UNIVERSITÀ DI TORINO

DBMSS
Dipartimento di Biotecnologie Molecolari e Scienze per la Salute

Integrated Digital Learning Environments: theoretical frameworks and applications

Marina Marchisio

Università degli Studi di Torino

With the patronage of

PUPKEWITZ FOUNDATION

University of Turin

Founded in **1404**, the University of Turin is one of the **most ancient** and **most prestigious** Italian universities.

Hosting about **80000 students**, the University is today **one of the largest Italian Universities**, open to international research and training.

It carries out scientific research and organizes courses in **all disciplines, except for Engineering and Architecture**.

Digital
Education for
Learning and
Teaching
Advances
RESEARCH GROUP

Learning Environment

A place where learning is fostered and supported.

(Wilson, 1995)




Learning Environment

What elements should be included?

Learning Environment

It includes at least two elements:

learner

setting or space wherein the learner acts

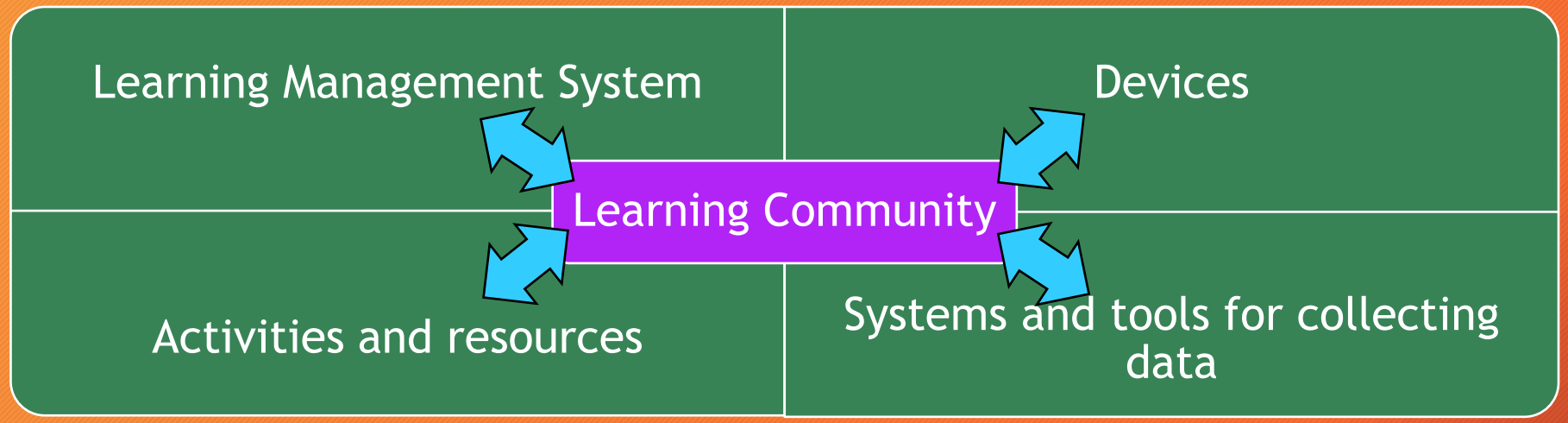
Ecosystem

*A complex of **living organisms**, their **physical environment**, and all their **interrelationships** in a particular unit of space.*

Encyclopaedia Britannica

Digital Learning Environment (DLE)

*A learning **ecosystem** in which teaching, learning, and the development of competence are fostered in classroom-based, online or blended settings. It is composed of a **human component**, a **technological component**, and the **interrelationships between the two**.*

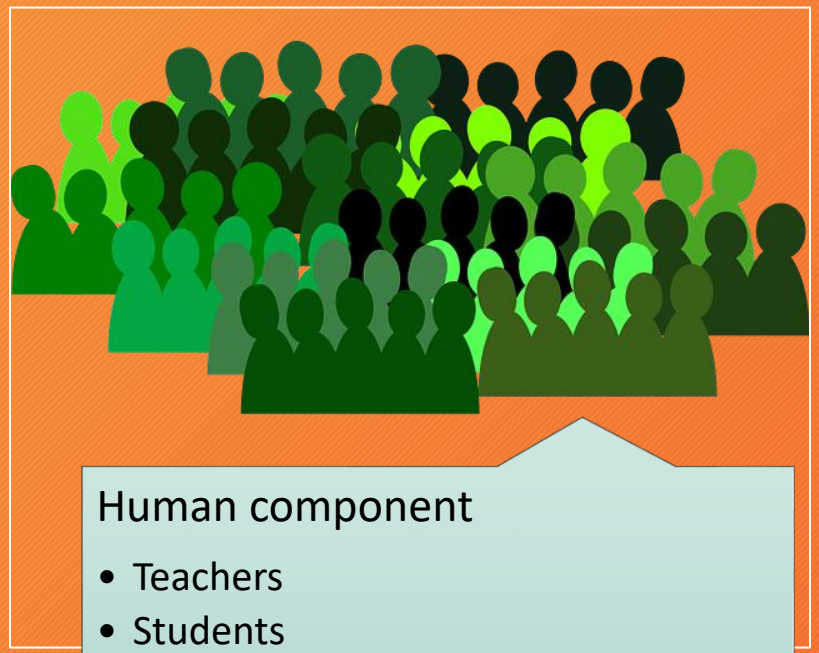


(Barana & Marchisio, 2021)

Components of a DLE

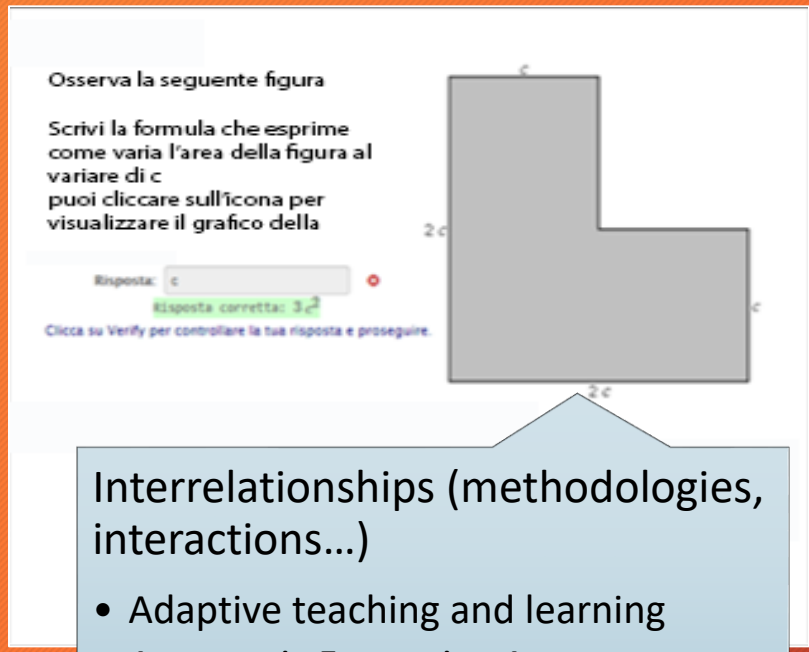
Technological component

- Learning Management System
- Integrations for Mathematics
- Tools for communication and collaboration
- Devices
- Digital activities



Human component

- Teachers
- Students
- Tutors



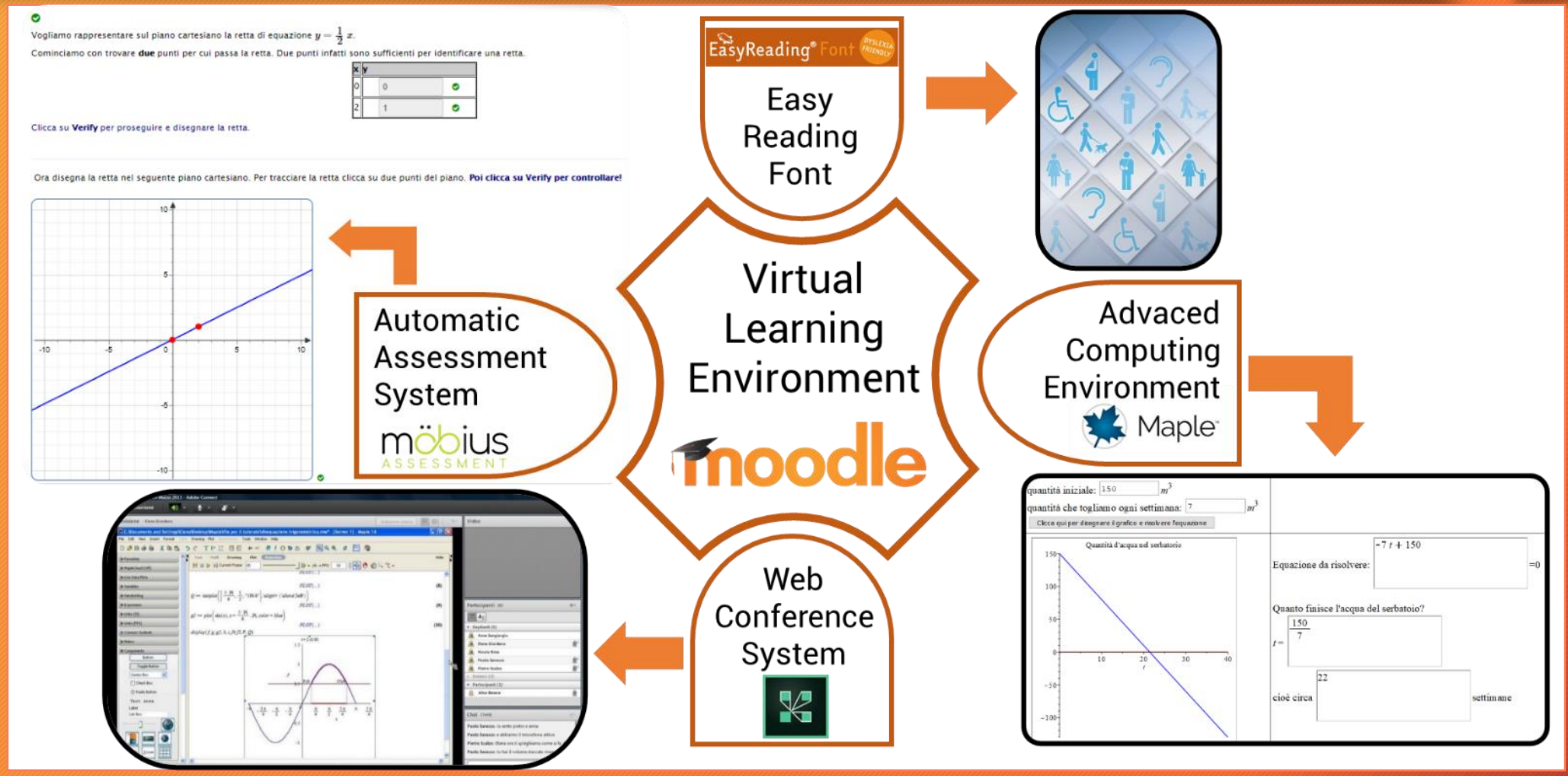
Interrelationships (methodologies, interactions…)

