From the Telescope to the Microscope:

Useful and Entertaining Science

VAST values across space & time

HTTPS://WWW.VAST-PROJECT.EU/

Preface

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Project: VAST: Values Across Space & Time

https://www.vast-project.eu/

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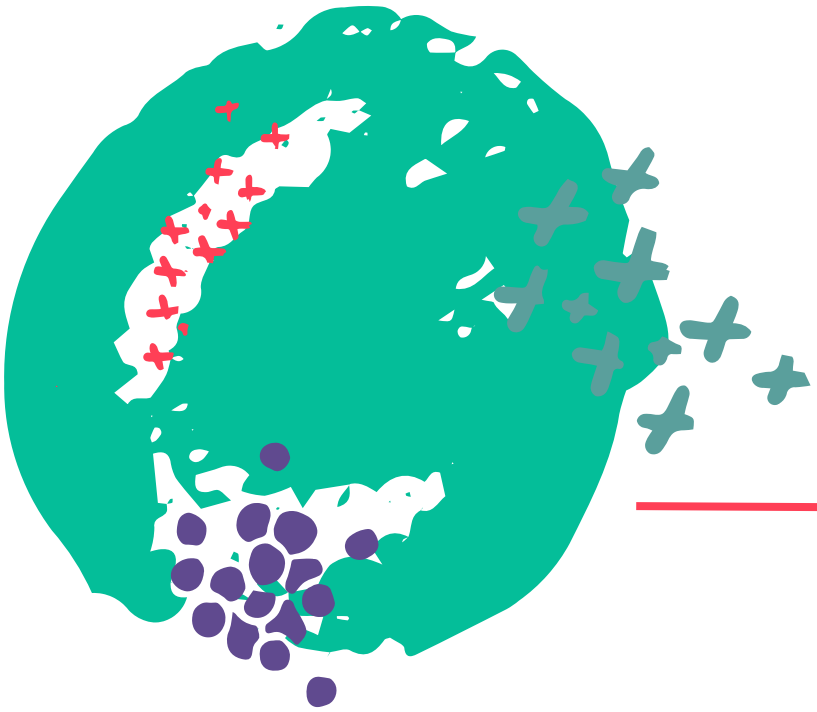


overview

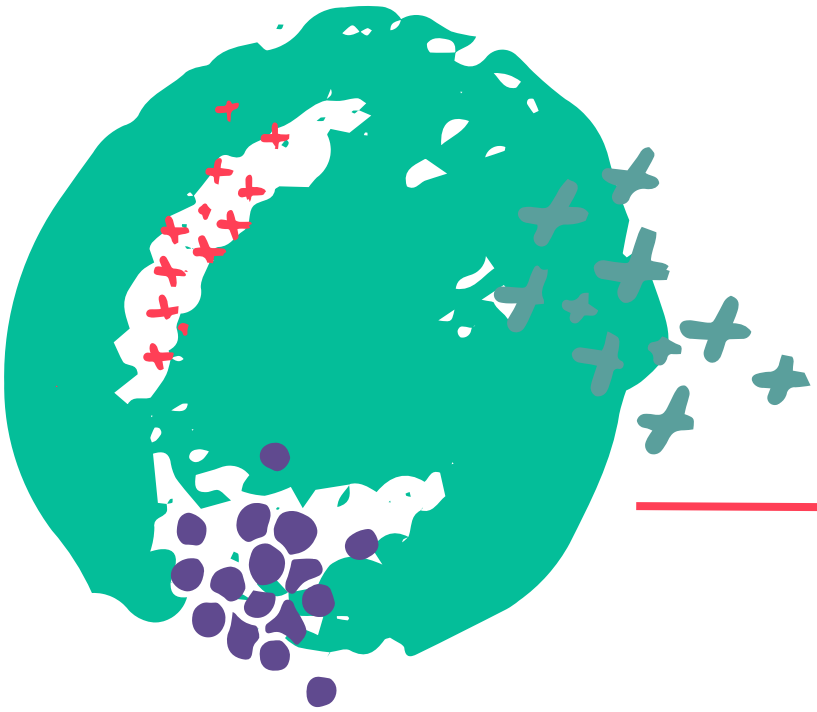
The H2020 European research project VAST- Values Across Space & Time is a collaboration among the National Center for Scientific Research ‘Demokritos’ (Greece), National and Kapodistrian University of Athens (Greece), the Athens & Epidaurus Festival (Greece), Università degli Studi di Milano (Italy), Fairytale Museum (Cyprus), Museo Galileo (Italy), Universidade NOVA de Lisboa – NOVA (Portugal) and Semantika (Slovenia).

