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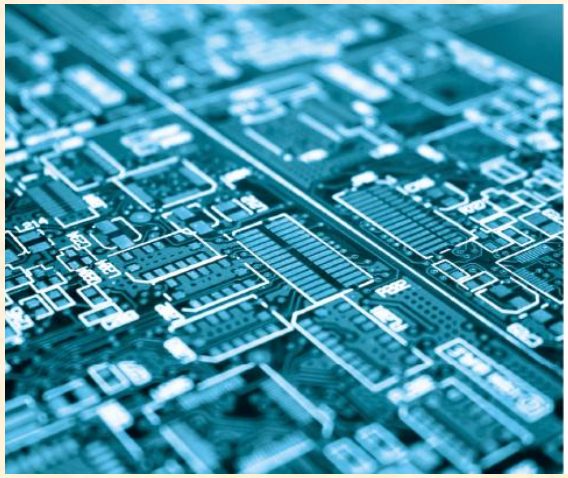
OPEN DISCOVERY OF STEM LABORATORIES



SMART TEACHER-GENERATED EDUCATIONAL MATERIALS

SCIENCE TECHNOLOGY ENGINEERING MATHEMATICS

BRIDGING INQUIRY APPROACH AND μ–MOOC VISION

Erasmus+ KA2 *Cooperation for Innovation and the Exchange of Good Practices - Strategic Partnerships for school education*

Dominique Persano Adorno, Acicastello July 21, 2017

WHAT IS INQUIRY-BASED LEARNING?

Inquiry-based learning is a form of active learning that starts by posing questions, problems or scenarios.

"*a seeking for truth, information, or knowledge -- seeking information by questioning*."

Individuals carry on the process of inquiry from the time they are born until they die. Unfortunately, students become less prone to ask questions as they move through the grade levels. In traditional schools, students learn not to ask too many questions, just to listen and repeat the expected answers.

Effective inquiry is more than just asking questions. A complex process is involved when individuals attempt to convert information and data into useful knowledge.

THE IMPORTANCE OF INQUIRY IN TODAY'S WORLD

Memorizing facts and information is not the most important skill in today's world. Facts change, and information is readily available -- what's needed is an understanding of how to get and make sense of the mass of data.

Educators must understand that schools need to go beyond data and information accumulation and move toward the generation of useful and applicable knowledge . . . a process supported by inquiry learning.

Inquiry implies emphasis on the development of skills and the nurturing of attitudes or habits of mind that will enable individuals to continue the quest for knowledge throughout life.

HOW DOES INQUIRY DIFFER FROM THE TRADITIONAL APPROACH?

The traditional approach to learning is more focused on mastery of content than on the development of skills and inquiring attitudes.

The current system of education is teacher centered: students are the receivers of information, and the teacher is the dispenser.

Traditional education is more concerned with preparation for the next grade level and in-school success than with helping a student to learn throughout life.

The use of resources is limited to what is available in the classroom or within the school. *Use of technology is focused on learning about the technology rather than its application to enhanced learning.*

HOW DOES INQUIRY DIFFER FROM THE TRADITIONAL APPROACH?

The inquiry approach is more focused on using and learning content as a means to develop information-processing and problem-solving skills.

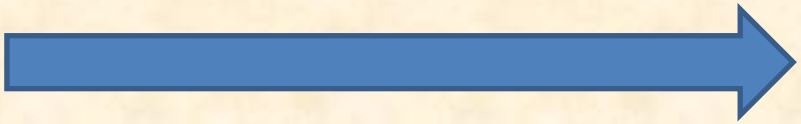
The system is more student centered, with the teacher as a facilitator of learning. Students are actively involved in the construction of knowledge.

The more interested and engaged students are by a subject or project, the easier it will be for them to construct in-depth knowledge of it. Learning becomes almost effortless when something fascinates students and reflects their interests and goals.

"Tell me and I forget, show me and I may remember, involve me and I will understand".

