



LEARNING FROM EXPERIENCE

Introduction to Empiricism: John Locke and David Hume

Learning Objectives	Students will understand the importance of scientific observation and experimentation by studying the ties between philosophy and science.
Subjects	Chemistry, Physics, Biology, Philosophy
Recommended Age (10-12 or 12-14)	10-12, 12-14 years old
Number of students involved	Groups of 8-12 students.
Duration	90 minutes (approximately 2 class periods)
Skills Developed	Logic, attention to detail, problem-solving, and critical thinking.
Material Needed	Laptops and/or notepads. School Laboratory equipment: <ul style="list-style-type: none"> - A flask - Measuring cups - Teaspoons and tablespoons (for measuring) - Safety glasses - Plastic Gloves - Liquid dish soap - 6% or 15% hydrogen peroxide - Dry Yeast - Warm water - Liquid food colouring (optional)
Inclusion Best Practices	This lesson plan offers a digital version of the Lab experiment, which offers an opportunity for students with accessibility issues to experience the experiment on their own time and pace.



Instructions for implementing the lesson plan

This lesson plan offers an introduction to empiricism. Empiricism is a field of philosophy that argues that all knowledge comes from experience ([Britannica, 2023](#)). Two of the main philosophical figures of empiricism in John Locke and David Hume.

John Locke was born in 1632 and he is considered one of the main philosophers who inspired the European Enlightenment period. David Hume, was a Scottish philosopher who built on John Locke's epistemology and contributed greatly to the development of the philosophical theory of Empiricism. For more information about the philosophical work of these two great personalities, the students can read the Little Philosophers E-book 'Exploring Empiricism with Hume and Locke'.

Link to the e-book: <https://littlephilosophers.eu/r2-e-books-and-augmented-reality-books/>.

Using this lesson plan, students will be able to understand the notion of empiricism through the implementation of actual experiments. According to David Hume in his paper 'A Case for Scientific Realism', there is a clear connection between experiments and observation and empiricism ([Murphy, 2021](#)).

This lesson plan should be implemented in a science classroom (i.e., Chemistry, Physics or Biology), and more particularly in a School Science Lab. This lesson plan uses the Elephant Toothpaste Experiment as the basis for exploring empiricism through scientific experimentation and observation, but other experiments could also be used.

In case you are not able to implement the lesson plan within a Lab, you can use the virtual 'Elephant Toothpaste Experiment' which was developed as part of the Erasmus+ project "VM STEM".

Link to the virtual museum of STEM: <http://www.vmstem.eu/resources/>.

To access the virtual museum, press the download button under the Virtual Museum, and you will be redirected to the Online Virtual Museum which includes 60 collections of virtual Science exhibitions, exhibitions of Technological advancements, contemporary Engineering collections and exhibitions of Mathematics.

The virtual 'Elephant Toothpaste Experiment' can be found under the virtual Science exhibition.

Step 1: Introduction to the philosophical topic (15 minutes)

This lesson plan aims to introduce students to Empiricism and the main philosophical arguments of John Locke and David Hume. It is suggested that you



give students a short introduction to the philosophical work of Locke and Hume, before moving on with the science experiments.

Short introductory information:

John Locke is considered one of the main defenders of Empiricism, which states that our knowledge comes from experience and empirical observation ([Internet Encyclopedia of Philosophy, n.d.](#)). His work on experimental philosophy was by Isaac Newton, with whom he also shared a close friendship ([Stanford Encyclopedia of Philosophy, 2022](#)). To explain his argument that all knowledge comes from experience and observation, Locke proposed a hypothetical scenario in which the mind is a white paper, without any ideas ([Works & Days, n.d.](#)). In order to decorate it and fill it with ideas, materials of reason and knowledge, one should first experience all these 'decorations' (ibid.). When it comes to experiencing things, Locke talked about two different types of sources for all the ideas we have: **sensation** and **reflection**.

Sensation: According to Locke, sensations is the source for all the ideas we have which are based on our senses. For example, the idea we have about chocolate is that we expect it to be sweet and have a nice taste. The source of this knowledge is based on sensation (ibid.).

Reflection: The ideas and knowledge that come through reflection, are all those ideas which we gain through an internal reflection of how our mind operates. For example, thinking, doubting, believing, willing, and all the different actions of our mind lead to knowledge through reflection (ibid.).

David Hume is considered as the leading figure of philosophical naturalism whose work was also influential for Darwin's theory of evolution.