- Adaptive teaching and learning
- Automatic Formative Assessment
- Problem solving
- Collaborative learning

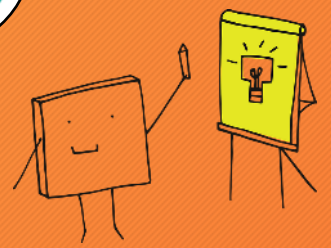
Components of a DLE

Integrated Digital Learning Environment

Technological components of a DLE for Mathematics



Virtual Learning Environment



In this Section you will learn how to:

- recognize simple models involving elementary functions
- perform transformations of graphs
- determine domains of functions

Functions and models

Transcript of the video Functions and models

1.1 - INTRODUCTION

Lesson 1.1.1 — To do: Go through the activity to the end

1.2 - A CATALOGUE OF ELEMENTARY FUNCTIONS

Lesson 1.2.1 (Linear and Power Functions) — To do: View

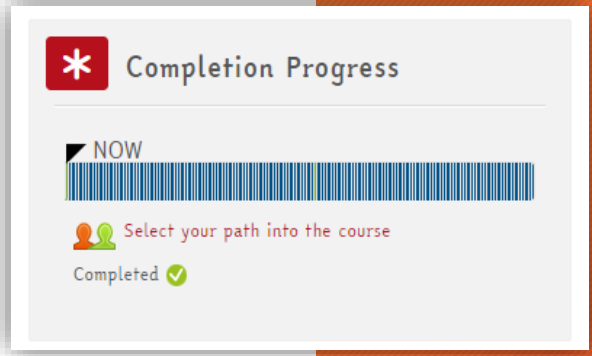
Lesson 1.2.2 (Exponential and Logarithmic Functions) — To do: View

Lesson 1.2.3 (Trigonometric Functions) — To do: View

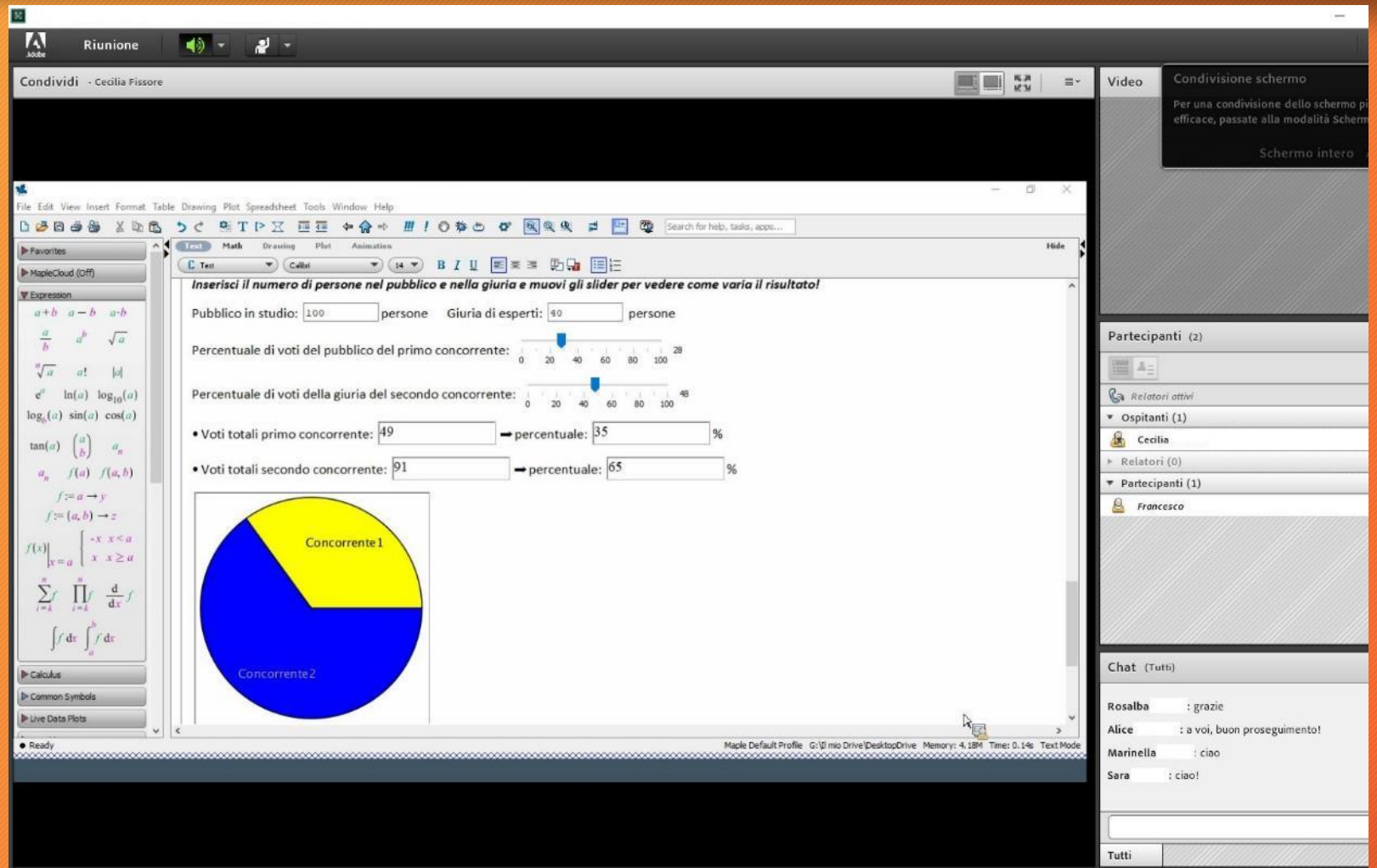
Your turn: Explore the following models related to topics explained in Lesson 1.2.2 .

Explore: Population growth — To do: View

Explore: Richter scale — To do: View



Web conference tool

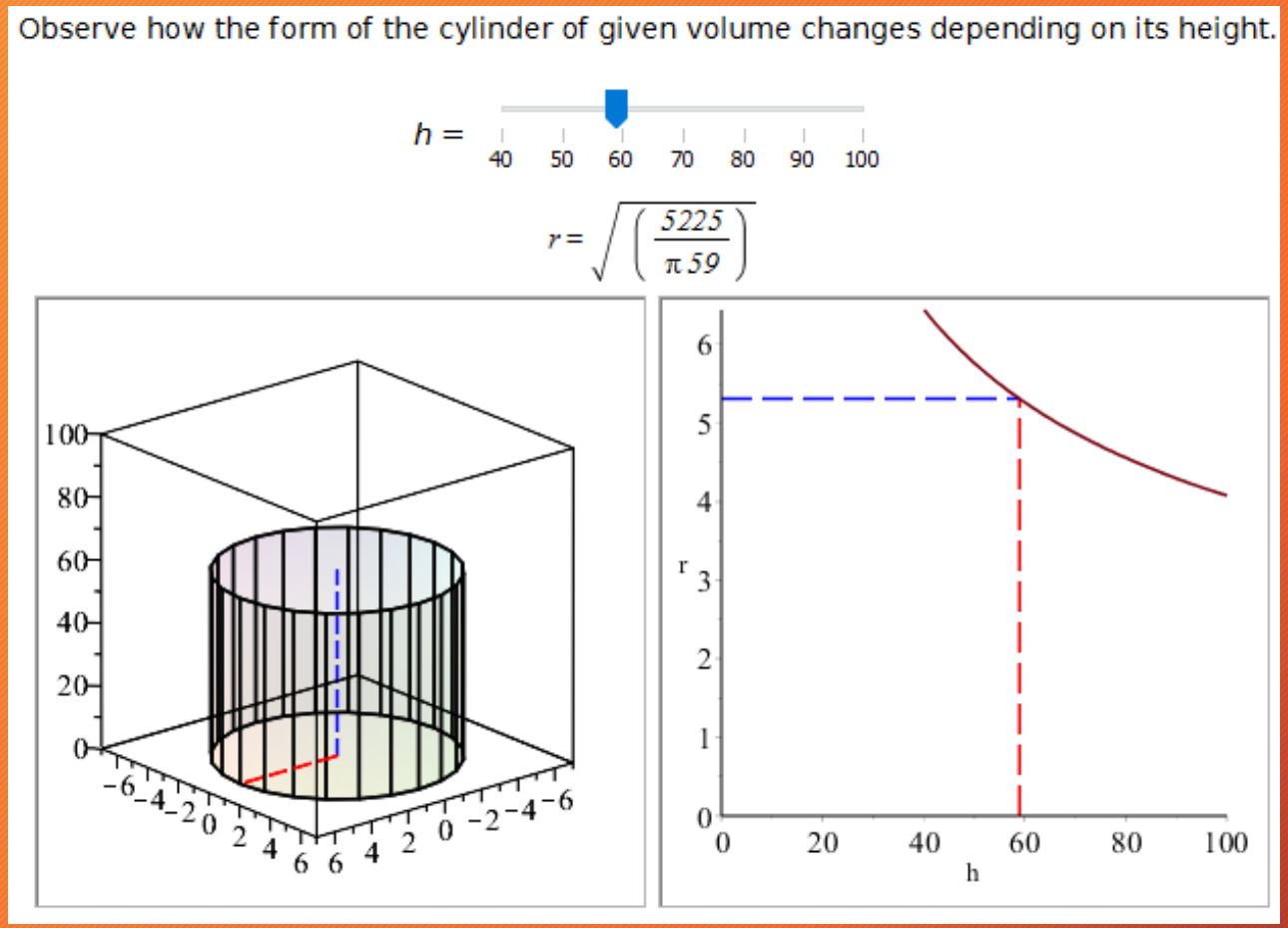


Advanced Computing Environment (ACE)

System which allows to embed in a single worksheet:

- **text**
- **numeric** computations
- **symbolic** calculus
- geometric **visualizations**
- **interactive components**
- algorythms and **procedures**

FLEXIBLE TOOL FOR STEM



Advanced Computing Environment (ACE)

ACTIVE USE of the ACE

- Students actively use the ACE to solve problems

INTERACTIVE USE of the ACE

- Teachers create interactive worksheets and make them available to students through the DLE

Thanks to the integrated platform, the worksheets can be uploaded in the platform and visualized without having the software installed, maintaining the **interactivity**.

- To overcome difficulties
- To boost Math competence
- To develop Problem Solving skills
- To study, review, understand theoretical concepts

Automatic Assessment System

Question 3: *Score 1/1*

Question type: Mathematical Formula

Quali sono i vertici dell'ellisse di equazione $\frac{x^2}{9} + \frac{y^2}{16} = 1$?

Correct

Elenca tutti i punti separati da ;

Esempio: (0,1); (1,0); (1,1)

Your Answer: (0,4);(0,-4);(3,0);(-3,0)

Correct Answer: (3,0); (-3,0); (0,4); (0,-4)

Comment:

Question 4: *Score 0/1*

Your response	Correct response
Trova lo zero della funzione	Trova lo zero della funzione
f(x) = $\frac{\ln(x-1)}{x}$.	f(x) = $\frac{\ln(x-1)}{x}$.
X = 0 (0%)	X = 2

Incorrect

Total grade: 0.0×1/1 = 0%

Comment:

Question 5: *Score 1/1*

Question type: Maple-Graded

Scrivi l'equazione della circonferenza di centro (0, 0) e raggio 3 .

