

Science communication in secondary schools through limnology



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- *Why science communication ?*
 - *Increase scientific competence of youngsters.*
 - *Foster citizen science*
- *Why physical limnology ?*
- *Why Secondary Schools ?*
- *How to communicate*
- *When and who*

- *Why science communication ?*
 - *Explain the environmental relevance of lakes*
 - *Foster citizen science*
- *Why physical limnology ?*
 - *Area of Research and environmental relevance of lakes*
 - *Create interest towards lakes through youngsters*
 - *genius loci*
 - *Scientific Completeness*
- *Why Secondary Schools ?*
- *How to communicate*
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 - Alternanza Scuola Lavoro
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 - Original Lectures +, Direct involvement through experiments
 - Data manipulation through Spreadsheets and programming
- **When and who**

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 - Liceo Scientifico Calini, Brescia;
 - Liceo Scientifico Leonardo, Brescia;
 - Liceo Antonietti Iseo

First Slide of the seminar

Leading Idea

Method

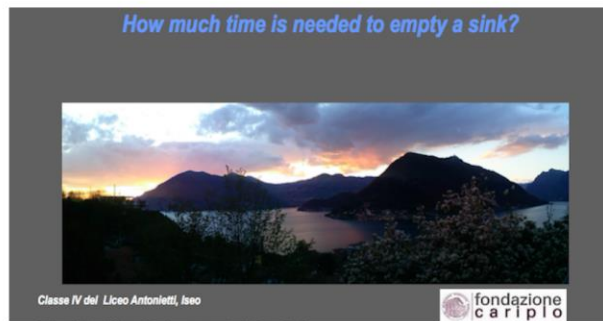
Curricular Competence



Why water is important

- Analysis of Hydrologic Balance
- Statistical analysis of the average water consumption of the students in the class

- natural science
- statistics



Physical law have a predictive power

- Experiments of mass conservation with a simple reservoir
- Use of a Spreadsheet

- physics
- math

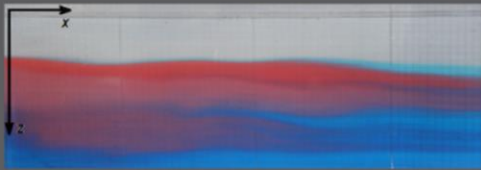


Simple models must be refined to get the right answer...

- Experiments of pollutant dilution with time in a CSTR

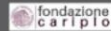
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- math

The role of density in lake dynamics



Classe IV del Liceo Antonietti, Iseo

Relatori : Prof. Marco Pilotti, marco.pilotti@ing.unibs.it
Dott.ssa Giulia Valerio giulia.valerio@ing.unibs.it



If thermal stratification is at play, the model must be further refined ...

- Physical model of a stratified lake, with visualization of overflow, intrusion and plunging flow
- Internal waves by artificially generated wind

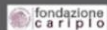
- physics
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Introduction to scientific programming



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Sometimes a spreadsheet is not the easiest way to deal with the problem ...

- Introduction to the implementation of simple algorithm with a free PASCAL compiler

- algorithmic thinking
- math
- computer science

roots of a second order equation
Cramer's rule for a 3x3 system
recursive equation for mass conservation

Why lake Endine freezes and Lake Iseo does not ? (i.e., the energy balance of a lake)



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The importance and implication of the energetic balance of a lake

- hands on working on the data measured by our LDS
- Computation of energy balance with a spreadsheet and with a simple code

- physics
- math
- computer science

The role of Earth rotation on the dynamics of a large lake

Classe IV del Liceo Calini
Liceo Leonardo da Vinci
Professori: Aldo Auditore
Marco Longhi



Earth rotation has a role to play...

- Visit to the laboratory at the University
- Physical experiment exploring the role of Coriolis' force on the lake inflows
- Physical experiment on Taylor's columns

• A glance on the world of University and Research

Some chemical and ecological dynamics of a lake



Classe IV del Liceo Antoniotti, Iseo
Relatori: Prof. Marco Pilotti,

Physics, chemistry and Ecology of a lake are deeply interconnected

- The chemistry of photosynthesis
- The Lotka Volterra Model
- A simple code to solve the Lotka Volterra system of equations

• chemistry
• ecology
• math
• computer science



Is it only Theory ?