The project envisions to study the dissemination of the european values (such as freedom, democracy, equality, tolerance, dialogue, human dignity, the rule of law) in space and time through the use of digitised materials and intangible cultural artefacts as well as to explore the communication, reception and perception of these values in the modern era. For the purposes of this research, three pilots have been described concerning: 1. the theatre/ancient drama, 2. the scientific texts of the 17th century, 3. the fairy tales.

A digital platform has been developed, as part of the project, with open access to citizens. In this platform, values-related scientific and educational materials and research evidence/results will be posted, as well as various tools for scientific and research study.

Do not miss visiting!

The current activity retraces some of the milestones of human progress through the accounts of Galileo Galilei, Vincenzo Viviani, and Robert Hooke, with a particular emphasis on the freedom of scientific research and contemplation of contemporary discoveries along with their moral implications.



activity

Institution

Museo Galileo (Institute and Museum of the History of Science)

Audience

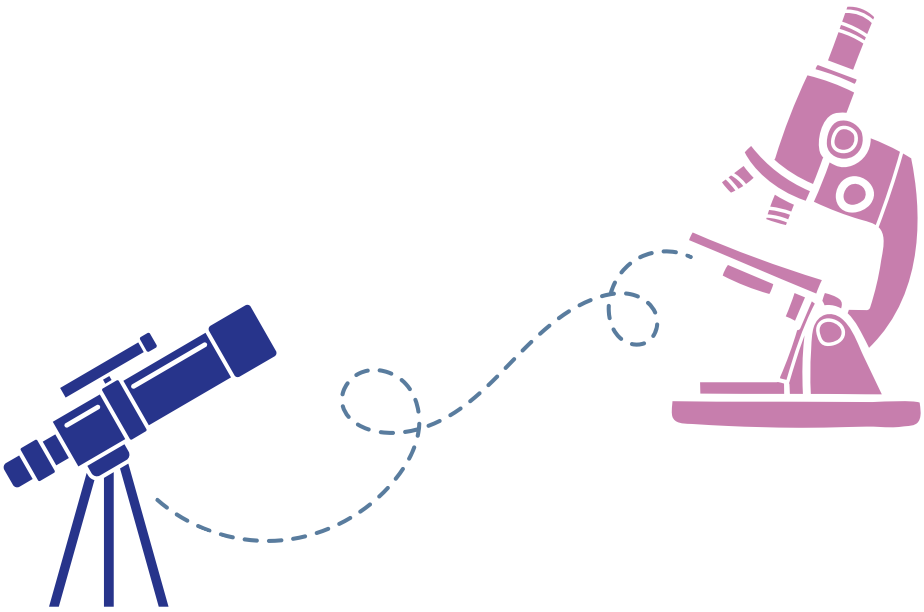
11 to 13 years old

Title

From the Telescope to the Microscope: Useful and Entertaining Science.

Description

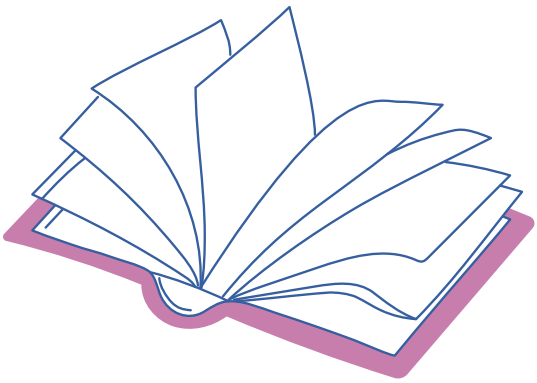
This activity is designed to highlight the connection between the "infinitely large world" and the "infinitely small world" revealed by the telescope and the microscope. By exploring the contributions of Galileo Galilei, Antonie van Leeuwenhoek, and Robert Hooke, we trace the milestones of human progress in understanding the world around us, focusing on the values of scientific freedom, critical thinking, demonstrable truth, progress, cooperation, and equality. Additionally, we engage the students in a dialogue about technological advancements in microscopy, encouraging them to consider the ethical implications of current discoveries.



