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New Tools for laboratory teaching in Pre- and Primary Schools

Research group

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The School and the Maker Movement

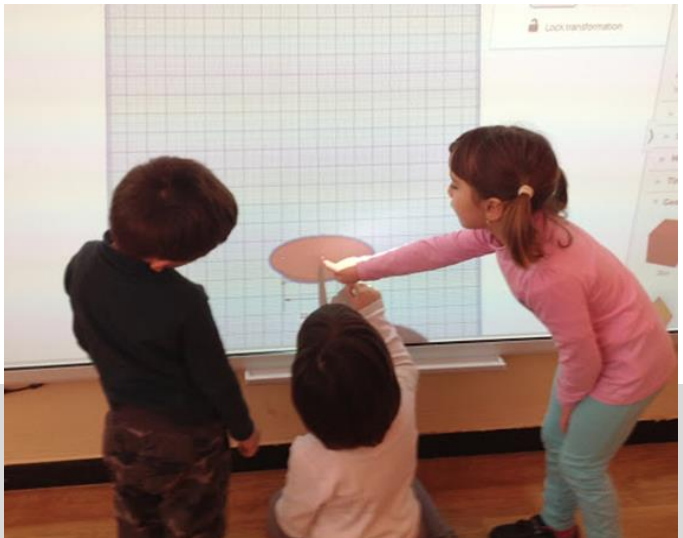
- It recalls the «Digital Fabrication Labs», environments where processes typical of «computation», «thinking» and «engineering» come together;
- It is based on a culture substrate which combines the artisanal spirit with the EXPERIMENTAL GAME/GAMING (Honey & Kanter, 2013);
- It defines educational activities in appropriate social and collaborative «doing» spaces (makerspaces), where anyone can contribute to innovation (Hatch, 2014, p. 10);
- It enhances the natural inclinations of children;
- It is based on the value of learning and thinkering by doing (Sharples et al., 2014).
- The elements of the Maker movement can be adapted in order to respond to K-12 FORMAL PATHS (Blikstein, 2013; Halverson & Sheridan, 2014)
- It recalls the FabLearn Labs Assessing the "Makers and the project-based learning (Worsley, M. & Blikstein, P.)