Correct

Your Answer: x^2+y^2-9=0

Correct Answer: x^2+y^2 = 9

Comment:

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.

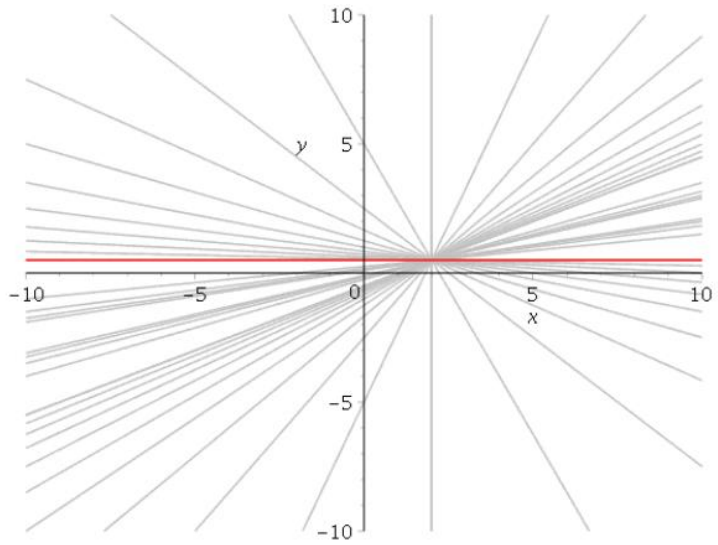
Equation Editor

a^b $\sin(a)$ $\frac{\partial}{\partial x} f$

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

Grade Refresh Close

Preview



Close

Adaptivity

Immediate feedback

Algorithm based questions

Open Math answers

Automatic Assessment System

Look at the following equality:

$\left(\frac{1}{4}\right)^{-4} = \frac{1}{4^4}$

Is it correct or incorrect?

- It is correct.
- It is incorrect.

Correct response:

It is incorrect.

The equality is incorrect.

To simplify the power, we need to use the following property:

$\left(\frac{a}{b}\right)^{-n} = ($ b/a $)^{n}$

Correct response: b/a

Use the symbol / to write a fraction. E.g.: a/b

Thus the result is the following: $\left(\frac{1}{4}\right)^{-4} = ($ 4 $)^{4} =$ 256

Correct response: 4

Correct response: 256

Use the symbol ^ to write an exponent. E.g.: 3^2

Step-by-step solving processes

Automatic Assessment System

A mountain spring constantly feeds a tank with 5 m^3 of water each week. Today the tank contains 160 m^3 of water and a village starts getting 9 m^3 of water each week.

Complete the following table with the number n of m^3 of water that the tank contains in function of the number t of weeks, starting from today.

t (weeks)	n (m^3)
0	160
1	156
2	152
3	148
4	144

Write an expression representing the number n of m^3 of water that remain in the tank, in function of the numerb t of weeks.

$n(t) =$ 160-4t

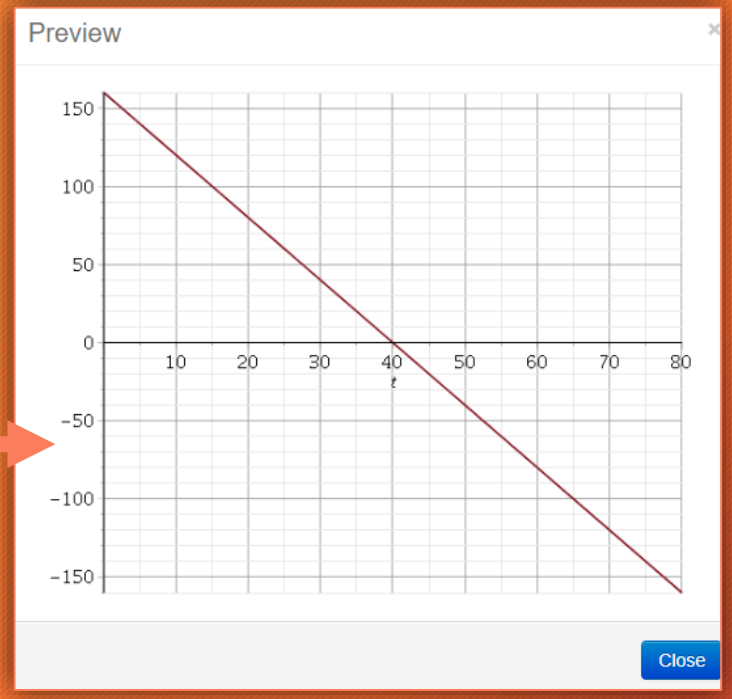
Correct response: 160-4*t

After how many weeks will the tank be empty?

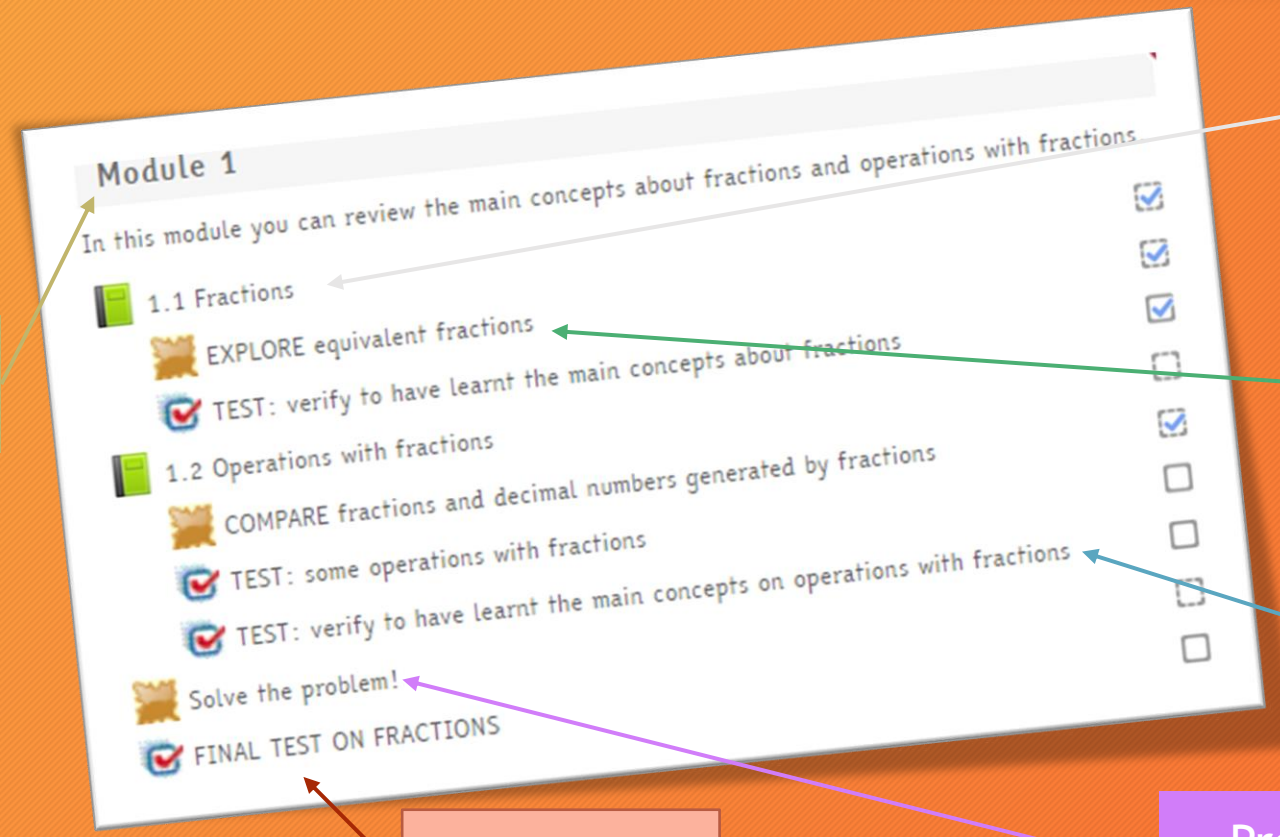
40

Multiple representations

Real-world problems



Integrated virtual learning environment



Modular structure

Review of the theory

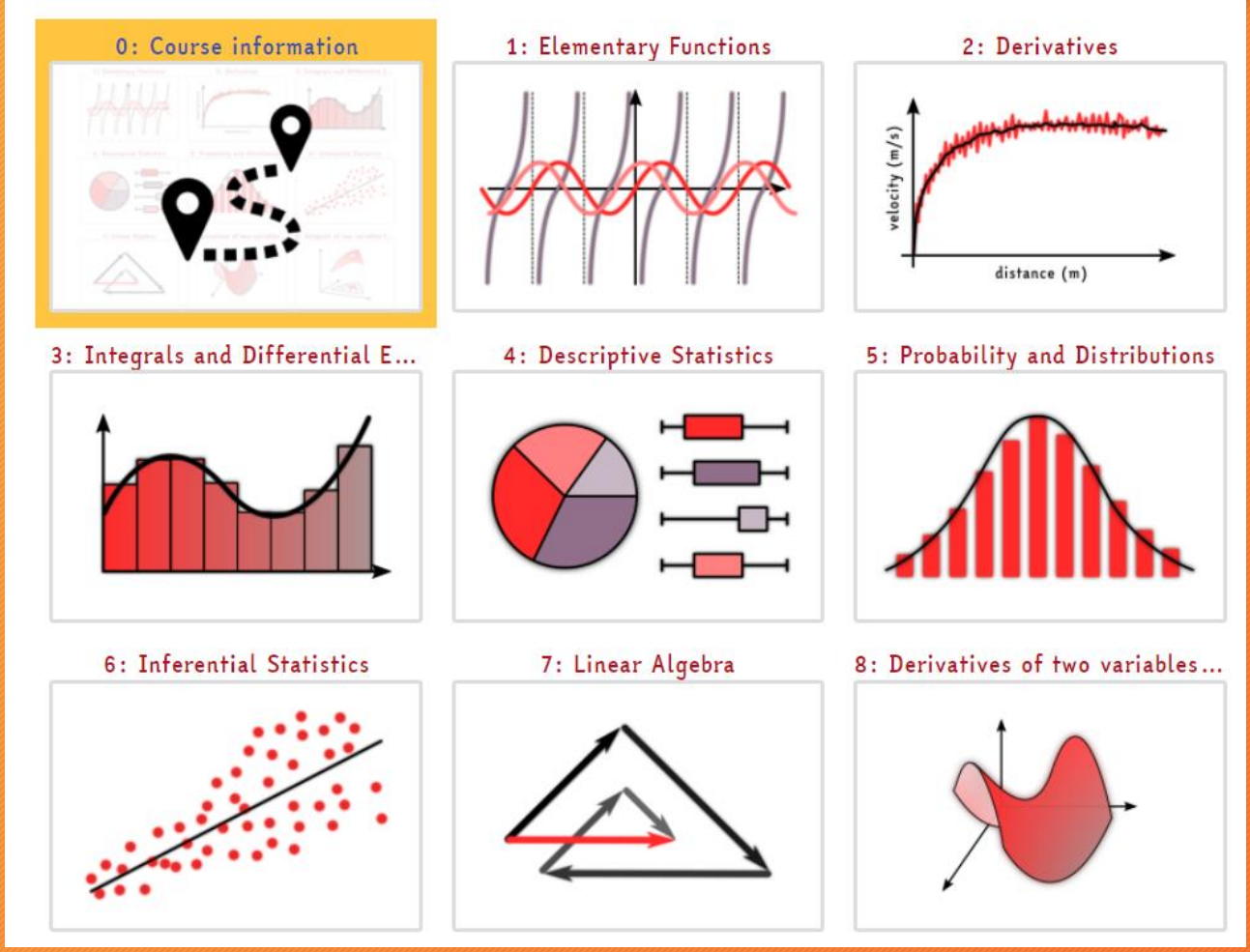
Explorative interactive activities

Automatic assessment

Problem Solving

Final tests

Integrated virtual learning environment



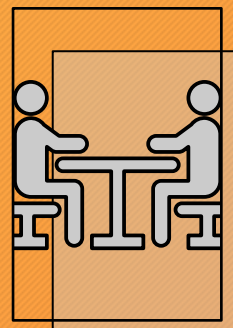
ACTIVITIES

- Interactive files
- Quiz
- Forum
- Glossary
- Submission of assignments
- Online meeting
- ...

