TIWI: Multiplier Event

Inquiry Based Learning for science education in primary and secondary school.
The Go-Lab ecosystem for innovative STEM education

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Deusto
Universidad de Deusto
Deustuko Unibertsitatea
University of Deusto

Co-funded by the Erasmus+ Programme of the European Union

Roadmap / outline

- TIWI Project briefly
- Inquiry learning as active learning
- How to make inquiry effective
- The Go-Lab ecosystem at a glance

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TIWI --> Teaching ICT With Inquiry

MAIN IDEA:

Structure of STEAM career (*present + future*):
a composition of the science and ICT:

Science: Inquiry-based Learning approach (Go-Lab ecosystem)

ICT: coding languages (Scratch, Python, and Excel)

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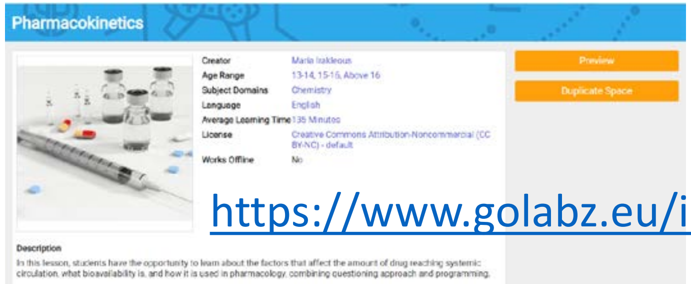
TIWI using Go-Lab ecosystem

https://bit.ly/2u1cn7W

https://bit.ly/2BbhqCM

https://www.golabz.eu/ils/augmented-reality



https://www.golabz.eu/ils/pharmacokinetics

https://bit.ly/30sGily

https://bit.ly/2owljQe

http://tiwi.eun.org/

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Inquiry learning as active learning

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The discourse

- The problem for STEM education
  - Students often do not reach (deep) conceptual knowledge
  - Students often lack motivation
- The solution
  - Introduce active learning
  - Technology to foster and enable the transition between traditional and active learning

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What is an Active Learning?

Active learning is any learning exercise in which a student is actively engaged, i.e. participates or interacts, with the learning process, as opposed to passively taking in the information.

Unknown source

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Active Learning (evidence 1)

- *62 introductory courses*
- *6542 students*
- *Standardized conceptual knowledge*
- *test, pre- and post*
- *14 traditional (T) courses (N = 2084)*
- *48 interactive engagement (IE)*
- *courses (N = 4458)*

Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses

Richard R. Hake[a]
Department of Physics, Indiana University, Bloomington, Indiana 47405

(Received 6 May 1996; accepted 4 May 1997)

A survey of pre/post-test data using the Halloun–Hestenes Mechanics Diagnostic test or more recent Force Concept Inventory is reported for 62 introductory physics courses enrolling a total number of students $N=6542$. A consistent analysis over diverse student populations in high schools, colleges, and universities is obtained if a rough measure of the average effectiveness of a course in promoting conceptual understanding is taken to be the average normalized gain $\langle g \rangle$. The latter is defined as the ratio of the actual average gain (%⟨post⟩−%⟨pre⟩) to the maximum possible average gain (100−%⟨pre⟩). Fourteen "traditional" (T) courses ($N=2084$) which made little or no use of interactive-engagement (IE) methods achieved an average gain $\langle g \rangle_{T\text{-ave}}=0.23\pm0.04$ (std dev). In sharp contrast, 48 courses ($N=4458$) which made substantial use of IE methods achieved an average gain $\langle g \rangle_{\text{IE-ave}}=0.48\pm0.14$ (std dev), almost two standard deviations of $\langle g \rangle_{\text{IE-ave}}$ above that of the traditional courses. Results for 30 ($N=3259$) of the above 62 courses on the problem-solving Mechanics Baseline test of Hestenes–Wells imply that IE strategies enhance problem-solving ability. The conceptual and problem-solving test results strongly suggest that the classroom use of IE methods can increase mechanics-course effectiveness well beyond that obtained in traditional practice.

I. INTRODUCTION

There has been considerable recent effort to improve introductory physics courses, especially after 1985 when Hal-... cent con[11] and pro[12] arguments as to whether a high FCI score indicates the attainment of a unified force concept. Nevertheless, even the detractors have conceded that "the FCI is one of the most reliable and useful physics tests currently available for introductory physics teachers"[11(a)] and

- *Average gain IE almost* ***two standard deviations higher*** *than T*

Hake, R. H. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics*, *66*, 64-74

Active Learning (evidence 2)

- "The active learning interventions varied widely in intensity and implementation, and included approaches as diverse as occasional group problem-solving, worksheets or tutorials completed during class, use of personal response systems with or without peer instruction, and studio or workshop course designs."(p. 8410)
- Meta-analysis of 225 studies
  - Active learning increases performance by 0.47 SD
  - Students in traditional lectures were 1.5 times more like to fail in final exam than students in active learning classes
- "If the experiments analyzed here had been conducted as randomized controlled trials of medical interventions, they may have been stopped for benefit—meaning that enrolling patients in the control condition might be discontinued because the treatment being tested was clearly more beneficial" (p. 8413)

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, *111*, 8410-8415.

