STEAMCITY CURRICULUM

FACTBUSTERS

Deciphering truth from falsehood using the scientific approach

thematic: citizen engagement, governance and data

Introduction

The **FactBusters Protocol** enables students to proactively discover the **scientific method** in a structured and progressive way, by deconstructing and demystifying commonplaces and pseudo-sciences. In today's fast-paced society, where fake news can spread easily, it is essential to develop a critical mind.

By learning to deconstruct information and construct **verification protocols**, students not only strengthen their understanding of science, but also become more informed and responsible citizens.

Thanks to the scientific approach, human beings have the intellectual tools to become **conscious and responsible actors in their relationship with the world and in the transformation of societies**.

This activity therefore aims to prepare students to navigate critically and reflectively in an increasingly complex and interconnected world.

Understanding Information Distortion

Myths are traditional stories or beliefs that explain natural or social phenomena. Often deeply embedded in culture, myths serve social functions but lack empirical verification. While they may contain wisdom or cultural insights, they are not based on systematic observation or testing.

Pseudoscience presents itself as scientific but fails to adhere to scientific methodology. It typically features unfalsifiable claims, cherry-picked evidence, resistance to peer review, and an overreliance on confirmation rather than refutation. Unlike genuine science, pseudoscience doesn't evolve with new evidence and often appeals to tradition or authority rather than empirical data.

Fake news consists of deliberately fabricated information presented as factual reporting. Unlike myths (which evolve culturally) or pseudoscience (which attempts to mimic scientific authority), fake news is intentionally created to mislead for political, economic, or social gain. Its rapid spread through digital platforms makes it particularly dangerous in modern information ecosystems.

Interdisciplinarity

civil & moral education
sciences
technology and engineering

Sustainable Development Goals

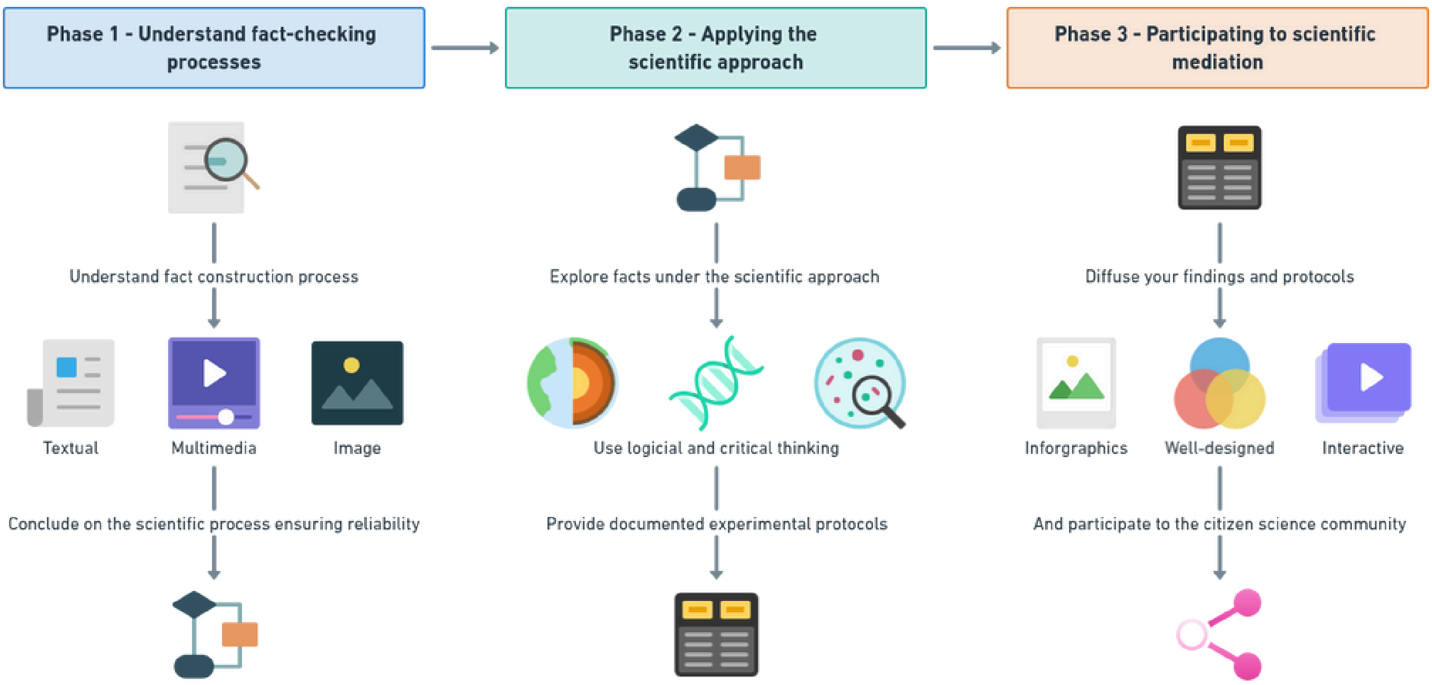
4 QUALITY EDUCATION
11 SUSTAINABLE CITIES AND COMMUNITIES
16 PEACE, JUSTICE AND STRONG INSTITUTIONS