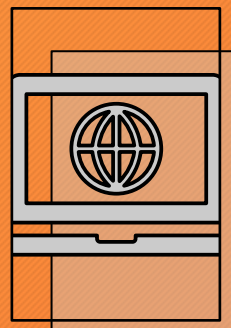
RESOURCES

- Static pages
- Pdf files
- Videos
- Podcast
- Url
- ...

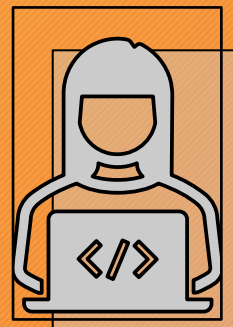
Teaching and learning modalities in a DLE



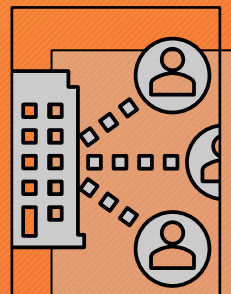
Face-to-face



Online



Blended



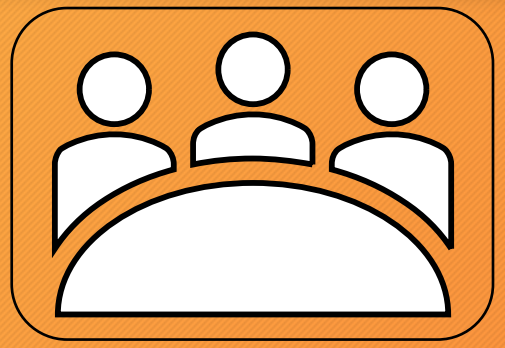
Hybrid

Time of the activities in a DLE

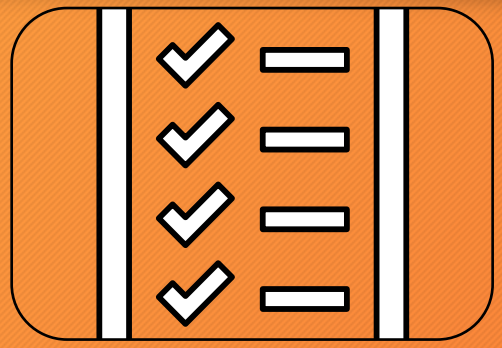
Syncronous

Asynchronous

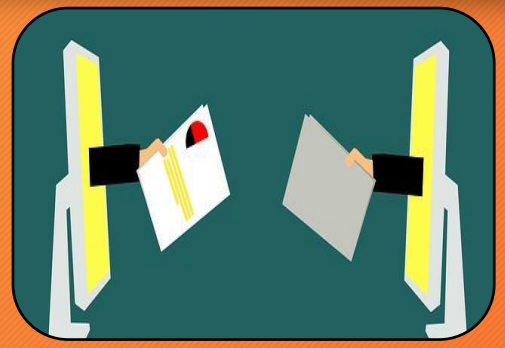
Asynchronous activities



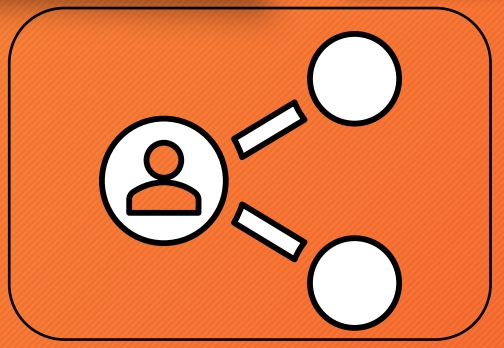
Discussions



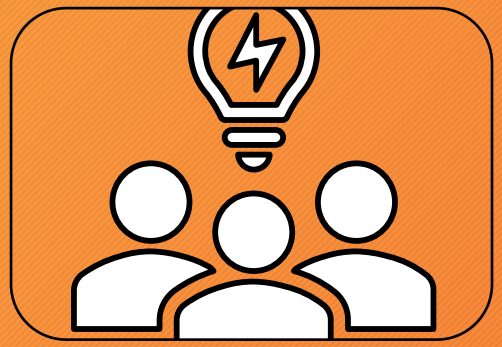
Automatic assessed tests



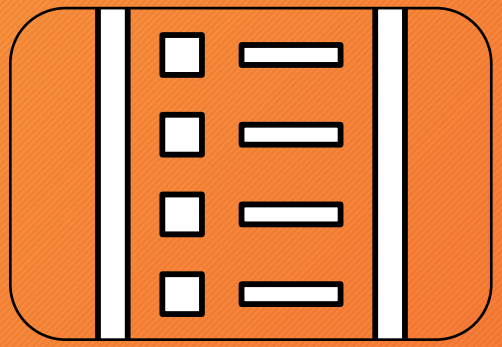
Submission of assignments



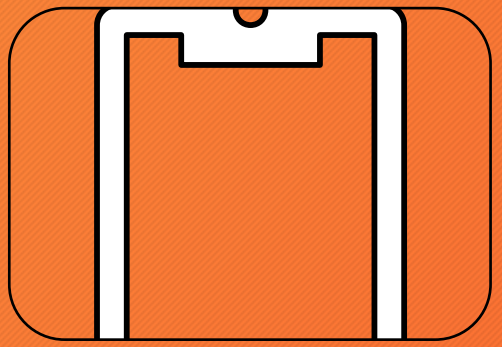
Shared materials



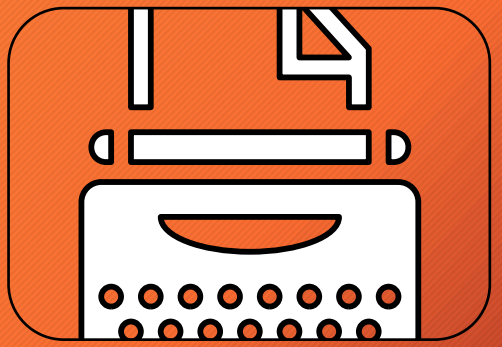
Workshops



Questionnaires



Surveys



Logbook

Functions of a DLE

Creating and managing courses and activities

Delivering and displaying activities and resources

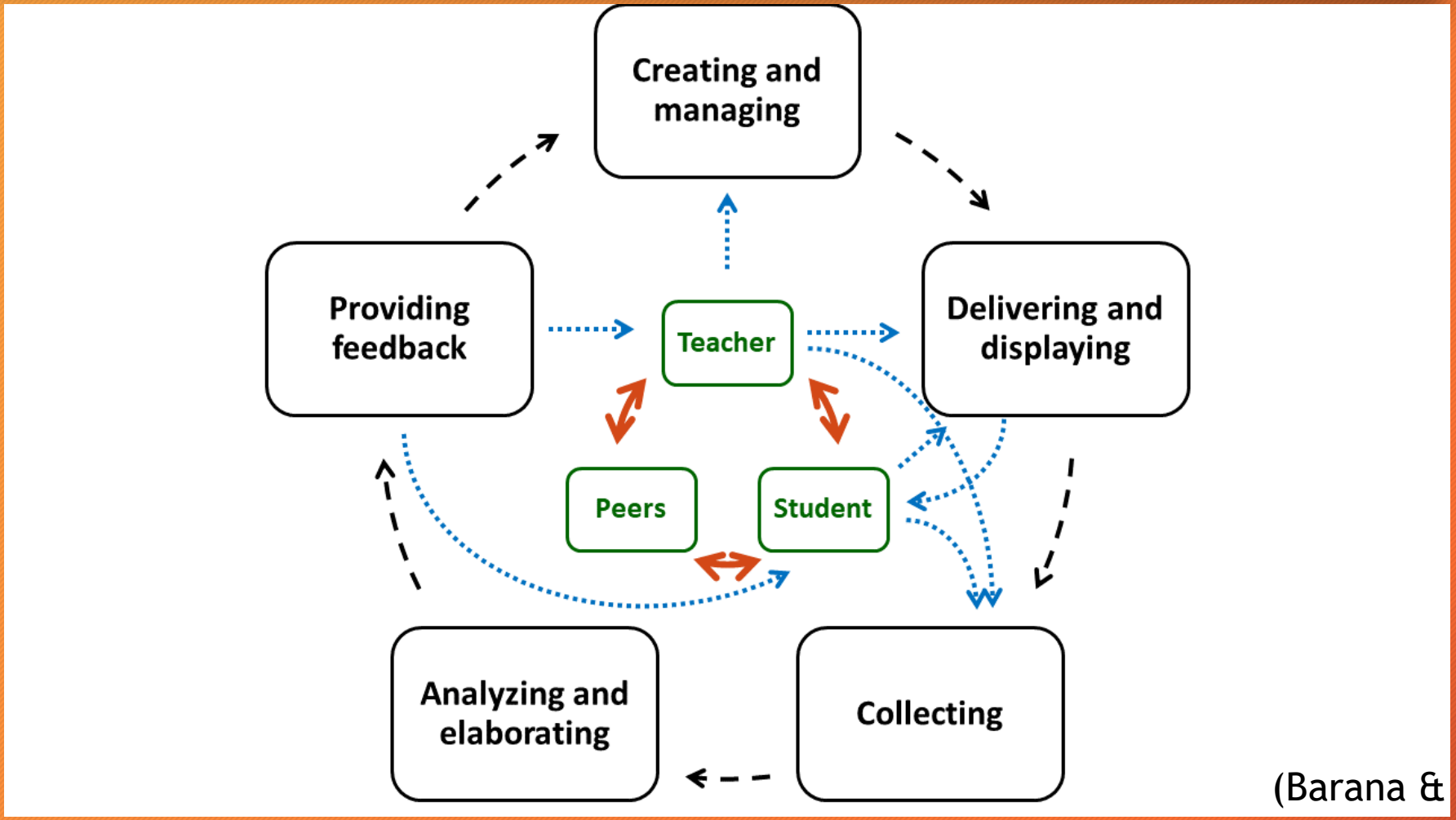
Collecting qualitative and quantitative data

