through collaborating with others
- Articulating and sharing ideas
- Finding solutions to the challenges posed within their context

(J. Deppeler, 2007)

Learning by doing

In the context of scientific disciplines, the **experimental dimension** must always be kept in mind

It is appropriate to identify some particularly significant **experimental activities** to be carried out in the laboratory, in the classroom or online, to be privileged over purely theoretical and/or mnemonic activities

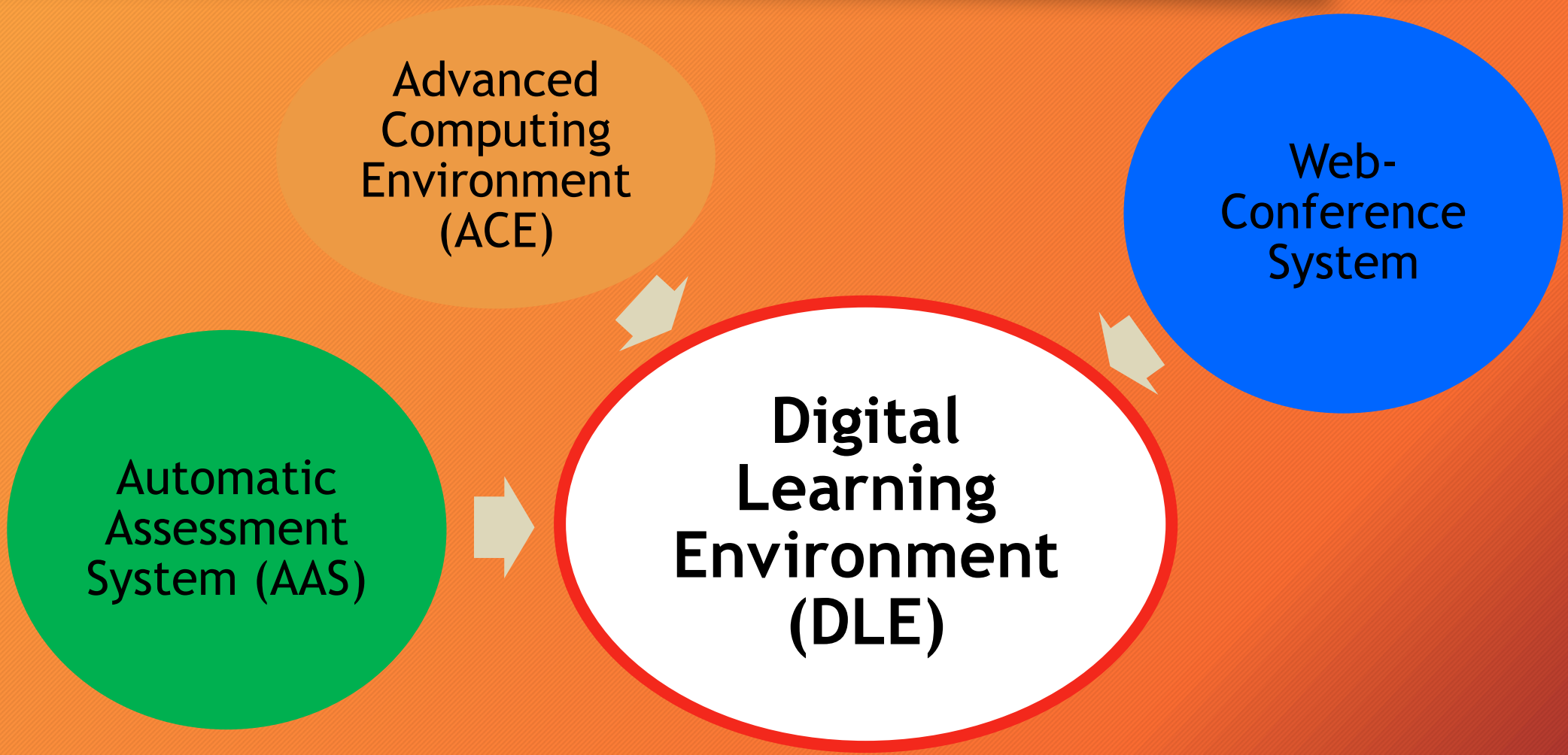
A workshop activity can be understood as a **teaching-learning environment** that can be compared to the Renaissance workshop, where one learned by doing and seeing done, communicating with classmates as well as by imitation of the expert

Activity

- As a student, have you ever participated in activities in which one of these methodologies was used?
- What is your opinion on these methodologies?

Technologies can support these methodologies

Technologies used in adaptive strategies



DLE

(Fissore, Marchisio & Rabellino, 2020)

Adaptive strategies in DLE

- Continuous Support
- Tracking progresses and activities
- Teachers can find out interests, difficulties of students and use information to create contexts
- Collaborative learning, peer evaluation
- Interactivity and interaction
- Suitable material for Dyslexic

- Synchronous and asynchronous discussion
- Integrated gradebook
- Questionnaires and user details
- Workshop
- Integration with the tools for computing and assessment
- EasyReading, high-readibility font

Adaptive strategies supported by AAS

Formative assessment

Time optimization

Open Math answers

Algorithm based questions

Adaptivity

Immediate feedback

Find the value of k for which $(1+k)\,x - 4\,k\,y - 2 = 0$ is a line parallel to the x-axis.

k= -1

Write the equation of the sheaf of lines which corresponds to the value of k that you have found.

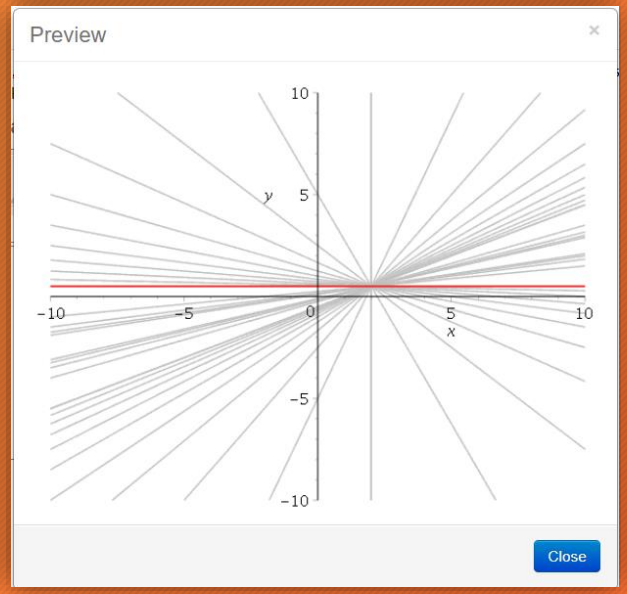
Then, click on the **P** icon to visualize the graphic of the line and to check that is belongs to the sheaf.

