aggiornaMenti
teaching physics in middle school

Andrea Beraudo on behalf of the collaboration

Istituto Nazionale di Fisica Nucleare - Sezione di Torino

EPS2025

Marseille, 6-11 July 2025

Why a training program for middle-school science teachers?

- Primary school teachers now receive professional university-level training provided by the degree program in Primary Education Sciences, which also includes courses in science education.

Why a training program for middle-school science teachers?

- Primary school teachers now receive professional university-level training provided by the degree program in Primary Education Sciences, which also includes courses in science education.
- For high-school teachers of mathematics and physics, there are already many opportunities for training and professional development, offered for example by specific national programs or by the Masterclasses of major experiments.

Why a training program for middle-school science teachers?

- Primary school teachers now receive professional university-level training provided by the degree program in Primary Education Sciences, which also includes courses in science education.
- For high-school teachers of mathematics and physics, there are already many opportunities for training and professional development, offered for example by specific national programs or by the Masterclasses of major experiments.
- Middle school represents a critical level for various reasons:

Why a training program for middle-school science teachers?

- Primary school teachers now receive professional university-level training provided by the degree program in Primary Education Sciences, which also includes courses in science education.
- For high-school teachers of mathematics and physics, there are already many opportunities for training and professional development, offered for example by specific national programs or by the Masterclasses of major experiments.
- Middle school represents a critical level for various reasons:
  - Teachers often have to teach topics outside their area of expertise (which is predominantly in the life sciences);

Why a training program for middle-school science teachers?

- Primary school teachers now receive professional university-level training provided by the degree program in Primary Education Sciences, which also includes courses in science education.
- For high-school teachers of mathematics and physics, there are already many opportunities for training and professional development, offered for example by specific national programs or by the Masterclasses of major experiments.
- Middle school represents a critical level for various reasons:
  - Teachers often have to teach topics outside their area of expertise (which is predominantly in the life sciences);
  - Not feeling confident *with the content*, they tend to avoid experimenting with more engaging, hands-on teaching approaches;

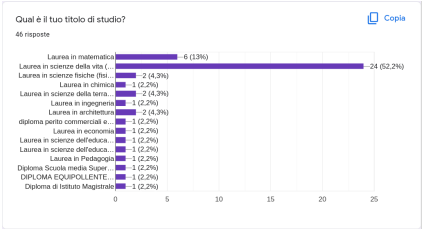
Why a training program for middle-school science teachers?

- Primary school teachers now receive professional university-level training provided by the degree program in Primary Education Sciences, which also includes courses in science education.
- For high-school teachers of mathematics and physics, there are already many opportunities for training and professional development, offered for example by specific national programs or by the Masterclasses of major experiments.
- Middle school represents a critical level for various reasons:
  - Teachers often have to teach topics outside their area of expertise (which is predominantly in the life sciences);
  - Not feeling confident *with the content*, they tend to avoid experimenting with more engaging, hands-on teaching approaches;
  - Students are in a critical phase of their lives, where they must choose the type of school that will shape their future, and are influenced by the educational experiences they've had.

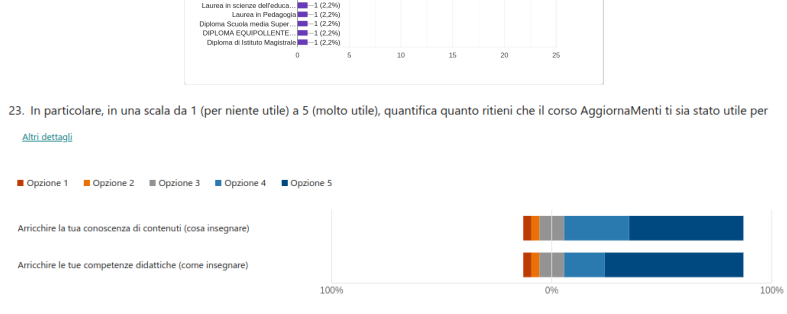
Why a training program for middle-school science teachers?