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Models & Strategies of Active Learning

Chris O'Neal and Tershia Pinder-Grover, Center for Research on Learning and Teaching, University of Michigan, http://crlt.umich.edu/sites/default/files/resource_files/02_Active%20Learning%20Continuum.pdf

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Inquiry Learning (Inquiry Based Learning)

- Expository methods (traditional teaching)
  - Teacher explains – students do exercises (ready made science)
  - First: presentation of scientific principles (lecture)
  - Then: experiment to verify (confirm) the principle (laboratory)

- Inquiry methods (learning)
  - Students are ***researchers***: do explorations first and design concepts and laws together with their teachers (science-in-the making)
  - Students construct (not only confirm) meaning
  - No clear separation between the lecture and the lab

Schuster, D., Cobern, W. W., Adams, B. A. J., Undreiu, A., & Pleasants, B. (2018). Learning of core disciplinary ideas: Efficacy comparison of two contrasting modes of science instruction. *Research in Science Education, 48,* 389-435.

Trout, L. Lee, C., Moog, R., Ricky, D. (2008). Inquiry learning: What is it? How do you do it? In: *Chemistry in the National Science Standards, 2nd Edition*, S.L. Bretz (Ed.). Washington, DC: American Chemical Society.

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Main features of inquiry learning

- Learners try to formulate hypotheses and scientifically oriented questions and get answer on them
- Learners collect evidence by actively performing experiments
- Learners formulate explanations from evidence
- Learners evaluate their explanations in light of alternative explanations
- Learners communicate and justify their proposed explanations

Based on: National Research Council. (2000). *Inquiry and the national science education standards. A guide for teaching and learning*. Washington DC: National Academy Press.

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Four Forms of Inquiry (instructional settings)

- *Confirmation inquiry*

Learners are given a question, as well as a method, to which the end result is already known. The goal is to confirm the results.

- *Structured inquiry*

Learners are given the question and the method of achieving the result, but the goal is to provide an explanation that is already supported by the evidence gathered during and through the investigative process.

- *Guided inquiry*

Learners are only given a question. The main goal is to design the method of investigation and then test the question itself. This type of inquiry is not typically as structured as the previously mentioned forms.

- *Open inquiry*

Learners must form their own questions, design investigative methods, and then carry out the inquiry itself. They must present their results at the end of the process.

Based on: Christopher Pappas. (2014). *Instructional Design Models and Theories: Inquiry-based Learning Model*. Available: https://elearningindustry.com/inquiry-based-learning-model.