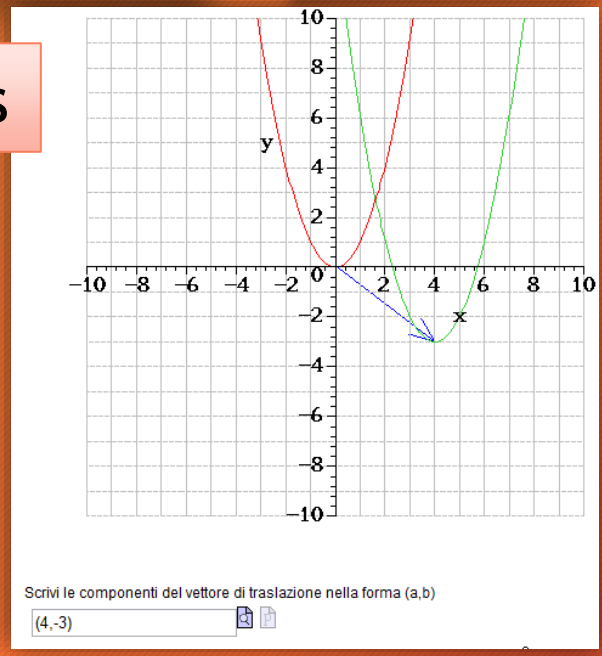
Equation Editor

a^b $\sin(a)$ $\frac{\partial}{\partial x} f$ ⠿ ∞ α Ω Help

$y = \frac{1}{2}$

Grade Refresh Close





Ten good reasons to adopte the AAS

STUDENTS

1. Availability
2. Immediate feedback
3. Adaptivity
4. Learning from mistakes
5. Respect of rules

TEACHERS

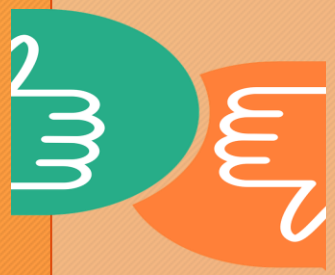
6. Feedback
7. Change of role
8. Teacher training
9. Saving resourses
10. Repository of questions

AAS

Standardized/summative assessment

- Teachers can automatically evaluate, collect and analyze students' responses

In Italy INVALSI tests (Mathematics, English and Italian disciplines) https://invalsi-areaprove.cineca.it/



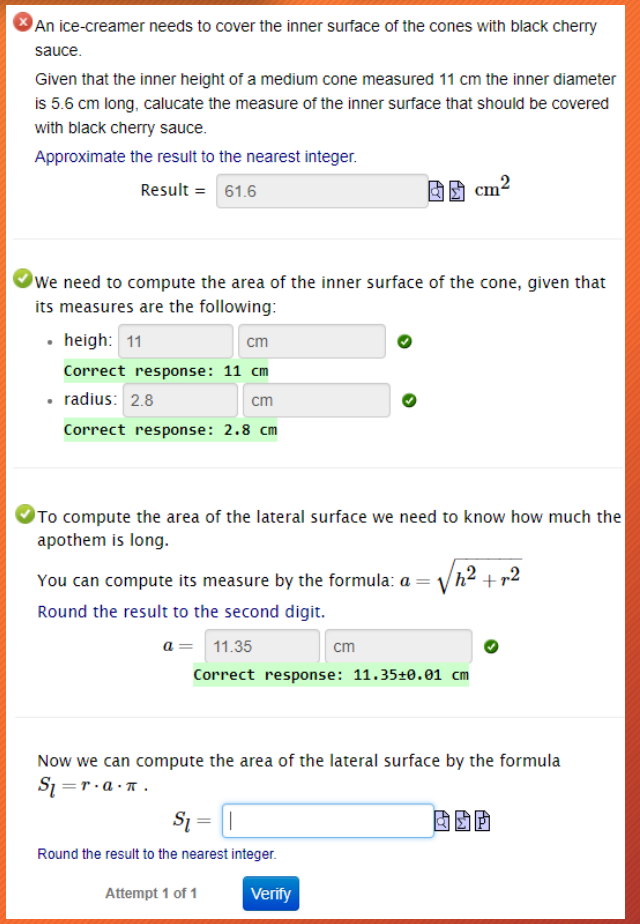
Formative assessment

- Students can be trained in self-assessment to better prepare themselves

Model for automatic formative assessment through the use of an AAS

Our model of automatic formative assessment

- Availability
- Algorithm-based questions and answers
- Open answers
- Immediate feedback
- Interactive feedback
- Contextualization



(Barana, Fissore & Marchisio, 2020)

Our model of automatic formative assessment

- **Availability**
- Algorithm-based questions and answers
- Open answers
- Immediate feedback
- Interactive feedback
- Contextualization

Test with automatic assessment

Multiple attempts

Encourage positive motivational beliefs and self-esteem

Our model of automatic formative assessment

- Availability
- **Algorithm-based questions and answers**
- Open answers
- Immediate feedback
- Interactive feedback
- Contextualization

Variable parameters and formulas

Focus on processes and not on results

In the case of multiple attempts, the feedback information can be used to bridge the gap between current and desired performance

Our model of automatic formative assessment

- Availability
- Algorithm-based questions and answers
- **Open answers**
- Immediate feedback
- Interactive feedback
- Contextualization

The multiple choice answer mode is not used exclusively

The use of different registers in the answers is required: words, numbers, symbols, tables, graphics, diagrams

Our model of automatic formative assessment

- Availability
- Algorithm-based questions and answers
- Open answers
- **Immediate feedback**
- Interactive feedback
- Contextualization

Results shown while students are focused on the activity

No more than 5 questions per assignment

Facilitates the development of self-assessment

Our model of automatic formative assessment

- Availability
- Algorithm-based questions and answers
- Open answers
- Immediate feedback
- **Interactive feedback**
- Contextualization

Step-by-step guided resolution

Provides interactive standards

It helps to clarify what the good performance is

Provides high quality information: background and process that allows students to solve the problem

Our model of automatic formative assessment

- Availability
- Algorithm-based questions and answers
- Open answers
- Immediate feedback
- Interactive feedback
- **Contextualization**

Real context

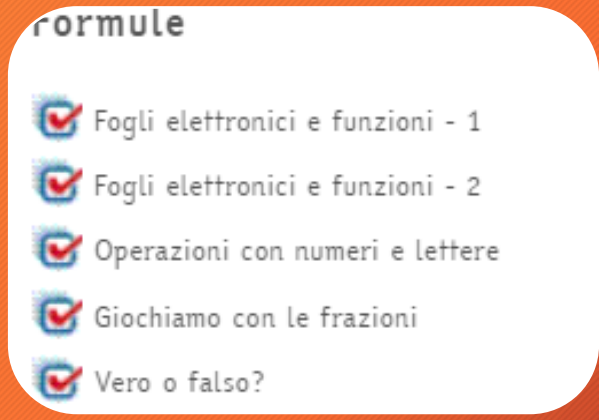
It contributes to the creation of meanings and to a deeper understanding

