University of Tartu, EE

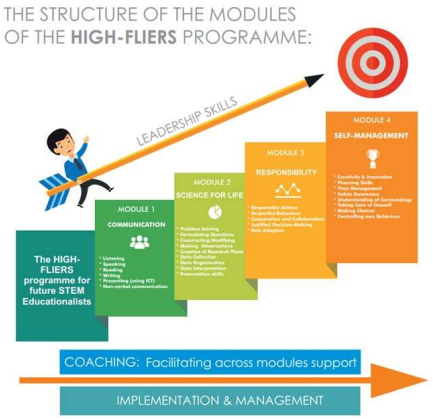
University of Eastern Finland, FI

University of Lisbon, PT

Institute of Social Sciences, Ivo Pilar, HR

MODULE 2 – SCIENCE FOR LIFE

ONLINE HIGH-FLIERS OPERATIONAL MANUAL FOR UNIVERSITY SCIENCE STAFF



Guidelines to implement module 2

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Structure of the Module 2

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Session 1	Session 2	Session 3	Session 4
Recognizing the science in everyday situations - questioning	Understanding the need/ importance of science knowledge -inquiry	Understanding science as process which impacts society	Recognizing science as **opposed** to pseudoscience
• Introducing the scenario • Job-shadow programme (if possible undertake a visit) • Meaningful questioning	• Identifying problems for research • Understanding science (scenario - Dead Sea) • Commenting statements	• What is the nature of the processes which relate the society to science	• Science versus pseudoscience • A focus onScience career awareness • 3 minute video presentations

The goals

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- To promote the importance of learning STEM subjects through science teaching and raising interest in studying science.
- To establish an essential base for all future STEM learning.
- To recognise transferability of STEM learning, especially associated with learning science and interrelated technology within, or for, society.
- To promote an awareness of skills and competences needed for being

  (a) STEM teacher, (b) scientist, and (c) functioning as a community member.
- To create a 3-minute video, identifying a scientific problem, or socio-scientific issue associated with an everyday situation.

Before you begin the module

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Please undertake:

- The pre-survey questionnaire (*if not already undertaken*)

And also

- The following participant task:

  - Please introduce yourself in 2-3 sentences.
  - Seek to do this using sentences which **don`t appear** in a traditional CV form.

Session 1 – Introduction to a Scenario

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Birgit and Laura are friends. However -

In school, Birgit does not like science classes, because these are seen as too theoretical and seemed very far from life. She is always very critical of the need for science learning.

But, her friend Laura wants to continue post-school studies in the field of paediatrics and is happy to learn science. She never complains about learning science.

One day, a *job-shadow programme* was introduced as part of the science course.

Several job-shadowing options were put forward e.g. visiting and appreciating the work in a science laboratory within an industrial complex, or company manufacturing site.

The two friends decided they would like to undertake job shadowing through visiting and learning about the role of science laboratory in a cosmetic industry.

Job shadow highlights

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The following slides include photographs of the following:

Sites/tools/materials/reports

to which the two students paid attention.

Video: https://www.youtube.com/watch?v=YocAqIUk_W4

https://blog.humanesociety.org/2022/05/cosmetics-animal-testing-is-in-the-spotlight-nows-the-time-to-end-it.html





[Link to images]

Tasks

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(for those who undertake this module)

a) Create up to 6 questions related to the photos (individual work).

b) Select 6 questions from those put forward in the group (groupwork: 3-4 students per group).

a) Then, first identify and secondly, present the 2 most relevant questions to the class, explaining your choice.

Exemplary questions asked during the shadowing

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By Birgit:

1. Should all cosmetics products undergo animal testing?
2. I noticed researchers discussing! Do you ever modify procedures based on team members opinions?
3. I noticed products may be tested manually, as well as in a computerised way – how is this decided?

By Laura:

1. Which functional groups does the structural formula include for the lotion/solution? (is it a solution?)
2. What conditions need to be followed when undertaking computerised titration?
3. How many different products do you test during one day?