- Measurement campaign in lake Iseo
- lake trip to the LDS
- Use of an oceanographic probe
- Use of a Van Dorn bottle
- Use of Secchi disk
- Evaluation of P and N content in deep and epilimnic waters

• Experimental skills in the field

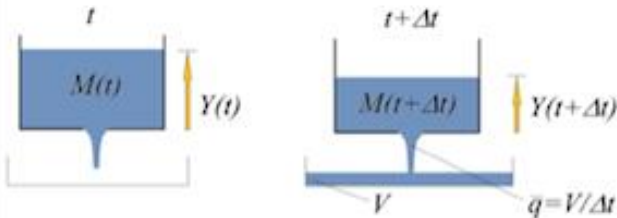


Let us explore
the multifaceted
reality of the
environment
where we live

- **Group Assignments on topics selected from a wide list of proposals regarding the lake and the surrounding environment**

- **Group working**
- **All the skills listed above**
- **Set up of a Final Report**
- **Set up of a presentation**

Seminar 2



$$M(t) = \rho \cdot A \cdot Y(t)$$

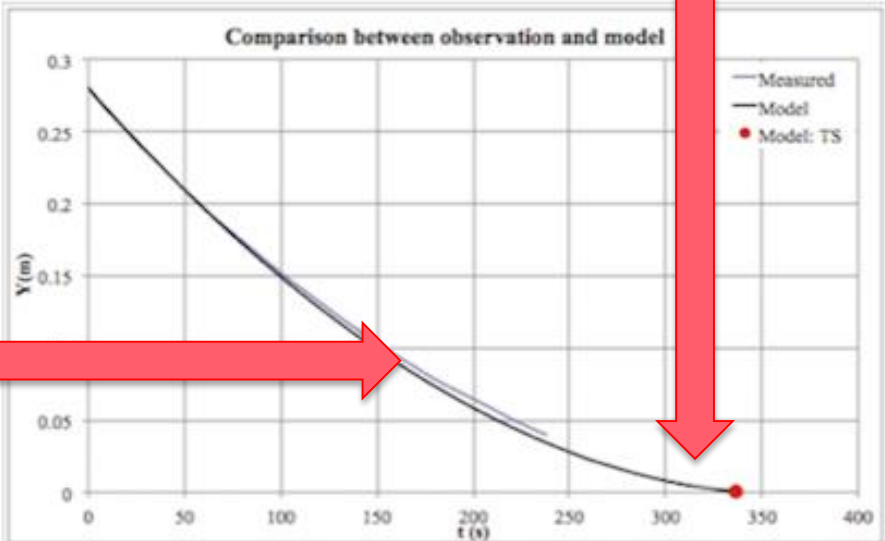
$$M(t) = M(t + \Delta t) + \rho \cdot V$$

$$M(t + \Delta t) = M(t) - \rho \cdot V$$

$$Y(t + \Delta t) = Y(t) - \frac{V}{A}$$

$$Y(t + \Delta t) = Y(t) - C \sqrt{Y(t)} \quad C = \frac{a \sqrt{2g \Delta t}}{A}$$

Parameters and constants			
Area orifice (m²)	0.0001	Orifice diameter (mm)	11.33
Orifice diameter (mm)	11.33	Orifice area (m²)	0.0001
Area tank (m²)	0.01	Volume tank (m³)	0.01
Area tank (m²)	0.01		
Area tank (m²)	0.01		
Acceleration gravity (m/s²)	9.81		
Results			
Time (s)	Time (s)	Time (s)	Time (s)
0	0	0	0
10	10	10	10
20	20	20	20
30	30	30	30
40	40	40	40
50	50	50	50
60	60	60	60
70	70	70	70
80	80	80	80
90	90	90	90
100	100	100	100
110	110	110	110
120	120	120	120
130	130	130	130
140	140	140	140
150	150	150	150
160	160	160	160
170	170	170	170
180	180	180	180
190	190	190	190
200	200	200	200
210	210	210	210
220	220	220	220
230	230	230	230
240	240	240	240
250	250	250	250
260	260	260	260
270	270	270	270
280	280	280	280
290	290	290	290
300	300	300	300
310	310	310	310
320	320	320	320
330	330	330	330
340	340	340	340
350	350	350	350
360	360	360	360
370	370	370	370
380	380	380	380
390	390	390	390
400	400	400	400