HOW DOES INQUIRY DIFFER FROM THE TRADITIONAL APPROACH?

Inquiry classrooms are open systems where students are encouraged to search and make use of resources beyond the classroom and the school. *Teachers who use inquiry can use technology to connect students appropriately with local and world communities which are rich sources of learning and learning materials.*



μ-MOOCs

UNTIL NOW…

Open Educational Resources

MOOC concepts

MOOC platform

Interdisciplinary Learning

Inquiry in the classroom

MOOC in the classroom

Hands-on activities

FROM TUESDAY…

- **Group brainstorming** → **Idea for the topic**
- **Group discussion** (Collaborative work) → **Learning path MOOC design**
- Hands-on experiments → **Inquiry practice**
- Today… → **Inquiry based μ-MOOC**

Refine your learning path!

The key role in making successful the proposed teaching strategy is played by the choice of the topic and of the learning environment in because *what piques student's curiosity will depend on the student's interests, experience and prior knowledge.*

A good μMOOC topic should

✓provide affective engagement to the students;

✓generate curiosity and leads to questions;

✓generate a cognitive conflict;

✓be scientifically investigated and explained within the competence of the students involved;

✓create scientific knowledge;

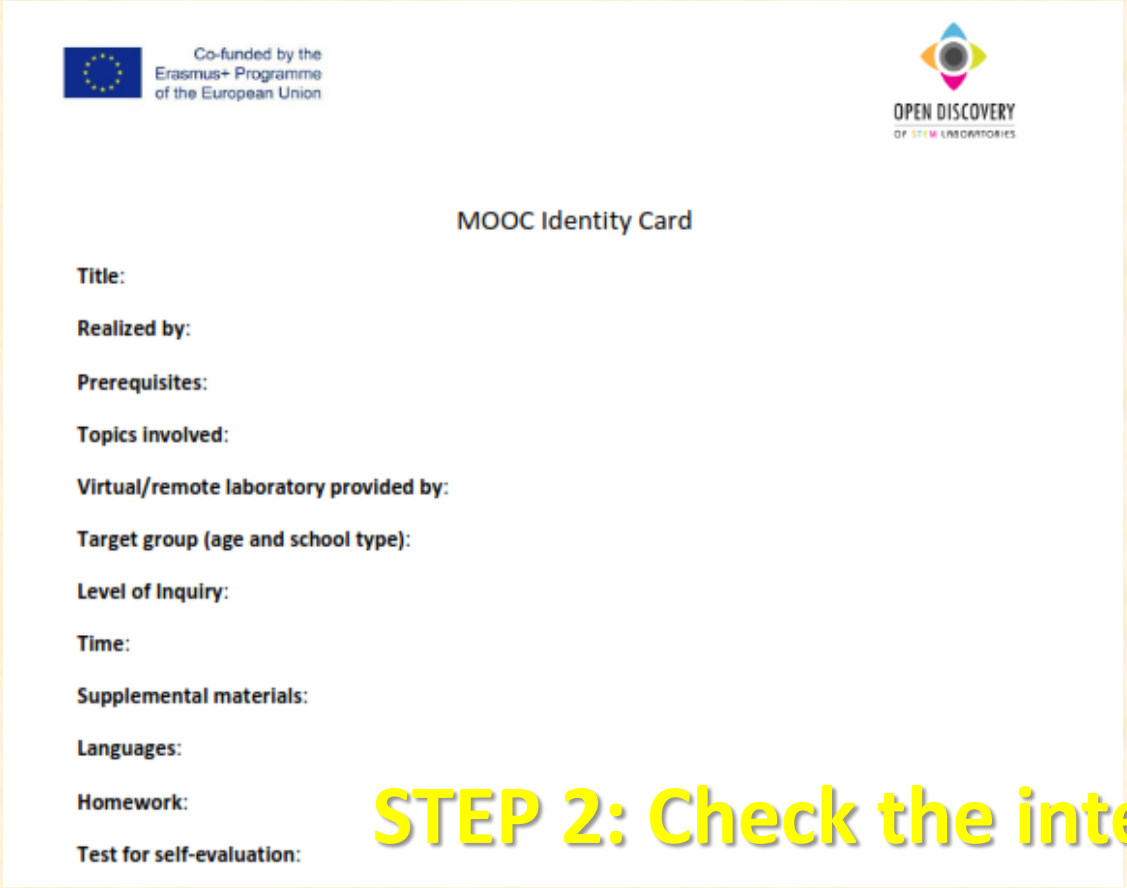
✓require the students to use inquiry skills to explain the involved phenomena;