Educational Objectives

Through this activity the participants are expected to:

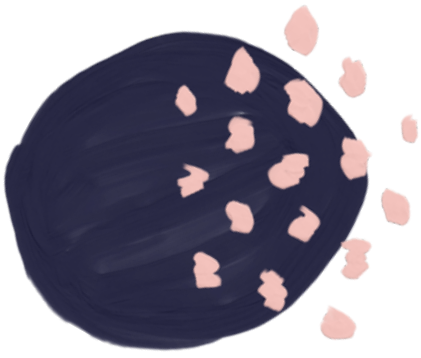
1. come into contact with scientific tools and learn how to use them effectively
2. understand the basic principles of microscopy and how it has evolved over time
3. learn about the scientific concepts and values associated with microscopy and observation, like scientific freedom, critical thinking, demonstrable truth, progress, cooperation, and equality
4. exercise their critical thinking by identifying relationships between concepts and creating mind maps
5. understand concepts of the past that still have both cultural and scientific significance in the present



Expected outcomes

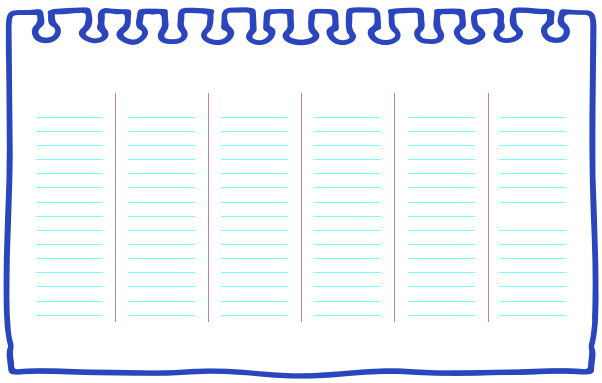
After completing the activity, the participants:

1. will have understood the principles of microscopy and its importance in scientific observation
2. will have an overview of the scientific concepts and values associated with microscopy
3. will have understood the importance of hands-on experimentation and observation in scientific discovery
4. will have constructed mind maps that illustrate the relationships between scientific concepts and values
5. have worked together to argue and defend their ideas and conclusions
6. will have realised the importance of scientific inquiry in understanding the world around them



Structure

Duration	**90′ - 120′**
Educational materials/tools	• **Paper (or digital) pre-visit questionnaires for teachers** • **Video teaser** • **PPT projection with texts and images** • **Concave and convex lenses** • **Simple portable “toy” microscopes** • **Binocular stereoscopic microscopes** • **One monocular stereoscopic microscope connected to a computer** • **Discussion and reflection** • **Learning through inquiry system and instruments replicas’ manipulation** • **Magnetic board & colored markers** • **Magnets with sets of values** • **Visit to the museum collection** • **Paper (or digital) post-visit questionnaires for teachers**
Educator/facilitator	**1 educator/facilitator for up to 25 students**
Target group	**Secondary school students (from 11 to 13 years old)**



Modules/sections (design)

Pre-visit questionnaire	Described in pages:	11
Welcome	Duration:	10'
	Materials/tools:	Video
	Described in pages:	12
1st part of the activity	Duration:	20'
	Materials/tools:	Concave and convex lenses, magnetic board
	Described in pages:	13
2nd part of the activity	Duration:	20'
	Materials/tools:	Power point with texts and images
	Described in pages:	14-16

3rd part of the activity

Duration:	30'
Materials/tools:	Microscopes, magnetic board, magnets with values, colored markers
Described in pages:	17-19