Seminar 3



$$C = V/V_L$$

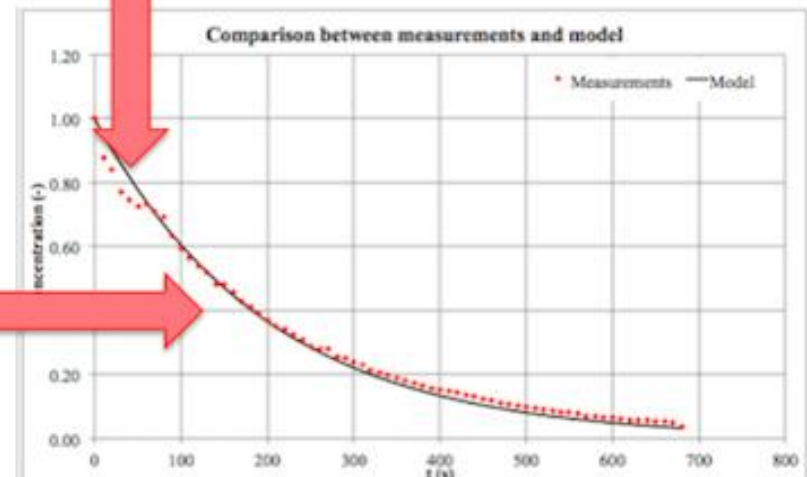
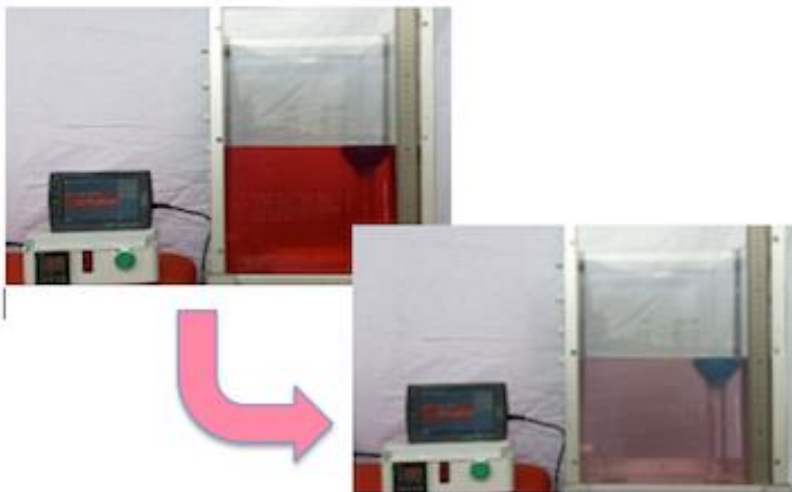
$$V(t + \Delta t) = V(t) - C(t)q\Delta t$$

$$\frac{V(t + \Delta t)}{V_L} = \frac{V(t)}{V_L} - \frac{C(t)q\Delta t}{V_L} = \frac{V(t)}{V_L} - \frac{C(t)\Delta t}{T_R}$$

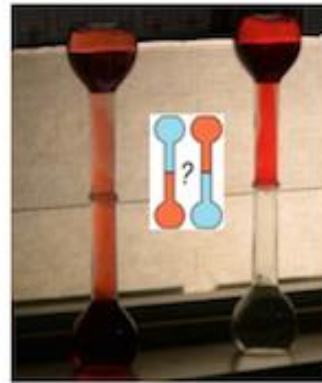
$$T_R = \frac{V_L}{q}$$

$$C(t + \Delta t) = C(t)\left(1 - \frac{\Delta t}{T_R}\right)$$

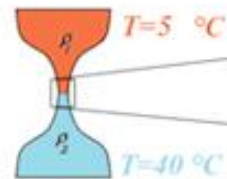
Parameters of the lake				Parameters of the inlet flow			
Volume (m ³)	1000	Concentration (kg/m ³)	1.0	Flow rate (m ³ /s)	0.01	Concentration (kg/m ³)	0.01
Area (m ²)	100	Concentration (kg/m ³)	0.01	Flow rate (m ³ /s)	0.01	Concentration (kg/m ³)	0.01
Length (m)	10	Concentration (kg/m ³)	0.01	Flow rate (m ³ /s)	0.01	Concentration (kg/m ³)	0.01
Width (m)	10	Concentration (kg/m ³)	0.01	Flow rate (m ³ /s)	0.01	Concentration (kg/m ³)	0.01
Depth (m)	1	Concentration (kg/m ³)	0.01	Flow rate (m ³ /s)	0.01	Concentration (kg/m ³)	0.01
Volume (m ³)	1000	Concentration (kg/m ³)	0.01	Flow rate (m ³ /s)	0.01	Concentration (kg/m ³)	0.01
Area (m ²)	100	Concentration (kg/m ³)	0.01	Flow rate (m ³ /s)	0.01	Concentration (kg/m ³)	0.01
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Depth (m)	1	Concentration (kg/m ³)	0.01	Flow rate (m ³ /s)	0.01	Concentration (kg/m ³)	0.01



