PROMOTING EARTH SCIENCES TEACHING-LEARNING IN THE ITALIAN SCHOOLS: A RESEARCH OF LEARNING OBJECTS, EFFECTIVE EDUCATIONAL APPROACHES, TO IMPROVE SKILLS AND COMPETENCES

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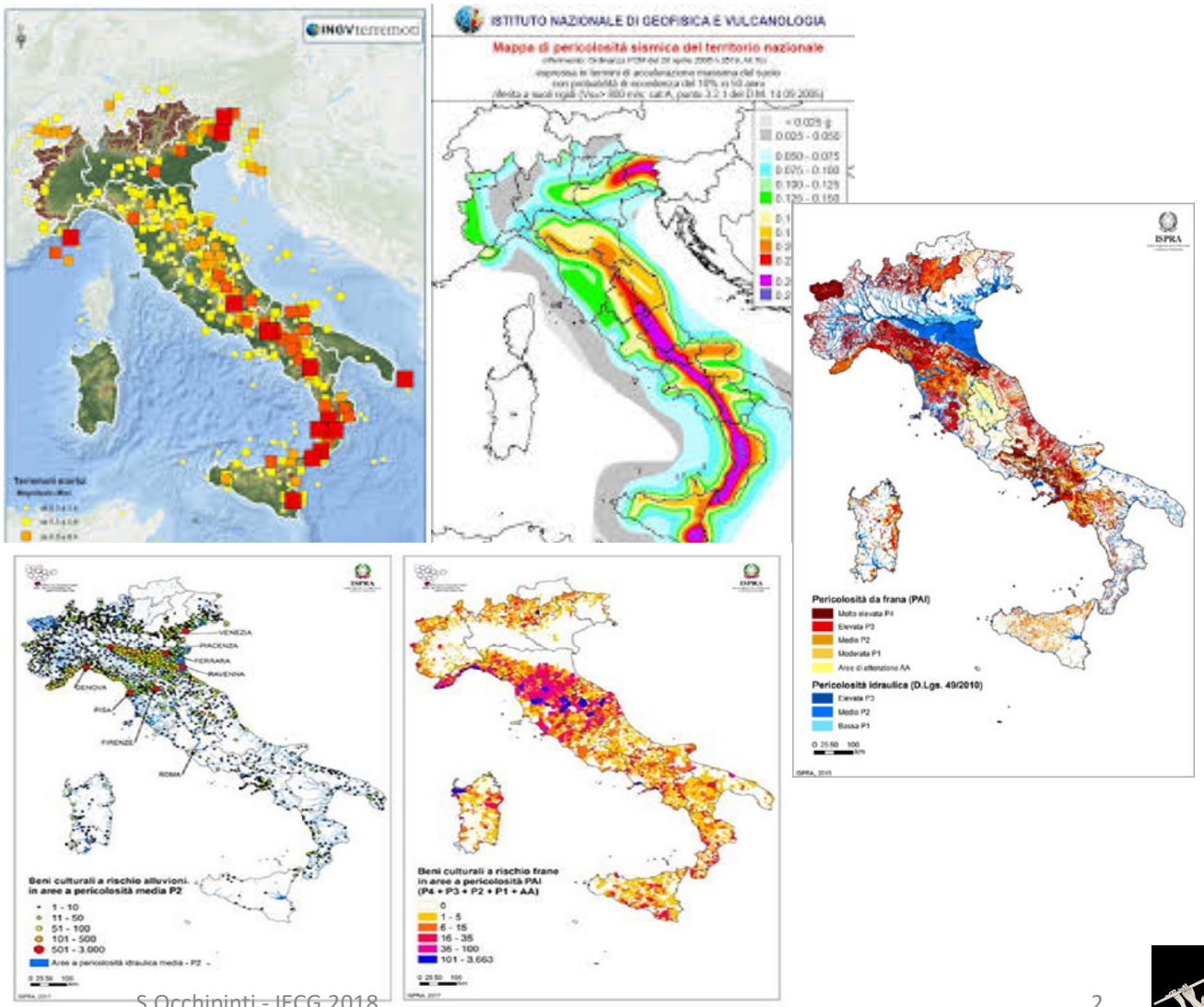
In the Italian context, where Earth sciences are poorly considered

- in the education system and
- in the common thinking,

  - to promote a widespread and deep-rooted culture of natural hazards,
  - the danger inherent in the geological evolution of the territory,
  - the responsible use of the environment,
  - the perception of phenomenon as part of the dynamics of the Earth

is a priority.



A lack of a careful teaching-learning across all levels of education, as requested by the curricula issued by the Italian Minister of Education, produces a general lack of scientific knowledge (European Commission, 2003).
As a direct consequence on Earth sciences, this also produces among the students a diminished interest to continue their Geosciences studies at university level (and pursue a career in Geosciences), which creates also a worrying lack of scientific knowledge and social awareness about the environment and its natural phenomena.

Much work is still needed

- to promote Earth Sciences education in the Italian schools
- to increase the interest of students towards geosciences, to find ways to improve Earth sciences teaching-learning
- to enhance teachers' competence in the use of new and more effective educational approaches.

From the teaching point of view, it is important to highlight that the richness and complexity of the various branches of its disciplines and the numerous possible links with many other scientific fields, make Earth Sciences a remarkable tool to promote competences and skills in students, in all scientific areas.