4th part of the activity

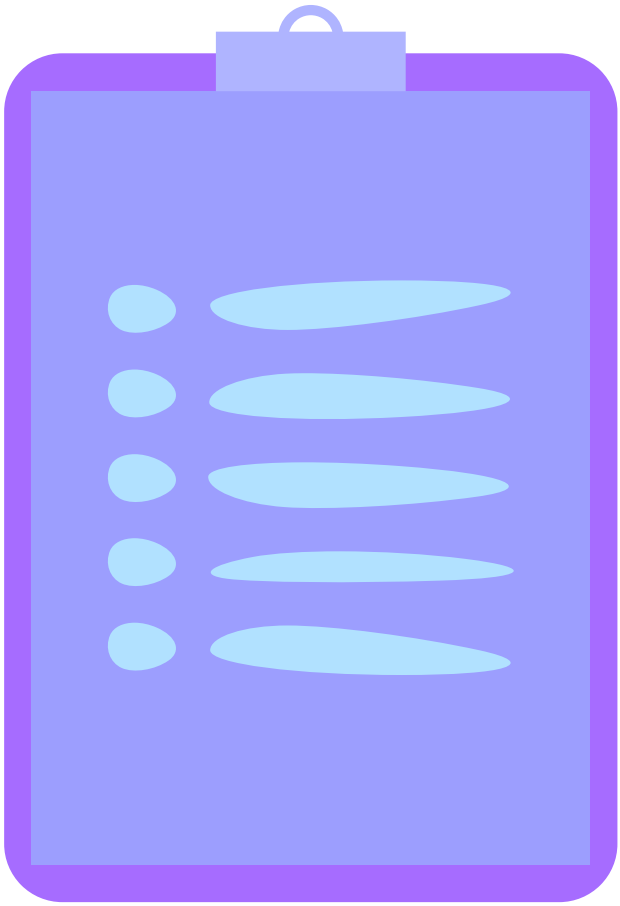
Duration:	30'
Materials/tools:	-
Described in pages:	20

Farewell - Activity evaluation

Described in pages:	21

Pre-visit questionnaire

Before the visit occurs, teachers are given a short questionnaire (Appendix I) to complete. The aim is to gather information about the demographic and cultural setting. Such information will play a crucial role in ensuring a more precise interpretation of the final evaluation phase of the activity.



Welcome

A. Introduction (5')

Welcome to the participants.

B. Ice breaker activity (5')

Video teaser: introducing the values (https://youtu.be/QvbfEBLjCgA)

A short video is shown as an introduction to the theme of the laboratory. The students are asked what stood out to them and what message they think was being conveyed. The focus is on the last sentence that appears in the video, taken from Robert Hooke's *Micrographia*: "By the help of microscopes, there is nothing so small as to escape our inquiry." The students are then asked if they know the fundamental function of a microscope and if they have ever used one. They are also prompted to consider what they believe are the main characteristics that a scientist should have, and whether they themselves possess curiosity.

Note: A video teaser can be a powerful tool to capture the attention of students and introduce them to key concepts and values that will be explored in an upcoming activity. By combining images, music, and key phrases, a video can engage students and provide a glimpse into what they can expect. In addition to introducing the topic, the teaser can also be used to gauge the background knowledge of students and to determine how far the discussion can be taken.

1st part of the activity: *Magnifying the World: Discovering the Properties of Lenses*

In this part, the group will learn about the properties of the lenses.

Discussion

The telescope and microscope are two important objects in science that have made sensational discoveries possible. The students are prompted to consider what these two objects have in common, with a focus on the lenses.

Activity

During this section, both concave and convex lenses are passed around for the learners to handle and examine. This hands-on activity demonstrates the difference between the two types of lenses and their respective properties. To further analyze them, a magnetic board is used to demonstrate how different lens shapes affect the path of light rays. For example, a concave lens is thinner at the center than at the edges, causing light rays to diverge as they pass through it. In contrast, a convex lens is thicker at the center and causes light rays to converge towards a focal point. By manipulating the lenses and observing the resulting patterns of light on the magnetic board, the students gain a better understanding of how lenses work and how they can be used in telescopes and microscopes to magnify and clarify images.

2nd part of the activity: *Exploring the History and Significance of Microscopy*

In this unit, the group will learn about the history of the microscope and conduct their first observations.

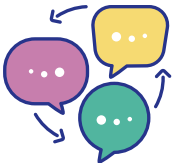
Discussion

Galileo built the telescope with the goal of enlarging objects to observe the sky, but he also wondered if the same system could be used to enlarge small objects. This led to the invention of the microscope. In a letter to Federico Cesi, Galileo wrote: "I have contemplated countless tiny animals with infinite admiration, among which the flea is most hideous, the mosquito and the moth are most beautiful; and with great pleasure, I have seen how flies and other tiny animals walk on mirrors, and even upside down".