Meeting with the company leader who is visiting the laboratory

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Unexpectedly, Dr Professor Hundy, the company leader from overseas, was visiting the research laboratory on the same day. He became interested in what Birgit and Laura were doing in the research laboratory. On learning about the job shadow programme, he decided to find out

- **why did they decide to come to this company, and how did they like the job shadow programme.**

After initial discussions, Birgit asked him whether the company could employ students over the summer to work in the department of R&D, and if so, could they try to design new products?

Also she asked whether the company could advertise a competition for that?

Prof Hundy asked whether Birgit had an idea of which product to design?

Birgit and Laura both drew something on a piece of paper - Dr Hundy laughed and asked whether he could keep those.

Both girls also shared with him the questions which they asked earlier.

3 months later

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Birgit received a letter from Prof. Hundy.

Prof. Hundy asked whether Birgit would be interested in undertaking studies in the prestigious Cambridge University, funded by a scholarship by his industry and including practicing in industry.

However, unfortunately, Laura did not get any letter.

Tasks (for those who undertake the module)

Discuss, in groups, why Birgit impressed Prof. Hundy and what might she have scribbled on the piece of paper.

Feedback

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- Prof Hunday was impressed by the creative ideas by Brigitte (especially her product design idea).
- Prof Hunday was also impressed by the meaningful questions which Birgit asked.

Tasks *(for those who undertake the module)*

- Based on your questions, what do you think – would you have received a letter?

Session 2

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Science/scientific knowledge about the Dead Sea

- Identifying problems for undertaking research
- Scientific knowledge
- What is science?
- https://www.youtube.com/watch?v=hoeeSYa8uIM

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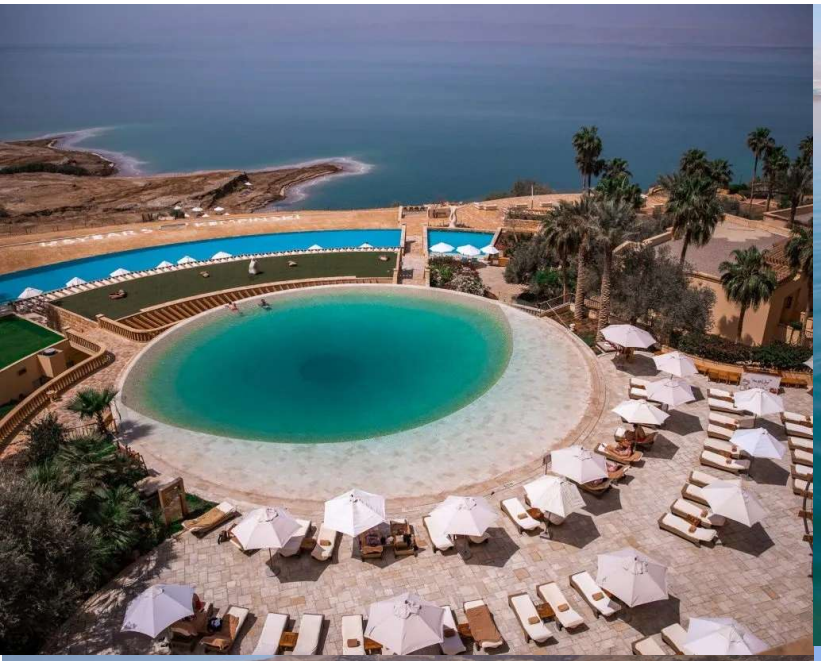
Dead Sea – a wonder in the world

- https://www.youtube.com/watch?v=qIipINltwUk




Haifa
Nazareth
Irbid
Netanya
Nablus
Jerash
Tel Aviv-Yafo
Amman
WEST BANK
Ashdod
Jerusalem
Madaba
Azraq
Bethlehem
Be'er Sheva
Kerak
Israel
Mitzpe Ramon
Shobak
Wadi Musa
Ma'an
Yotvata
Al-Quwayrah
Aqaba
Bayir
Kilwa

Tasks

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For those who undertake the module:

- identify 5 problems which you notice (individual work).
- select 5 problems which can be used for initiating research by scientists (groupwork: 3-4 students per group). Please justify you reasoning.