Maker Pedagogy at school

persistence during a challenge

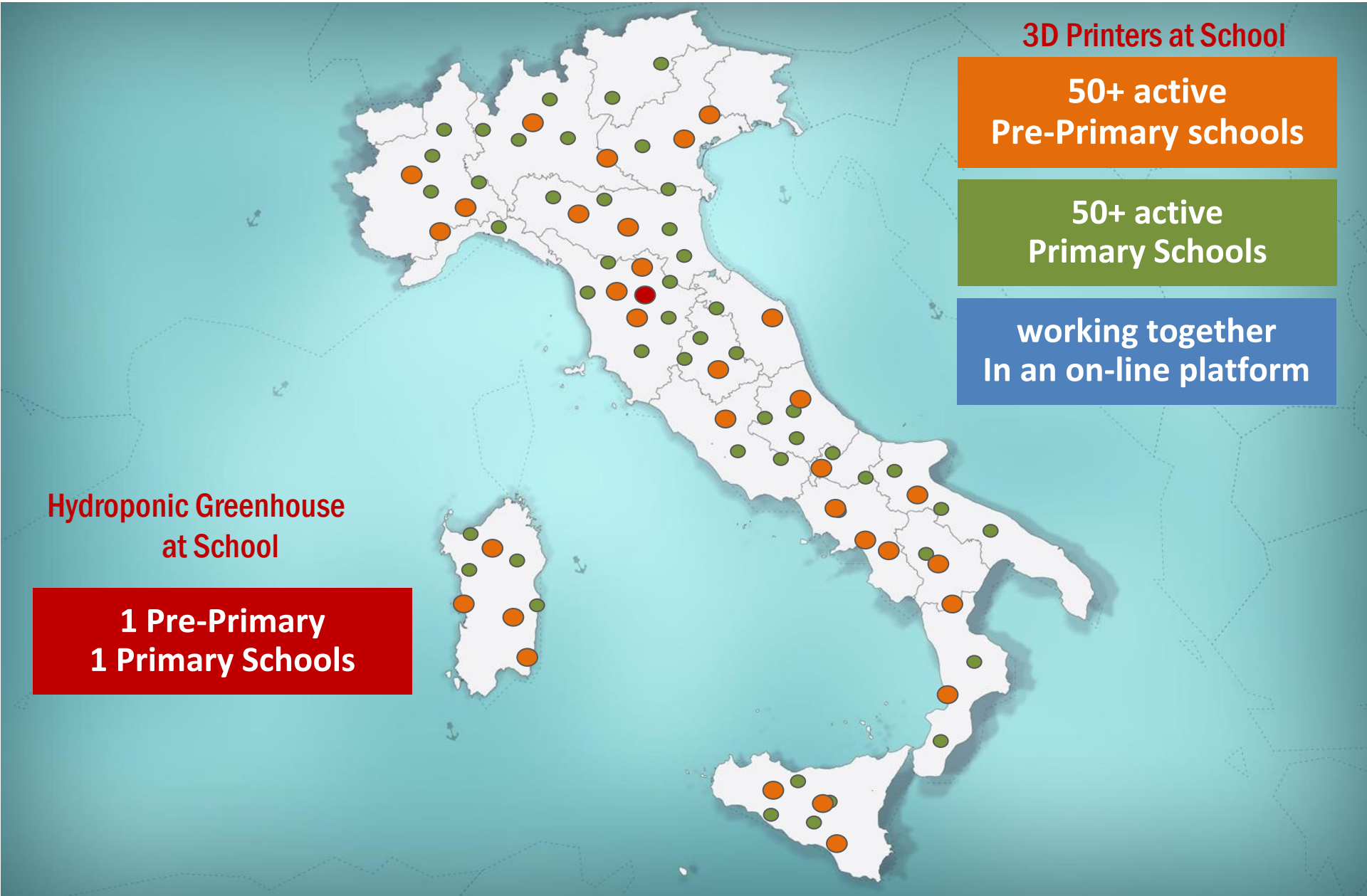
customization

peer feedback



failure = opportunity for improvement

State of the art



3D Printer - Research Questions

An **educational path focused on the 3D printer** in a playful context, working with 5 year old children and older, promotes the development of:

- **Awareness** of the task
- **Logical thinking**
- Foresight capacity for **abstraction**
- **Lateralization** skills
- Ability to **verbalization** of the strategies
- **Metacognitive** skills

GOAL: Identification of the potential use of 3D printing in the kindergarten as a part of educational pathways for the development of skills

3D Printer – in the classroom

INDIRE «Think Make Improve» Method

The TMI stages can be characterized in the following way:

THINK: Problem setting, the teacher allows the children to come up with a design using various materials: play-doh, drawing or maybe LEGO bricks.

MAKE: The project itself is created by using a design software. At this time is when we see the challenge that comes from making the object in the way it was assigned in the previous stage.

IMPROVE: This stage focuses on the object itself, the children reflects on the product realized, making sure if it relates to the object what was designed during the previous phase

In this context, a failure is as an opportunity to improve and enhance the project.

3D Printer - research results and further investigations

Achieved results

- The 3D printer is a tool for **teaching for competence** (think, make, improve)
- Efficacy of 3D printing in supporting the **strengthening of lateralization, logical thinking and abstraction**
- 3D printing stimulates the **attitude to STEM** independent of gender

Research on large numbers

- **Provide** teachers with the "good practices" already validated
- **Co-Research** with teacher to create new assignments based on their experience in class
- **Sustain documentation** so to be **useful example** for other teachers
- **Sustain 3D printer** as real **part** of the **everyday** didactic **activity** in a strict relationship with the curriculum

In order to achieve these aims, create an online environment oriented to self evaluation, peer review, reflection and sharing.