- Primary school teachers now receive professional university-level training provided by the degree program in Primary Education Sciences, which also includes courses in science education.
- For high-school teachers of mathematics and physics, there are already many opportunities for training and professional development, offered for example by specific national programs or by the Masterclasses of major experiments.
- Middle school represents a critical level for various reasons:
  - Teachers often have to teach topics outside their area of expertise (which is predominantly in the life sciences);
  - Not feeling confident *with the content*, they tend to avoid experimenting with more engaging, hands-on teaching approaches;
  - Students are in a critical phase of their lives, where they must choose the type of school that will shape their future, and are influenced by the educational experiences they've had. However, this stage also offers the opportunity to have an impact on a minimum-bias sample of students!

From the feedback of our sample of teachers...



23. In particolare, in una scala da 1 (per niente utile) a 5 (molto utile), quantifica quanto ritieni che il corso AggiornaMenti ti sia stato utile per



Most teachers also need training on *what* to teach

Initial situation at the start of the project (pre-2017)

The course originated in Turin from occasional activities in individual schools, based on direct relationships with teachers. The situation encountered: science classrooms were

- underused (often used as audiovisual rooms);
- poorly equipped (today perhaps better equipped, but with tools few know how to use)

Initial situation at the start of the project (pre-2017)

The course originated in Turin from occasional activities in individual schools, based on direct relationships with teachers. The situation encountered: science classrooms were

- underused (often used as audiovisual rooms);
- poorly equipped (today perhaps better equipped, but with tools few know how to use)

Turning a limitation into an opportunity by proposing a hands-on teaching approach using objects that anyone can find at home or buy cheaply. Advantages for students:

- not passive observers of experiments that can only be done at school, but active participants, building what they need themselves;
- they can repeat the experiments at home
- and bring out skills (crucial for doing science!) that are rarely valued in traditional lessons (manual dexterity, creative problem solving, teamwork...)
- Students with special educational needs (SEN) are more easily engaged in this type of activity than in traditional lectures

All this led to a national INFN teacher training project

AggiornaMenti: who are we?

12 INFN sections with 68 staff members involved (researchers, technologists, and technical-administrative staff).
Partial complementarity in training offer, with the possibility to participate in multiple local editions. In addition to basic physics:

- Ferrara: coding and robotics
- LNF: modern physics
- Trieste: teaching methodologies (Inquiry-Based Science Education, Investigative Science Learning Environment)

Partnerships with other educational organizations (Fondazione Golinelli, Next-Land, Laboratorio Scienza)

Teachers at work...

Approach applied to the teaching of all areas of physics

Teachers at work...

Approach applied to the teaching of all areas of physics

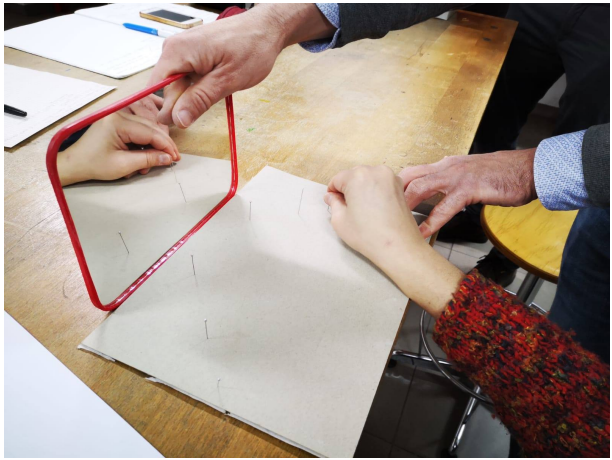
Teachers at work...

Approach applied to the teaching of all areas of physics

Teachers at work...

Approach applied to the teaching of all areas of physics

Teachers at work...