For course leader:

- introduce different types of problems (scientific, social, socio- scientific).
- which problems can be the focus of research undertaken by scientists?

Dead Sea – a wonder in the world

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- **Exemplary problems identified by students:**

- Climate change has caused a decrease in the size of the Dead Sea.
- The Dead Sea is very salty.
- Human activity is influencing the natural surroundings of the Dead Sea.
- There is a danger that human activity can destroy the rock- salt formations.
- The cosmetic industry is utilising too much Dead Sea water.
- Dead sea minerals can be used in homeopathy.
- Tourism is causing problems in the Dead Sea area.

Session 3

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What is the Nature of the Processes which Relate to Science?

- Is Science a process which can solve all kinds of problems and questions?
- What is your viewpoint?
- *A possible viewpoint you may feel you hold:*

  The scope of science is limited strictly to solving problems related to the natural world. Science is not equipped to address the supernatural realm (as such), nor the realm of values and ethics (or religious beliefs).

Science is a process which:

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Cannot ignore rules ?

- A possible viewpoint - Science must follow certain rules (such as seeking evidence); otherwise, it's not science.

Science seeks the truth, or the facts ?

- A possible viewpoint – The goal of science is to come as close as we can to understanding the cause – effect realities of the natural world.
- It's never "truth" or "facts". "Truth" and "facts" can mean different things to different people.

THE GOAL OF SCIENCE IS NOT ABOUT ACQUIRING FACTS !!

Aspects of the Nature of Science (NOS)

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Tentative

- Scientific knowledge is **subject to change** with new observations and with the re-interpretations of existing observations. Other aspects of NOS provide the rationale for the tentativeness of scientific knowledge.

Empirical

- Scientific knowledge is **based on and/or derived from observations** of the natural world.

What do you see in the picture?

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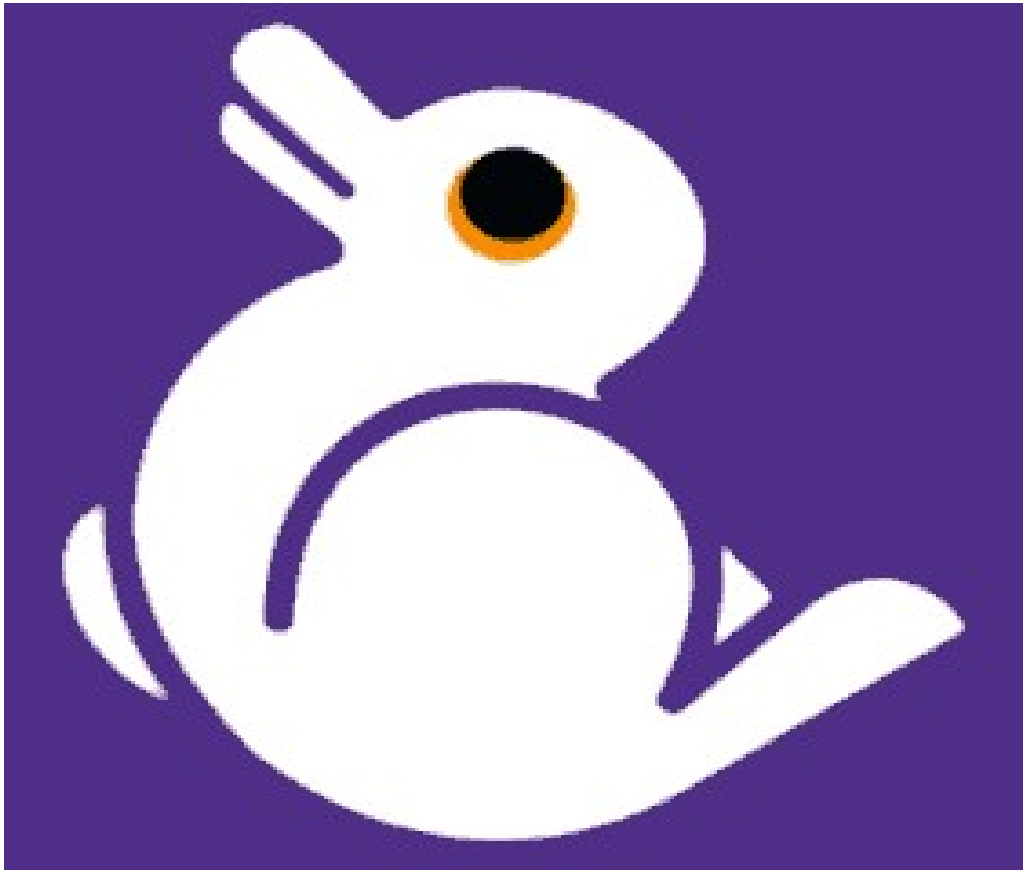