To understand how the microscope works, it is important to understand how our eyes work. The microscope is made up of a system of lenses that magnify objects beyond the resolution of the human eye. This allows us to see details that are otherwise invisible to the naked eye. The students are introduced to the basics of how a microscope is constructed and how it works, and the significance of the term "microscope" is also discussed.

Activity

At this stage, students begin to observe objects using simple, portable “toy” microscopes, where they can conduct their initial experiments. The purpose of this is to introduce the concept of magnification using a straightforward tool, before moving on to more structured optical instruments. This progression allows students to reflect on the concept of technological evolution, as they gain a deeper understanding of the principles behind magnification and observation.

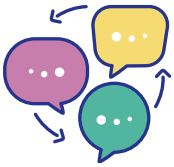


Discussion

The exploration of the microscope's history continues, with a focus on the contributions made by important figures such as Galileo, Antonie van Leeuwenhoek, and Robert Hooke. Their pioneering work, which resulted in significant breakthroughs in the field of microscopy, was often motivated by a practical need to solve real-world problems. For instance, van Leeuwenhoek's desire to examine the details of fabrics for his cloth merchant business led him to use his microscope to make groundbreaking discoveries about microorganisms (animacula). Similarly, Hooke's serendipitous observation of a piece of cork under his microscope allowed him to discover the cell and advance our understanding of the microscopic world.

Discussion

The focus then turns to a couple of quotes from Hooke's *Micrographia*: "Every considerable improvement of the telescope or microscope produces in fact new worlds and unknown territories for our view." "The great advantage of men over other creatures is that we are not only capable of contemplating the works of nature or simply of sustaining our lives by means of them, but we also have the power to consider them, compare them, alter them, care for them, and perfect them for various uses." These quotes serve as a powerful reminder of the unique and extraordinary capabilities of human beings. We are not limited to simply observing the natural world around us, but we have the power to alter it and perfect it for various uses. As we reflect on the impact of human action on the environment, it is crucial to consider our responsibility to care for and protect the planet and the creatures that inhabit it. The modern generation of young people has shown an increasing awareness and sensitivity towards this issue, recognizing the need for sustainable and responsible actions to preserve our environment for future generations.



Discussion

As we progress, we also delve into the topic of telescope developments, explaining that it wasn't until the mid-19th century that advanced optical systems were integrated into microscopes, allowing for more detailed examination of the microscopic structures of bodies. This breakthrough not only unveiled the origins of numerous diseases but also significantly advanced our comprehension of the microscopic realm. It highlights the vital role of technological evolution in scientific progress, encouraging students to ponder the importance of continuous innovation in propelling scientific discoveries. This serves as a reminder of the fundamental link between scientific advancement and technological development, mutually reinforcing each other.

3rd part of the activity: *Hands-on Observations and Mind Mapping*

In this part, the group will conduct observations using stereoscopic microscopes.

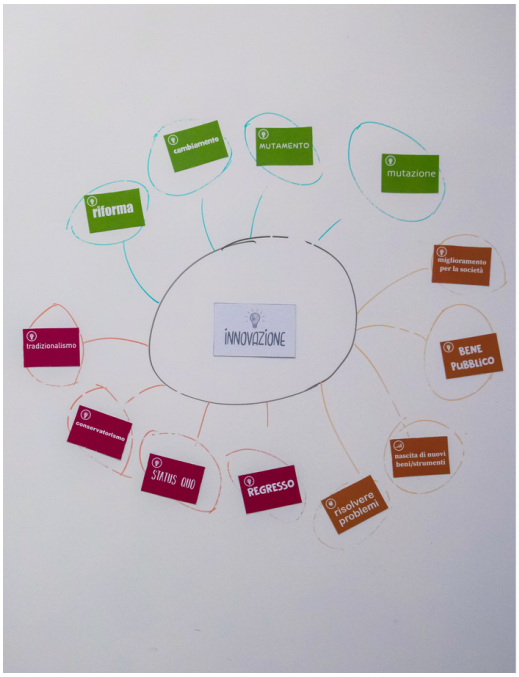
Activity

At first, we guide the students to observe various types of slides using a monocular microscope connected to a computer that allows us to examine prepared slides in greater detail. This type of microscope is ideal for studying the internal structures of cells and tissues, and for capturing high-resolution images that can be analyzed and shared digitally. We compare the ancient drawings made by early microscopists, such the ones in Hooke's *Micrographia*, with the images that can be obtained using this modern microscope. This allows students to appreciate the evolution of microscopy and the significant impact that technological advancements have had on scientific progress.