Organize work with the AAS with students

In the classroom with BYOD modality

In the laboratory

In class with pen and paper using the IWB

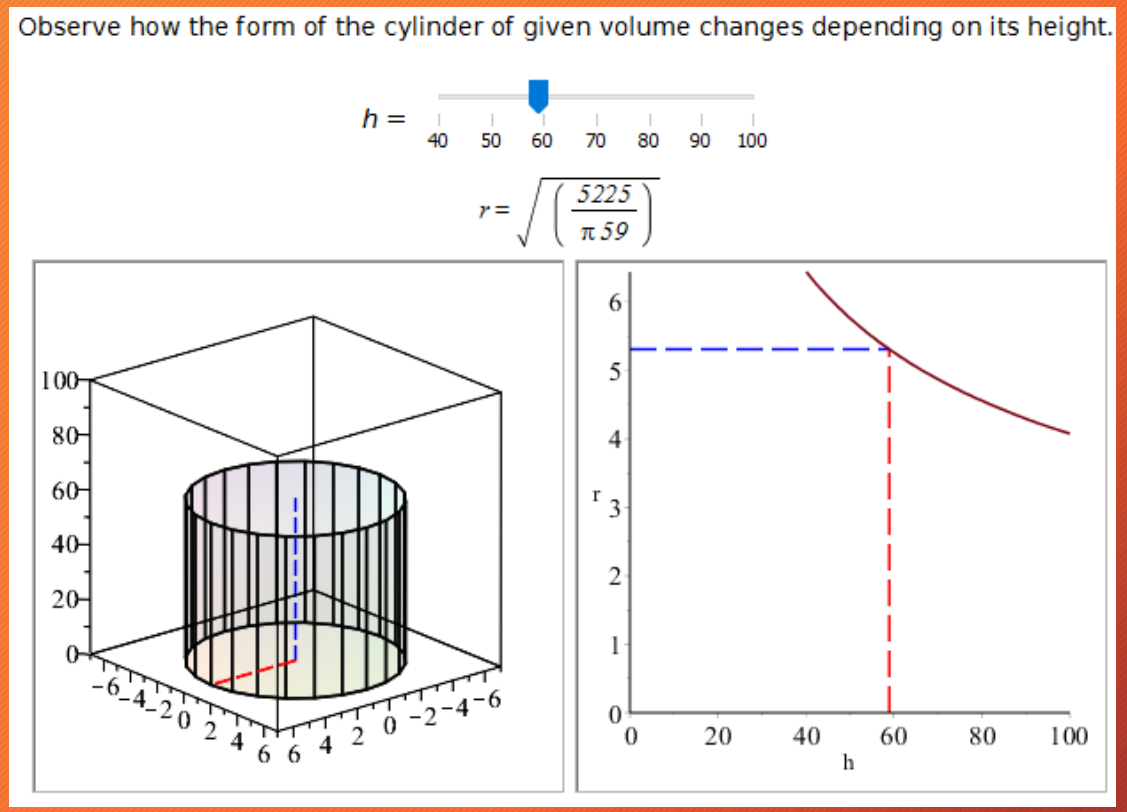


Online

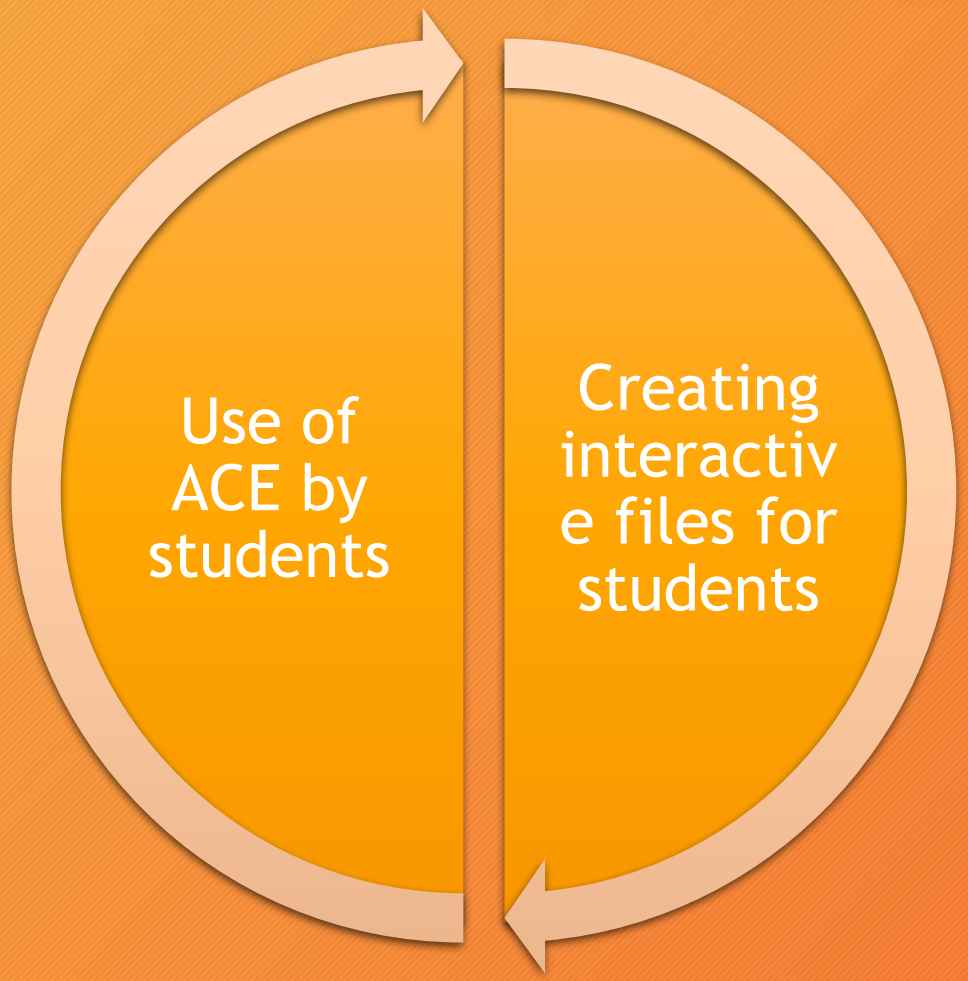
DLE for STEM: ACE

- ✓**Numeric** computations
- ✓**Symbolic** calculus
- ✓**Graphical representations**, static and animated, in 2 and 3 dimensions
- ✓**Procedures** in a simple programming language
- ✓**Interactive components** to visualize how a results change when the input parameters are changed
- ✓Connecting all the **different representation registers** in a single worksheet

Tool to enhance teaching and learning of STEM



DLE integrated with the ACE



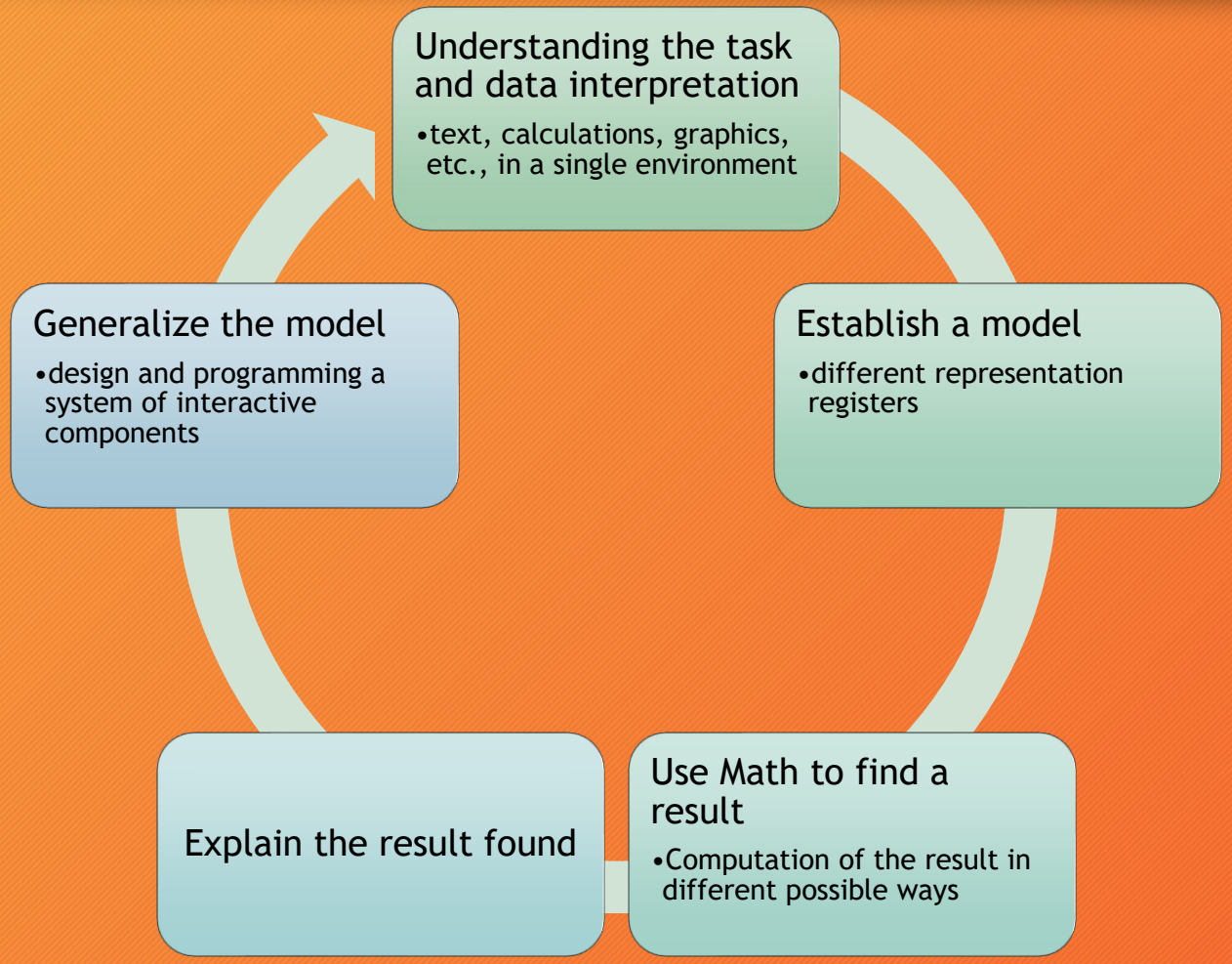
Thanks to the integrated platform, files created with ACE can be uploaded to the platform and viewed even without having installed the software, maintaining interactivity