Analyzing and elaborating data and answers

Providing feedback to students and teachers

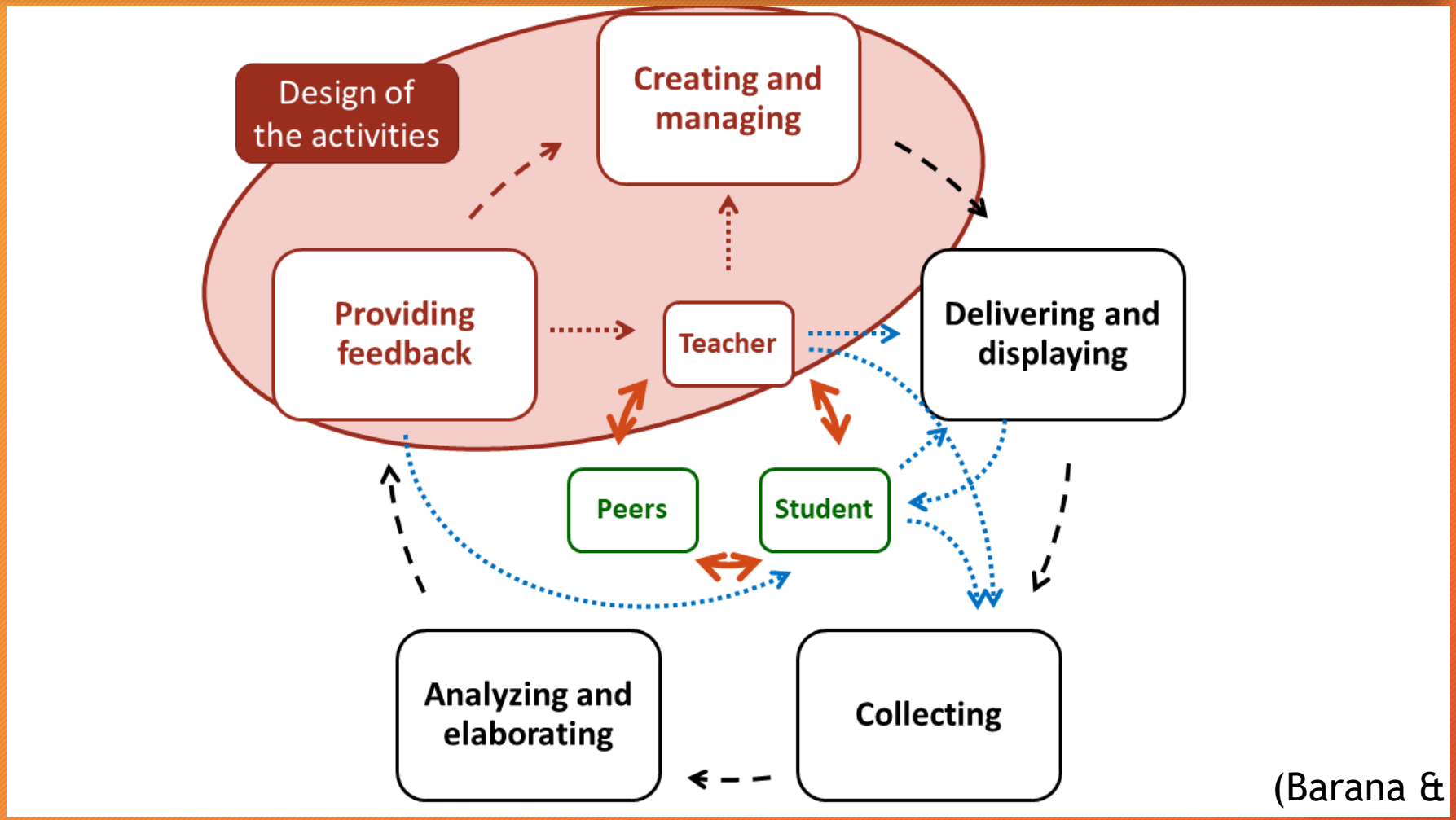
(Barana & Marchisio, 2021)

Modelling interactions in a DLE



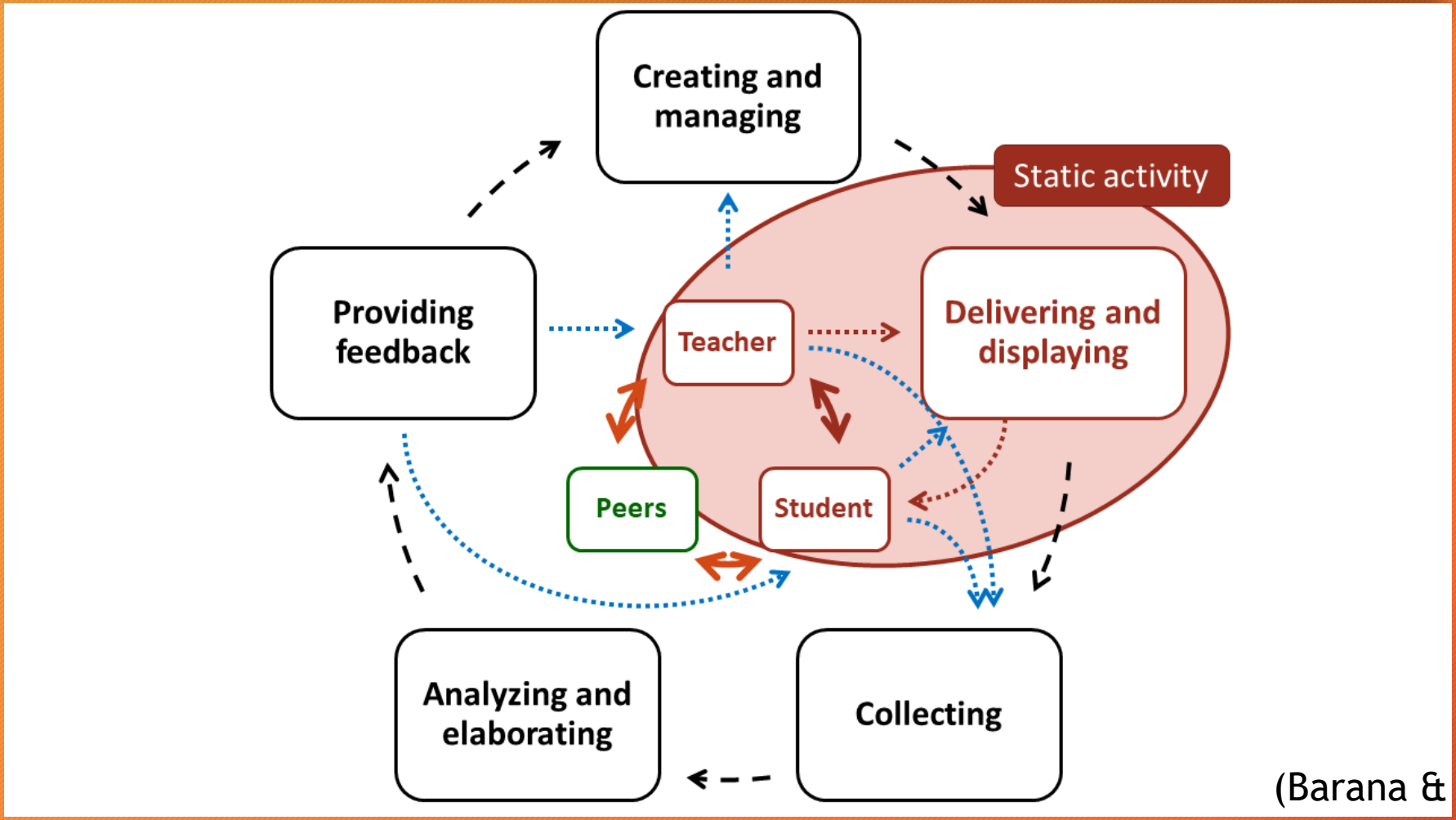
(Barana & Marchisio, 2021)

Modelling interactions in a DLE



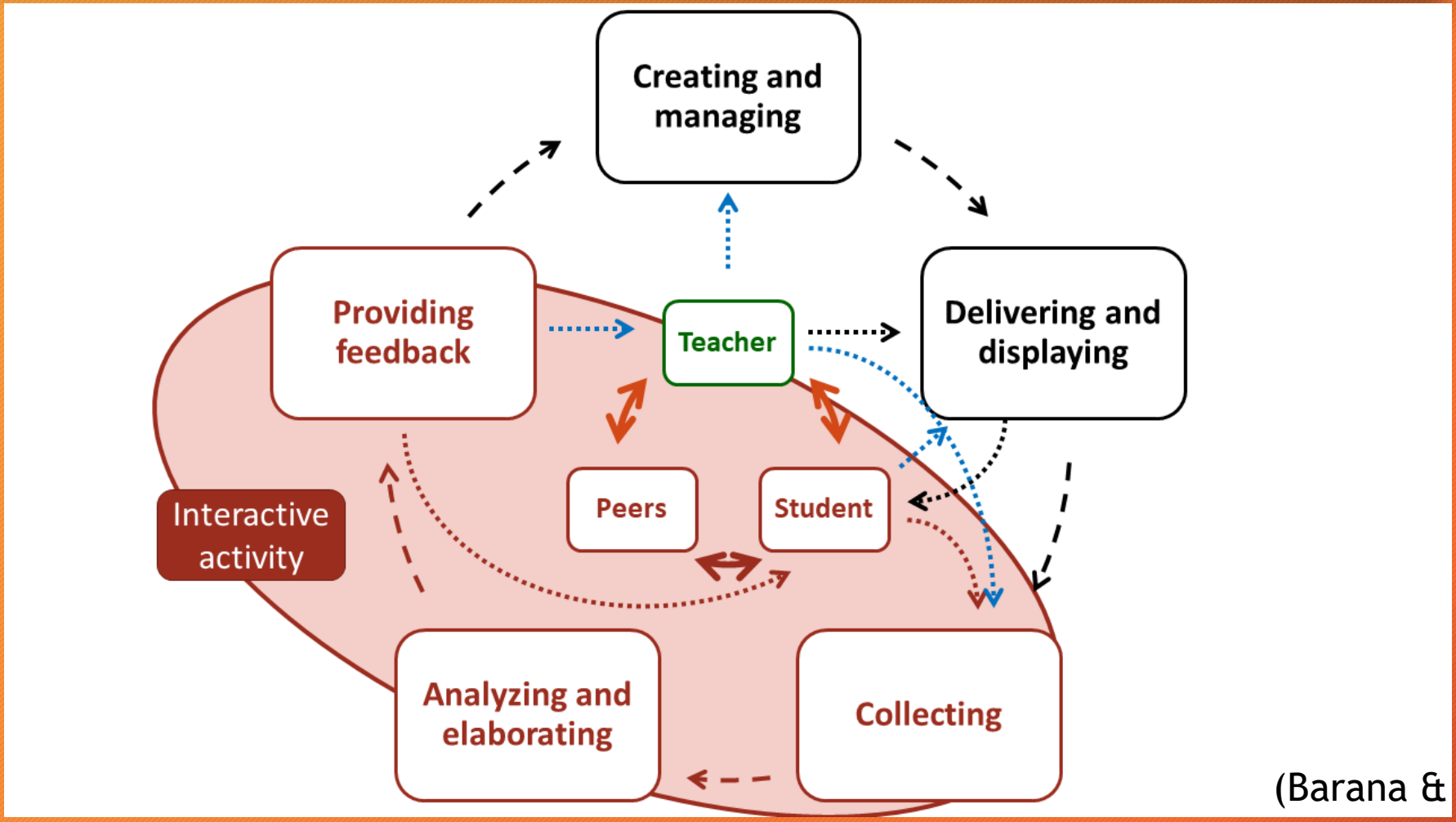
(Barana & Marchisio, 2022)