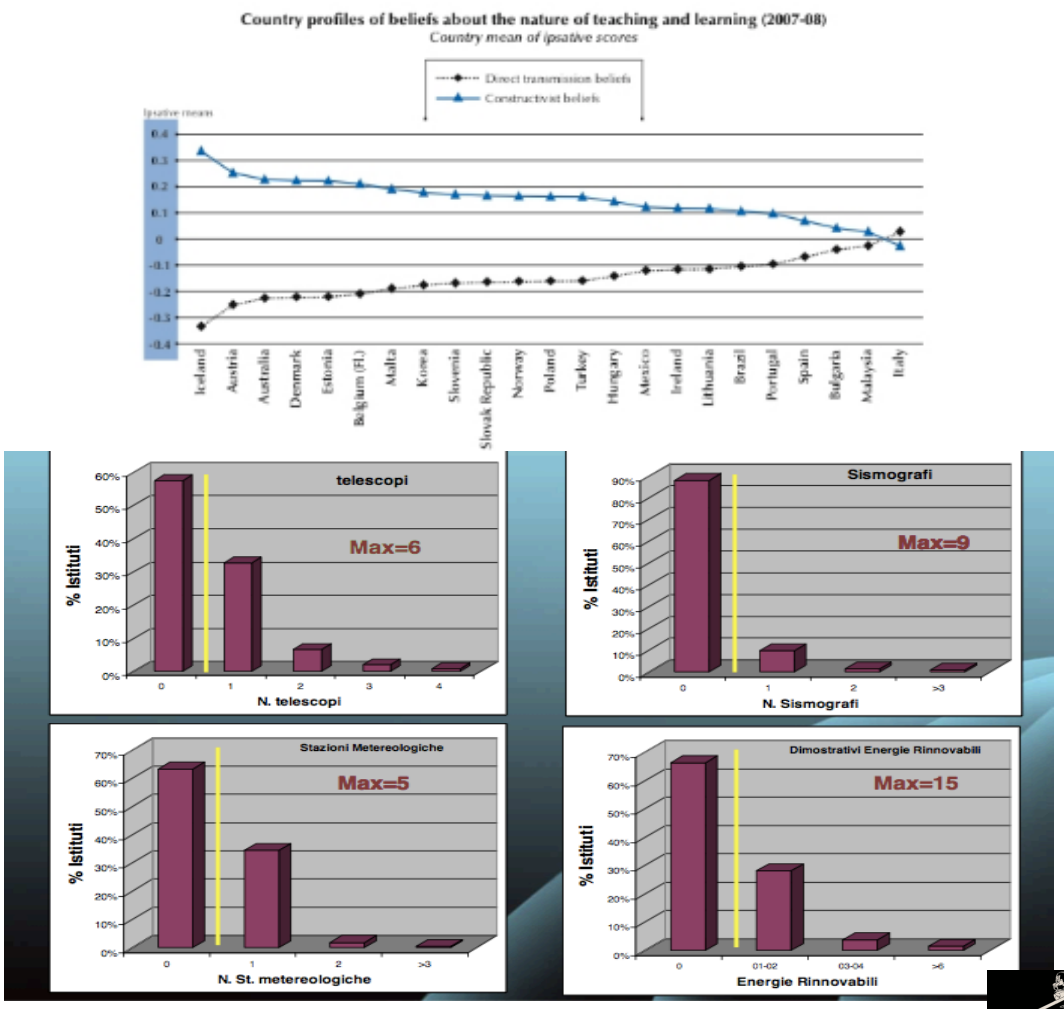
ACTIVE TEACHING-LEARNING

- INQUIRY BASED SCIENCE EDUCATION - TEACHING /LEARNING
- CASES ANALYSIS
- PEER EDUCATION/ COOPERATIVE LEARNING
- INVESTIGATION
- ROLE PLAYING
- PROJECT WORK
- HANDS-ON ACTIVITIES

A profound change of mentality is needed:

- traditional scientific instruments, seismographs, weather stations, telescopes may be necessary in some situations.
- collection of minerals, rocks and fossils are essential for the approach to the contents of the discipline, and are useful because they allow students a manipulative approach

But while it is easily possible to be fascinated by the beauty of minerals, from the history contained in a fossil, less easily into what "hides" a rock sample: too often that this appeal does not emerge, and a rock remains a simple stone. For the Earth sciences is necessary to search for a different approach, which would show the richness of relationships between biotic and abiotic world, the global dynamics, the contribution that every piece of matter may have in the complex system of the Earth.



The Italian education system is still mainly based on the transmission of knowledge and does not support the teachers in a transformation towards more effective teaching approaches which could favour the evolution towards the EU objectives.
In fact, despite what is being proposed in the Indicazioni Ministeriali (MIUR, 2008) that clearly distinguishes between goals and objectives, most of the teachers remain anchored to a traditional process of transmitting knowledge.
The new approaches should be structured starting

- by identifying the priority skills,
- then the goals and, only later,
- the involved disciplinary objectives.

The knowledge should be just a mean that allows to transform abilities into skills. However, in everyday practice, the simple testing of acquired knowledge of the students seems to be still the priority. But turning this traditional and consolidated working method into a process that starts from skills, requires constant commitment.

MINISTERO DELL'ISTRUZIONE, DELL'UNIVERSITÀ E DELLA RICERCA

Scienze, come cambia l'insegnamento alla luce delle nuove indicazioni. Determinante per pensiero logico e critico

orizzontescuola.it/scienze-cambia-linsegnamento-alla-luce-delle-nuove-indicazioni-determinate-pensiero-logico-critico/

March 9, 2018

Le **competenze chiave di "cittadinanza attiva"** da conseguire a conclusione del primo ciclo di istruzione, stabilite nelle Indicazioni Nazionali 2012, vengono ribadite nel documento "Indicazioni Nazionali e nuovi scenari" e **coinvolgono tutte le discipline**, ciascuna delle quali può offrire importanti contributi.

Come sottolineato nelle Nuove Indicazioni, i docenti sono chiamati "*non a insegnare cose diverse e straordinarie, ma a selezionare le informazioni essenziali che devono divenire conoscenze durevoli, a predisporre percorsi e ambienti di apprendimento affinché le conoscenze alimentino abilità e competenze culturali, metacognitive, metodologiche e sociali per nutrire la cittadinanza attiva*"

Una delle discipline che contribuisce in misura determinante alla costruzione del pensiero logico e critico è rappresentata dalle Scienze, disciplina che consente agli studenti di acquisire la capacità di leggere la realtà che li circonda in modo razionale.

As teachers consider too often science, and in particular Geosciences, an unfriendly discipline, little known and little loved, and finally, too often just taught, these skills are particularly difficult to implement.
It is true that in the Italian educational system, placed in the European and international context, the framework of competences is very complex,
and difficult to be related:
for example, to compare

- "Goals for the development of skills of secondary school",
- "Basic skills to compulsory school" required in Italy by students aged 16,
- the "Citizenship skills",

requested by the Ministry of Education,

- the "European key skills"
- the "European Quality Framework"

could be a very difficult work.