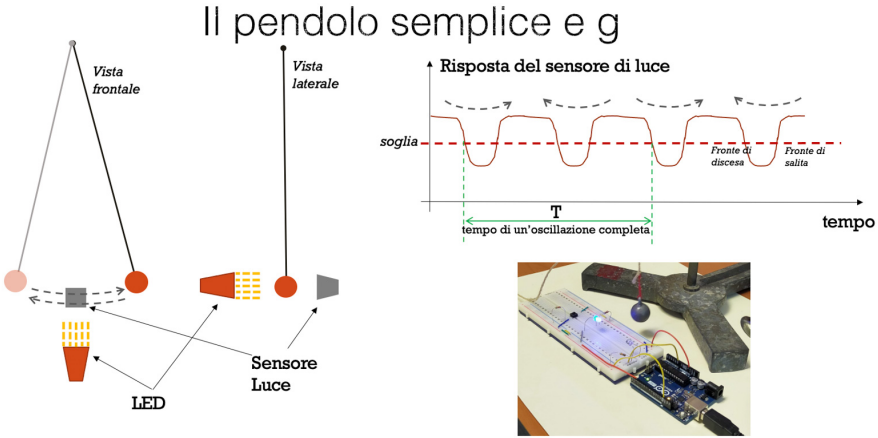


Approach applied to the teaching of all areas of physics

Teachers at work...

Approach applied to the teaching of all areas of physics

Teachers at work...



Approach applied to the teaching of all areas of physics

Educational Resources: Videoclips

Thematic learning paths (optics completed) through video clips (edited by M. Passaseo, INFN-PD):

- Simple materials, easily replicable experiments (science is everywhere!)

Educational Resources: Videoclips

Thematic learning paths (optics completed) through video clips (edited by M. Passaseo, INFN-PD):

- Simple materials, easily replicable experiments (science is everywhere!)
- Wow Effect as a starting point to ask non-trivial questions

Educational Resources: Videoclips

Thematic learning paths (optics completed) through video clips (edited by M. Passaseo, INFN-PD):

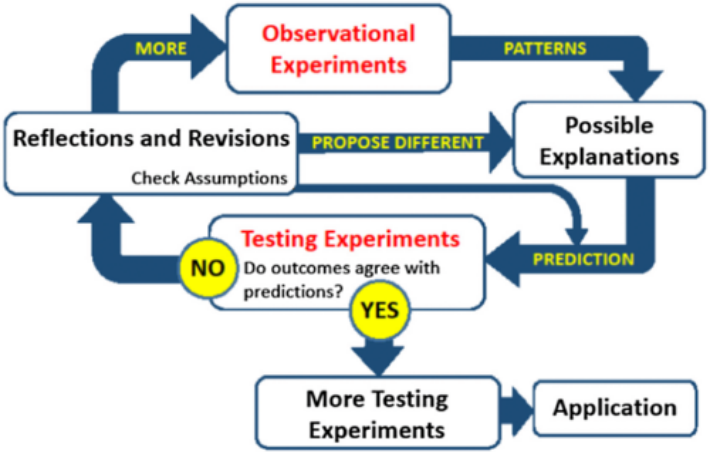
- Simple materials, easily replicable experiments (science is everywhere!)
- Wow Effect as a starting point to ask non-trivial questions

Started a new path on Archimedes' Principle.

Educational Resources: Worksheets

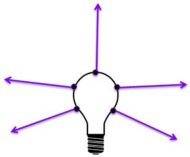
Development of educational worksheets currently underway, coordinated by Grazia D'Agostino (LNS). For some of them, implementation of the ISLE approach under the supervision of Valentina Bologna (INFN-Trieste). Activity carried out with the support of 3 tutors (CA, LNS, TO), some of whom are currently teaching in middle/high school.

ISLE in a nutshell

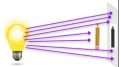
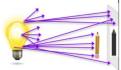
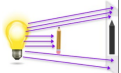
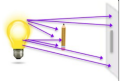


From J.P. Canright and Suzanne White Brahmia, Phys. Rev. Phys. Educ. Res. 20, 010146

Worksheets with ISLE Approach

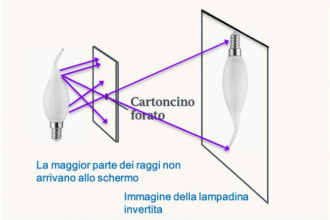


Modello di molteplici raggi emessi da ogni punto:

a un metro. 	sullo schermo, perché i raggi del bulbo non arrivano allo schermo 	sullo schermo, perché i raggi del bulbo non arrivano allo schermo 	
2 Illuminare una matita posta a distanza inferiore a un metro. 	Si prevede un'ombra nera e netta della matita sullo schermo, perché i raggi del bulbo non arrivano allo schermo, come per l'esperimento 1 	Si prevede che lo schermo sia praticamente illuminato uniformemente con un accenno di ombra. 	Si vede un'ombra sfocata e tenue (diversa dall'esperimento 1)