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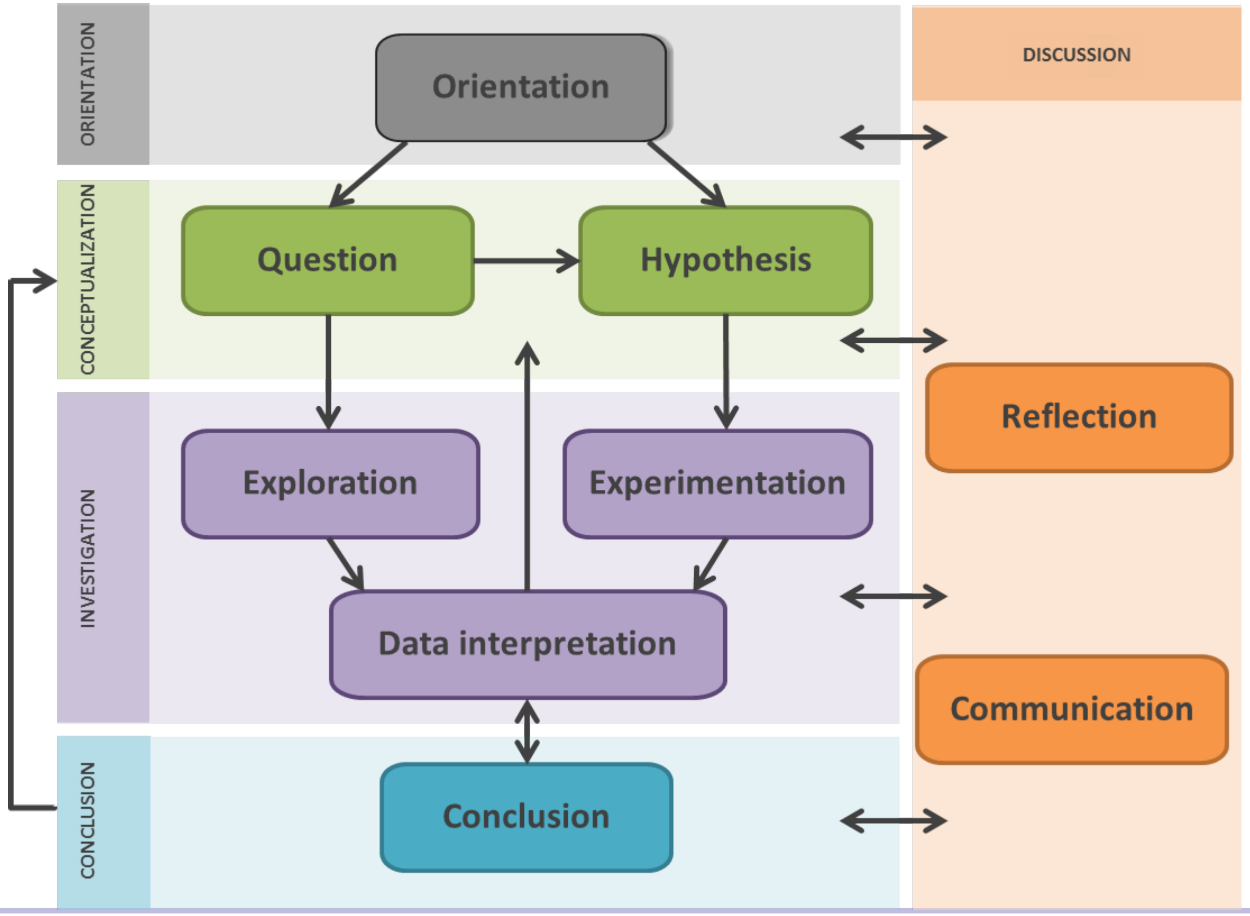
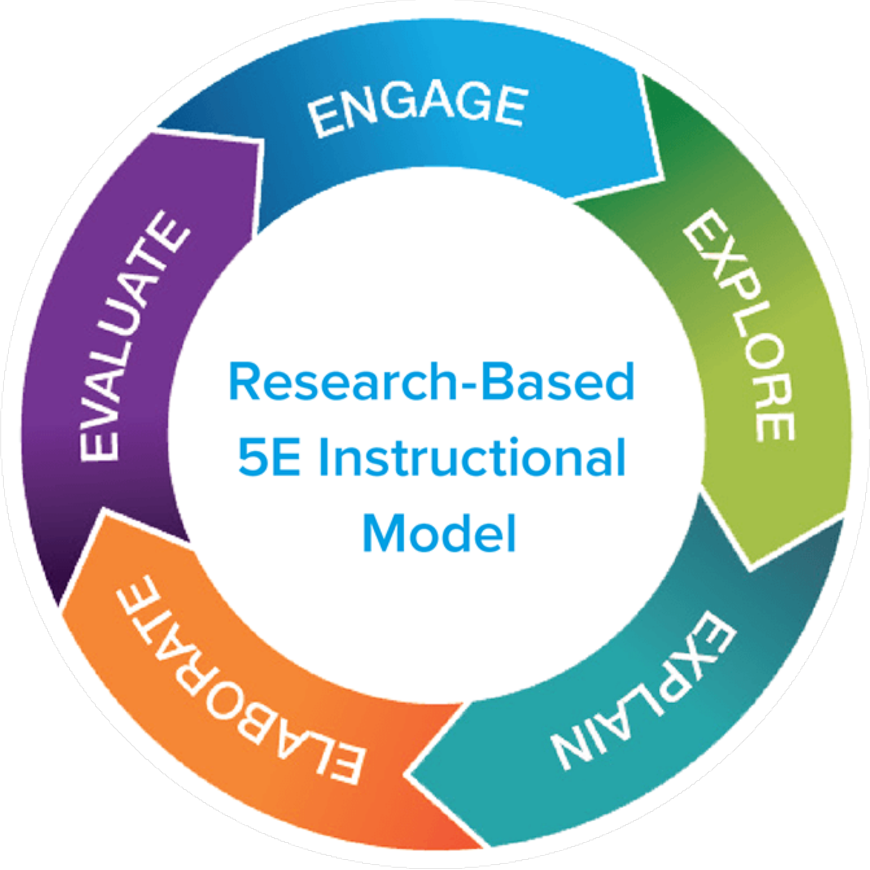
The Go-Lab inquiry cycle & 5E





Pedaste, M. Mäeots, M. Siiman L. A., de Jong, T., van Riesen, S. A. N., Kamp, E. T., Manoli, C. C., Zachariac, Z. C., & Tsourlidaki, E. (2015). Phases of inquiry-based learning: definitions and the inquiry cycle. *Educational Research Review*, *14*, 47-61.

Bybee, R., Taylor, J. et al. (2006). *The BSCS 5E instructional model: Origins and effectiveness*. Colorado Springs, CO: BSCS.