Descriptors defining levels in the European Qualifications Framework (EQF)

Each of the 8 levels is defined by a set of descriptors indicating the **learning outcomes** relevant to qualifications at that level in any system of qualifications

EQF Level	Knowledge	Skills	Competence
	In the context of EQF, knowledge is described as *theoretical and/or factual.*	In the context of EQF, skills are described as *cognitive* (involving the use of logical, intuitive and creative thinking), and *practical* (involving manual dexterity and the use of methods, materials, tools and instruments)	In the context of EQF, competence is described in terms of *responsibility and autonomy.*
Level 1	Basic general knowledge	Basic skills required to carry out simple tasks	Work or study under direct supervision in a structured context
Level 2	Basic factual knowledge of a field of work or study	Basic cognitive and practical skills required to use relevant information in order to carry out tasks and to solve routine problems using simple rules and tools	Work or study under supervision with some autonomy
Level 3	Knowledge of facts, principles, processes and general concepts, in a field of work or study	A range of cognitive and practical skills required to accomplish tasks and solve problems by selecting and applying basic methods, tools, materials and information	Take responsibility for completion of tasks in work or study; adapt own behaviour to circumstances in solving problems
Level 4	Factual and theoretical knowledge in broad contexts within a field of work or study	A range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study	Exercise self-management within the guidelines of work or study contexts that are usually predictable, but are subject to change; supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities

Earth Science requires, and provides, skills and competences strictly related to contents. In this table Table, that I have processed as an exercise, we try to interrelate the different skills requested, with the aim of:

- sharing the specific language on skills
- recognize and enhance cross-disciplinary and interdisciplinary nature of some skills;
- recognize the importance of the joint construction of knowledge,
- recognize the complexity of the discipline, which implies the need to develop all the scientific issues and exceed the encyclopaedism
- recognize the importance of the lab essential for the promotion of skills, but also of the interest and guidance;
- recognize the need to build vertical paths

COMPETENZE *	ABILITA/CAPACITA' **	TRAGUARDI ***	COMPETENZE CHIAVE DI CITTADINANZA****	COMPETENZE CHIAVE EUROPEE APPRENDIMENTO PERMANENTE *****
Osservare, descrivere e analizzare fenomeni appartenenti alla realtà naturale e riconoscere nelle varie forme i concetti di sistema e complessità	Raccogliere dati attraverso l'osservazione diretta dei fenomeni naturali (fisici, chimici, biologici, geologici, ecc.) o degli oggetti artificiali o la consultazione di testi e manuali o media.		Acquisire ed interpretare l'informazione	Competenza matematica e competenze di base in scienza e tecnologia
	Organizzare e rappresentare i dati raccolti.	classificare,		
	Individuare, con la guida del docente, una possibile interpretazione dei dati in base a semplici modelli.	sapere effettuare connessioni logiche	Individuare collegamenti e relazioni	
		formulare ipotesi in base ai dati forniti,		
	Presentare i risultati dell'analisi. Esercizio	comunicare in modo corretto ed efficace le proprie conclusioni utilizzando il linguaggio specifico	Comunicare	Comunicazione nella madrelingua Comunicazione nelle lingue straniere
	Utilizzare classificazioni, generalizzazioni e/o schemi logici per riconoscere il modello di riferimento.	trarre conclusioni basate sui risultati ottenuti e sulle ipotesi verificate	Risolvere problemi	
	Riconoscere e definire i principali aspetti di un ecosistema			
	Essere consapevoli del ruolo che i processi tecnologici giocano nella modifica dell'ambiente che ci circonda considerato come sistema.	applicare le conoscenze acquisite a situazioni della vita reale risolvere situazioni problematiche		
	Analizzare in maniera sistemica un determinato ambiente al fine di valutarne i rischi per i suoi fruitori.		Progettare	Spirito di iniziativa e imprenditorialità
	Analizzare un oggetto o un sistema artificiale in termini di funzioni o di architettura.			
Analizzare qualitativamente e quantitativamente fenomeni legati alle trasformazioni di energia a partire dall'esperienza	Interpretare un fenomeno naturale o un sistema artificiale dal punto di vista energetico distinguendo le varie trasformazioni di energia in rapporto alle leggi che le governano.			
	Avere la consapevolezza dei possibili impatti sull'ambiente naturale dei modi di produzione e di utilizzazione dell'energia nell'ambito quotidiano			
Essere consapevole delle potenzialità e dei limiti delle tecnologie nel contesto culturale e sociale in cui vengono applicate	Riconoscere il ruolo fondamentale della tecnologia nella vita quotidiana e nell'economia della società			Competenza digitale;
	Saper cogliere interazioni tra esigenze di vita e processi tecnologici			
	Utilizzare strumenti informatici e di comunicazione per l'apprendimento elaborare dati, testi e immagini e produrre documenti in diverse situazioni.			
	Riconoscere potenzialità e rischi connessi all'uso delle tecnologie più comuni, anche informatiche			
			Imparare ad imparare	Imparare ad imparare
			Agire in modo autonomo e responsabile	Competenze sociali e civiche Collaborare e partecipare Consapevolezza ed espressione culturale.

To capture complex skills teachers need to renew our science teaching; we need to break the habit, encouraged by the textbooks, to present science as a finished product.
Instead we need to try to show it as a passionate
problem solving, an adventure to which many researchers have dedicated themselves, namely an adventure full of passion, hard work, intelligence.
The path for the promotion of the teaching-learning in Earth Sciences should pass through

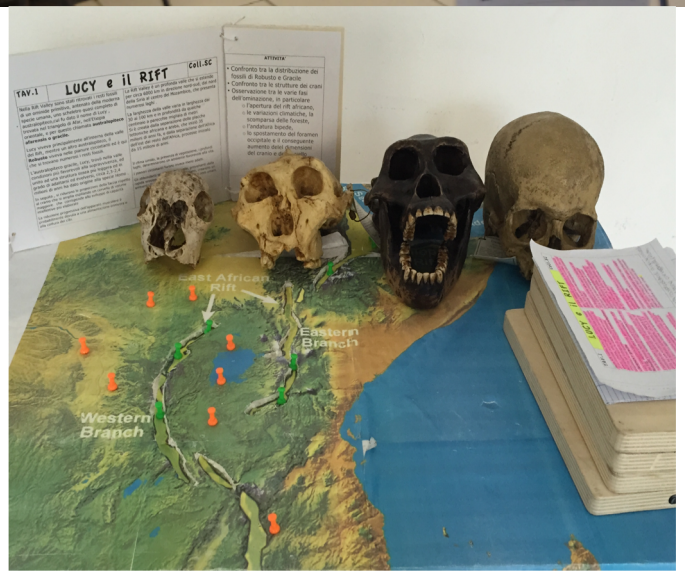
- the practice of active educational approaches, attention to the personalization,
- use of models and guidelines to produce tools and learning objects.