Modelling interactions in a DLE



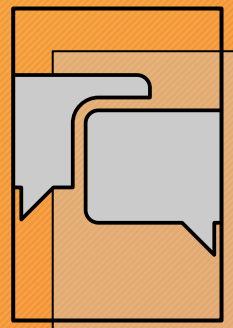
(Barana & Marchisio, 2022)

Modelling interactions in a DLE

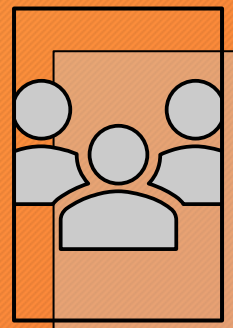


(Barana & Marchisio, 2022)

Outcomes of an integrated DLE



To Create an Interactive Learning Environment



To Support Collaborative Learning

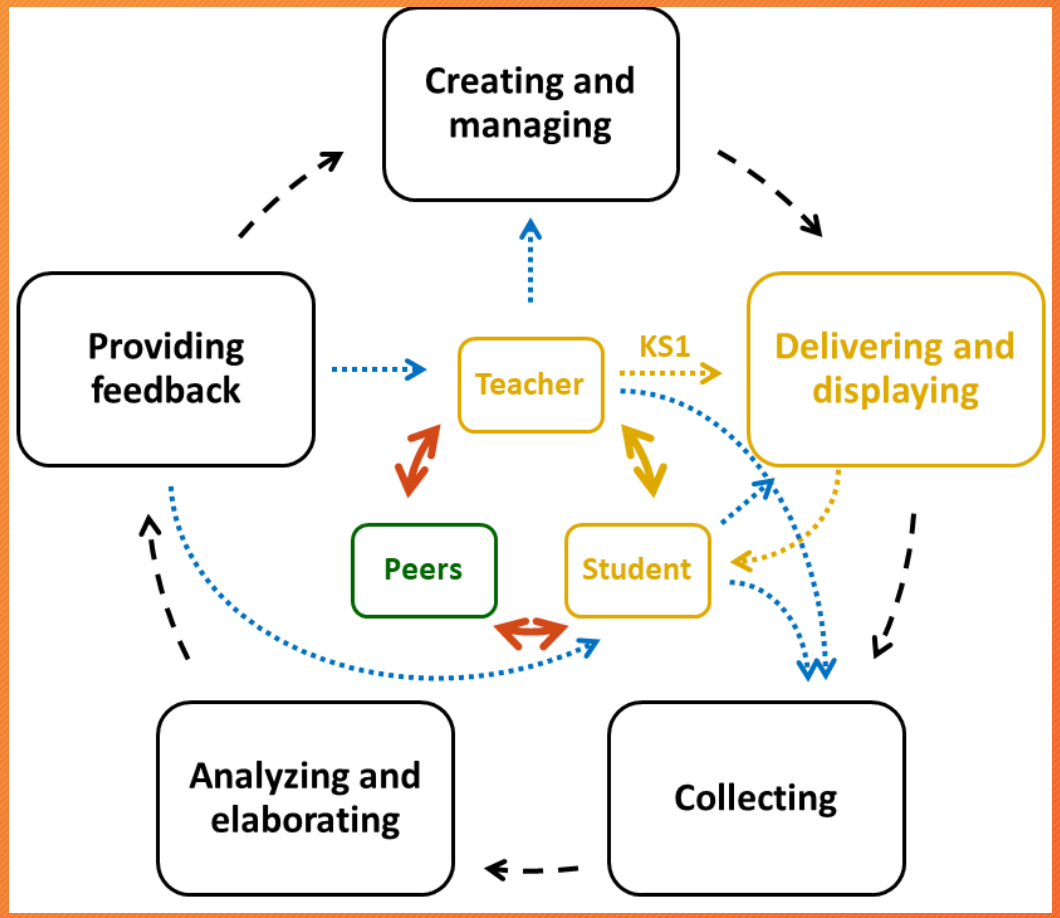
To Promote Formative Assessment

(Barana & Marchisio, 2022)

Example

"Look at this figure. Write the formula which expresses how the area of this figure varies when *a* varies. That is, how long is this side?"

It's *a*.



DLE:

- LEARNING COMMUNITY: teachers and students
- TECHNOLOGIES: IWB, computers, LMS integrated with an AAS for Mathematics
- INTERRELATIONSHIPS: formative assessment, classroom discussion

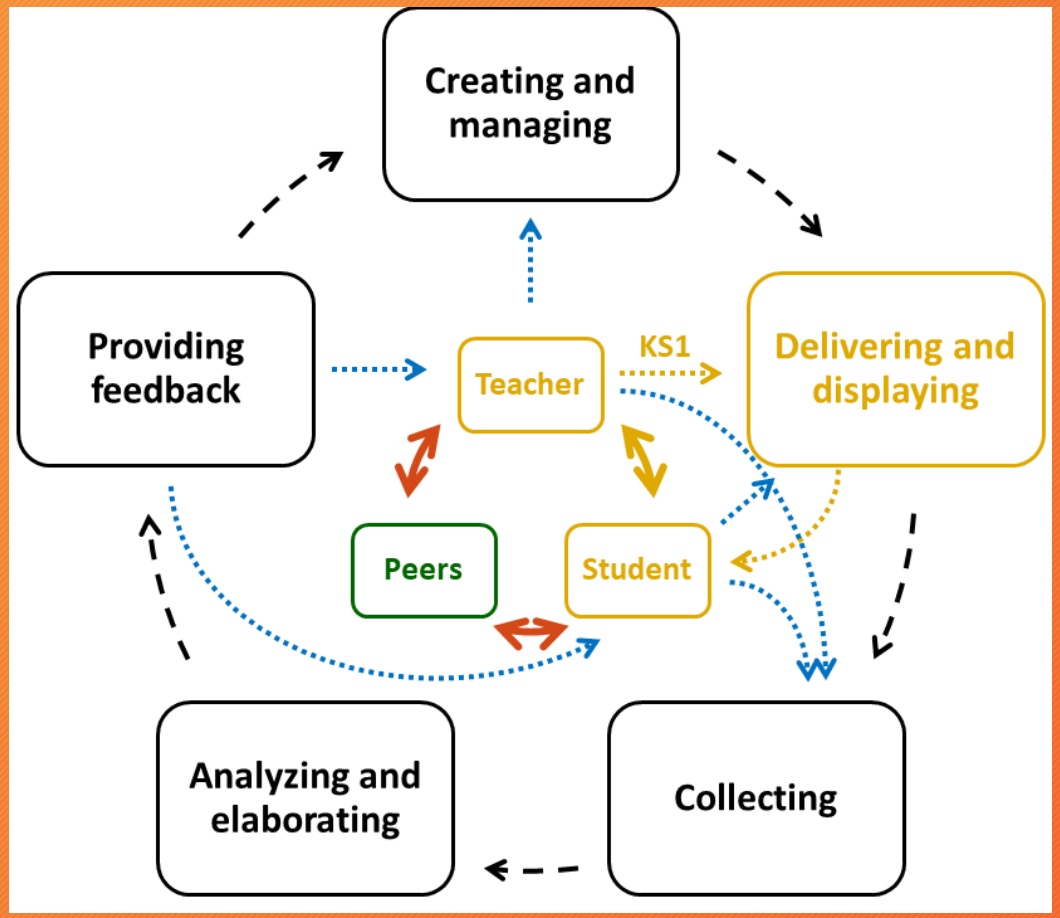
MODALITY: face-to-face

(Barana & Marchisio, 2022)

Example

Well, you have to compute the area of this figure using *a*. Those sides measure *a*. What does it mean? What is *a*?

A variable.



DLE:

- LEARNING COMMUNITY: teachers and students
- TECHNOLOGIES: IWB, computers, LMS integrated with an AAS for Mathematics
- INTERRELATIONSHIPS: formative assessment, classroom discussion

MODALITY: face-to-face

(Barana & Marchisio, 2022)

Example

We have to compute the area, but we don't have any data!

But we have *a*.

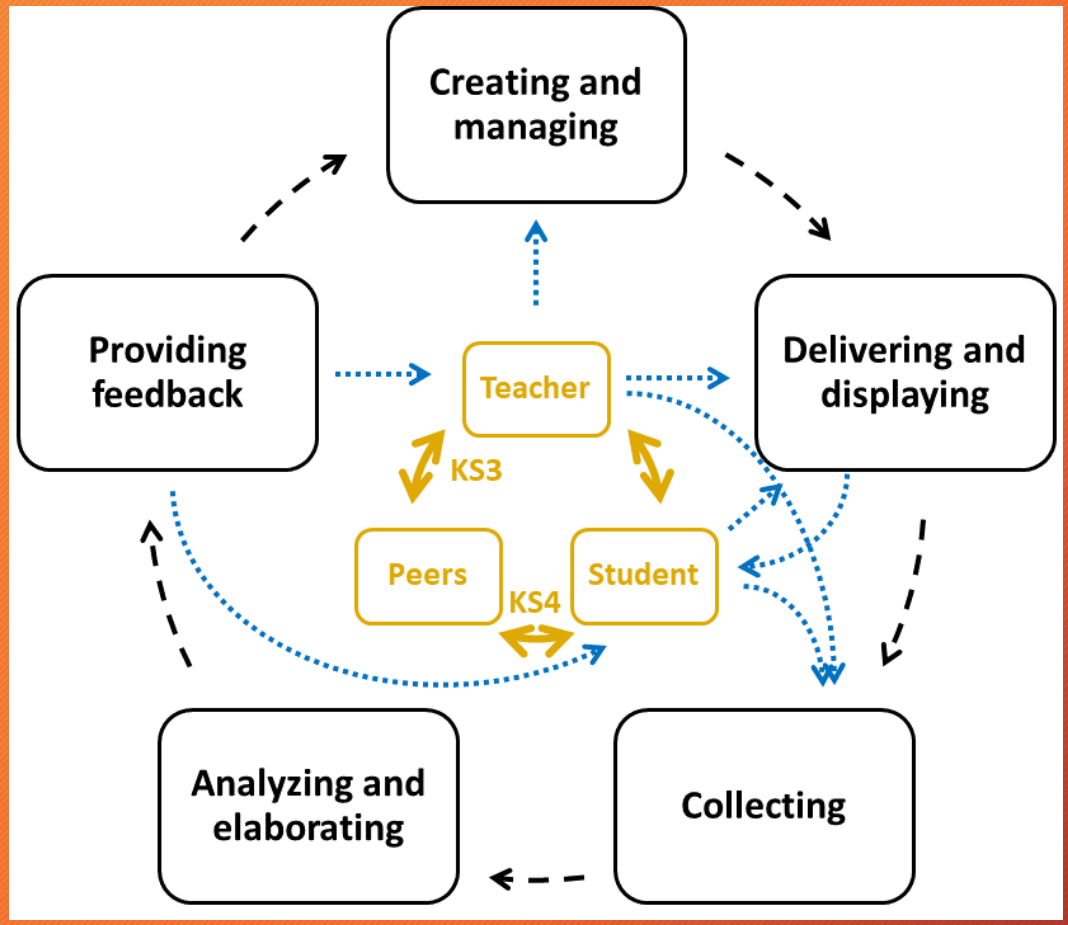
But *a* is not a number!