- For recovery
- For strengthening
- To develop problem solving skills
- To study, review or deepen theoretical concepts

The use of an ACE

- Extends ways of reasoning on mathematical tasks
- Enhances exploration of multiple representational forms (e.g., numerical, symbolic, graphic)
- Allows to represent and explore dynamically mathematical tasks
- Allows to generalize the solving process of a problem
- Allows to create interactive files in which the user interacts with the software

Our "Solution Plan" for modelling activities with an ACE

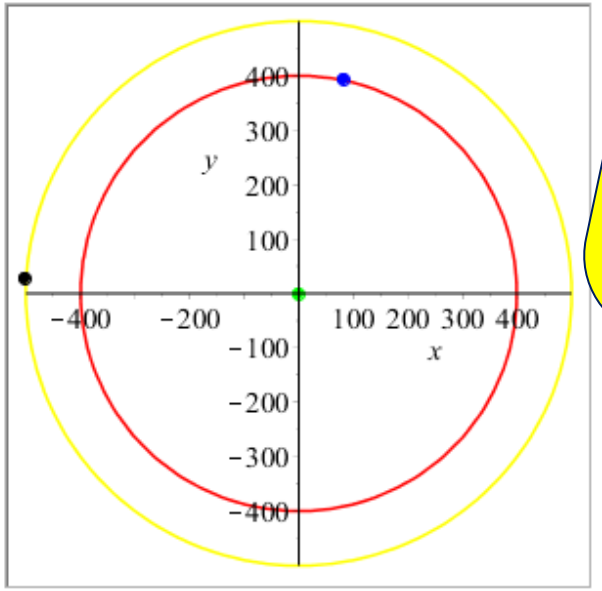


Example of interactive material

Satellite angle 1 (in degrees) 78 Satellite angle 2 (in degrees)

Satellite angle 1 converted into radians: 1.361356817 Satellite angle 2 converted into radians: 3.089232776

View perpendicular to the plane of the 2 orbits:



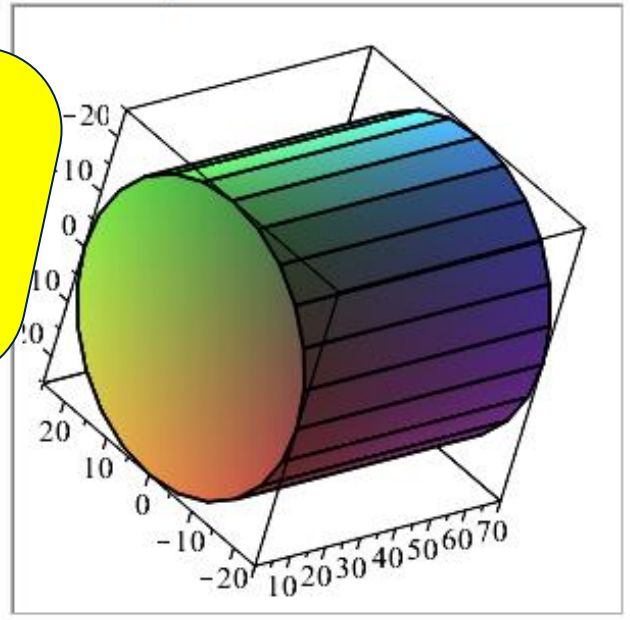
Distance as the crow flies between the 2 satellites [km] 687.4400235 Conlcusion: The 2 satellites can communicate

As the slider cursor changes, the graphs change accordingly

Radius R: mm

Length: L: mm

3D drawing of the circular section beam:



Example of interactive material

Study of finite energy signals, their spectrum and autocorrelation

Define the support:

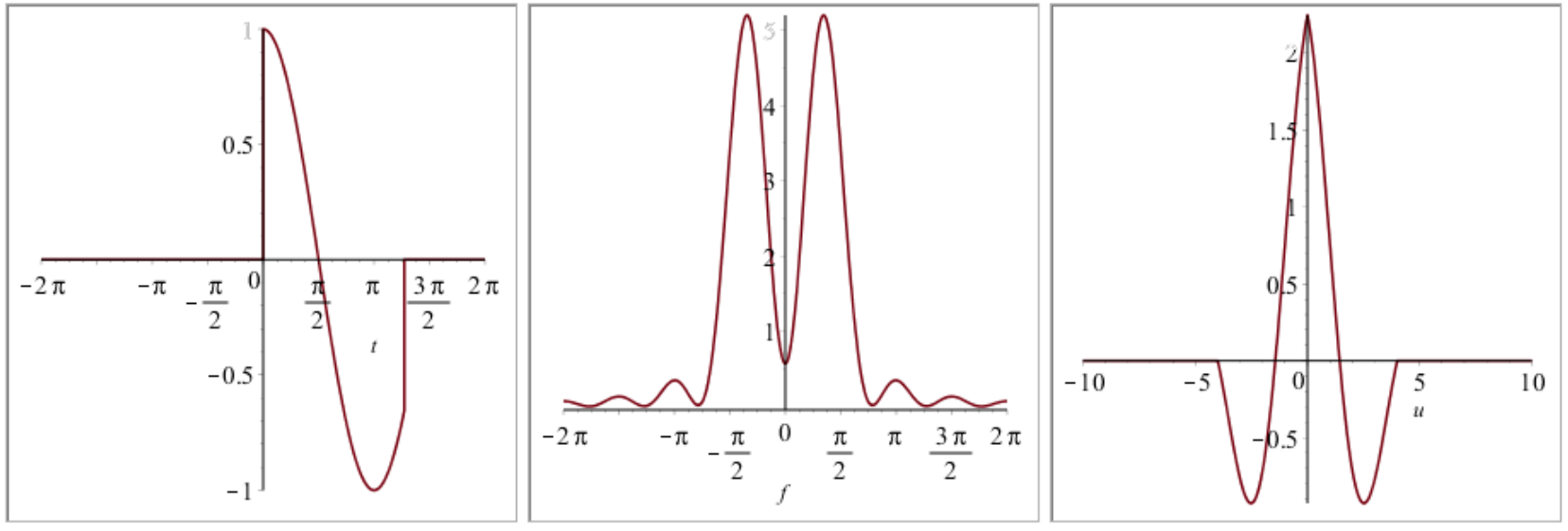
a = 0 b = 4

Define the (real) function on [a, b]:

$gt := t \to \cos t$

Button

Graphs of the function, its amplitude spectrum and its autocorrelation:



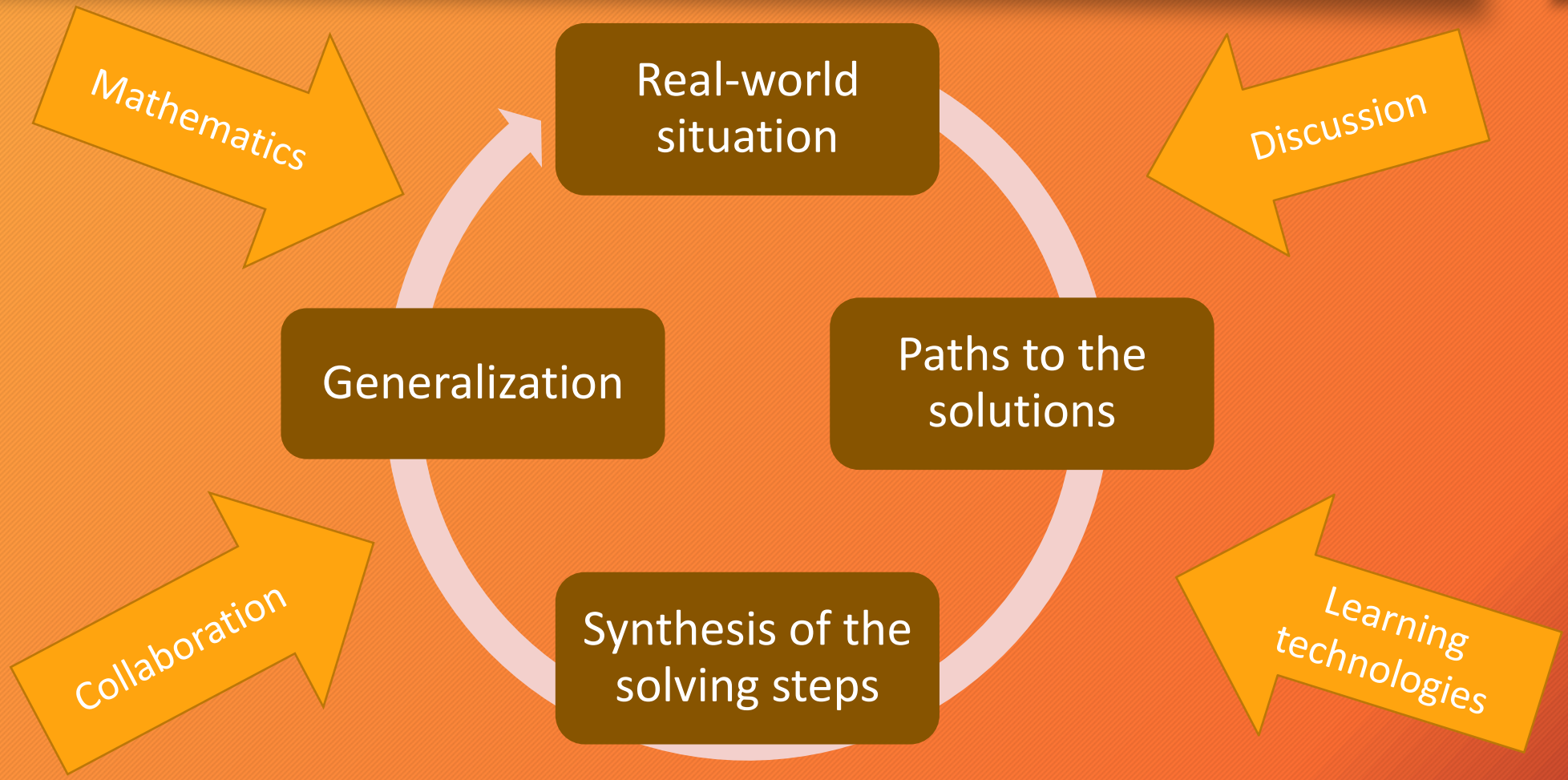
1. INPUT DATA

2. CLICK THE BUTTON

3. OUTPUT DATA

Study of signals

Adaptive strategies in Problem Solving



Adaptive strategies in Problem Solving

- Engaging starting points, adapted to students' interests
- Motivational lever
- Facilitate comprehension of theory
- Clarify usefulness of Mathematics

SUN'S HEIGHT ABOVE THE HORIZON

Problem

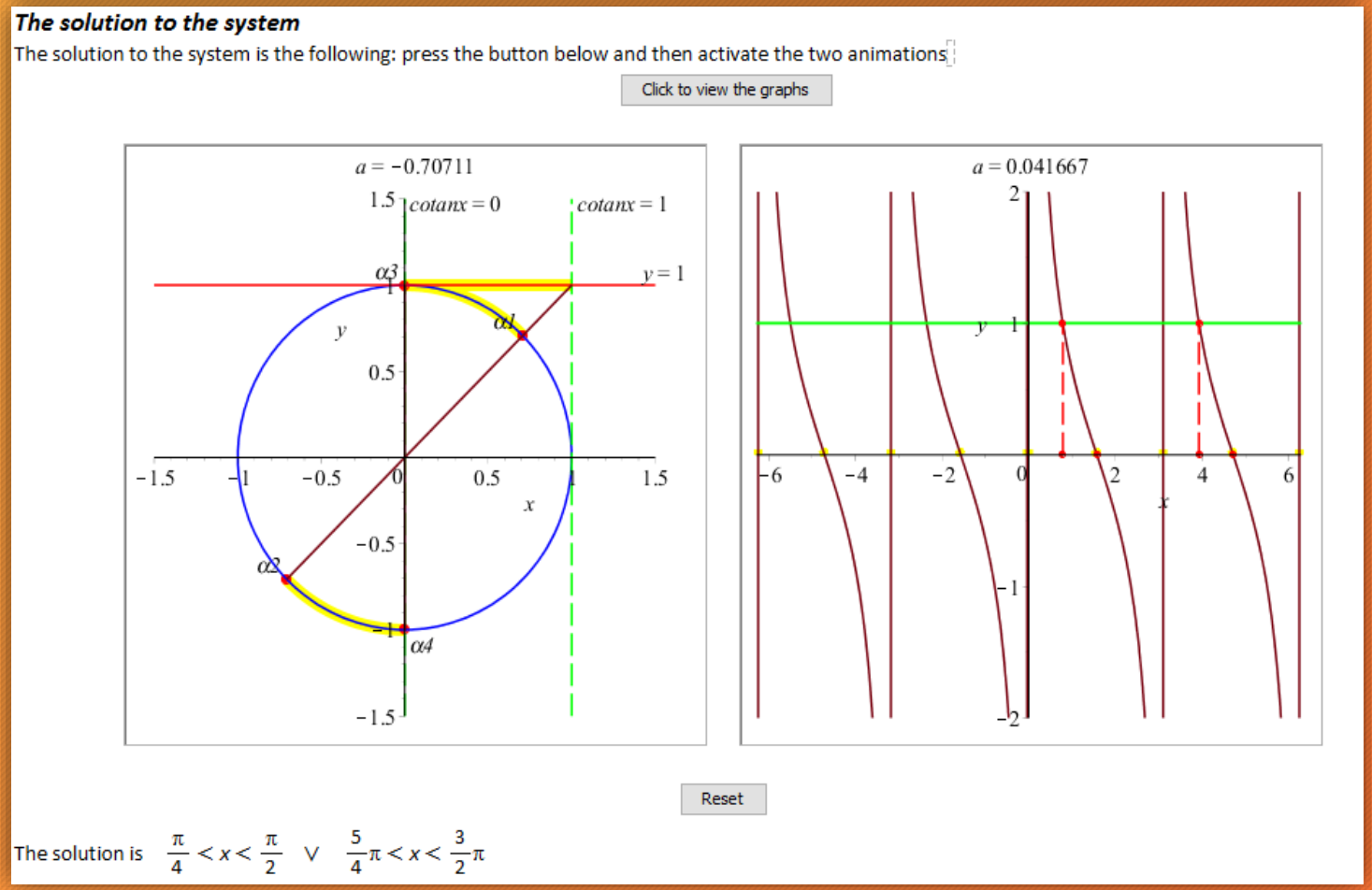
At a certain time of the day the shadow of a building turns out to be shorter than his actual height. How much high can the Sun be on the horizon?