Overview

Protocol Structure

The **FactBusters Protocol** is structured in three complementary phases, each reinforcing students' understanding and skills in applying the scientific method.

- **Step 1: Understanding the fact-checking process.** In this first phase, students discover the scientific method and fact-checking techniques. They learn to analyze and evaluate the reliability of information from different sources. This phase lays the foundation for the scientific approach by teaching students how to distinguish reliable information from false information and understand approaches to constructing facts. This allows them to develop critical thinking skills and a method necessary for the subsequent steps.
- **Step 2: Constructing fact-checking protocols.** The second phase emphasizes putting the scientific method into practice. Students, organized in groups, develop verification protocols to test the validity of common beliefs. They learn to formulate hypotheses, design experiments, and write detailed protocols. This phase reinforces their understanding of the rigor and reproducibility necessary in scientific research. It allows students to move from theory to practice by applying the concepts learned in the first phase.
- **Step 3: Disseminating scientific culture (optionnal).** Finally, the third phase aims to teach students how to popularize and present their approaches in a clear and understandable manner. They create visual and media materials to share their protocols. This phase develops their skills in scientific communication and pedagogy. This final step allows students to address the importance of disseminating scientific knowledge to encourage informed and responsible citizenship.



Getting started

Duration: This activity can be spread over several sessions, or across multiple disciplines in an interdisciplinary approach. It is possible to use phase 1 independently (about 30 minutes), to combine phases 1 and 2 (2 sessions) or to carry out all three phases. A minimum of 3 sessions would be needed to complete the entire activity.

Level of difficulty: *The activity involves critical thinking, logical reasoning, and a good understanding and usage of the scientific approach.*

Material needed:

- Step 1: Understanding the fact-checking process: Access to resources (books, articles, videos, images...) that will form the literature basis of the analysis
- Step 2: Constructing fact-checking protocols: No specific materials needed. An internet access will be an added value to search for specific processes and examples of protocols for complex topics (such as medical ones)
- Step 3: Disseminating scientific culture: For a digital version, access to computers or tablets and graphic creation tools (Canva, for example, offers a free version for schools). For a paper version, access to foam board panels to create posters, and regular drawing material

Glossary

Keywords & Concepts	Definitions
Scientific approach	Methodical research process including observation, hypothesis formulation, experimentation, analysis of results and conclusion
Scientific protocol	Set of rules and procedures defined for conducting scientific research or experiments
Hypothesis	Supposed proposal as a starting point for scientific investigation
Fact-checking	Process of verifying facts to determine their veracity
Debunking	Refuting or dismantling a false idea or myth
Commonplace	An idea widely accepted as true without necessarily being based on solid evidence
Pseudo-sciences	Disciplines or practices that falsely claim to be based on scientific methods but do not meet the criteria of rigor and verifiability
Critical thinking	Ability to evaluate information objectively and rationally, questioning sources and evidence presented
Science literacy	The process of making scientific knowledge accessible and understandable to a non-specialist audience
Fake news	Deliberately false or misleading information disseminated to manipulate public opinion
Source	Origin or starting point of information. In the context of research and fact-checking, a reliable source is a credible, verifiable reference that often comes from recognized institutions, academic publications, or professionals who are experts in a specific field

Protocol

Step 1 - Understanding the fact-checking process

Background and description of the problem to be solved in this step: Students will learn to analyze the process of construction, justification, and referencing of given information to understand its reliability. The objective is to develop critical thinking skills when faced with information available in the media and to be able to differentiate between those who adopt a rigorous approach and those who merely state facts without relying on a strict verification and experimentation approach.

Learning Objectives: Develop students' critical thinking skills, learn to evaluate the reliability of information sources, understand and apply the scientific method.