Ok, but we can compute the area using *a*.

Teacher, how can we compute the area without numbers? Can we use a?

Yes, it is like a generic number.

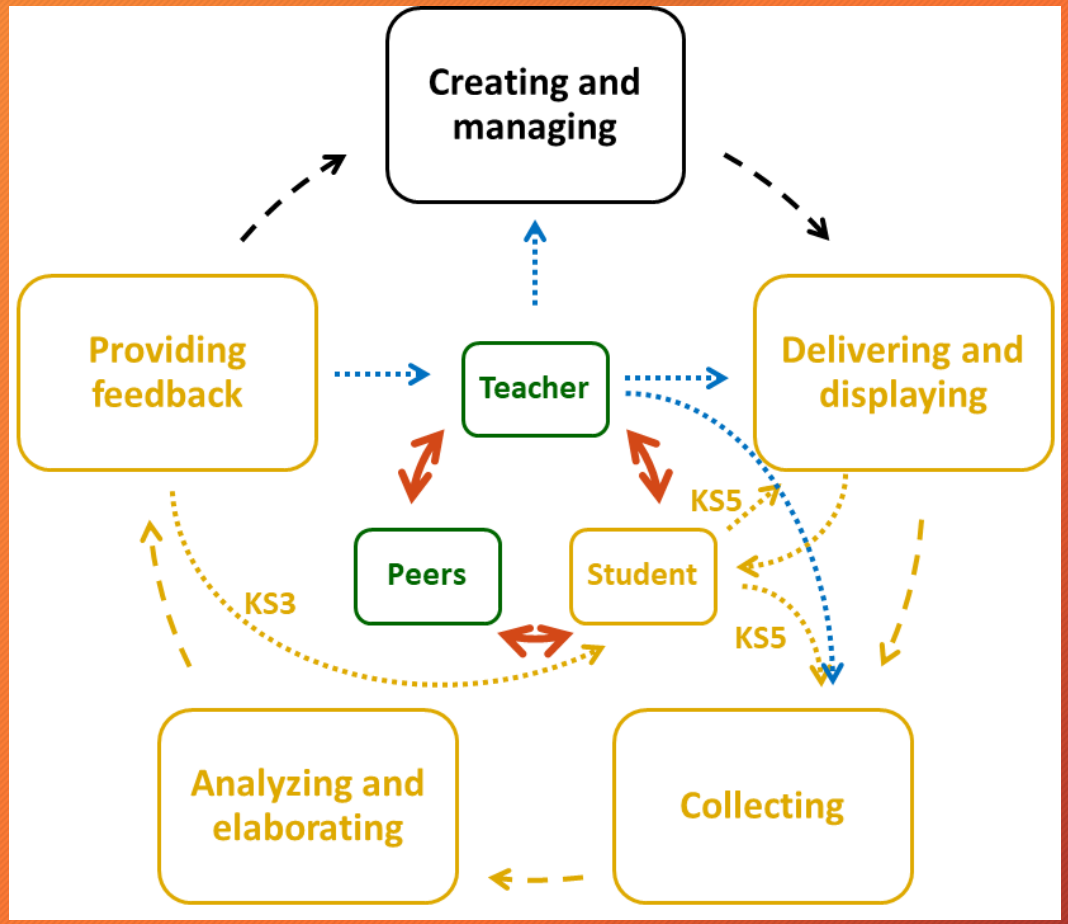
We have to write a formula using *a*, isn't it?



(Barana & Marchisio, 2022)

Example

$$\text{Area} = ((a+a)\cdot(a+a)) - \sqrt{a^2+a^2}\cdot\sqrt{a^2+a^2}$$



(Barana & Marchisio, 2022)

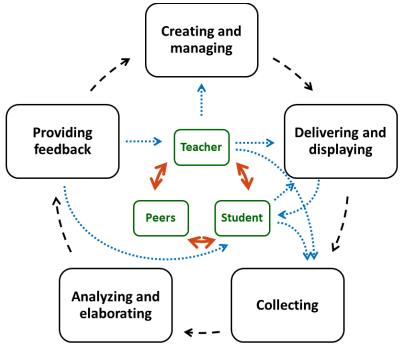
ACTIVITY - PART 1

Think about a learning situation in a Digital Learning Environment that you experienced in your career. Try to model the DLE and the interactions occurring through the given framework.

COMPONENTS:
✓Learning community: _____
✓Technologies: _____
✓Methodologies/interactions: _____

MODALITY (face-to-face, blended, online, hybrid): _____

DIAGRAM OF THE INTERACTIONS:



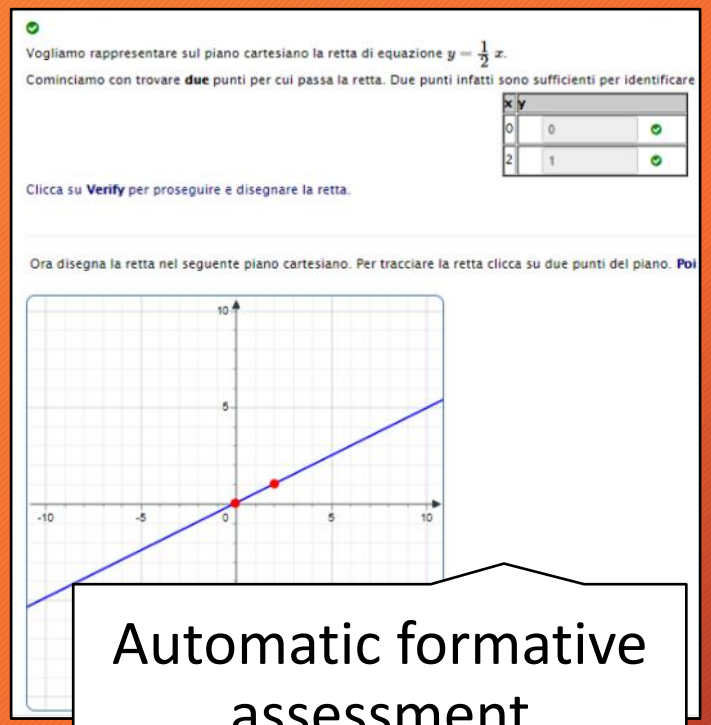
WHAT OUTCOMES HAVE BEEN ACCOMPLISHED?
- ❑ To Create an Interactive Learning Environment
- ❑ To Support Collaborative Learning
- ❑ To Promote Formative Assessment

Advantages of using a DLE

For teachers…

Practice community

Adaptive teaching



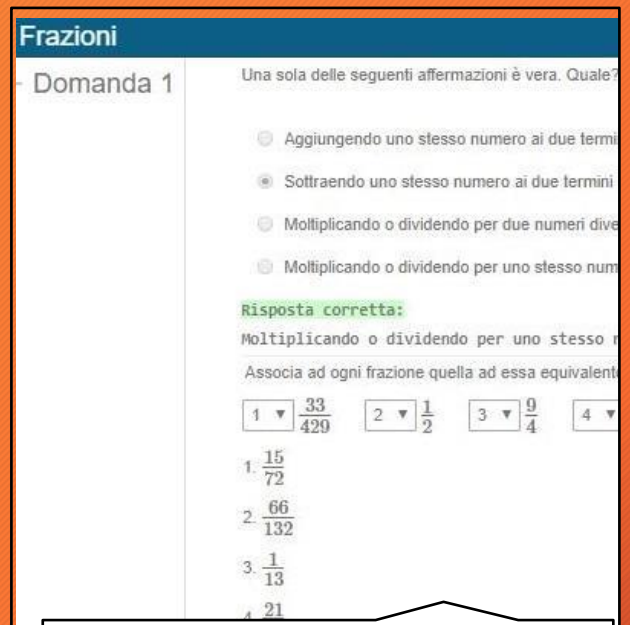
Automatic formative assessment

Advantages of using a DLE

For learners…

Learning community

Adaptive learning



Automatic and interactive feedback

Theoretical frameworks to build DLEs

Different terms, different concepts

Emergency education

Distance education

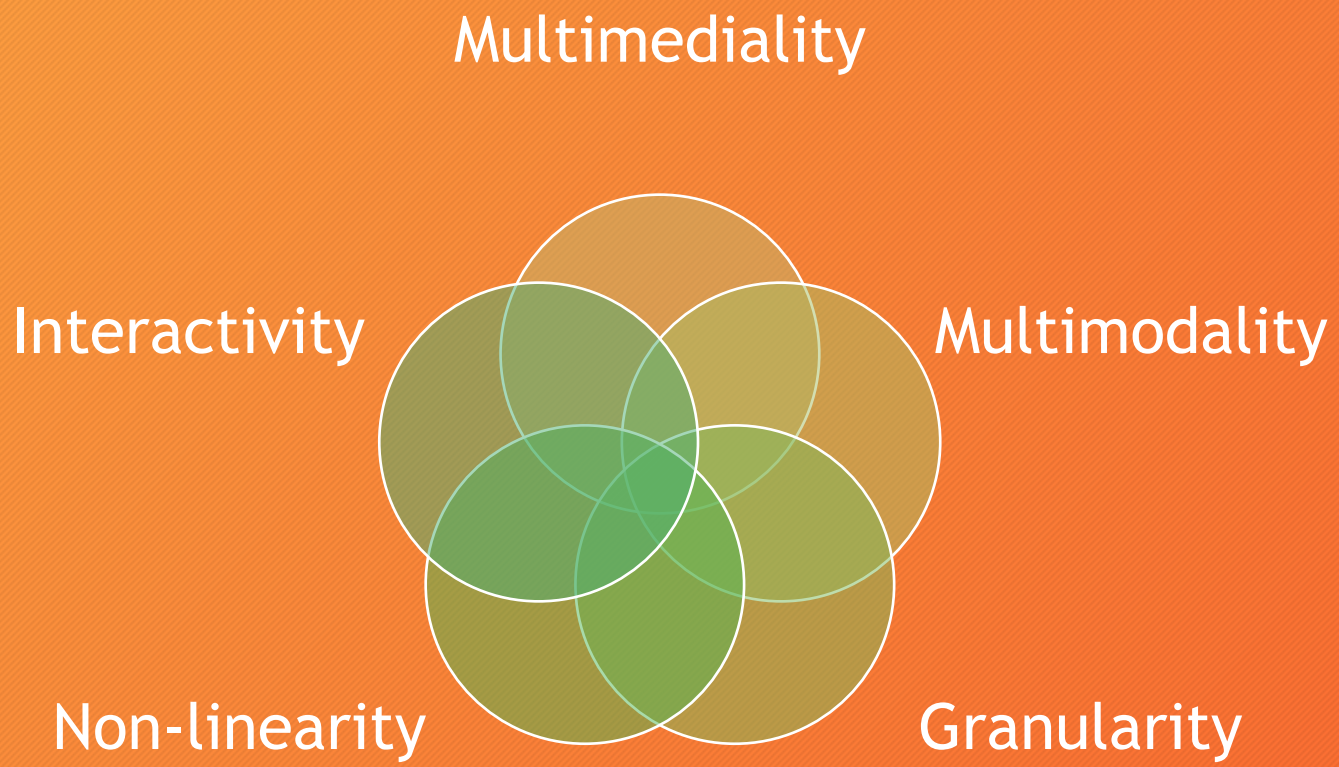
Online/digital education

4 “A” in education

Human Rights Obligations in Education

- ✓ Acceptability
- Accessibility
- Adaptability
- Availability

Online didactics



Characteristics of online resources

- Schematism
- Syntattic semplicity
- Visual impact
- Brevity
- Heading
- Thematic compactness
- Engaging