Resolution

Clearly, when we talk about the "height of the Sun," we do not mean an actual height measured in meters. We rather mean the inclination of the Sun's rays with respect to the surface of the Earth.

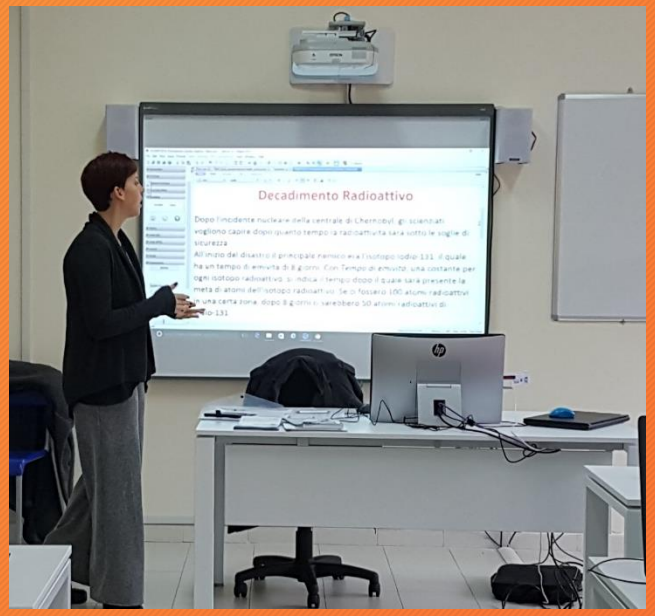
Let's model the problem by indicating the height of the building with the letter h; we denote by x the angle corresponding to the inclination of the solar rays with respect to the surface. By finding the inclination angle x, corresponding to the angle $\overset{\frown}{CAB}$ of the figure below, we would know the height of the Sun on the horizon.

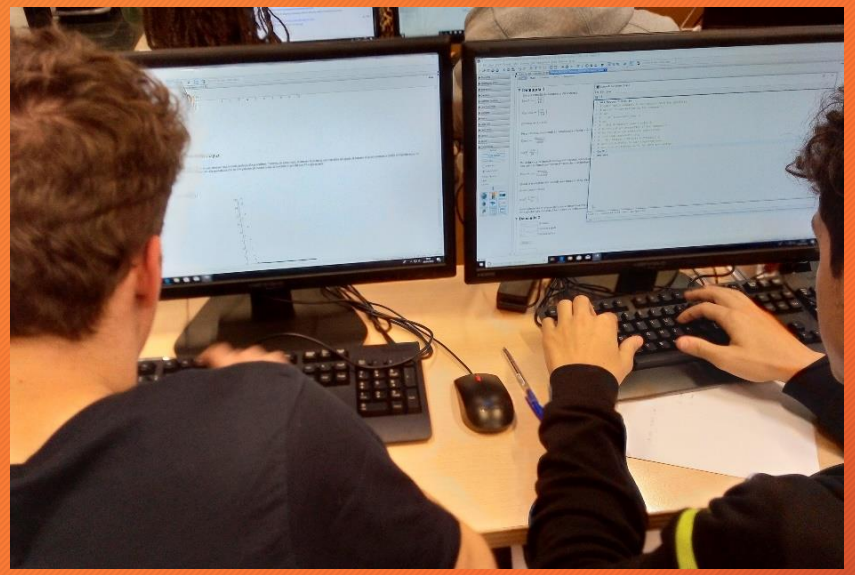
Adaptive strategies supported by ACE



- Exploration of possible solutions
- Interactivity
- Different ways of representation
- Feedback from automatic computations
- Autonomous study, guided by the tutor

Problem solving activities with students within the DLE





Online math educational software

Use of cloud systems and free software for sharing resources (including interactive)

- Geogebra cloud
- Wolfram|Alpha (http://www.quickmath.com/)
- Maple Learn (https://learn.maplesoft.com/)

Collaborative Learning in the DLE

Community of teachers

Community of students

Community class

Collaborative Learning in the DLE

Not just online

DLE for asynchronous collaboration

It amplifies peer support

It supports the dynamics of interaction and participation within a group

It allows you to expand the space for interactions, giving you more possibilities for expression

Es: Forum

Activity

- What characteristics do the presented methodologies have in common?

Students are Protagonists!

Awareness

Repeat the reasoning

Work independently

Management of time

Self organization

Actively try and explore

Design of didactic activities

Didactic planning index

1. Regulations
2. Objectives / Prerequisites
3. Methodologies
4. Type of activities and timing
5. Technologies
6. Poor and interactive materials
7. Multi- and interdisciplinary
8. Inclusion
9. Evaluation
10. Metariflexion

1. Regulations

The planned activity must always be framed within the existing legislation

Ministero dell'istruzione, dell'università e della ricerca

Schema di regolamento recante "Indicazioni nazionali riguardanti gli obiettivi specifici di apprendimento concernenti le attività e gli insegnamenti compresi nei piani degli studi previsti per i percorsi liceali di cui all'articolo 10, comma 3, del decreto del Presidente della Repubblica 15 marzo 2010, n. 89, in relazione all'articolo 2, commi 1 e 3, del medesimo regolamento."

Example: "Italian national guidelines regarding the specific learning objectives concerning the activities and teachings included in the study plans for high school pathways" (2010)

2. Objectives/Prerequisites

Topic

Specific topic that is covered in the activity

Class

Class that students attend

Type of institution

Specify the type of institution

Period

In what period of the school year?

Context

- Context in which the problem or proposed exercise is inserted

Didactic objectives

- What training objectives do you want to achieve through this activity?

Prerequisites

- What do participants need to know in order to perform the activity in the best possible way?

Estimated time

- Estimated time for carrying out the activity with the students

2. Objectives/Prerequisites

What knowledge do I want you to learn?

What skills do I want to develop (disciplinary/transversal)?

What skills do I want to acquire?

3. Methodologies

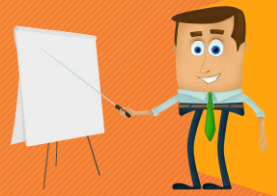
- Problem Posing
- Problem Solving
- Learning by doing
- Collaborative learning
- Automatic Formative Assessment
- ……

4. Type of activities and timing

Specify in detail the various components of the activity

Individual activities

Group activities



Theoretical presentations

Time scan for each of the various phases into which the activity is divided

5. Technologies

Specific software

- Geogebra, Maple, Autocad….

Tools to increase participation

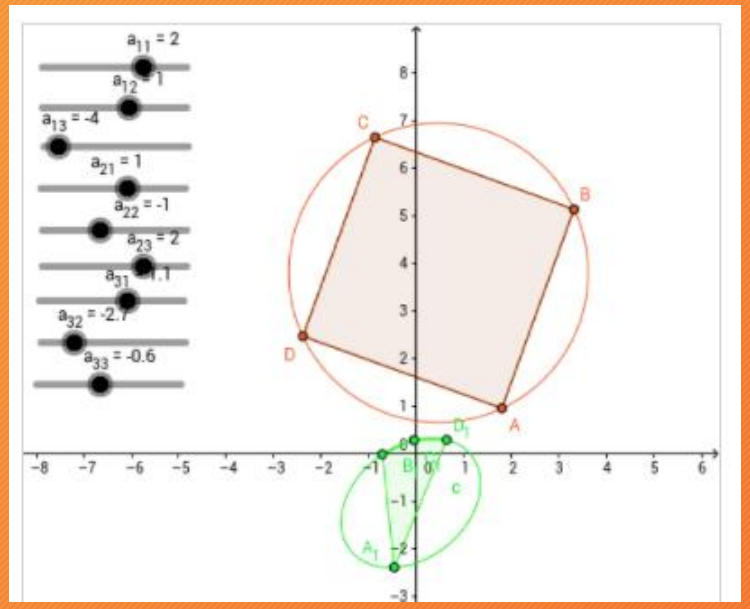
- Mentimeter, google form, Wooclap ...