Esperimento di applicazione

Condividere e discutere i disegni/le rappresentazioni dell'immagine che si forma sullo schermo. Utilizzando delle lampadine a forma di candela si può fare l'esperimento anche con gli studenti. Il risultato è quello che si può vedere nell'immagine di seguito riportata con la candela:



Experiment Worksheets

aggiornaMenti LABORATORIO DI DIDATTICA DELLA SCIENZA — INFN — UNICA — IOM ISTITUTO OFFICINA DEI MATERIALI

I fluidi

La spinta di Archimede nell'aria

Obiettivo: Osservare l'azione della spinta di Archimede in aria.

Difficoltà di esecuzione (da 1 a 5): 2

Materiali:

- Una bottiglia
- Un palloncino
- Aceto
- Bicarbonato
- Una bilancia.

Esecuzione: Inserire il bicarbonato nel palloncino e l'aceto nella bottiglia. Agganciare il palloncino al bordo della bottiglia e posizionarla sulla bilancia, registrando il peso iniziale. Versare il bicarbonato nella bottiglia e aspettare che avvenga la reazione. Misurare nuovamente il peso una volta che la reazione è terminata.

Riflessioni: Il sistema bottiglia-palloncino è isolato rispetto all'ambiente esterno, per cui la massa al suo interno si conserva (è un sistema chiuso). Dopo la reazione però, il palloncino si gonfia aumentando il suo volume e spostando un volume di aria maggiore rispetto a quello spostato dal sistema prima della reazione. Questo fa si che il sistema sia sottoposto ad una spinta di Archimede maggiore al termine della reazione, per cui il peso registrato dalla bilancia sarà minore rispetto a quella registrato all'inizio.

Se si immagina di eseguire l'esperimento nel vuoto, ci si aspetta che il peso misurato rimanga lo stesso prima e dopo la reazione.

Si consiglia di lasciare formulare agli studenti le ipotesi sul risultato aspettato.

Approfondimenti/collegamenti con la realtà (se previsto):

Collegamento con altre discipline (se previsto):

Chimica: legge di conservazione della massa nelle reazioni chimiche.

Riassumendo… L'esperimento evidenzia il ruolo della spinta di Archimede anche nell'aria. Nonostante la massa resti conservata, il maggiore volume occupato dal sistema bottiglia-palloncino dopo la reazione sposta una maggiore quantità d'aria, facendo in modo che questo senta una spinta verso l'alto più grande e di conseguenza un peso minore misurato dalla bilancia.

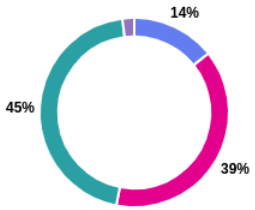
Project impact

Since 2017, approximately 800 participants have attended the various local editions. Actual impact on teaching was assessed through a national questionnaire administered at the end of the school year.

18. In quante classi hai utilizzato, anche parzialmente, la nuova modalità di insegnamento della scienza appresa durante i l corso? (0 punto)

Più dettagli

Nessuna	7
Una classe	19
Da due a tre classi	22
Più di tre classi	1



Project impact

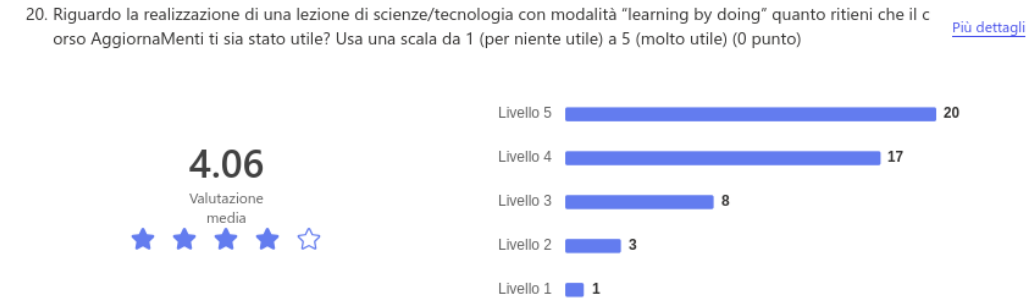
Since 2017, approximately 800 participants have attended the various local editions. Actual impact on teaching was assessed through a national questionnaire administered at the end of the school year.