Whom do you see?

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To see the horse, you should have a 'theory' about how a horse looks.

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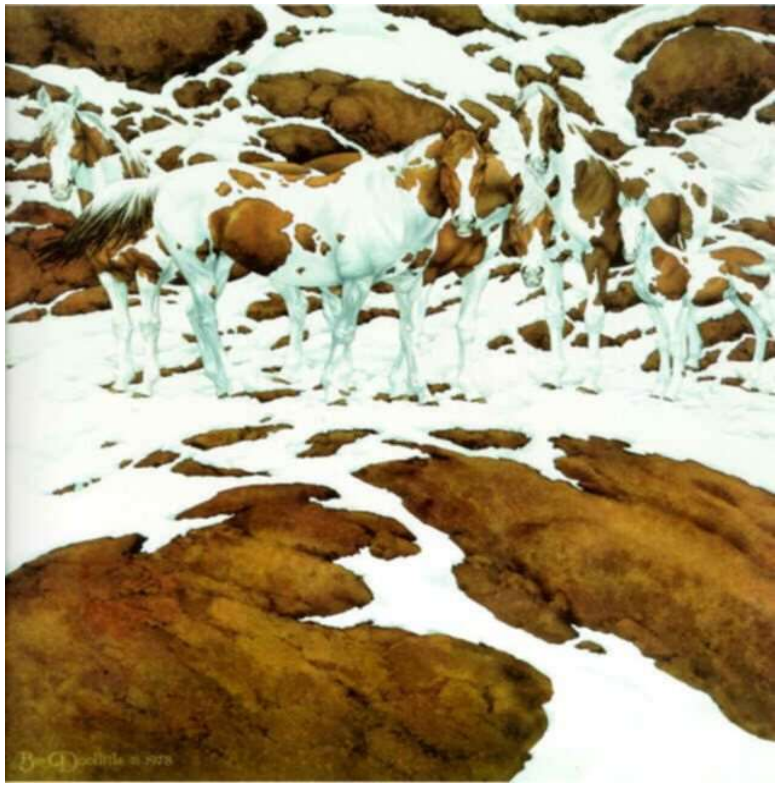

Observation and Inference

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- Science is based on both observation and inference.
- Observations are gathered through human senses, or extensions of those senses.
- Inferences are interpretations of those observations.
- The perspectives of current science and the scientist guide both observations and inferences.
- Multiple perspectives contribute to valid multiple interpretations of observations.

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Creative Thinking

Scientific knowledge is created from human imagination and logical reasoning.

- This creation is based on observations and inferences of the natural world.