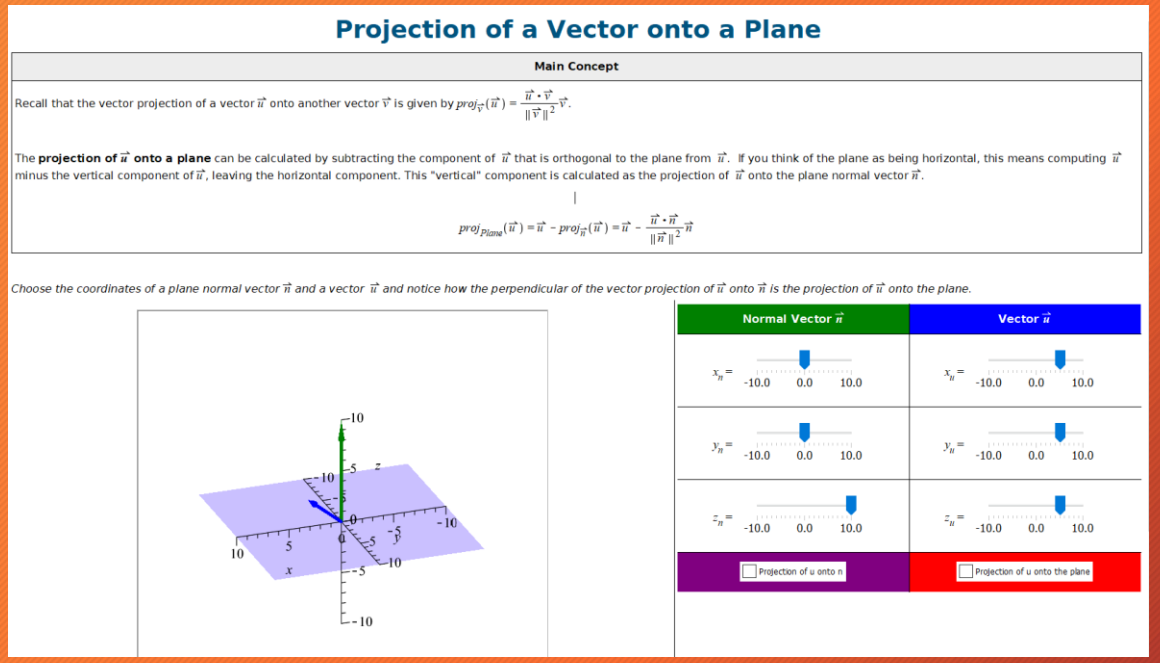
Better if all integrated into a DLE

- For example, Moodle integrated with other software: activities such as the questionnaire, the forum, the delivery, the quiz, the workshop and multiple resources

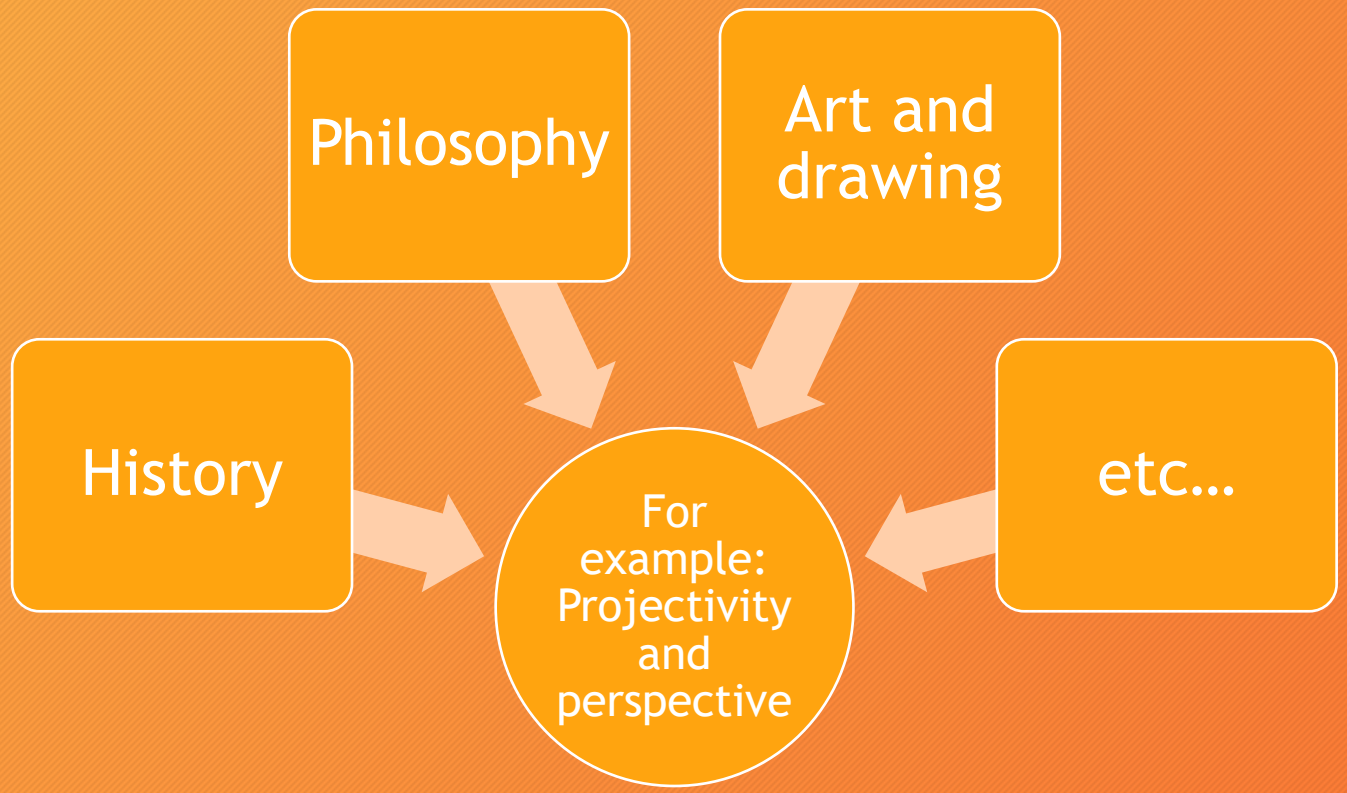
6. Poor materials and interactive materials

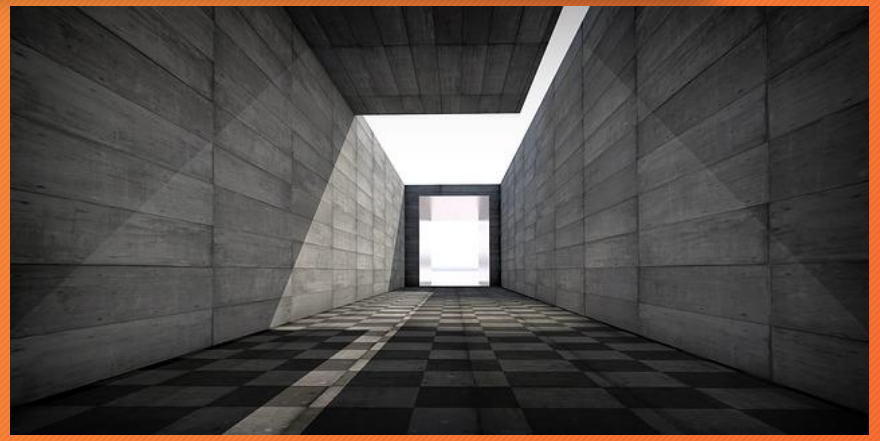
- Paper, pen, scissors,….
- Open educational resources: videos, images, ...
- Interactive materials prepared ad hoc