✓be faced in a limited span of time (1–2 lessons for the presentation and use of remote/virtual labs).

STEP 1: Check the chosen topic!

Common aspects of all scenarios for μ-MOOCS

All different scenarios for μMOOCs are laboratory-based experiences and should have a high degree of interactivity.



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MOOC Identity Card

Title:

Realized by:

Prerequisites:

Topics involved:

Virtual/remote laboratory provided by:

Target group (age and school type):

Level of Inquiry:

Time:

Supplemental materials:

Languages:

Homework:

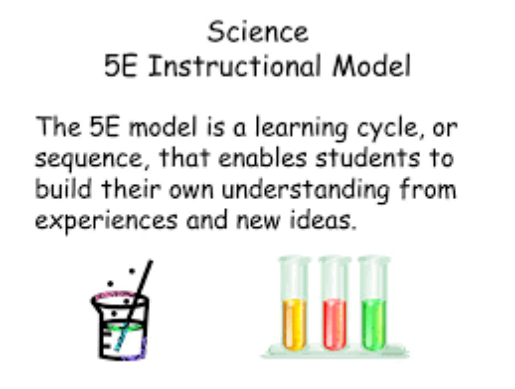
Test for self-evaluation:

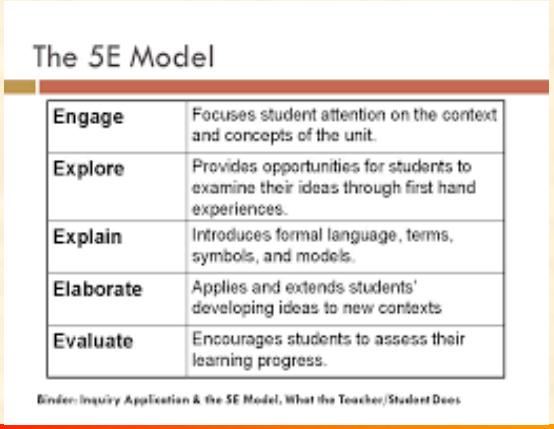
STEP 2: Check the interactivity!

Methodology to be used: the 5E learning cycle

The 5E learning cycle is a student-centered instructional model where the students perform five phases of instruction:

- ✓ Engagement (students activate and assess prior knowledge by connecting the "new to the known"),
- ✓ Exploration (students explore a real-world problem),
- ✓ Explanation (students explain their thinking),
- ✓ Elaboration/Extention (students elaborate on their reasoning, solidify and extend their understanding),
- ✓ Evaluation (students assess their own learning and their progress).





Common aspects of all scenarios for μ-MOOCS

Their duration must be limited approximately to 20-30 minutes, inclusive of the exploration of the remote/virtual labs.

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Time schedule for micro-MOOC development

Phase	Description	Time	Total time (min-max)
1	Topic Introduction	1-3 min	1-3
2	Student **Engagement** and Motivation	4-6 min	5-9
3	Initial **Exploration** of the virtual/remote Lab	3-6 min	8-15
4	Questioning - Stimulating curiosity	2-4 min	10-19
5	Performing virtual experiments I	2-5 min	12-24
6	Questioning - Stimulating reasoning	2-4 min	14-28
7	Performing virtual experiments II	2-5 min	16-33
8	Questioning – Providing reasonable **explanations**	2-4 min	18-37
9	Performing virtual experiments III	2-5 min	20-42
10	Questioning – Providing concluding remarks	2-5 min	22-47

STEP 3: Check the 5E phases!