19. Il nuovo approccio didattico ti ha portato a utilizzare, almeno in parte, nuove modalità di valutazione dell'apprendimento? (0 punto)

Più dettagli

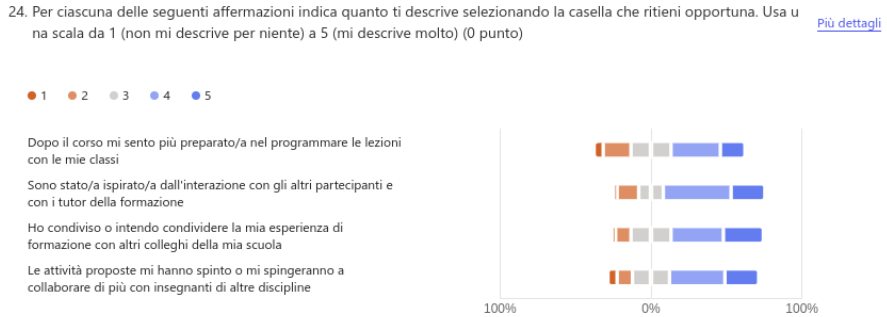
Project impact

Since 2017, approximately 800 participants have attended the various local editions. Actual impact on teaching was assessed through a national questionnaire administered at the end of the school year.



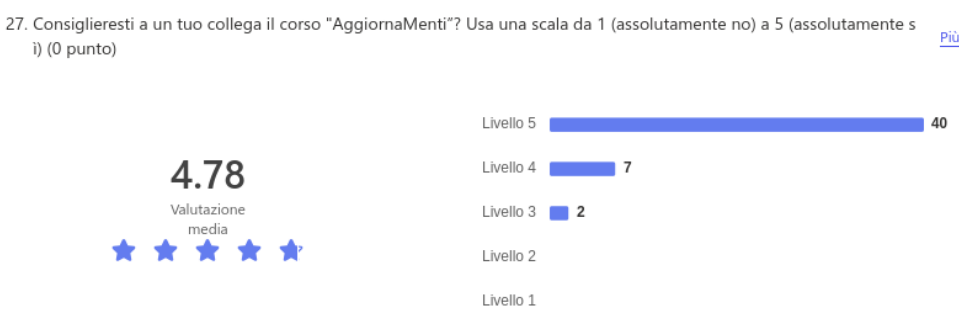
Project impact

Since 2017, approximately 800 participants have attended the various local editions. Actual impact on teaching was assessed through a national questionnaire administered at the end of the school year.



Project impact

Since 2017, approximately 800 participants have attended the various local editions. Actual impact on teaching was assessed through a national questionnaire administered at the end of the school year.



To learn more about us...

Visit our national webpage

Two takeaways

- Science is not an activity carried out by a few researchers in inaccessible labs, disconnected from the daily life of normal people: Science enters into almost any aspect of everyday life;

Two takeaways

- Science is not an activity carried out by a few researchers in inaccessible labs, disconnected from the daily life of normal people: Science enters into almost any aspect of everyday life;
- Even the simplest experiment can be used to develop the scientific method: formulating hypotheses, designing further tests to reject them, distinguishing the essential aspects from the details, identifying possible systematic errors in measurements...

Two takeaways

- Science is not an activity carried out by a few researchers in inaccessible labs, disconnected from the daily life of normal people: Science enters into almost any aspect of everyday life;
- Even the simplest experiment can be used to develop the scientific method: formulating hypotheses, designing further tests to reject them, distinguishing the essential aspects from the details, identifying possible systematic errors in measurements...

In all of this, the added value brought by those who conduct scientific research every day is fundamental