Seminar 4



$$T = \frac{L}{\sqrt{g \frac{\rho_2 - \rho_1}{\rho_2} \frac{h_2 h_1}{h_2 + h_1}}} = 30s$$



$$m\vec{a} = \sum \vec{F}$$

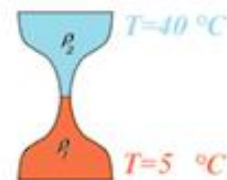
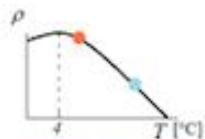
$$\rho_1 V \vec{a} = \vec{g} \rho_1 V - \vec{g} \rho_2 V$$

$$\vec{a} = \vec{g} \frac{(\rho_1 - \rho_2)}{\rho_1} > 0$$

$$\rho_2 V \vec{a} = \vec{g} \rho_2 V - \vec{g} \rho_1 V$$

$$\vec{a} = \vec{g} \frac{(\rho_2 - \rho_1)}{\rho_2} < 0$$

INSTABILE



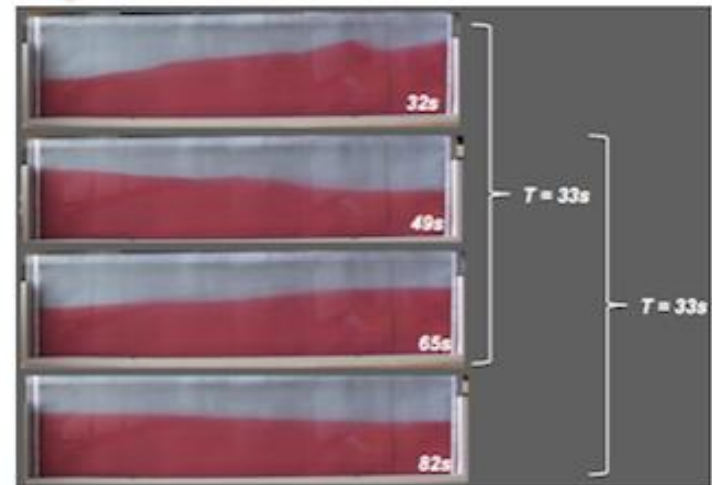
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$$\vec{a} = \vec{g} \frac{(\rho_2 - \rho_1)}{\rho_2} < 0$$

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$$\vec{a} = \vec{g} \frac{(\rho_1 - \rho_2)}{\rho_1} > 0$$

STABILE



Protected: Ciclo seminariale Licel Calini e Leonardo – Brescia

In questa sezione è raccolto il materiale didattico utilizzato nell'ambito del progetto "Il lago, genius loci del territorio bresciano, occasione di introduzione al pensiero scientifico", rivolto agli studenti del liceo Calini e del Liceo Leonardo (anno scolastico 2014-2015) e coordinato assieme ai docenti dei corsi di Fisica e Matematica, Prof. Aldo Auditore e Prof. Marco Pietro Longhi. Questo progetto è cofinanziato dalla Fondazione della Comunità Bresciana Onlus.

- [Questionario relativo al consumo di acqua](#) da completare da parte di ciascun studente
- [Seminario_1.pdf](#)
- [Presentazione_delle_interviste.pdf](#)
- Intervista a [Steven Chapra](#), Tuft University, Boston
- Intervista a [Charlie Hogg](#), PostDoc, Cambridge University
- Intervista a [Roberta Fornarelli](#), Environmental Engineer in Perth, Australia
- Intervista a [Nino Frosio](#), ingegnere, esperto di utilizzo idroelettrico delle risorse idriche
- [Seminario_2](#)
- [Seminario_3](#)
- [Seminario_4](#)
- [Seminario_5](#)
- [Seminario_6](#)
- [Seminario 7](#) (4/5/2015 con foglio elettronico sottostante)

Materiale di supporto relativo ai diversi seminari

- Elenco delle [domande](#) poste durante le interviste e spiegazione di alcuni termini utilizzati
- Mappa delle [precipitazioni medie annue](#) in Lombardia
- Report UNESCO sui [Flussi virtuali di acqua](#)
- Report USGS sulla misura della [conducibilità](#)
- [Seminario2_foronomia.xls](#)
- [Seminario3_sul tempo di ricambio in un serbatoio.xls](#)
- Seminario 5: fogli elettronici [Analisi_dati_temperatura](#) e [Bilancio_energetico_giornaliero](#)
- Seminario 6: [articolo scientifico](#) sul modello fisico del Lago d'Iseo
- Seminario 7: [Foglio di calcolo](#) sulla dinamica delle popolazioni
- [Articolo divulgativo](#) sull'eutrofizzazione
- [Articolo scientifico](#) sull'eutrofizzazione