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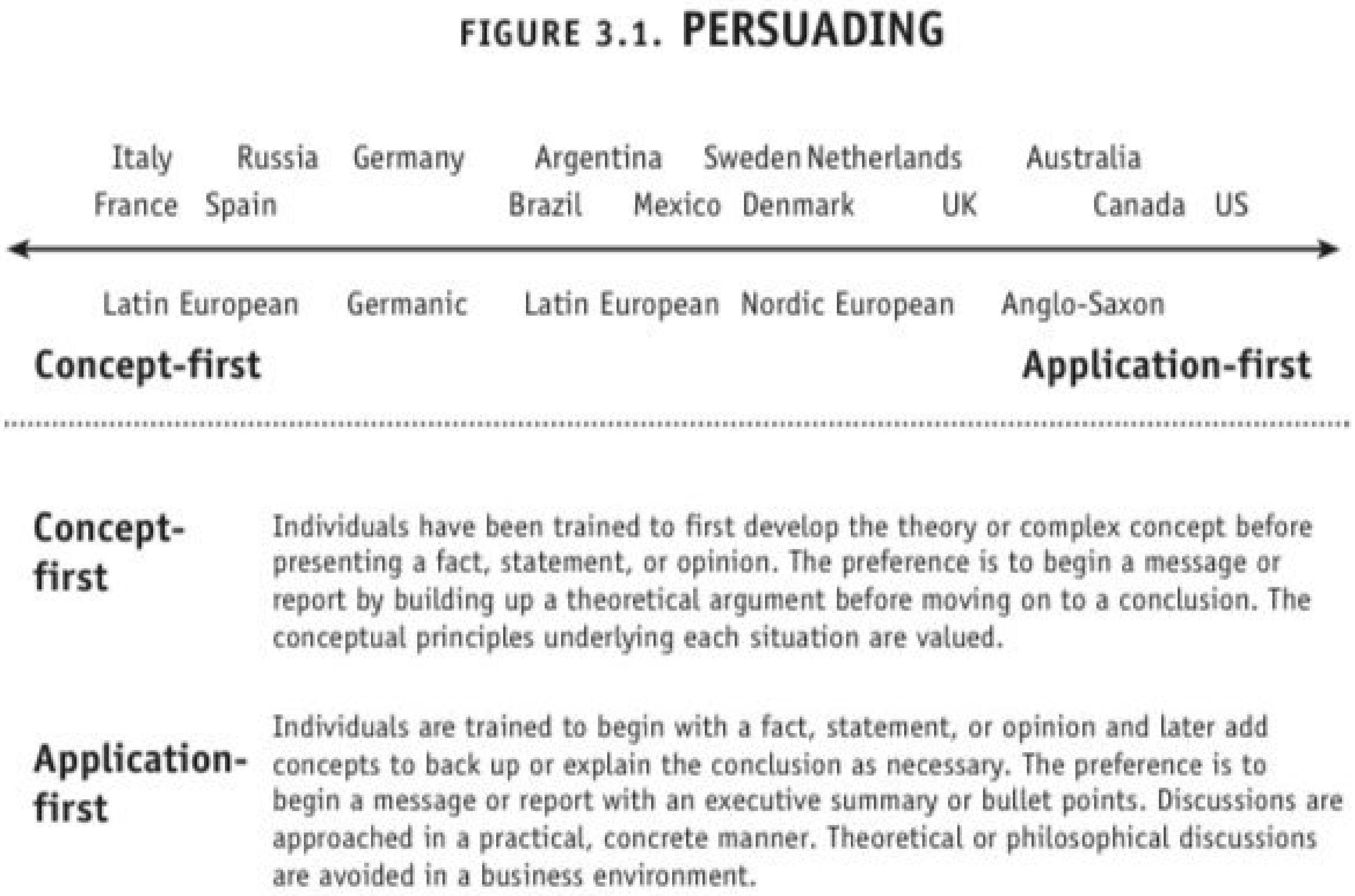
Study: cultural differences in the business

GO-LAB Inquiry Cycle

5E



Meyer, Erin. 2014. *The Culture Map: Breaking Through the Invisible Boundaries of Global Business*. New York: PublicAffairs.

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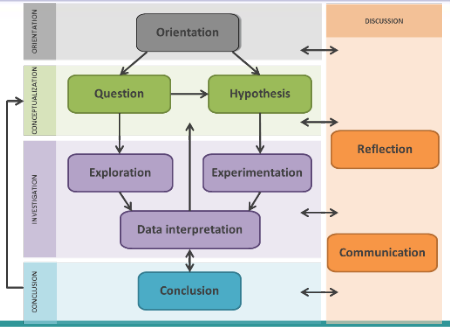
Hands-on Inquiry Activity



Floating and sinking

1. Explore the materials

Materials: bowl, water, paper, aluminium foil and several objects. Look at the materials and create a boat. Play with the boat and try to put on it as many objects as you can.

1.a Can you think of examples where you yourself deal with floating and sinking?

1.b When does an object float or sink?

2. Research Question

Think of a short question that you want to investigate regarding floating and sinking. Your question has to be clear enough so anyone that reads it, immediately understand what you want to investigate.

2.a Write down your research question.

2.b What do you think the answer is to your question? (Write down what you think will happen when you investigate your question)

3. Research Plan

There are a few things you can change about the floating and sinking; we call these things **variables**. When you investigate your question, you might want to change some variables, but not some other variables.

3.a Which variables can you identify?

3.b Write down for each variable whether you want to change it or not.

4. Experimentation

Conduct your experiment. You may need to keep records of your data.

5. Results

When you are done with experimenting and measuring, you will write down your results.

5.a Write down below what you have found and how your findings relate to your question.

5.b Is the result in line with what you expected would happen?

6. Outlook

6. Can you think of a new research question about floating and sinking based on your findings?

How to make inquiry effective

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Inquiry needs to be supported

- How to support students?
  - By balancing instruction and inquiry
  - By providing students with an overall strategy (inquiry cycle)
  - By giving students the right level of control
  - By providing students with scaffolds (apps)

- The trick is to give just enough domain knowledge and just enough structure (in strategy, control, and scaffolds).

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Guiding inquiry with scaffolds (tools/apps)

- Enable to perform tasks a student could not do without the scaffold
- Geared towards specific difficulties that students experience
- Possibility of fading (spend more time on the some exercises)

Ton de Jong presentation

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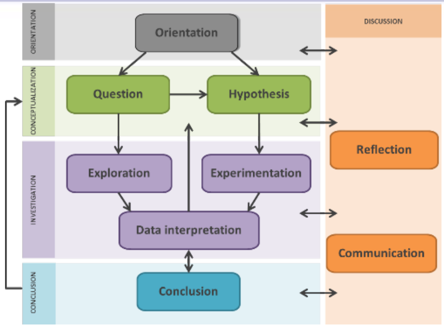
Hands-on Inquiry Activity