Hume was concerned with human nature and he offered an empiricist alternative to traditional **a priori metaphysics**, that is reasoning or knowledge that proceeds from theoretical deduction rather than from observation or experience ([Stanford Encyclopedia of Philosophy, 2019](#)). As a naturalist and empiricist, Hume explained the way our mind works based on a Newtonian image of the world, defending the opinion that all arguments derive from experience and we should reject all ideas that are not founded on fact and observation (ibid.).

Before moving to the next steps of implementing this lesson plan, you can share some questions with your students and ask them to think about these questions as they are implementing their experiments:

- Can you be certain of the knowledge you have?
- How do you tend to learn new things?
- Do you know how to cook pasta, if you read a recipe?
- Do you know how to cook pasta, if you have never tried it before?



Step 2: Introduction to the science experiment (15 minutes)

The Elephant Toothpaste Experiment shows the chemical decomposition of hydrogen peroxide (H_2O_2). When hydrogen peroxide breaks down, it turns into oxygen (O_2) and water (H_2O). This process is normally very slow and what this experiment aims to do is to make that reaction happen faster. To achieve this, a catalyst is needed. One potential catalyst for this experiment is **yeast**.

Before giving time to your students to conduct the Elephant Toothpaste Experiment, you should give them a list of the equipment and the material they will need (which are stated at the first page of the lesson plan), as well as step-by-step guidance on how to implement the experiment ([Cool Science Experiments HQ, n.d.](#)):

Step 1: Wear your safety glasses and a pair of plastic gloves.

Step 2: Combine 2 tablespoons of warm water with 1 teaspoon of yeast in a small cup and mix until the yeast is completely dissolved in the water.

Step 3: Pour $\frac{1}{2}$ cup hydrogen peroxide into an empty flask. You can try to complete this experiment using 6% hydrogen peroxide in one flask and 15% hydrogen peroxide in a bigger flask.

Step 4: Add a few drops of food colouring into the flasks (optional).

Step 5: Add some drops of dish soap into the flasks.

Step 6: Pour the mixture of water and yeast into the flasks. Watch carefully and observe what happens.

It is very important to step away from the flasks as the reaction is an exothermic one and it produces heat. Do not touch the foam immediately as it will be warm.

Students can also access the virtual experiment on the VM STEM website: <http://www.vmstem.eu/resources/>.

Step 3: Experimentation and Observation (45 minutes)

Once you have explained the experiment to your students, you should divide them into groups of four students and ask them to conduct the experiment in their groups. You should give them approximately 45 minutes to prepare, conduct their experiments and note their observations.

Make sure that all the students wear protective glasses and plastic gloves and observe the process closely to help your students as needed.

When working in their groups, the students should try to think about empiricism and whether implementing this experiment offers them new knowledge. Ask your students to take notes of the steps they take and the observations they make at each step.



For example, when they added soap to hydrogen peroxide, there was no major reaction. It is only once the catalyst is added that the foam is formed. What does this mean and what knowledge do we gain from it?

You could also give them some questions to answer:

- What is the role of the yeast in the experiment?
- What makes the foam appear?
- What is the role of oxygen in this process?
- What would happen if you tried the experiment without soap?

Step 4: Debriefing and Conclusion (15 minutes)

To conclude the lesson, you should ask all students to gather back into one big group and discuss their main observations from the Elephant Toothpaste Experiment.

Do they agree that experience and observation should be our main sources of knowledge? Did they understand the philosophical work of Locke and Hume better after implementing the experiment?

At this stage, students can also discuss the questions they were previously given, and you can answer any questions they might have in regards to empiricism and to the chemical decomposition they studied.

References:

Britannica. (n.d.). Empiricism. <https://www.britannica.com/topic/empiricism>.

Cool Science Experiments Headquarters. (n.d.). Elephant Toothpaste Science Experiment. <https://coolscienceexperimentshq.com/elephant-toothpaste/>.

Internet Encyclopedia of Philosophy. (n.d.). Locke: Epistemology. <https://iep.utm.edu/locke-ep/>.

Little Philosophers EU project, <https://littlephilosophers.eu>.

Murphy. (2021). A short note on Science and Empiricism. <https://medium.com/paul-austin-murphys-essays-on-philosophy/a-short-note-on-science-and-empiricism-50409b8dbd81>.

Stanford Encyclopedia of Philosophy. (2019). David Hume. <https://plato.stanford.edu/entries/hume/>.

Stanford Encyclopedia of Philosophy. (2022). John Locke. <https://plato.stanford.edu/entries/locke/#KnowProb>.

The Virtual Museum of STEM. <http://www.vmstem.eu/resources/>.



Works & Days. (n.d.). John Locke on Empirical Knowledge.

<https://newlearningonline.com/literacies/chapter-11/john-locke-on-empirical-knowledge>.