Hydroponic Garden
a tool for scientific inquiry at school

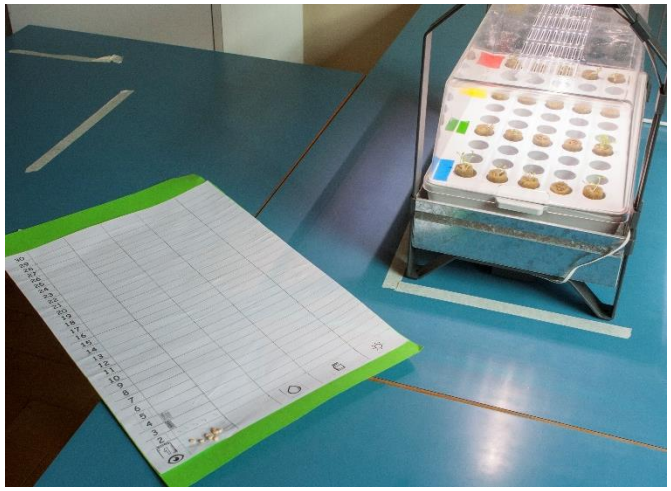
- The research is based on a methodology of laboratory teaching already tested by the research group on the use of 3D printer at school and with the inclusion of the "Bifocal modeling", an approach of investigation on scientific models developed by the University of Stanford.

- The observation of the physical event and the theoretical modeling are used to familiarize with the most common methods of scientific research

Hydroponic Garden
a tool for scientific inquiry at school

The classroom activity is based on the scientific method which involves 3 stages:

- inductive (observation and formulation of hypotheses),
- deductive (formulation of a model)
- hypothesis (formulation of a theory).



The activity promotes the formulation of hypotheses for the purpose of creating a simple scientific model based on direct observation of a natural phenomenon.

Hydroponic Garden - research questions

Experience scientific inquiry as an active process. In the classroom activity, the students:

- Create questions by their own
- Obtaining the supporting evidence to answer the question
- Explain the evidence collected and connect it to the knowledge obtained from the investigative process
- Create an hypothesis for the explanation

This steps are supported by creating models of the process observed.
Learning about the nature and utility of scientific models and engaging in the process of creating and testing models as an important part of science education. Due to this it also creates a better understanding of models and the information provided by them.

Hydroponic Garden - in the classroom

The activity in class is defined by **inquiry cycles**. Every cycle is composed by three main tasks: **observation, modeling** and **forecast** .

Observation (Documentation): Students will be invited to observe the process of growing of the plants and to documentate the collected data.

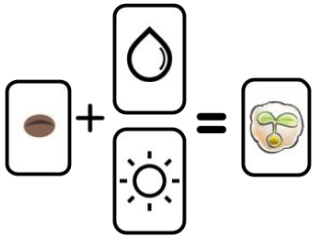
	1 Sprout Plug Nursery	2	3	4	5 Plant Pot Grow Box	6	7	...
	✓	✓	✓	✓	✓	✓	✓	...
	✓	✓	✓	✓	✓	✓	✓	...
					✓	✓	✓	...
		1	1	2	4	5	5	...

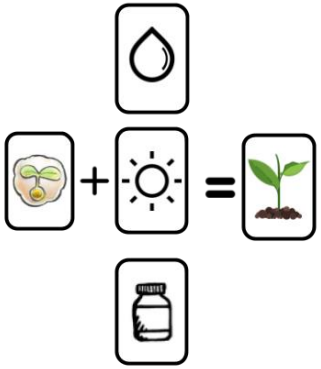
Hydroponic Garden - in the classroom

Modeling (Deduction - Reflection):

Reproduce the process observed in the hydroponic greenhouse in a model.

Important task in this process is the **peer valuation** of the models

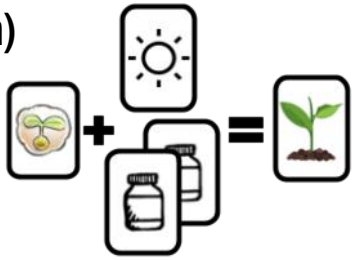




Forecast (Review - Improve):

Definition of a new hypothesis of plant behavior when a variable changes (for example, the relationship between light and growth)

Reproduce the forecast in a model.