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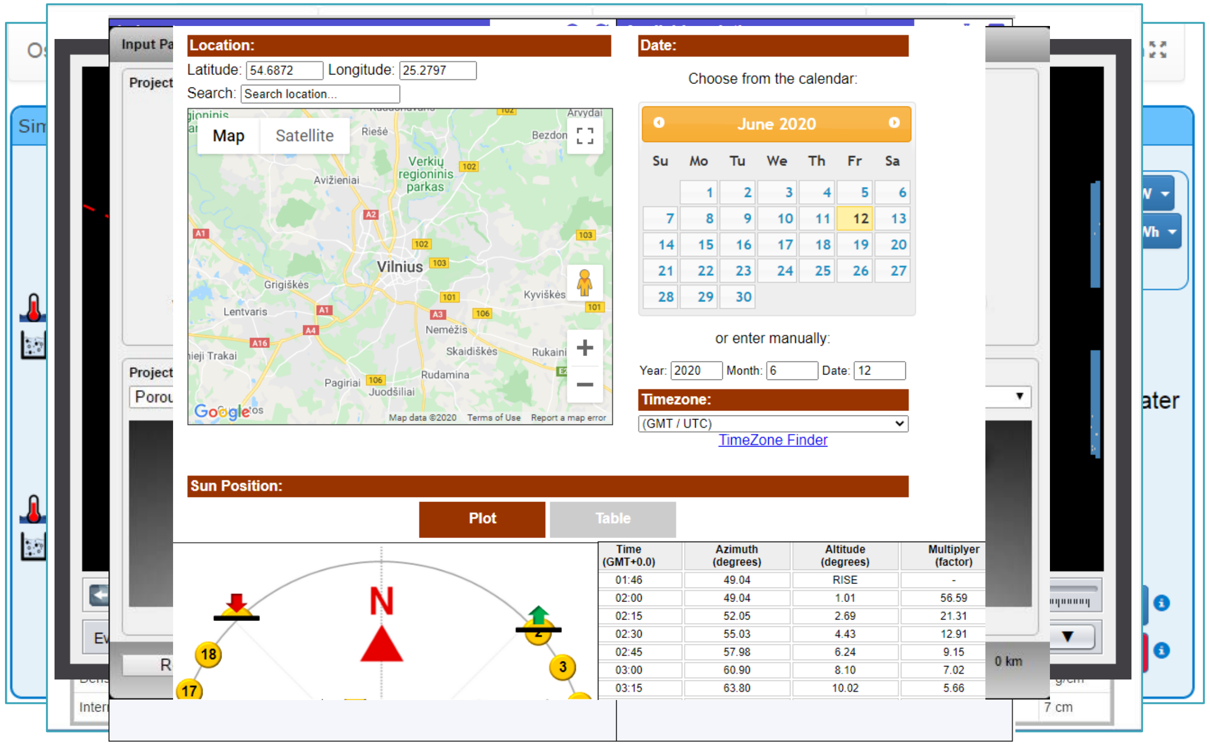
Research Tool (Online labs) - golabz.eu



- 600+ labs
- STEM subject domains
- Types: virtual, remote and datasets
- Age range 6+
- 38 Languages

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Scaffolds (apps) in Go-Lab (45+)- golabz.eu

- Concept map
- Hypothesis scratchpad
- Question scratchpad
- Experiment design tool
- Observation tool
- Data viewer

- Conclusion tool
- Reflection tool(s)
- Quiz tool
- Reporting tool

- Learning Analytics Apps
  - Online Users Visualisation
  - Time Planner, Spent and Checker
  - Timeline….
- Collaboration Apps
  - Chat
  - Ride Assessment App
  - Peer Assessment Tool
  - Collaboration Tool
  - Zoom…
- Programming Apps:
  - Scratch
  - Python

Organized in an inquiry cycle

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Inquiry Learning Space (ILS) - golabz.eu

Pusiausvyra

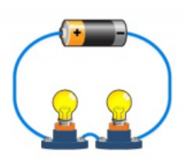
★★★★★ No votes have been submitted yet.

Students will become familiar with the concept of balance. Practice balance lab work. The Scratch program will create a program with two interlaced characters.

Vandens Apytakos Ratas

★★★★★ No votes have been submitted yet.

Mokinių pasiekimai: Naudodamasis schema paaiškina vandens apytaką gamtoje. Atpažįsta dažnai stebimus gamtos reiškinius, įvairias kritulių rūšis. Mokytojo veiklos siekiniai: 1. Padėti suprasti vandens apytakos principą ir jo svarbą gamtai.



Elektros Grandinė

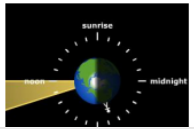
★★★★★ Rating: 5 - 5 votes

Elektros grandinės sandara, veikimo principas. Išsiaiškinti kas yra elektra, kaip ji atkeliauja į namus, medžiagas laidžias ir nelaidžias elektrai. 3 klasė

Physics On The Road

★★★★★ No votes have been submitted yet.

Uniformly variable movement.



Moon Phases

★★★★★ Rating: 1 - 1 votes

This learning environment helps to understand why and how the lunar phases change. The Lunar Phase Simulator is included.