To work in this direction there is an increasing need of a networking action for sharing didactic resources.

Our network of schools

If the goal is to promote Earth sciences education, in the Italian schools,
in all levels of education, then it is necessary:

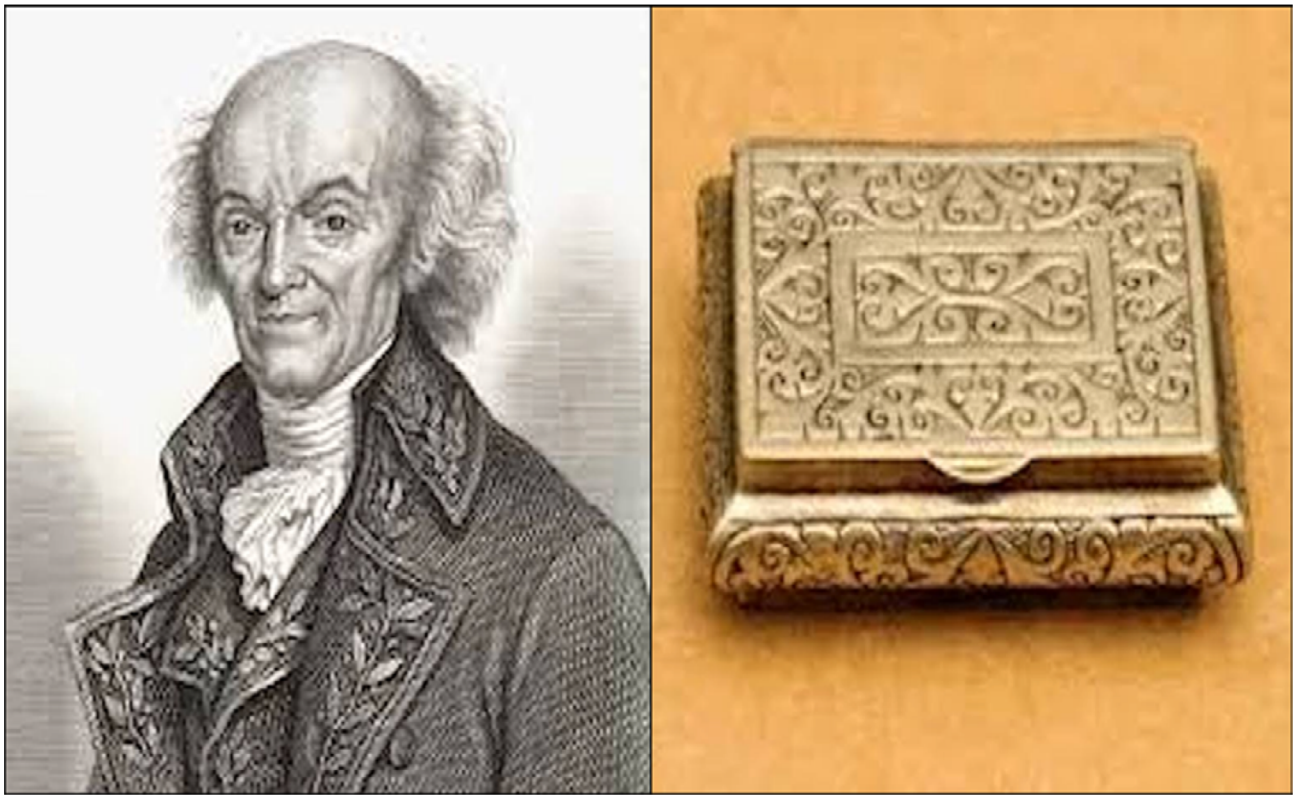
- to increase the interest of students towards geosciences
- to enhance teachers' competences
- to promote the use of new and more effectives educational inductive and adductive approaches,
  - using tools,
  - paths and learning objects,
  - based on hands-on practices, experimented in schools



One condition to promote interest among students is that the teacher is passionate, and is therefore able to capture the attention of the students.