Next, we move on to the value of hands-on experimentation and observation, where students use stereoscopic binocular microscopes to observe three-dimensional samples, such as insects, crystals, and tissues. This type of microscope provides a more immersive experience, allowing students to make their own observations and draw their own conclusions.

Activity

Some students take part in observation, while others engage in a guided mind-mapping activity on a rotational basis. As part of our microscopy workshop, we developed different sets of magnets with values associated with the concepts addressed in the previous discussions through three semantic links: ‘equivalent to’, ‘opposite to’, and ‘consequence of’. The students, divided into small groups, are instructed to choose a central value from which to start and populate, on a magnetic whiteboard, a mind map.
They must fill colored balloons representing these semantic links or propose new relations and concepts not already included on the magnets. Each magnet is distinctly marked with a small icon representing its respective set of values, simplifying the process for students to associate the right values with each concept. For instance, all keywords related to the value 'innovation' are represented by a little icon of a lit bulb, aiding easy identification.



Discussion

As the students observe under the microscope and engage in their game, quick interviews are conducted to inquire about any additional keywords they may think of, any difficulties they may be experiencing with the tools, whether they believe this theme is still relevant, if any of them aspire to pursue this profession in the future, and their thoughts on the importance of sharing information and cooperation between nations in the scientific field.

Note: Although the sets of values on the magnets were predefined, the students were encouraged to be creative and propose new relationships and concepts not already included on the magnets. This led to mind maps that mixed all the variables offered to the students and allowed them to explore new ideas and connections.

4th part of the activity: *Visit to the museum collection*

In this unit, the group visits the museum collection.

Activity

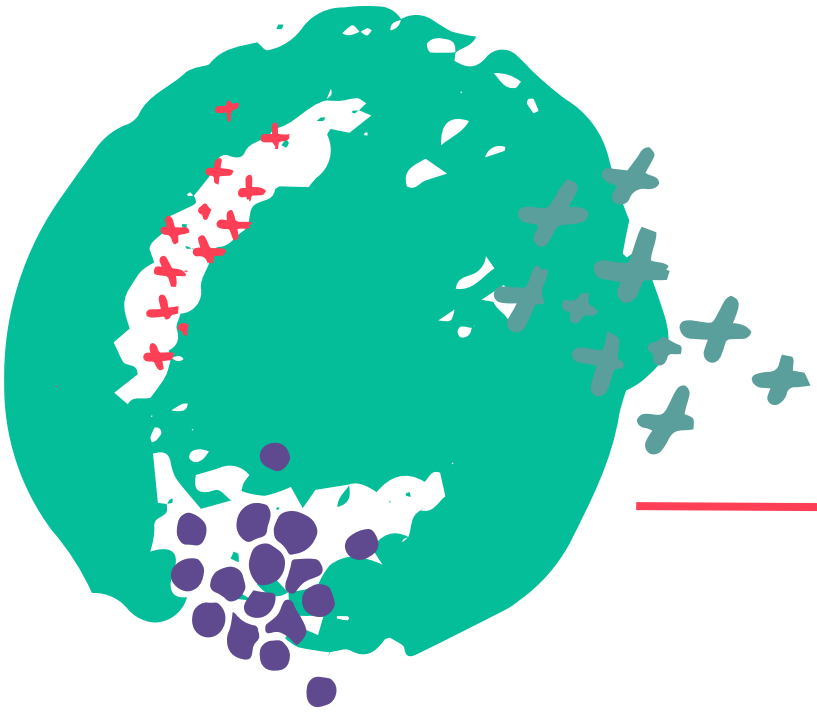
As a follow-up to the previous activities, the group is taken on a guided tour through the museum galleries to view the original objects that were previously discussed, with a focus on telescopes and microscopes. This experience helps to deepen the connection between the values and ideas that were addressed during the activities and the museum collections. By seeing the original objects firsthand, the students can gain a greater appreciation for their historical and cultural significance. The tour is designed to be interactive, with guides encouraging students to ask questions and engage in discussions about the scientific instruments and their context. This provides an opportunity for students to reflect on the connections between science, culture, and history, and to develop a deeper understanding of how these disciplines intersect and inform one another.