Laws and Theories

- Scientific theories and laws differ.
- Laws describe relationships, observed or perceived, between phenomena in nature.
- Theories are inferred explanations of natural phenomena and mechanisms between relationships among natural phenomena.
- In science, hypotheses may lead to either theories, or laws, based on the accumulation of substantial supporting evidence and its acceptance by the scientific community.
- Theories and laws do not progress into one another: they are distinct:

  - While a theory is a well-supported explanation of observations;
    a scientific law is a statement that summarizes the relationship between variables.

Additional aspects of Science

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Socially and culturally embedded

- Science is a human endeavour. It is influenced by the society and the culture in which it is practiced.
- The values, within a culture, determine what and how science is conducted, interpreted, accepted, and utilised.

Subjectivity

- The development of questions, undertaking investigations and the interpretations of data are filtered through the lens of currently accepted theories and laws.
- This is an unavoidable subjectivity which allows science to progress yet remain consistent. It contributes to change in science conceptualisations when previous evidence is examined from the perspective of new knowledge.

Session 4 – Science versus pseudoscience

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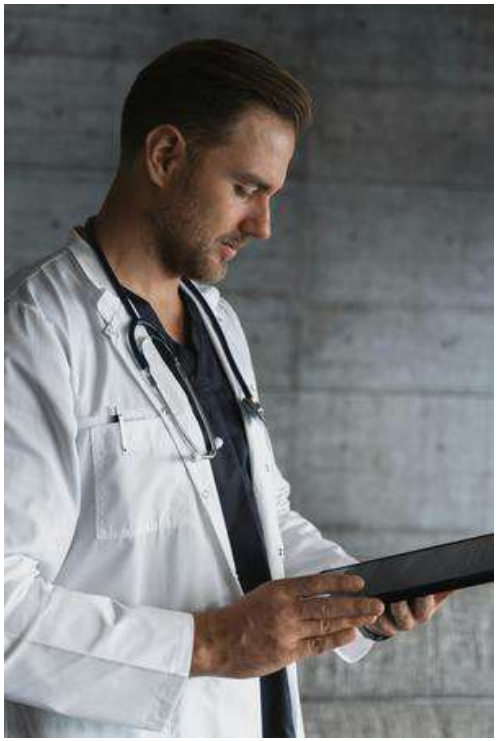
Scenario



Doctor Dunbar is a well-known family doctor.

He has good communication skills and also patients like him, because he always has time to discuss, give advice and show empathy.

During the COVID-19 pandemic, he struggled hard to convince people to get vaccinated.

Part of a discussion overheard between two elderly women:

„… well you can trust his advice – he never makes decision immediately without balancing different options.

You know… he was born at the beginning of October – typical Libra….

However, his friend, doctor Bush, is absolutely hopeless … his words are straightforward just like the hospital leaders suggest ….he is a careerist .. anything to get fast promotion – typical Leo.“