	Italy	16613 (89 %)
	United States	511 (3 %)
	Austria	155 (1 %)
	United Kingdom	146 (1 %)
	Netherlands	82 (0 %)
	Germany	82 (0 %)
	France	79 (0 %)
	Spain	54 (0 %)
	China	49 (0 %)

Total Visits: 18393

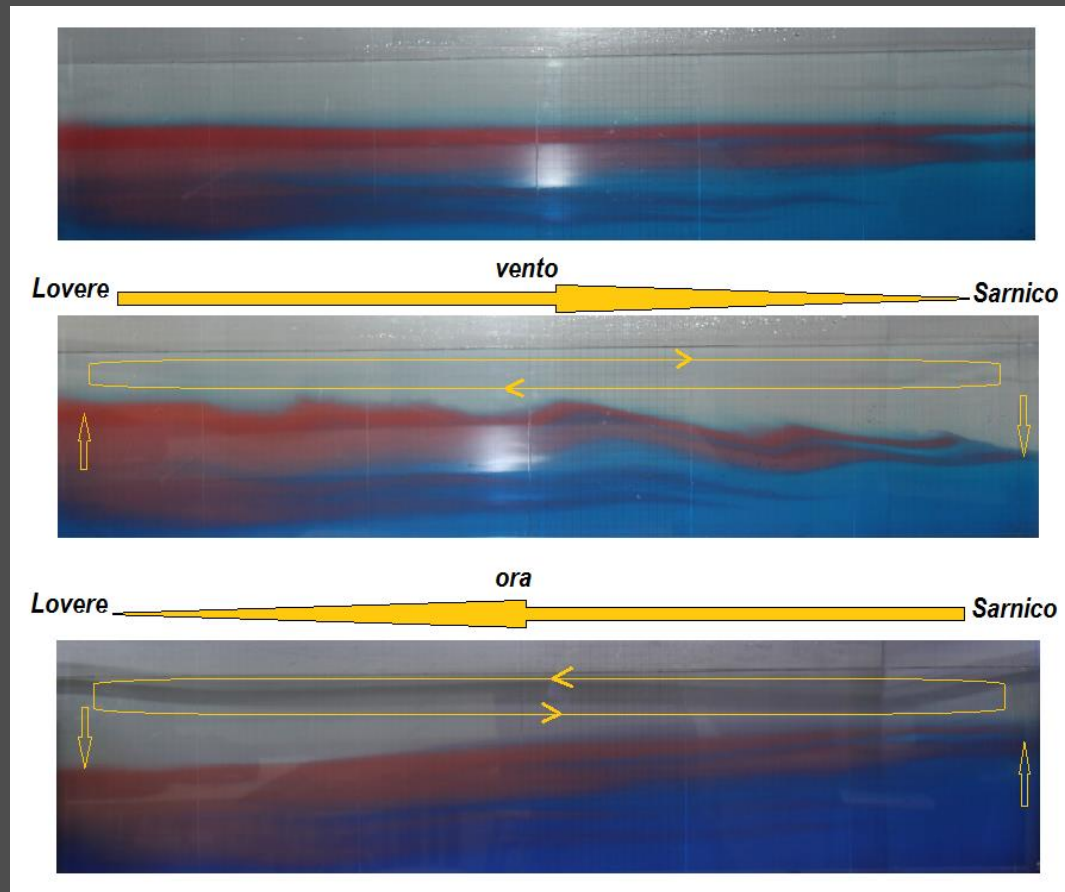
The activities partly presented in this presentation have been made possible also thanks to a grant by Fondazione della Comunità Bresciana, that, in 2014-2015 funded our project

“Il lago, genius loci del territorio bresciano e occasione di introduzione al pensiero scientifico”

*and by fondazione CARIPO, through the dissemination part of the ISEO project.
Their help is kindly acknowledged*



THANK YOU FOR YOUR ATTENTION



Is somebody interested in exploring a H2020 proposal on citizen science ?



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DICATAM – DEPARTMENT OF CIVIL ENGINEERING,
ARCHITECTURE, LAND, ENVIRONMENT AND MATHEMATICS



Hydraulics Research Group