Farewell - Activity evaluation

We summarize the most important points with children and ask the teachers to fill a post-visit questionnaire (Appendix II).

The purpose of this questionnaire is to understand:

- Whether the activity succeeded in stimulating a discussion on values among the students
- Whether it provided a broader perspective on scientific instruments
- Whether teachers believe that museums, as cultural institutions, can be a place for discussing the transformation of values in different eras
- If they believe that the digitization of experiences within the VAST Project can contribute to the study of values and their emergence in modern society
- Satisfaction with the experience



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APPENDIX - I

Pre-Visit Questionnaire for Teachers

Dear Teacher,

Thank you for the time you are dedicating to completing this survey. The questionnaire is anonymous, and your participation is entirely voluntary. The survey results will be evaluated and used for research purposes, and to enhance the educational offerings of the Museum. Should you have any questions regarding the survey, you can contact us.

Your contribution is greatly appreciated!

UNIQUE CODE*	

** Choose a unique code (word or number) and remember it to use in the post-visit questionnaire.*

Section 1 – Personal Information

1. Age
   - ☐ 22-30
   - ☐ 31-40
   - ☐ 41-50
   - ☐ 51-60
   - ☐ > 60
2. Gender
   - ☐ M
   - ☐ F
   - ☐ Other
   - ☐ I prefer not to answer
3. Where do you live?
   - ☐ Large City/Capital (>100.000)
   - ☐ Suburb near a large city
   - ☐ Small City (<100.000)
   - ☐ Town or Rural Area (<30.000)

4. Educational qualification
    - ☐ Bachelor's Degree
    - ☐ Master's Degree
    - ☐ Ph.D.
    - ☐ Other ……
5. Years of work experience in the educational field
    - ☐ < 5 years
    - ☐ 5-10
    - ☐ 11-20
    - ☐ 21-30
    - ☐ > 30
6. What type of school are you currently teaching at?

    ……
7. What is the age of your students?

    ……
8. What subject do you teach?

    ……

Section 2 - Museum Experience

9. Which museums have you already taken your students to?
    - ☐ Art Museums
    - ☐ Science and Technology Museums
    - ☐ Natural History Museums
    - ☐ Ethnographic, Anthropological, and Regional Museums
    - ☐ Archaeological Museums or Archaeological Parks
    - ☐ Historical Museums
    - ☐ House Museums
    - ☐ Military or War Museums
    - ☐ Maritime or Oceanographic Museums
    - ☐ Botanical Gardens
    - ☐ Outdoor Museums (e.g. caves and mining parks)
    - ☐ Fashion Museums
    - ☐ Sports Museums
    - ☐ Virtual Museums
    - ☐ Other ……

10. Do you recall a museum that left a particular impression on you? Could you explain why?

    ……

    ……

11. Is this the first time you are accompanying your students to our museum?
    - ☐ Yes
    - ☐ No

Section 3 - Museums and Values Communication

12. Have you ever participated with your students in an educational activity centered on values?
    - ☐ Yes
    - ☐ No

    If yes, which ones? ……

    ……

13. Do you believe that a museum can serve as a medium for promoting certain values and consequently contribute to societal change and the expression of values?
    - ☐ Yes
    - ☐ No
    - ☐ I'm not sure

    If you wish, please explain why ……

    ……

14. If your answer is positive, on which values would you like a museum to focus its attention?

    ……

    ……

15. Considering the current socio-political reality, do you think museums should contribute to reflecting on these events?
    - ☐ Yes
    - ☐ No
    - ☐ I'm not sure

    If you wish, please explain why ……

    ……

Section 4 - Activities at the Museum

16. What benefits do you expect for your students from this activity?

- ☐ Consolidation of knowledge
- ☐ Enrichment of cultural background
- ☐ Stimulating experience
- ☐ Sharing and exchanging opinions
- ☐ Development of critical thinking
- ☐ Other ……

17. Do you think an activity focused on the dissemination of the history of science is suitable for stimulating a discussion on values?