Astronomy vs Astrology

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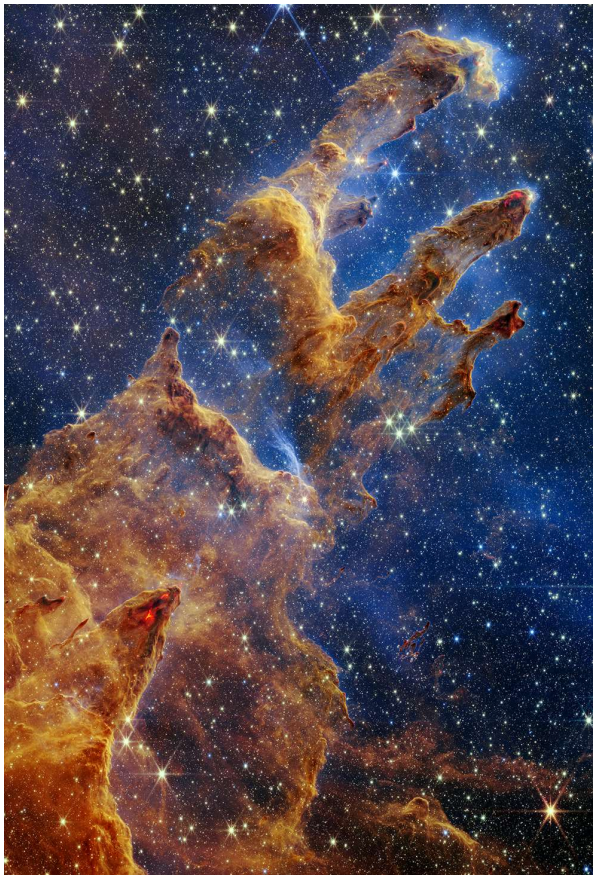
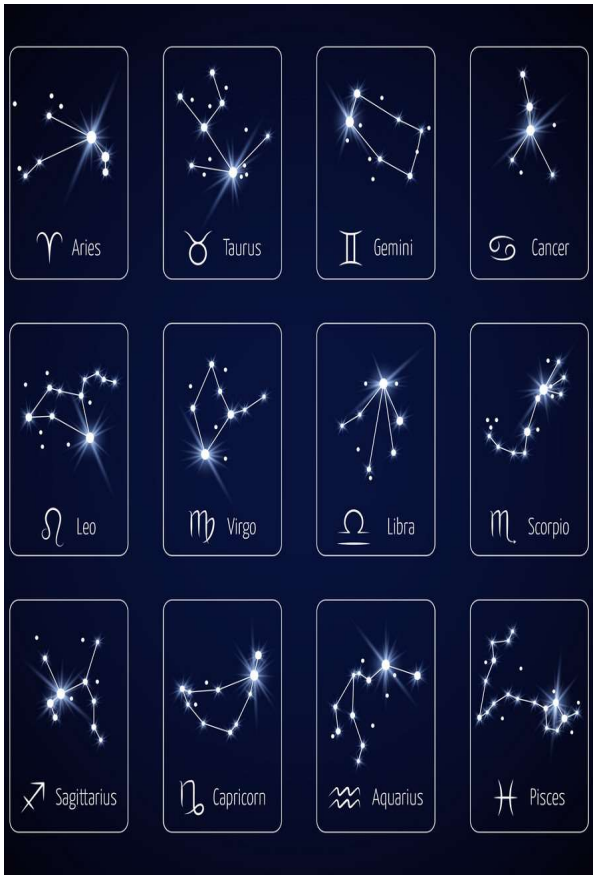


- Picture taken by NASA's new James Webb Space Telescope.
- An example of Astronomy



- Commonly believed Zodiac signs, based on the position of stars.
- An example of Astrology

Astronomy and Astrology (Continued)

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Most people have studied elements of astronomy,

But they are aware also about astrology and are able to:

- name the zodiac based on their birthday;
- possess information about different characteristics of zodiac signs, such as Libra, Scorpio, Leo, etc.
- many people have a belief that their birth zodiac determines their character and life orientation;
- people may read horoscopes so as to plan their activities successfully;
- some people choose friends based on their zodiac.

Imagine the situation:

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You start arguing with your friend whether astrology is a science or not.

The argument centred on:

- astrology is an age-old science, which includes long-lasting experiences of the human society;
- horoscopes are like making hypotheses – it's easy to check (falsify) whether they are applicable – this is similar to experiments in science;
- Over thousands of years, the sky-location has changed and the initial zodiac no longer corresponds with birth-dates;
- When determining the zodiac, you should not follow birth-dates, but the time when the embryo started developing.

Please justify your choice, giving an explanation!!