Conceptualisation

In this phase, we seek to understand how information is constructed and how to analyze whether it is based on a valid scientific process. By applying rigorous fact-checking techniques, we can evaluate at our level whether the information seems reliable and develop our critical thinking skills in the face of less rigorous information that we easily find in the media or on the internet. Several criteria allow us to conclude on the perception of reliability of information:

1. **Diversity of sources:** Reliable information must come from multiple independent sources. This allows for verifying the consistency of facts and reducing biases. By diversifying sources, we increase the likelihood that information is cross-checked and validated by different experts, thus enriching the veracity of the data. However, it is crucial to know how to evaluate the reliability of sources. For example, a cited author or expert should be recognized in their field, with peer-reviewed publications and a reputation for credibility. Verifying institutional affiliations and previous contributions can help assess this reliability.
2. **Coherence and clarity of presentation:** A clear and coherent presentation of information is essential for understanding and reproducing the verification process. The clarity of presentation facilitates the communication of results and allows other researchers to follow and validate the same steps. Well-structured and logical information is easier to analyze and compare with other sources, which reinforces its credibility.
3. **Objectivity and neutrality of the source:** Objectivity and neutrality ensure that the information is not influenced by personal, financial, or ideological interests. An objective source presents facts impartially, based on empirical evidence, which is fundamental for scientific credibility. It is important to recognize potential biases and seek sources that strive to minimize these biases by declaring their conflicts of interest and adhering to strict ethical standards.

These criteria are directly linked to the scientific approach, which requires:

- **Rigor:** Rigor refers to the precision and accuracy with which research or an experiment is conducted. This involves following strict methods and protocols to ensure that the results are reliable and valid. A rigorous approach minimizes errors and biases, thus ensuring that the conclusions drawn are robust and based on solid data.
- **Transparency:** Transparency involves making all steps of a research or experimentation process clear and accessible. This includes complete documentation of methods, raw data, analyses, and conclusions. Transparency allows other researchers to understand exactly how results were obtained, reproduce experiments, and verify the integrity of conclusions.
- **Reproducibility:** Reproducibility is the ability of research or an experiment to be reproduced by other researchers following the same methods and conditions. If results can be consistently reproduced, this strengthens its validity of conclusions. Reproducibility is a pillar of the scientific method, as it allows verification that discoveries are not the result of chance or biases specific to the initial researcher.

By questioning the diversity of sources, the coherence of presentation, and objectivity, students learn to apply a structured method of investigation, essential for evaluating the reliability of information.

To carry out this activity, and as a common thread throughout the sequence, we will use facts from commonplaces, myths, or pseudo-sciences that are widely spread in society. **For example, commonplaces can include “Spinachs are rich in ion”, “You can catch a cold by being exposed to cold weather” or “Goldfish have a three-second memory”. More complex pseudo-sciences can also be explored for instance “A perpetual motion machine can allow us to produce energy without input”, “There is no gravity in space” or “The Coriolis effect influences the direction of water in a sink”.**

We are aware that these beliefs and commonplaces may differ according to cultures and countries. We propose a **list of examples in annex to this protocol**, but feel free to adapt the proposals to what is widespread around you, so that it is relevant for your students.

Students Investigation

To carry out the activity, you can divide the class into **groups of 3 or 4 students** to whom you would distribute a **specific subject to study** (see the table in annex, but you can also choose your own subjects, or ask students about home remedies for example or common misconceptions they have often heard). For each group and each subject, you can prepare in advance a **bank of resources that students will need to analyze**: **articles with varying levels of sourcing, YouTube videos, TV reports, widely circulated images**... For each subject, distribute at least three different resources to analyze the impact of the distribution medium on the perception of information reliability.

Once the resources are identified and distributed, students will need to verify the approach used by the authors to ensure the reliability of the information. Several criteria will be analyzed: credibility of the author, diversity of sources, publication in peer-reviewed journals...

For each resource, students will need to fill out the following form (also available for printing in annex):

Date: .../.../......

Group: ....

Subject analyzed: ....

Analysis of the Information Source	
Source title:	
Author:	
Publication date:	
Type of source (article, video, image, etc.) :	

Content Analysis	
Content summary	
Hypothesis(es) formulated by the source	
Methodology used in the source	

Source Credibility - *Answer Yes or No and Justify*	
Is the author recognized and credible?	
Is the source published by a recognized institution?	
Does the source cite reliable research or sources?	

Fact Checking - *Answer Yes or No and Justify*	
Are the presented facts verifiable?	
Are the facts supported by empirical evidence?	
Is the methodology rigorous and reproducible?	

Evaluation Criteria - *Answer Good, Average or Poor and Justify*	
Diversity of sources	
Perception of the coherence and clarity	
Perception of the objectivity and neutrality	

Conclusion	
Is the source perceived as reliable and why?	
Improvements can be made to the methodology	
How does this analysis influence your perception of the subject?	