Hydroponic Garden - expected results

Science inquiry as an active process:

The activity engage a critical reflection on the observed process. Students are encouraged to sustain and proof their theories. It also stimulate an higher sensibility to environmental sustainability, like the availability of resources in nature and on food waste.

Verbalization:

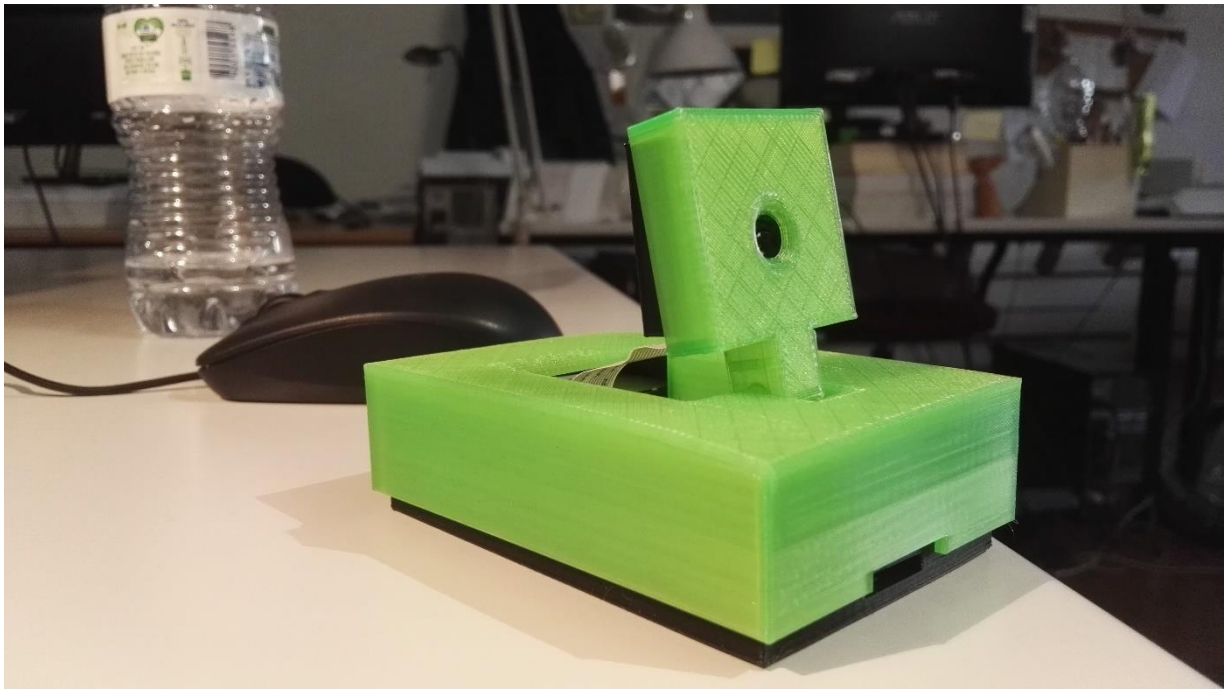
The use of the vocabulary linked to the process of modelling and the inquiry. Observation of the used keywords to explain the model (for. Example variables of the system) or the inquiry questions to define a new hypothesis

Understanding of models:

Students shift from defining models as an exact replica of the observed process to using them to enhance the explanatory power and to obtain the evidence for supporting inquiry theories and forecasts

Parallel research: in3Dire System

It was developed an open source software system and open hardware-based Raspberry Pi to make the design of the pieces to be printed independently by internet and paid software to facilitate work at the schools.