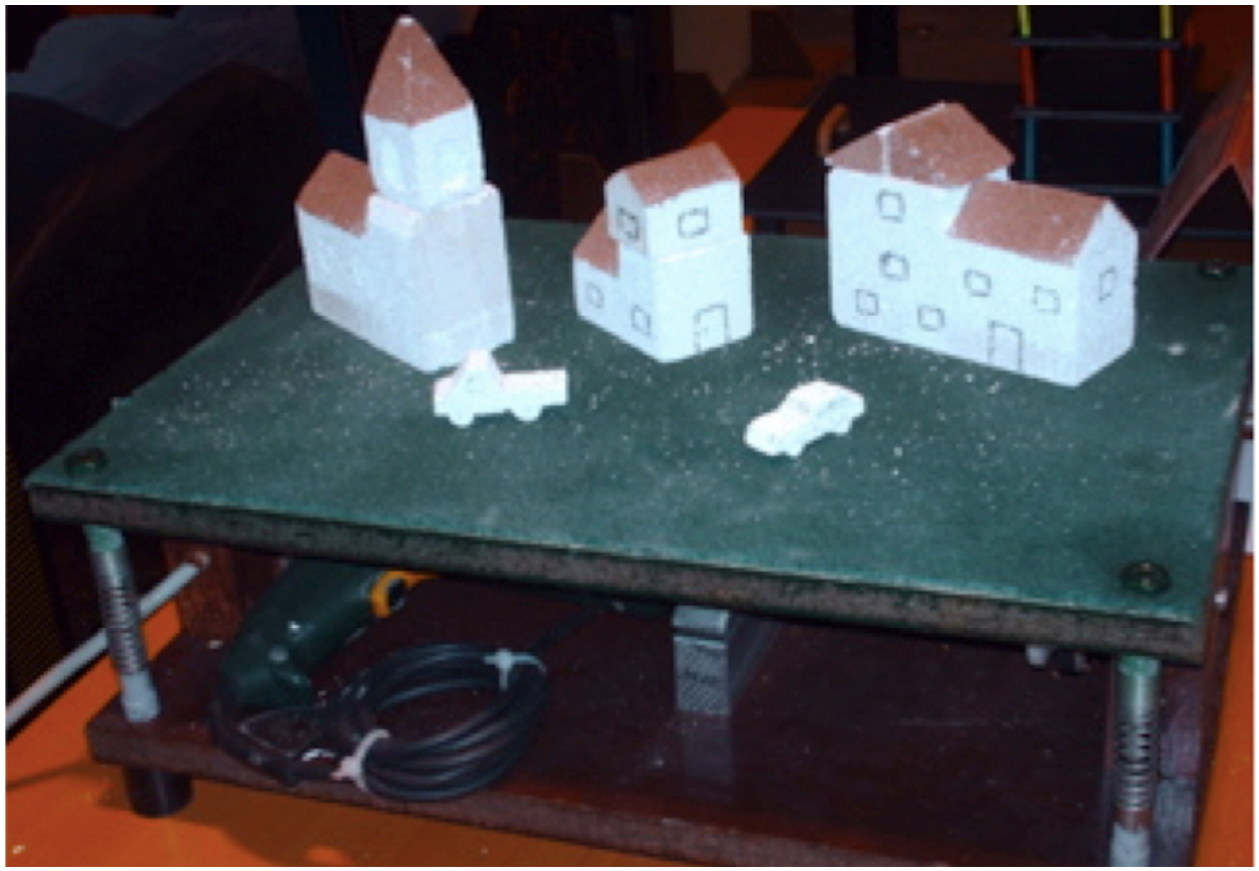
Jérome Lalande an astrophysicist who lived in the XVIII century, in order to attract Parisians along the Seine to observe his telescope, extracted spiders from his snuffbox pretending that he wanted to eat them, attracting the attention on what he was doing.

Without reaching these extremes, still we need to find "our own spiders" and engage the students.



Gerome Lalande and his snuffbox.

My "spider" has been in recent years a vibrating plate, constructed with an old drill and an eccentric to simulate catastrophic earthquakes.
As many of my teaching tools, it was homemade, realized with cheap materials mostly coming from my house, but for this reason this vibrating table attracted the attention of other teachers.



The vibrating plate.

I gradually realized new home-made tools, sometimes simple or trivial, sometime more complex,
but always designed to capture the attention of students, to reason, to "re-discover" scientific laws.

For example, to introduce or discuss stratigraphy topics, I built "the stratigraphic sequence useful to understand the principle of superposition.
It is an easily assembling experiment, composed of a few but well-designed objects, sequences, layers, rocks and guide fossils, which can be combined to approach general stratigraphy topics or elements of local geology

The stratigraphic sequence, from the stromatolites of the Archeozoic, to the moraines of the Neozoic.

The experimental activities, which in scientific disciplines play a key role, are often completely impractical in the context of Earth sciences.
Itis not possible to reproduce in the laboratory the movement of the plates, the eruption of a volcano, or the movements of the air:
it is necessary to use models.

In particular, in the different tools should have primarily the function of

- stimulating observations,
- hypothesis,
- reasoning and,
- the formulation of more general rules and, when possible, of laws.

Finally, the model may be able to stimulate the abstraction and the ability to identify connections between different elements and principles, intra- and inter-disciplinary.

The effort of the research was the shearing of models and guidelines to produce effective practices, easy to be practiced or realized in the school.

A risky valley

TOOLS AND MODELS FOR AN ACTIVE TL

TOOLS / ACTIVITIES

Name	Approach	Examples
Scientific protocol	Practical /laboratory work: Formal laboratory approach	Use of instruments Minerals recognition Hydro geological and hydrological analysis
Hands on	Hypothetic deductive approach	Rock analysis Observation of outcrops or landscape
Minds on	Inquiry deductive approach	Case analysis Structured question /open question

A scientific protocol needs

- To define laws and regularities
- To reproduce the experiment, in the same conditions
- To insert time factor
- To consider each phenomenon in its complex system

Even to consider butterfly effect- H. Lorentz law
And even Murphy law…

And in Earth Science this is not always possible

MODELS

Must be:

- Scientifically correct
- Efficient, significant
- Repeatable if possible
- Nontrivial

Examples of simulation of landslides and avalanches, using different

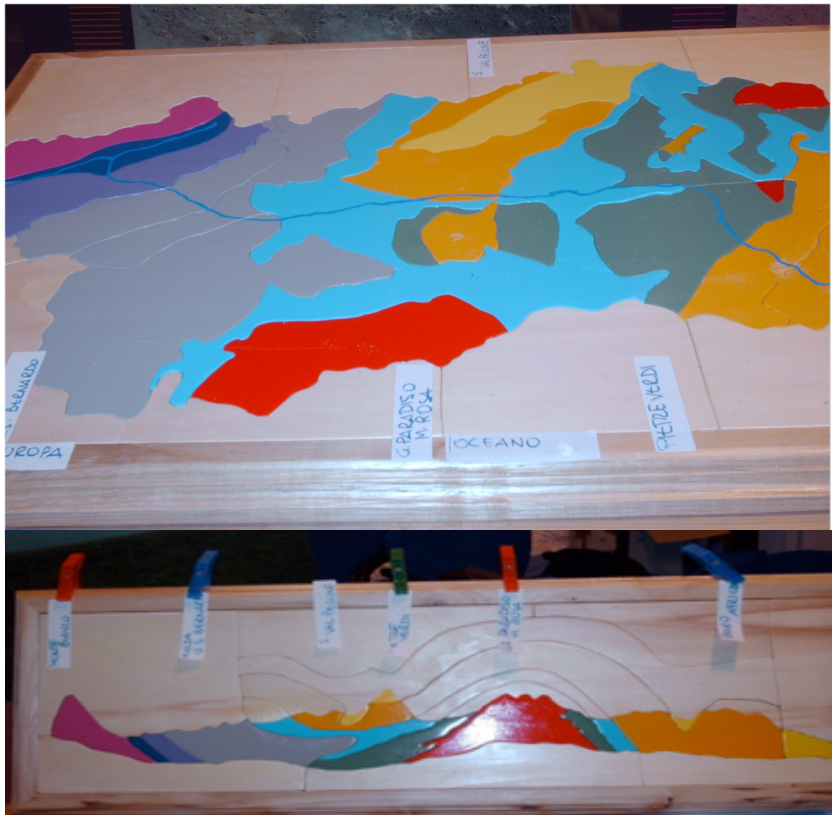
- materials,
- humidity,
- slope
- roughness of the substrate
- human actions