Big Ideas Of Science

- Energy Transformation (1)
- Fundamental Forces (1)
- Our Universe (1)
- Planet Earth (1)

Age Ranges

- 9-10 (3)
- 11-12 (1)
- 13-14 (1)
- 15-16 (2)
- Above 16 (1)

Languages

- Arabic (1)
- Basque (41)
- Bulgarian (4)
- Catalan (42)
- Croatian (6)
- Czech (2)
- Danish (2)
- Dutch (56)
- English (303)
- Estonian (27)
- Finnish (17)
- French (80)
- Galician (1[illegible])
- German (50)
- Greek (137)
- Hungarian (1)
- Italian (34)
- Lithuanian (5)
- Macedonian Slavic (6)
- Polish (6)
- Portuguese (145)
- Romanian (108)
- Russian (8)
- Serbian (7)
- Simplified Chinese (1)

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Is inquiry learning with online labs effective?

- Inquiry-based learning with online labs (and simulations) shows an advantage over expository instruction
- Students in online labs gain the same level of knowledge or a more advanced level of knowledge than students who learn in a real laboratory
- Inquiry learning with online labs is only effective when well structured and designed, this is guidance, e.g., scaffolds included.

de Jong, T. (2006). Computer simulations - Technological advances in inquiry learning. *Science*, *312*, 532-533.

de Jong, T., Linn, M.C., & Zacharia, Z.C. (2013). Physical and virtual laboratories in science and engineering education. *Science*, *340*, 305-308

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The Go-Lab ecosystem at a glance

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Why Go-Lab ecosystem?

- Go-Lab offers:
  - the world largest collection of online labs
  - a unique collection of apps to support the inquiry process
  - an authoring platform for teachers to create, adopt and adapt/tailor inquiry learning spaces
  - an authoring platform for teachers to personalize inquiry learning spaces
  - collaboration and sharing facilities

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Why Go-Lab ecosystem?

21st century skills

applied skills

Problem solving
Critical thinking
Reflection
Collaboration
Communication

basic skills

Mathematics
Science
Writing & Reading
History
Art, etc.

Information, media and technology skills

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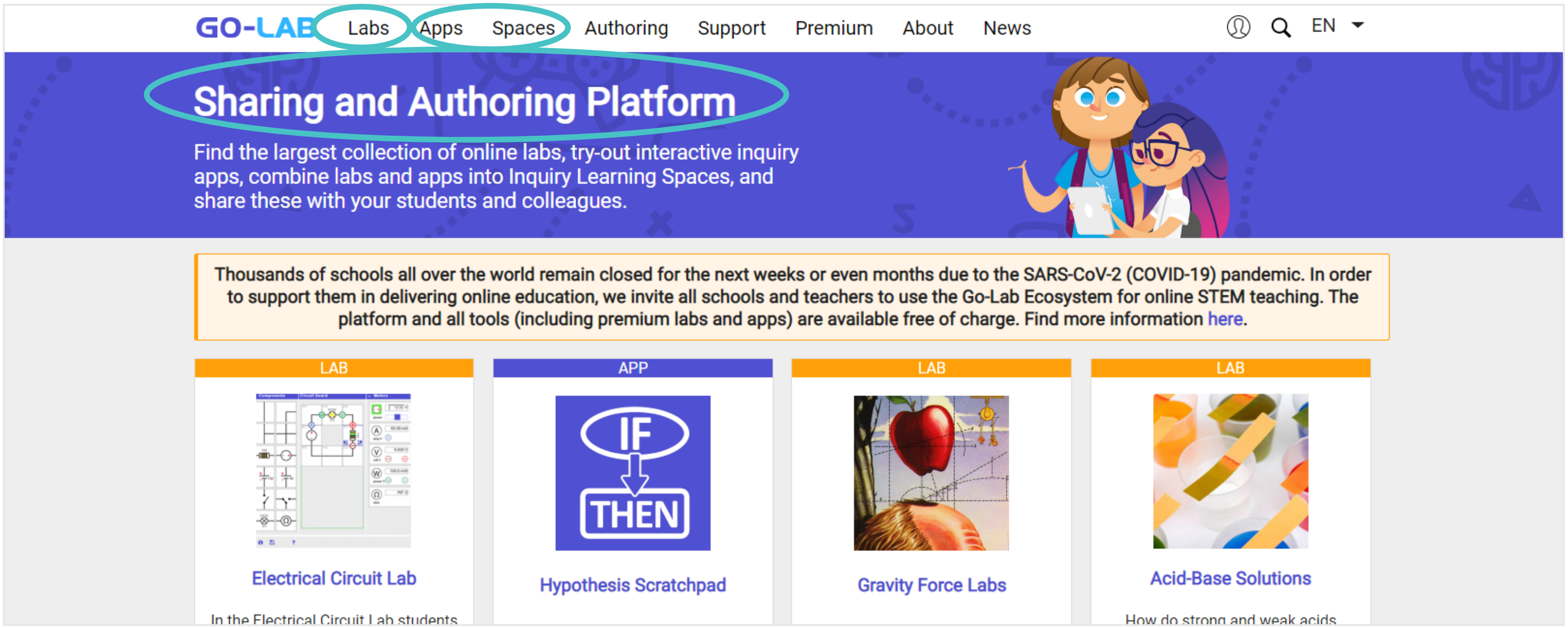
Go-Lab in one sentence

Federation of online labs ….

…Embedded into educational resources and guidance ….