7. Multi- and interdisciplinary





Città ideale - Galleria Nazionale delle Marche, Palazzo Ducale di Urbino

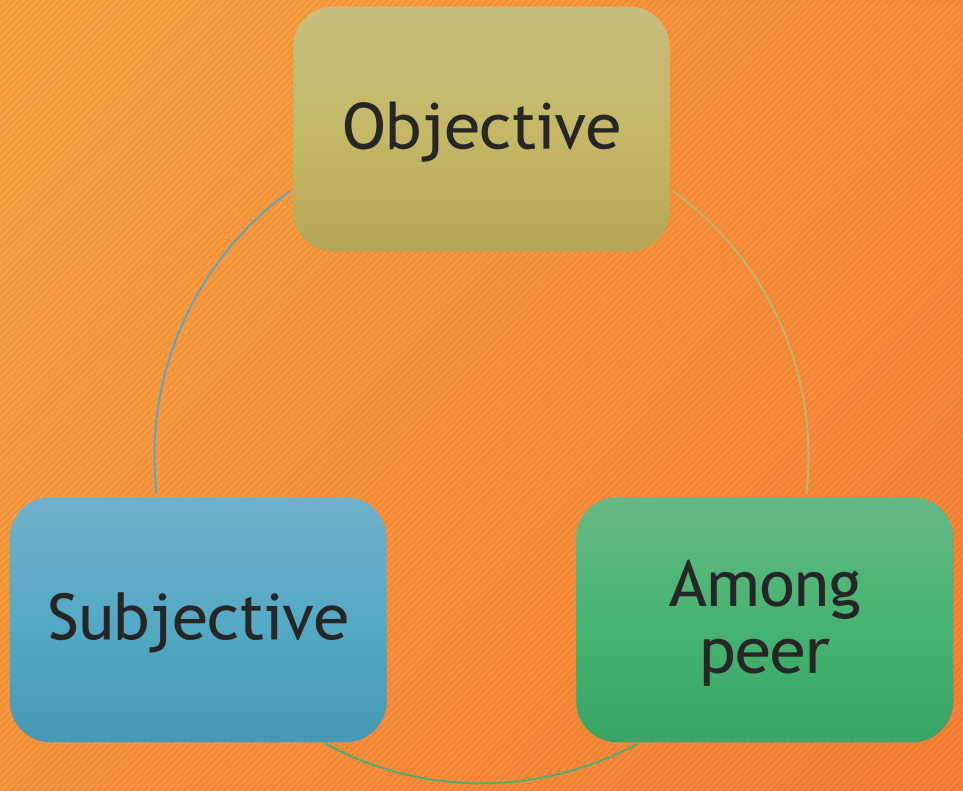
http://www.gallerianazionalemarche.it/collezioni-gnm/citta-ideale/

8. Inclusion

It means taking into account special educational needs (for example, visually impaired, dyslexic, ...) and then setting the teaching activity in a way that can be personalized, adapted (adaptive teaching and learning)

It can be done in different ways: by planning different activities, using specific fonts, making materials available….

9. Evaluation



For each it is important to clarify and share an assessment grid and learning objectives

What kind of evaluation?

- among peers
- objective
- subjective

What kind of feedback can I give through this activity?

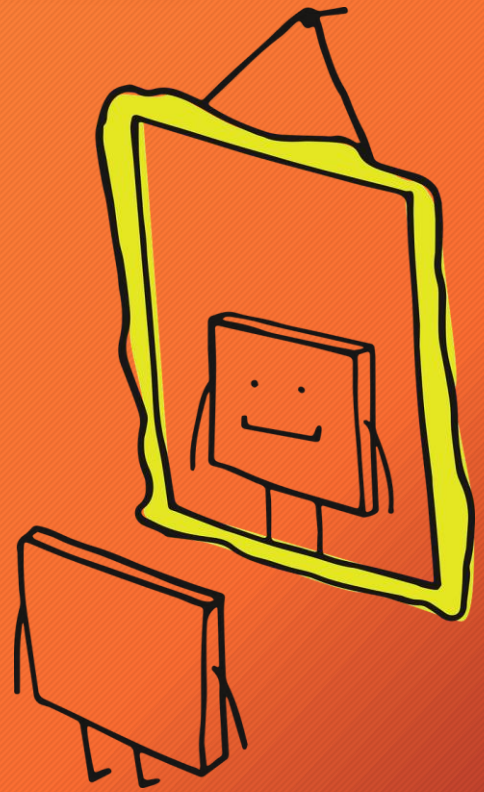
- general feedback
- interactive feedback

Subjective evaluation

Through self-assessment and reflection, students learn to evaluate their learning and reflect on their work

It is important that the student:

- Understand the learning objectives
- Understand how the business is valued
- Get feedback
- Have the opportunity to confront a good practice



Peer evaluation

Each student evaluates the work of their peers based on the same grid of evaluation that they would have used to evaluate their own

Delivery phase of an assignment

- From every student
- In a certain time frame

Destruction of one or more deliveries to each student

- Manual or automatic
- Different from their own

Evaluation phase

- With a well-defined evaluation grid
- Possibility to insert comments
- In a certain time frame

Publication of evaluations

- Each student can take one grade for submission and one grade for assessment

Objective evaluation

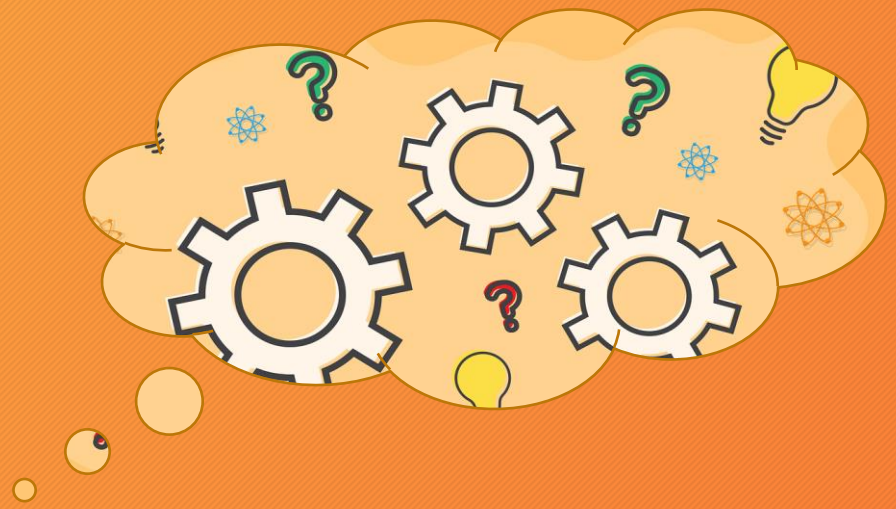
Diagnostic evaluation	Formative evaluation	Summative evaluation
• To detect the adequacy of students' preparation in relation to the planning of new teaching activities	• To detect pupils' learning in progress and how they receive new knowledge	• To detect the knowledge and skills at the end of the learning units

10. Metariflexion

- Do the materials meet the needs of the students?
- At what point of the activity can my students encounter problems or difficulties?
- Are feedback and suggestions helpful in overcoming these difficulties?
- Does the evaluation take into account all aspects of the activity?
- Are the objectives and prerequisites consistent with the activity?
- What difficulties did I encounter in planning the activity?

Activity: first steps for planning an educational activity

Now it's your turn! Design an educational activity of your choice.



Objectives / Prerequisites

Topic
Class
Type of institution
Period

- Context
- Didactic objectives
- Prerequisites
- Estimated time

Methodologies

Type of activities and timing

Technologies and materials

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Thank you for the attention!

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