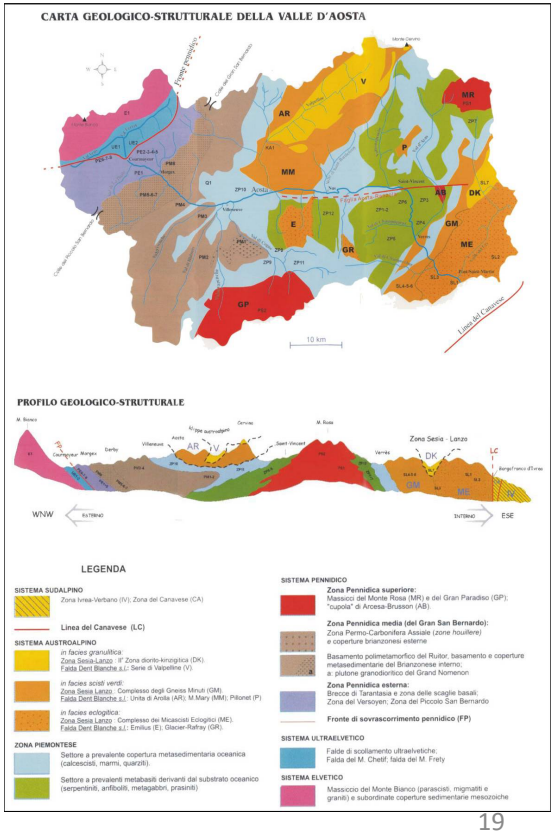
Examples of simulation of landslides and superficial erosion by action of rains and runoff water
, using different

- materials,
- humidity,
- slope
- grass cover
- human actions

Structural geological models useful to understand that our regional contest (Valle d'Aosta) is obviously the result of the dynamism of Earth.
In effect, the structural model of the Aosta Valley is particularly "lucky" and useful to understand the convergence of the South of the World in the Pangea, the Paleoafrica.

Paleoafrica is here the Sesia Lanzo gneiss, which represents the ancient shores of the southern border of the Tethys sea, where we could imagine dinosaurs of a warm climate walking along the seashore colliding with the North, the Paleo-Europe, again with deposits of shores and lagoons and shallow cold seas.





All the educational tools have been tested and evaluated
and are collected in easy kits now freely usable

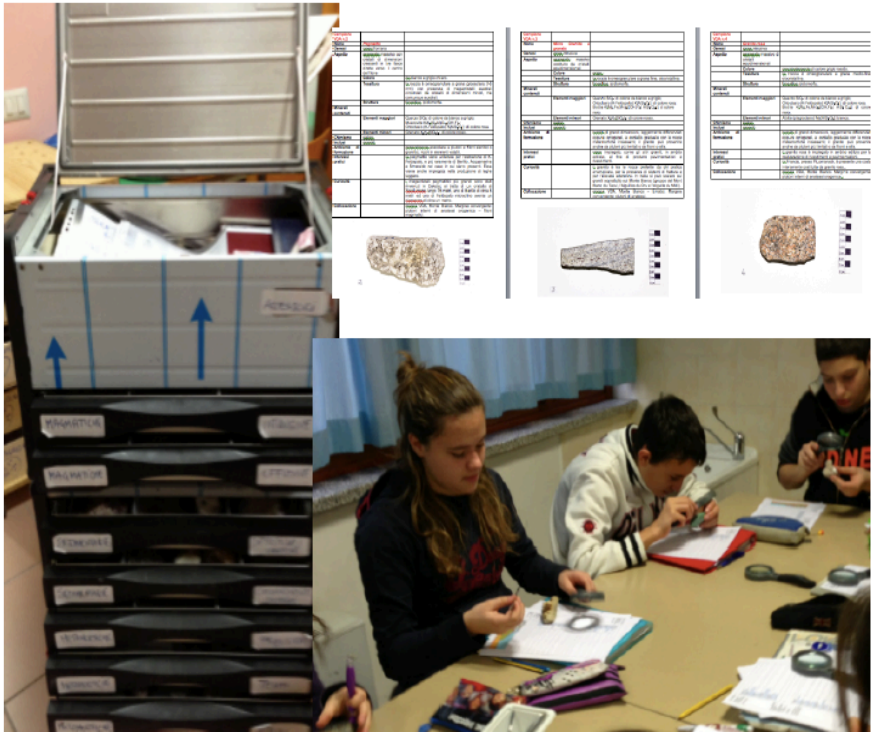


FIG. 4.13 – THE TROLLEY

FIG. 4.14. - PRESSURE-TEMPERATURE TRAY

FIG. 4.15 - SYSTEMATIC TRAYS

All the materials and the educational paths are presented in working booklets freely downloadable

And, more specifically for Earth sciences

www.scuole.vda.it/scienze/images/Viaggio.pdf.

www.earthlearningidea.com

Earth Learning Idea

Innovative, Earth-related teaching ideas

Geoscientist, August 2007

ASE's (Association for Science Education) 'Education in Science', September 2007

Earth Science Teachers' Association

Science Teaching Alive

NAGT (National Association of Geoscience Teachers)

Earth Science Week

University of Wales CELT News

Science in School

University of West Indies Seismic Research Centre

The Eggs EGU Newsletter

Intute

The Daily Reviewer

Geoscientist February 2009

Geoscientist July 2009

International Union of Soil Sciences

Geoitalia No. 26 - March 2009, pages 4 - 11

Naturfag.no

Geologi.No

Naturfagsenteret

ESERA European Science Education Research Association

Linx Magazine 2009, pages 30 - 35

Seismology@School - Earth Learning Idea: attività didattiche 'povere' ma belle

NAGT (National Association of Geoscience Teachers) Feb 2013

Earthlearningidea: A Worldwide Web-Based Resource of Simple but Effective Teaching A...