Constructivist DLEs

*Learning is a **lifelong active process of knowledge building** mediated by experiences and relations with the environment and the community*

(von Glasersfeld, 1989)

Constructivist DLEs

Technology can support the creation of constructivist digital environments through

- computer mediated **communication**
- computer supported **collaborative work**
- **case based** learning environments
- computer supported **cognitive tools**

(Jonassen, et al., 1995)

Example: the Digital Math Training Project

Challenging real-world math problem

Forum to discuss about how to solve the problem

Submission of students' solutions

Self-assessment questionnaire

Interactive solution

Example: the Digital Math Training Project

Case-based learning environment

Computer supported collaborative work
Computer mediated communication

Case-based learning environment

Computer supported cognitive tools

Computer supported cognitive tools

Constructivist DLEs

7 goals for building learning environments

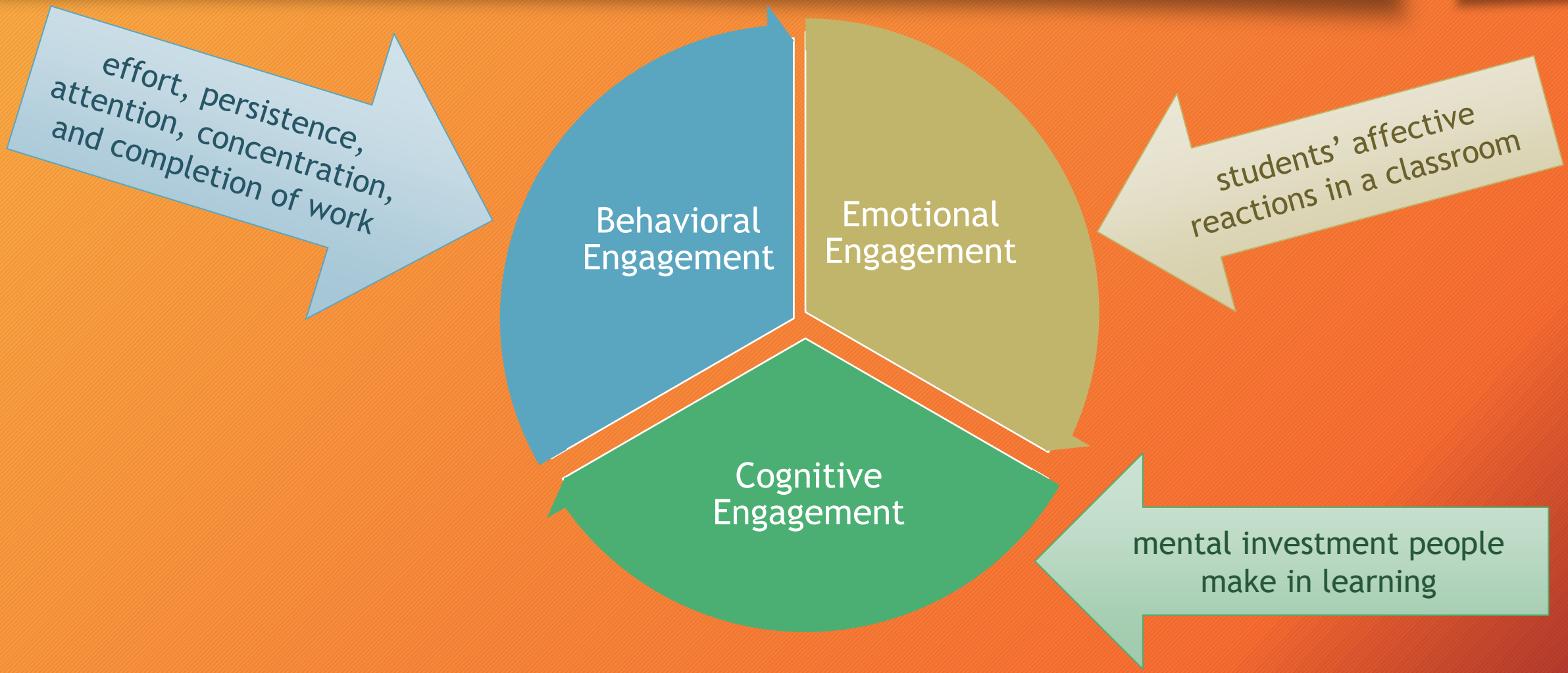
(Honebein, 1996)

- to provide experience with the **knowledge construction** process
- to provide experience in and appreciation of **multiple perspectives**
- to embed learning in **realistic and relevant contexts**
- to encourage **ownership and voice** in the learning process
- to embed learning in **social experience**
- to encourage the use of **multiple modes of representation**
- to **encourage self-awareness** in the knowledge construction process

Constructivist DLEs

to provide experience with the **knowledge construction** process	Problem Solving Interactive activities
to provide experience in and appreciation of **multiple perspectives**	Explorations Interactive feedback
to embed learning in **realistic and relevant contexts**	Real-world problems
to encourage **ownership and voice** in the learning process	Interactive activities Automatic assessment
to embed learning in **social experience**	Classroom activities Forum discussions
to encourage the use of **multiple modes of representation**	Explorations Algorithmic questions
to **encourage self-awareness** in the knowledge construction process	Immediate feedback Self-assessment

Engagement


effort, persistence, attention, concentration, and completion of work
Behavioral Engagement
Emotional Engagement
students' affective reactions in a classroom
Cognitive Engagement
mental investment people make in learning

Engagement

Interactive technologies	Low socio-economic status

Approaches to foster equity in Mathematics

- teaching mathematics through more **open-ended, collaborative, problem-solving** approaches, with students in mixed-ability groups (Boaler, 2008)
- classrooms need to be places where students have the **opportunities to change their current situation**, that is, covering their next step in their learning path (Heritage and Wylie, 2018)
- **metacognitive reflection** helps develop a strong sense of personal agency and identity as competent and confident doers of mathematics (Heritage and Wylie, 2018)
- **peer collaboration** and working in small groups during Mathematics classes were effective for addressing and overcoming language difficulties (Elbers and de Haan, 2005)
- Using **computers** (Nortvedt & Buchholtz, 2018)

Approaches to foster equity in Mathematics

1. employing collaborative, discursive, p**roblem-solving**, and problem-posing pedagogies, which promote the engagement of learners with Mathematics;
2. recognizing and drawing upon learners' **real-life experiences** to emphasize the cultural relevance of Mathematics;
3. promoting mathematical **inquiries** that enable learners to develop greater understanding of their social, cultural, political, and economic situations;
4. facilitating mathematical investigations that develop learners' **agency**, enabling them to take part in social action and realize their foregrounds; and
5. developing a **critical understanding** of the nature of Mathematics and its position and status within education and society to maintain equity in the classroom.

(Wright, 2016)

ACTIVITY – PART 2

Start from the DLE you considered in the previous activity.

How could you change it in order to achieve Honebein's 7 goals for building learning environments?

You can add or change activities, elements, modalities, etc.

1. to provide experience with the knowledge construction process	
2. to provide experience in and appreciation of multiple perspectives	
3. to embed learning in realistic and relevant contexts	
4. to encourage ownership and voice in the learning process	
5. to embed learning in social experience	
6. to encourage the use of multiple modes of representation	
7. to encourage self-awareness in the knowledge construction process	

Thank you for the attention!

Marina Marchisio – marina.marchisio@unito.it

With the patronage of

PUPKEWITZ FOUNDATION

References (1/2)

- Barana, A., & Marchisio, M. (2021). Analyzing interactions in Automatic Formative Assessment activities for Mathematics in Digital Learning Environments. CSEDU 2021. Proceedings of the 13th International Conference on Computer Supported Education, 1, 497–504.
- Barana, A., Marchisio, M. (2022). A model for the analysis of the interactions in a Digital Learning Environment during mathematical activities. In Csapó, B., Uhomoibhi, J. (eds), Computer Supported Education. CSEDU 2021 (pp. 429–448). Communications in Computer and Information Science, vol 1624. Springer, Cham.
- Boaler, J. (2008). Promoting 'relational equity' and high mathematics achievement through an innovative mixed-ability approach. British Educational Research Journal, 34(2), 167–194.
- Elbers, E., & de Haan, M. (2005). The construction of word meaning in a multicultural classroom. Mediational tools in peer collaboration during mathematics lessons. European Journal of Psychology of Education, 20(1), 45–59.
- Heritage, M., & Wylie, C. (2018). Reaping the benefits of assessment for learning: Achievement, identity, and equity. ZDM, 50(4), 729–741.

References (2/2)

- Honebein, P. C., 1996. Seven Goals for the Design of Constructivist Learning Environments. In: Constructivist Learning Environments. Educational Technology Publications, New York, pp. 11–24.
- Jonassen, D., Davidson, M., Collins, M., Campbell, J., Haag, B. B., 1995. Constructivism and computer-mediated communication in distance education. American Journal of Distance Education 9(2), pp. 7–26.
- Nortvedt, G. A., & Buchholtz, N. (2018). Assessment in mathematics education: Responding to issues regarding methodology, policy, and equity. ZDM, 50(4), 555–570.
- von Glasersfeld, E., 1989. Constructivism in Education. In: Husen, T., Postlethwaite, T.N. (Eds.), The International Encyclopedia of Education. Pergamon Press, Oxford/New York, pp. 162–163.
- Wilson, B. G. (1995). Metaphors for instruction: Why we talk about learning environments. Educational Technology, 35(5), 25–30.
- Wright, P. (2016). Social justice in the mathematics classroom. London Review of Education, 14(2), 104–118.