… Shared with the community of users



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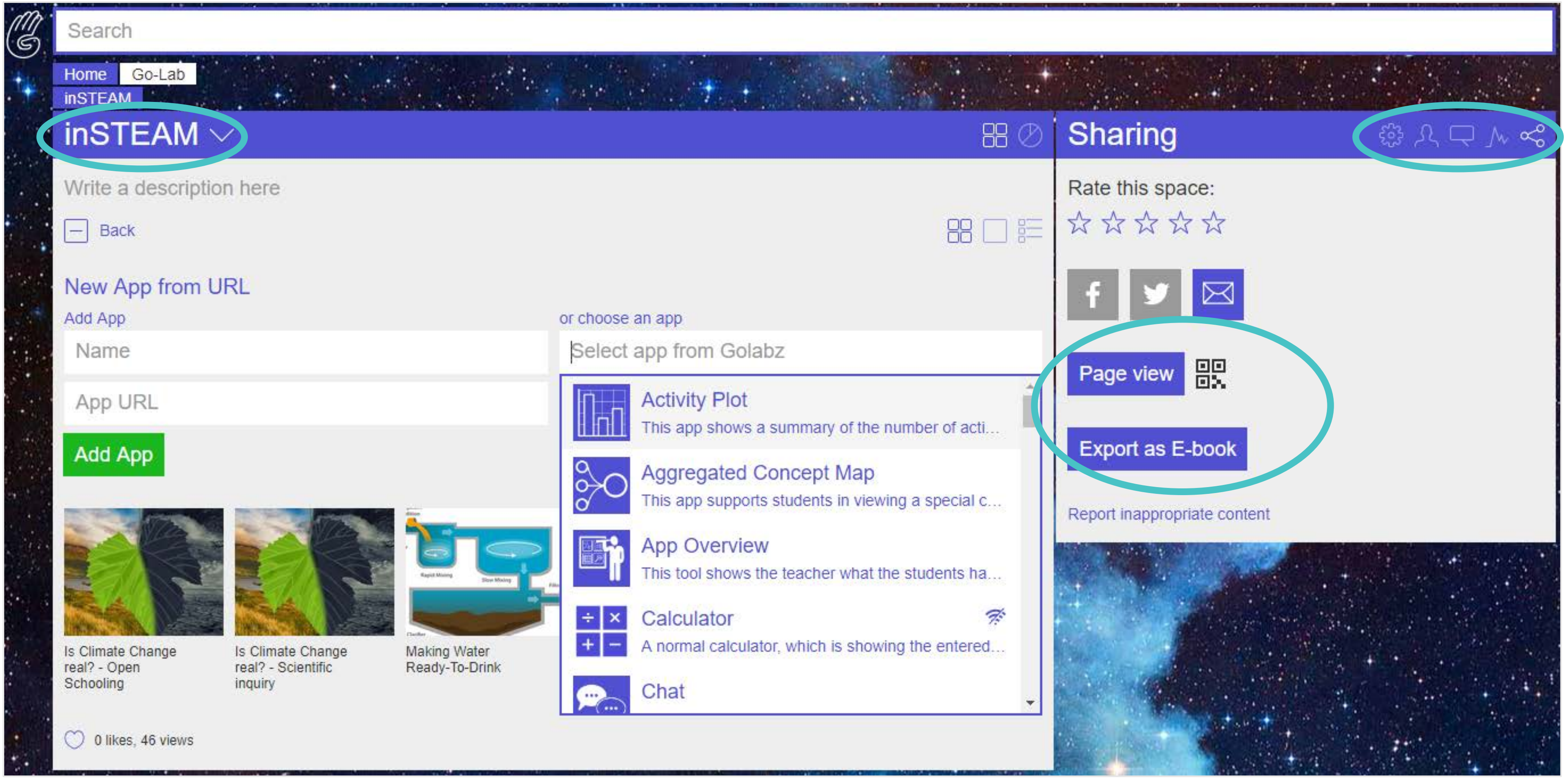
Authoring Platform - graasp.eu