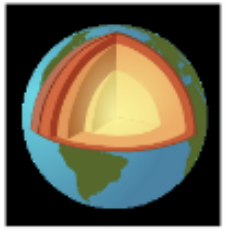
Viaggio al centro della terra: esperienze e attività di laboratorio - S. Occhipinti, 2013

Viaggio al centro della Terra

4° QUADERNO DI LAVORO:

ESPERIENZE E ATTIVITÀ DI LABORATORIO

DI SCIENZE DELLA TERRA



A CURA DI :

UFFICIO SUPPORTO AUTONOMIA SCOLASTICA -
AREA DELLA MATEMATICA, SCIENZE, EDUCAZIONE AMBIENTALE
REFERENTE PROF. SUSANNA OCCHIPINTI

AOSTA - 1A EDIZIONE LUGLIO 2012

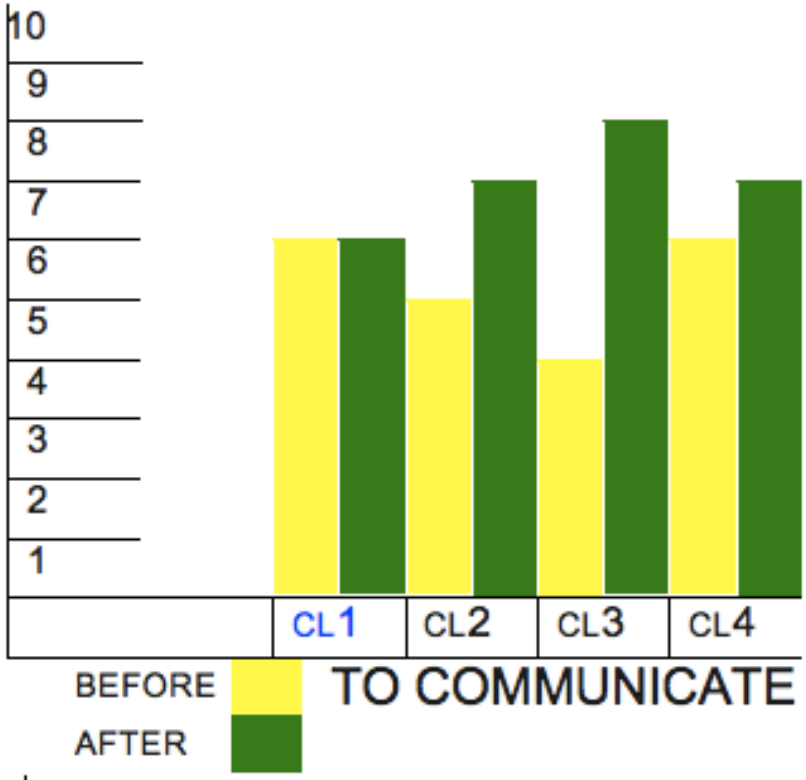
The result is , in our contest, an increasing sensitiveness towards Earth science teaching -learning, a widespread awareness towards the need of promoting competences and skills and a growing knowledge of the active and inquiry approaches.

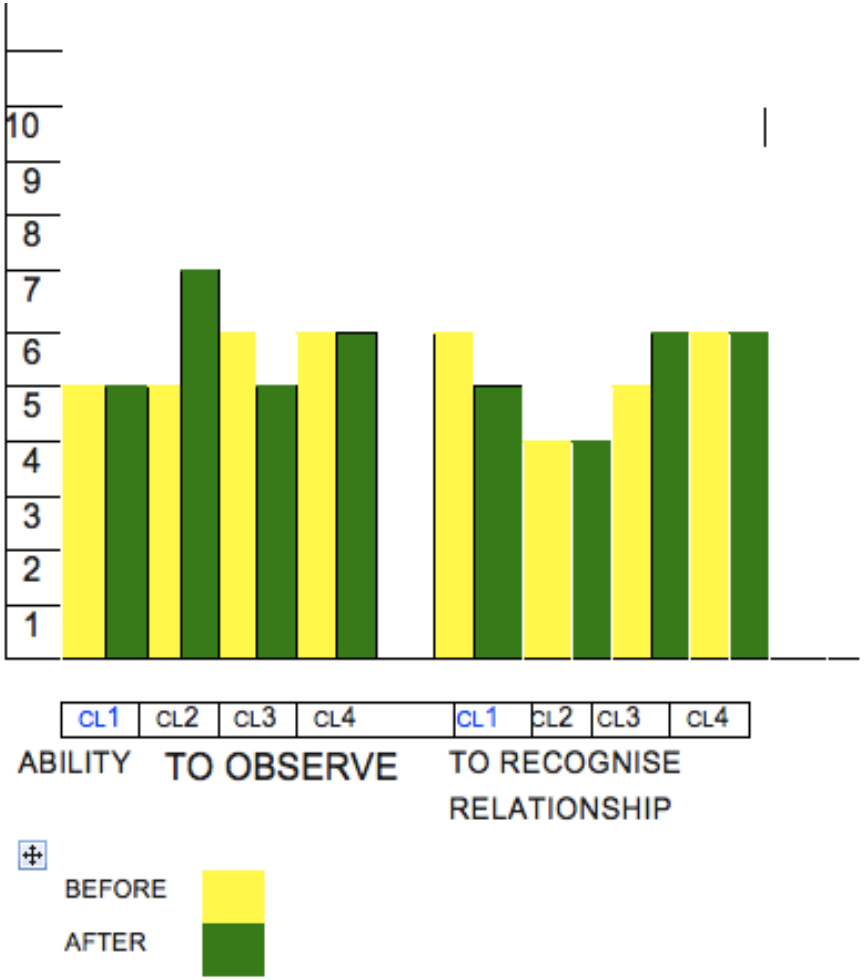
Some experiences are tested also referring to the acquired skills and competences of the students before and after their use.

The traditional definition coming from the literature is : "Competence means, in a given context, implementation of a performance involving the combined use of attitudes and motivations, knowledge, skills and abilities and it is aimed at achieving a purpose".
Also, "What, in a given context, one can do (ability) on the basis of a knowledge to achieve the expected goal and produce knowledge.
It means to choose, use and master knowledge, skills and abilities appropriate in a given context, to set and / or solve a given problem" (Carter, 1990).