Parallel research: SugarCAD

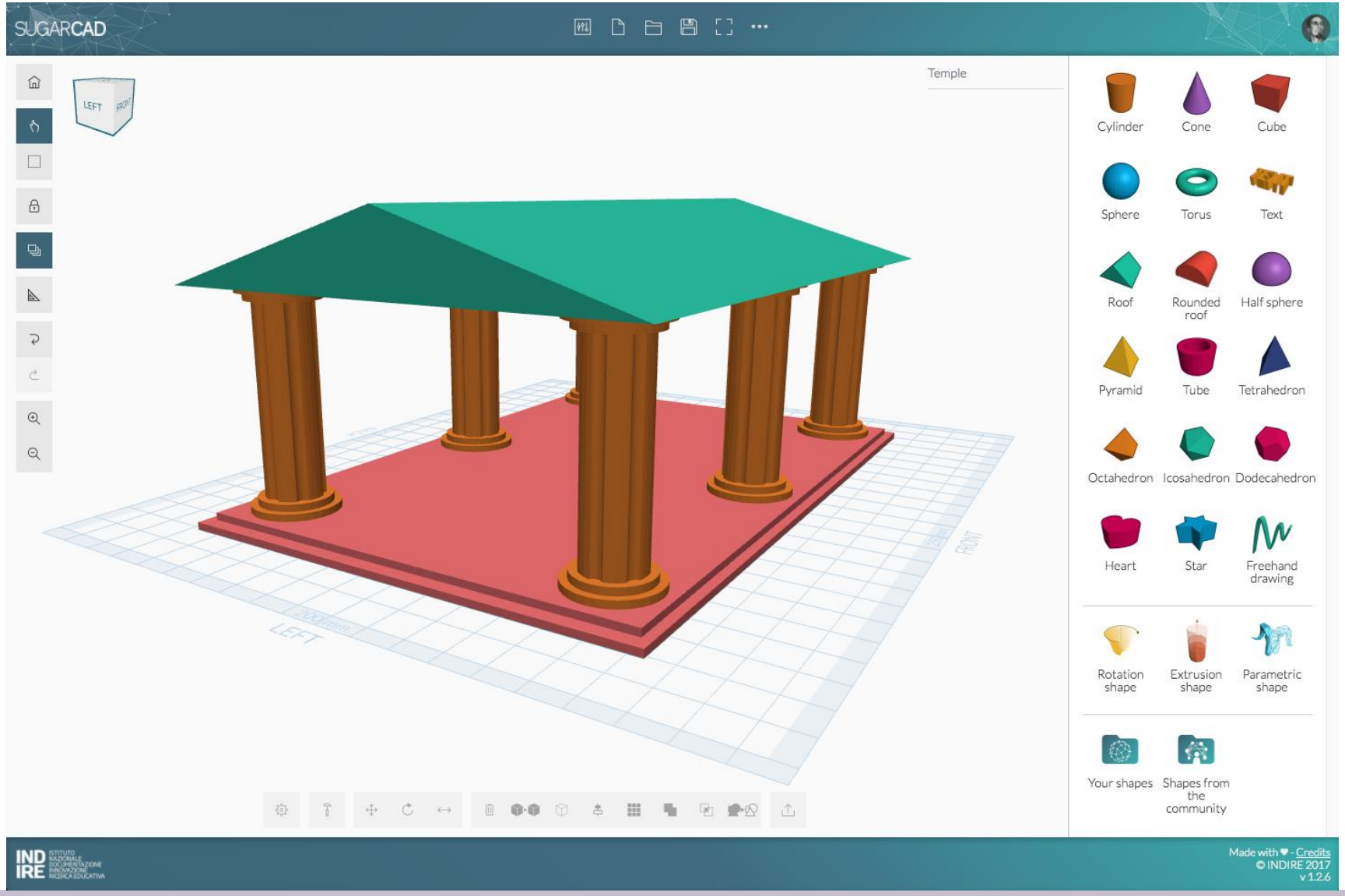
SugarCAD has been developed entirely at Indire

Teachers and students can design their own shapes and projects using the SugarCAD software directly from their web browser.