Extensions:

1. Bring your science lab at home (Stimulating the students to perform their own virtual/remote experiments at home – homework/research-like activities to be performed at home).

2. **Evaluate** your science lab experience (performing self-assessment).

Scenario development

The personalized teaching paths inside the μ-MOOC can differentiate for

(i) the level of teacher guidance;
(ii) the difficulty of the involved remote/virtual laboratories;
(iii) the requested student's cognitive skills.

3-levels Inquiry-based approach

Basic – Confirmation Inquiry

Intermediate – Structures/Guided inquiry

Advanced – Elicited/Open Inquiry

STEP 4: Choose the Inquiry level!

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Scenario 1: Basic (Confirmation Inquiry)

In the basic approach, the teacher provides students with the question, shows the use of the remote/virtual lab, illustrates the procedure and the method.

The results and their explanation are known in advance.

Confirmation Inquiry is useful when the teacher purpose is to reinforce a previously introduced idea, introduce students to the experience of conducting investigations, or have students practice a specific inquiry skill, such as the collecting and recording of data.

In this case the μMOOC topic will be previously introduced by the teacher and explained in depth; **but it will be contextualized in real-life situations**. The virtual/remote laboratories will be exploited by the teacher. All other phases of the 5E cycle are faced and discussed by the teacher.

After the μMOOC vision, the students will have the possibility to explore the remote/virtual experiments in class (in small groups working with tablets connected to the internet), or at home. They will be invited to write a scientific report on the experience done and on acquired concepts.

Main student outcomes: ***Practical applications of the theory.***

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Scenario 2: Intermediate (Guided/Structured Inquiry)

In the intermediate inquiry level, the question and the detailed procedure for the utilization of the labs are provided by the teacher, but the students generate an explanation supported by the evidence they have collected by experiencing the remote/virtual labs by themselves. They are responsible for uncovering the answer. The teacher acts as a knowledge facilitator, providing support or materials in the μMOOC.

The μMOOC topic will be previously introduced by the teacher and students have numerous opportunities to learn and practice different ways to plan experiments and record data (in class or at home) by changing the parameters. They will be invited to write a scientific report on the experience done and on acquired concepts.

Main student outcomes: Practical applications of the theory; reasoning efforts to generate explanations on the basis of their own investigation results. **Also useful for flipped classroom.**

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Scenario 3: Advanced (Elicited/Open Inquiry

In the Open inquiry the teacher takes the delicate role of defining the context for inquiry by presenting a multidisciplinary view of a theoretical problem or a real-life phenomenon.

Subsequently, he/she stimulates the students to define their relevant questions, design and carry out their independent investigations, construct coherent explanations, communicate and share their results.

An open inquiry-based instruction seems more efficient to reinforce learners' reasoning skills, also increasing the awareness of the process of scientific inquiry.

Despite this, students involved in open inquiry may develop feelings of frustration due to the lack of achieving the desired goals independently from teacher's hints (Quintana et al, 2005).

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The students by mean of the μMOOC will be involved in a learning path with a specific process of activation — Elicited Inquiry—, consisting of a learning environment in which the instructor actively will participate to the debate on the laws governing the observed experimental findings, never providing exhaustive explanations to the students, but giving comments and hints, sometimes expressly incorrect, always leaving the students in a state of uncertainty, stimulating their reasoning and activating their scientific inquiry.

Although teachers are less instructive, they provide a framework (scaffolding) for the process when needed, help students to manage this level of inquiry.

Main student outcomes: Through self-designed or stimulated exploration students make hypotheses, test their own predictions, and draw their own conclusions; they should reach higher levels of autonomy and develop higher-order thinking skills.

Group work on the μ-MOOC implementation