COVID-19:

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'tolerating pseudoscience can cause real harm'

Statements:

- Cow urine, bleach and cocaine have all been recommended as COVID-19 cures.
- Many 'wellness' gurus and alternative-medicine practitioners have pushed unproven potions, pills and practices as ways to 'boost' the immune system.
- You cannot just rely on those parts of science that are correct, since science is 'work in progress'.
- After all, much of what scientists claim is provisional and often turns out to be wrong. That does not mean those who were wrong were engaged in "pseudoscience", or even that they were doing "bad science"—this is just how science operates.
- Where do you place the boundary between "science" and "pseudoscience"?

  This question is more than academic.

Unexpected negative impacts on society

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- In a world where anti-vaccination advocates and climate-change denialists persist, talking sense might seem hopeless.

- THIS IS, especially when social-media algorithms and deliberating bad actors amplify pseudoscience messages.

Science Career Awareness

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- Proponent of homeopathy and energy therapies argue these are based on quantum physics.
- Also colonic hydrotherapy is justified using phrases borrowed from microbiome studies. And the language of stem-cell research is used to promote a spray claiming to have immune-boosting properties.

- There is a need for physicists, microbiologists, immunologists, gastroenterologists and other scientists, from relevant disciplines, to provide simple and shareable content, explaining why this '**hijacking' of real research** is inaccurate and scientifically dishonest.

Think about careers which contribute towards promoting awareness about science versus pseudoscience

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- Careers require scientific know-how (knowledge, skills, values, attitudes) for these professionals to work:
- Name 2-3 science-related careers, or choose from a given list.
  Justify, why these are science-related careers.
- What kind of knowledge, skills, attitudes and/or values are needed to be high-performers in these careers?
- Which **three skills** are considered most important in each of these careers?
- Please describe one situation, or task, where these three skills are needed? Explain, how these skills are useful and support high performance.

Presentation

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Give a presentation/public lecture/3-min online lecture on an attractive, controversial, STEM topic emphasising:

a)	*demonstrating creative problem solving*	*(research skills)*
b)	*understanding of science and pseudoscience*	*(thinking skills)*
c)	*demonstrating STEM-related career awareness*	*(self-management)*

1. How do you understand the nature of science? What is your opinion about the Nature of Science and Technology?

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Science is:

a) a study of fields such as biology, chemistry and physics.
b) carrying out experiments to solve problems of interest.
c) a systematic investigative process and the resulting knowledge.
d) inventing and designing things.
e) finding and using knowledge to make ~~this~~ our world a better place.
f) a body of knowledge that explains the world around us.
g) exploring the unknown and discovering new things about the world.
h) an organization of people called scientists who have ideas and techniques for discovering new knowledge.
i) (I do not know).

2. In your opinion, what is the aim of Science?

The aim is:

a) to make sure that what has been discovered about the world is really true.

b) to understand, explain and interpret the continuing change in nature and its characteristics.

c) to discover, collect and group facts about nature.

d) to find ways to make people's lives better.

e) I do not know.

3. Why do you think Scientists do Scientific Research ?

Scientists undertake research so as:

a) to make new discoveries.

b) to try out their explanations for why things happen.

c) to make something which will help people.

d) to collect as much data as possible, and to extract scientific laws from the data.

e) (I do not know).

4. A Scientific Theory is :

a) an idea about what will happen.

b) the most appropriate interpretation and explanation, which has been approved by scientists.

c) a fact, which has been proved by many experiments.

d) (I do not know).

Thank you!

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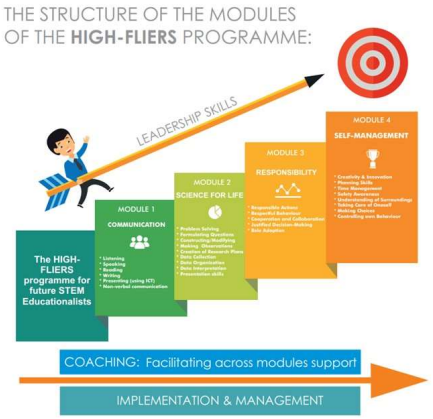

Find out more:
https://highflier.eu/

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