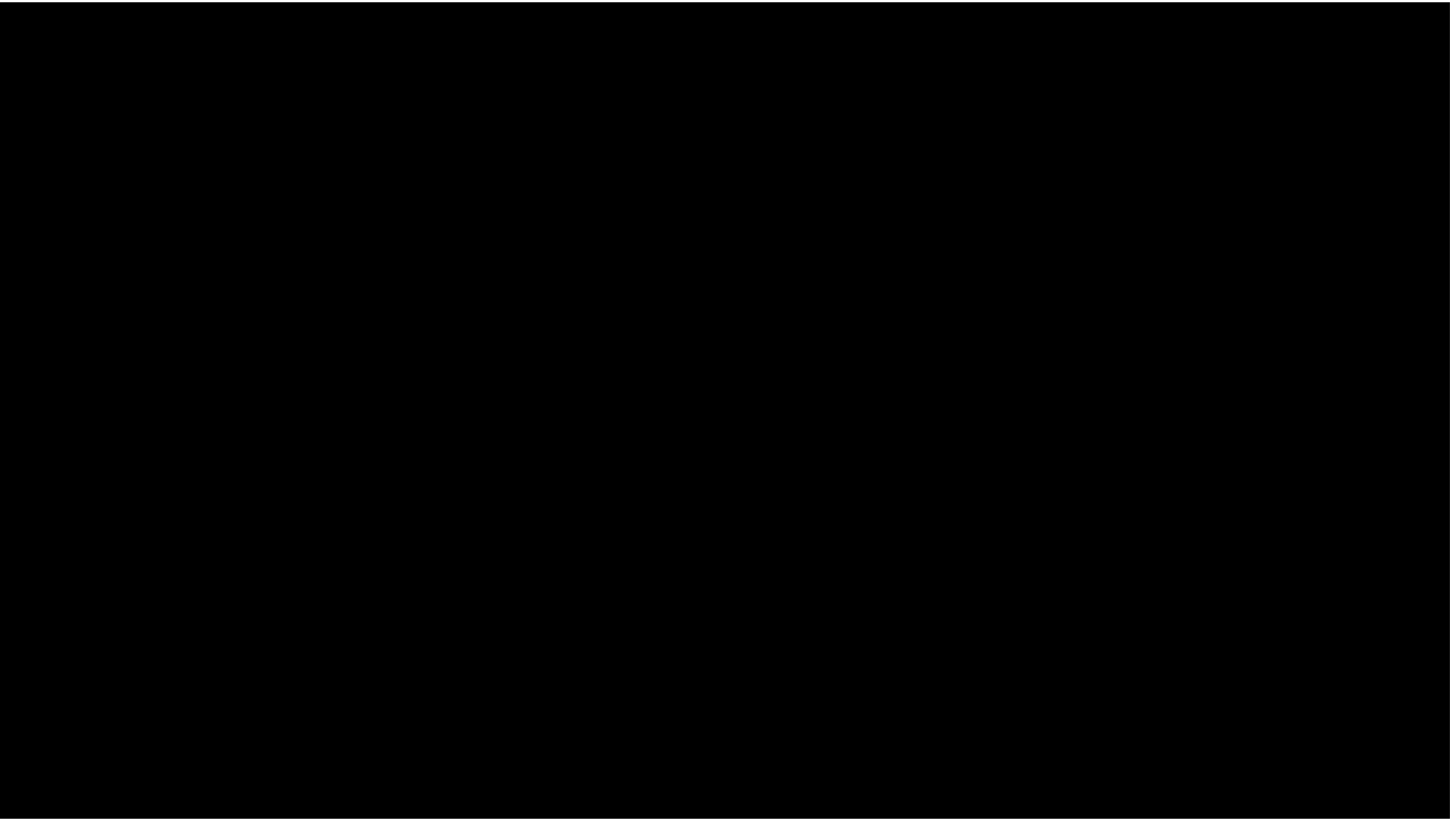
SugarCAD provides basic and complex functionalities, depending on the user's level, and permits to export the generated shapes in the STL format, which is the standard 3d printing file format.

SugarCAD is designed to be, as best as possible, intuitive and user friendly.

Parallel research: SugarCAD



Parallel research: SugarCAD

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