- ☐ Yes
- ☐ Somewhat
- ☐ No

  Why? ……

  ……

18. Do you believe there are inherent risks in this operation?

- ☐ Yes
- ☐ No
- ☐ I'm not sure

  If yes, what are they?……

  ……

APPENDIX - II

Post-Visit Questionnaire for Teachers

UNIQUE CODE*	

** Please, provide the unique code you used to complete the pre-visit questionnaire.*

1. How would you rate the activity?

   ☐ It was a pleasant surprise

   ☐ It was as I expected

   ☐ It was not very effective

   If you wish, please explain why ……

   ……

   ……

2. Do you believe the activity successfully stimulated a discussion on values?

   ☐ Yes

   ☐ Somewhat

   ☐ No

   If you wish, please explain why ……

   ……

   ……

3. Do you think the activity highlighted the connection between the displayed scientific instruments and the expressed values?

   ☐ Yes

   ☐ No

   ☐ Other ……

   ……

4. Do you believe the activity managed to provide a broader perspective on scientific instruments to your students?

   - ☐ Yes
   - ☐ No
   - ☐ I'm not sure

   Do you have any comments on this?

   ……

   ……

   ……

5. What did you like the most about the visit?

   ……

   ……

   ……

6. Which part of the laboratory activity do you think most stimulated your students?

   ……

   ……

   ……

7. The foundations upon which a value originates and develops lie within the social, cultural, and institutional context, as well as within the personality of individuals who are part of that context.
   Considering the activity conducted, do you believe that a museum, as a cultural institution, can be a place of interaction, where discussions about the transformation of values across different eras can take place?

   - ☐ Yes
   - ☐ No
   - ☐ Other ……

   ……

8. Values form the foundation of our intangible cultural heritage. Do you think that the digitalization of experiences carried out within the scope of the VAST Project could contribute to the study of values and their emergence in modern society?

   - ☐ Yes
   - ☐ No
   - ☐ I'm not sure

   If you wish, please explain why ……

   ……

   ……

9. Additional comments

……

……

……

APPENDIX - III

KNOWLEDGE

INFORMATION

AWARENESS

notions

idea

competence

culture

education

KNOWLEDGE

learning

understanding

SCIENCE

CONSCIENCE

cognition

GUIDE RESEARCH

RECOGNIZE FORGERIES

reduce errors

understand better

Face daily challenges

experience

GENERATE MORE KNOWLEDGE

problem solving

BE PREPARED

UNAWARENESS

disinformation

IGNORANCE

unpreparedness

incompetence

inexperience

PREJUDICE

bias

superstition

INCIVILITY

FAKE NEWS

evolution

development

improvement

refinement

ADVANCEMENT

path

CIVILIZATION

civilisation process

innovation

birth of new goods/tools

GREATER QUANTITY OF SERVICES

improve life

communicate more easily

move more quickly

find new treatments

improve production capabilities

ECONOMIC GROWTH

environmental disasters

ENVIRONMENTAL IMPACT

Global warming

pollution

backwardness

RETREAT

stagnation

REGRESSION

DECLINE

BARBARISM

involution

decline

deterioration

DIALOGUE COMMUNICATION

sharing	communication	dissemination
disclosure	TRANSMISSION	linkage
community	contact	understanding
harmony	comprehension	conversation
speech	dialogue	information accessible to all

identify common problems

FIND SOLUTIONS TO COMMON PROBLEMS

equality

democracy

multiculturalism

sharing of ideas

DIFFERENCE OF VIEWS

coldness

incommunicability

misunderstanding

indifference

disagreement

divergence

change

TRANSFORMATION

mutation

reform

RENEWAL

new order

novelty

REVOLUTION

overturning

improvement for society

PUBLIC GOOD

advancement of knowledge

change of perspective

overcoming challenges

enrichment
(more immaterial than material)

EXCHANGE

STATUS QUO

reaction

traditionalism

conservatism

REGRESSION

STAGNATION

values
across
space
& time

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