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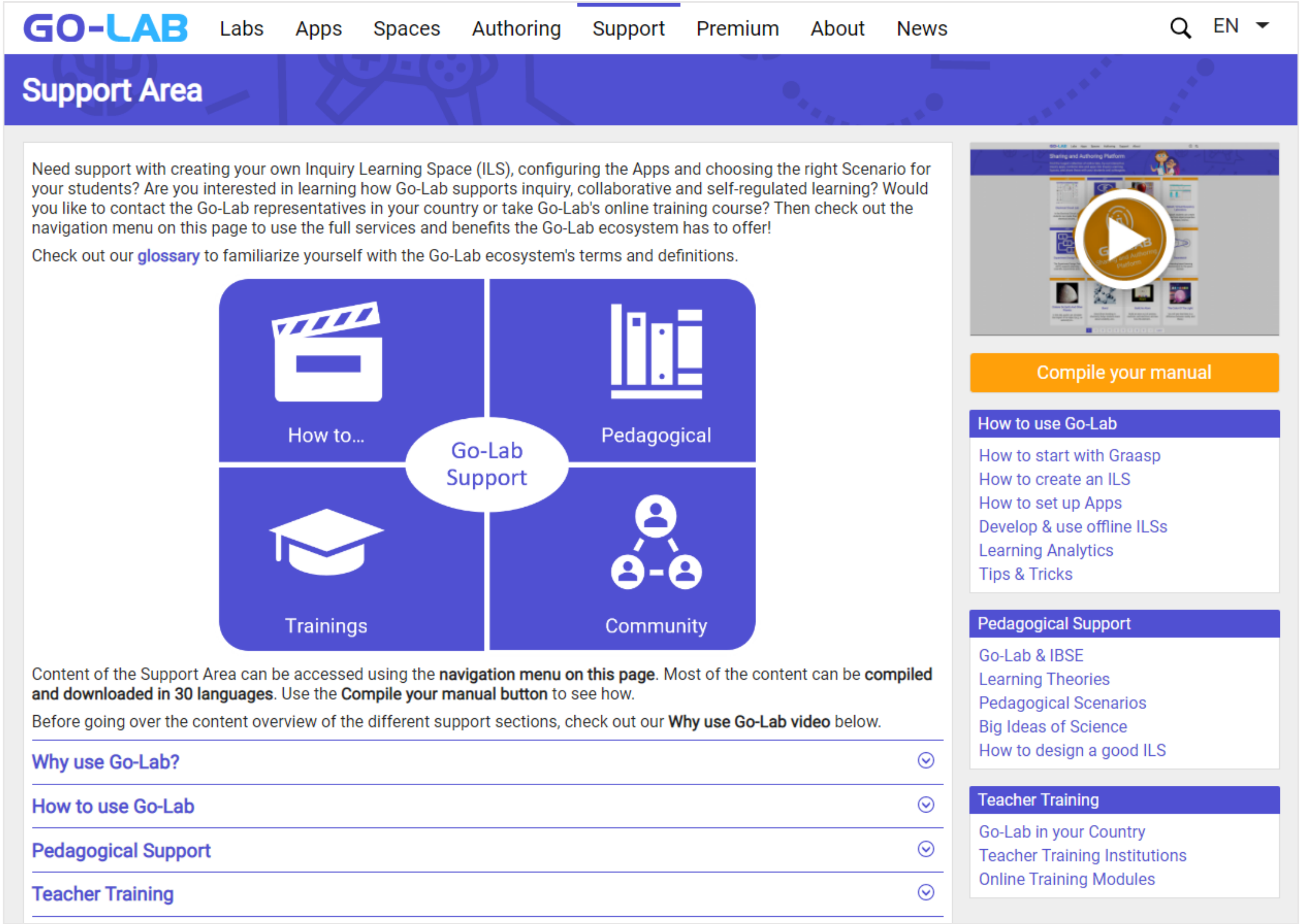
Support Service



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GO-LAB

- FP7 EU project
- 19 partners
- 4 years (2013-2016)
- Collaborative project

nextlab

- H2020 EU project
- 12 partners
- 3 years (2017-2019)
- Innovation action

GO GA

- H2020 EU project
- 8 partners
- 3 years (2018-2020)
- MI.TO. TECHNOLOGY SRL coordinator
- Innovation action

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The future of Go-Lab ecosystem

- At the end of 2020 the EU funding of the Go-Lab ecosystem stops
- **Go-Lab will continue!**
- Two versions
  I. Current version for free
  II. Premium version with extra facilities (in the SARS-CoV-2 (COVID-19) pandemic time the platform and all tools including premium labs and apps are available free of charge)
- Professional training courses (Inquiry approach and Go-Lab ecosystem)
- Premium contracts with schools, governments etc.

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Training courses set

Go-Lab Teacher Training

The Go-Lab Initiative team offers teachers, educators and school leaders a set of courses to help introduce Inquiry Learning with Go-Lab in the classroom. Ministries of Education, Teacher Training Institutes, and other stakeholders are also invited to book courses for their teachers!

Basic course (4 hours)

In this course, participants will learn in an interactive and playful way the basic principles of inquiry learning and how Go-Lab can help to introduce inquiry learning in the classroom. This course is suited for larger groups of teachers who would like to have a first and basic overview of the principles of inquiry learning and the technologies that can be used to support the inquiry process.

Advanced course 1 (4 hours)

In this course, the knowledge of inquiry processes is deepened, and characteristic problems of students are highlighted. Scientific evidence underlying inquiry learning is presented. During this course, participants will create their first and initial digital lesson or inquiry learning space (ILS) with the Go-Lab ecosystem. This is done in pairs or larger groups of teachers collaboratively creating an ILS.

Advanced course 2 (4 hours)

In the second part of the advanced course, advanced design elements of Inquiry Learning Spaces (ILSs) will be discussed and practiced. The topics include how to design an ILS based on principles of cognitive load theory, the use of learning analytics apps for teachers and learners, and inquiry learning and flipping the classroom with Go-Lab. Feedback on the initial ILS designs from the participants is given.

Dedicated course

If you have specific requirements, it is always possible to offer a tailor-made course. This can be an adaptation of an existing course or a newly designed course. All courses are given in an interactive way by instructors who have a solid background in inquiry learning and who have deep knowledge of the Go-Lab ecosystem. Topics in each course are related to the latest scientific findings from educational research. Courses can be given in English or in your local language.

https://premium.golabz.eu/services/training

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inSTEAM
Inclusive Environmental STEAM Education with Online Labs

Project (Erasmus+)

- 25 inclusive Inquiry Learning Lessons, classroom-ready
- Social inclusion: cultural, socio-economic, learning styles, no gender differentiation
- Manual : UDL (Universal Design for Learning) + IBL + Design Thinking
- Primary and secondary schools
- Environmental Study: climate change, water management and renewable energy

PARTICIPATION: https://insteam.deusto.es/participate/

https://www.facebook.com/erasmusK201

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GO-LAB

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TIWI

Teaching ICT with Inquiry

http://tiwi.eun.org/

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