It is surprising how these skills
can be easily applicable,
malleable and adaptable
to different contexts and contents
of Earth sciences,
where they become tools to think,
observe, connect, relate, research,
solve and communicate.
Therefore Earth sciences topics are taken as starting points to develop skills which can be easily applied to different science topics.

It was possible to verify, in sample classes of a technical secondary school, an interesting and sometimes significant increase in some skills, based on similar knowledge and corresponding abilities, as a result of practical activities and hands-on experiences in the field of Earth sciences

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TO RECOGNISE
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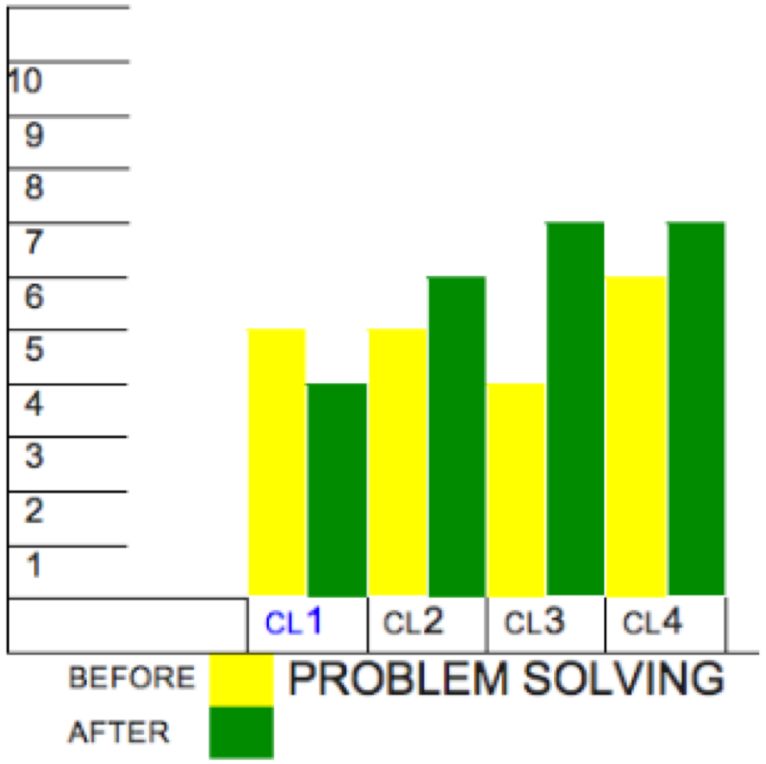
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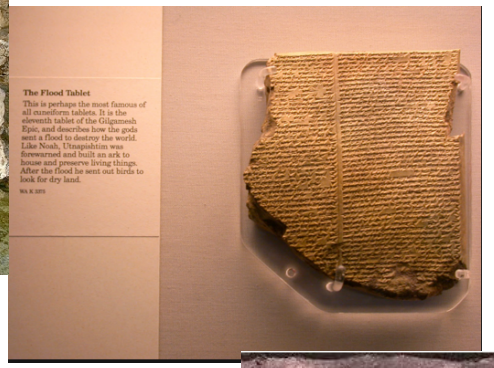
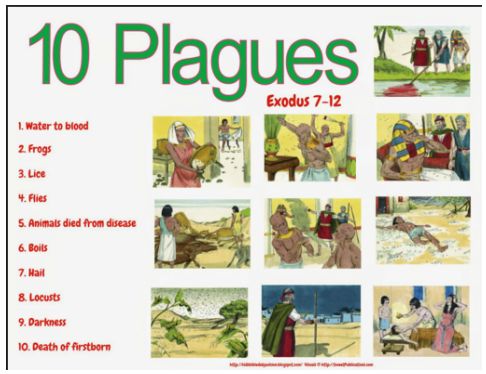
PROBLEM SOLVING

This experience has shown also that Earth science is in effect the discipline that more promote citizenship and transversal skills and, furthermore develops the ideas of system and complexity.

An example of the complex relationships the Earth sciences can stimulate to investigate linkages with other disciplines regards volcanoes, and more generally natural phenomena and climate.
This topic usually attracts very much the attention of students.





Many know the relationship between the eruption of Tambora, in April 1815, and some English literary works, such as Frankestein by Mary Shelley and John Polidori's Dracula.
The two authors, in the cold summer of the "Year without summer" that followed the eruption of Tambora, spent their holidays in Switzerland. Because of the bad weather, they could not spend the their time outside; then they challenged those who had written the best horror novel.

Less well known is that even the Fairy Tales of the Grimm Brothers conveyed the special cold climate
that marked that year.

Or how it influenced the colours of the well known paintings of William Turner , 1818

And European and Italian migrations to America as well as the Conquest of the West

Also it is known what was the impact of the Little Ice Age on history and society between 1650 and the end of 1800.
Less known is that the harsh climate marked the growth of the trees, making the growth rings smaller and the wood more compact, allowing the creation of musical instruments
such as the Stradivarius violins, particularly precious for their exceptional acoustics.

The need to change the traditional transmissive and deductive approach, with an active and inductive teaching-learning is now commonly known, although not yet shared and disseminated among the of every school grade.
The Italian school system, with its encyclopaedic content, does not facilitate the development of methodological approaches of active teaching-learning, such as

- Problem solving,
- peer education,
- case analysis,
- inquiry-based teaching learning.

These approaches, in fact, require the teacher to abandon the traditional role of master of knowledge, transmitter of contents to become guide, collaborator, mediator of the activities.
To achieve this transformation, it is necessary to change the methodological approach, in order to engage and motivate students.
It can be enough to have few

- teaching tools,
- few learning objects,
- but this requires, simultaneously,

To achieve this transformation, it is necessary to change the methodological approach, in order to engage and motivate students.
It can be enough to have few

- teaching tools,
- few learning objects,
- but this requires, simultaneously,
- the knowledge of the methodological approach from a theoretical point of view,
- a solid ability to manage the class,
- a talent to conduct activities and to master any unforeseen topic arising during the course.

Therefore, a change of teaching approach is a complex and multifaceted process.

THANK YOU FOR YOUR ATTENTION

ANY QUESTIONS?