Conclusion & Further Reflexion

To conclude the activity, students will gather for a collective discussion where each group will present their conclusions on the studied topics. This presentation will allow sharing the different approaches and methodologies used, as well as the results obtained. Students will reflect together on the following questions:

- **What difficulties were encountered when analyzing sources?**
- **How did the diversity of sources influence the perception of information reliability?**
- **What are the most important criteria for evaluating the credibility of an information source?**

These questions aim to strengthen their critical thinking and refine their understanding of fact-checking methods in order to prepare for the next phase.

Step 2 - Constructing fact-checking protocols

Background and description of the problem to be solved in this step: This phase focuses on constructing rigorous scientific protocols to verify facts and information. After analyzing the reliability of sources in the first step, students will learn to explore these facts scientifically. They will formulate genuine hypotheses, design precise experiments, and write detailed protocols.

Learning Objectives: Strengthen scientific rigor, acquire skills in experimental methodology, and understand how to validate or invalidate hypotheses in an objective and reproducible manner.

Conceptualisation

The scientific approach is a rigorous and methodical process used to explore, understand, and explain natural phenomena. It consists of several key steps that allow for formulating hypotheses, testing these hypotheses, and drawing conclusions based on empirical data:

1. **Observation:** The first step involves observing a specific phenomenon or problem. Scientists use their senses, as well as tools and instruments, to gather accurate and detailed information.
2. **Question:** Following the observation, a precise question is formulated. This question must be clear, concise, and oriented towards a specific aspect of the observed phenomenon.
3. **Hypothesis:** Scientists then propose a hypothesis, which is a possible explanation or provisional answer to the posed question. A good hypothesis must be testable and falsifiable.
4. **Experimentation:** To test the hypothesis, controlled experiments are designed and conducted. These experiments must be repeatable and include controlled variables to ensure that the results obtained are reliable and unbiased.
5. **Data Analysis:** The data collected during the experiments are systematically analyzed. Scientists use statistical tools and analysis methods to interpret the results and evaluate the validity of the hypothesis.
6. **Conclusion:** Based on the data analysis, a conclusion is drawn. If the results support the hypothesis, it is provisionally accepted. If the results do not support the hypothesis, it is rejected or modified.
7. **Publication and Replication:** The results and conclusions are shared with the scientific community through publications in peer-reviewed journals. Other scientists can then repeat the experiments to verify the results and strengthen the validity of the conclusions.

During this phase, students will be able to explore each of these steps in order to build a serious protocol, allowing them to test the commonplaces, myths, and pseudo-sciences discovered during the previous phase of this sequence. Their protocols should be clear, reproducible, and based on empirical evidence. Formulating a hypothesis will be an essential step to guide the research. The protocols should include controlled variables, comparison groups, and objective measurements.

The protocols proposed by the students are not intended to be implemented. Indeed, some may be difficult to implement in class, and it is essential to give students a wide margin for creativity and exploration. They can imagine using sophisticated measurement tools, accessing clinical trials... without being limited by material or logistical constraints. This freedom of invention helps stimulate their motivation and encourages ambitious scenarios. However, if simple and feasible protocols emerge, don't hesitate to consider an additional step to implement these experiments.

Students Investigation

Create a template of Scientific Protocol

To start this activity, and in connection with the analyses and conclusions of the previous phase, let the students discuss **what they perceive and know about the scientific approach**. As a whole class, open a discussion to define the **important phases of scientific investigation**. As a teacher, your role is to guide the exchanges and ensure that the major steps of an experimental protocol are identified. Based on these discussions, **define together a detailed protocol sheet covering all the steps**, which will be used by the different groups in the continuation of this phase.

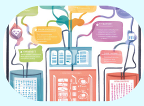
Advice to teachers: You can also accelerate or skip this step by proposing and presenting a protocol sheet that is already prepared and providing a theoretical basis to students on what is and how to use the scientific method.

This "Protocol Sheet" could look like this example (also available for printing in annex).

Date: .../.../......

Group: ....

Subject analyzed: ....



Observation - Precise description of the observed phenomenon or problem	
Question - Formulation of the specific question to explore	
Hypothesis - Proposal of a testable and verifiable hypothesis	
Experimentation	
Description of the experiment	
Controlled variables	
Comparison groups	
Detailed procedures	
Data Analysis	
Data analysis methodology	
Statistical tools and analysis methods	
Conclusion	
Results obtained	
Interpretation of results in relation to the hypothesis	
Acceptance or rejection of the hypothesis	
Publication and Replication	
Summary of conclusions	
Suggestions for future studies or replications of the experiment	

Defining validation scientific protocol

After defining the steps of the scientific approach collectively, reform the groups from the first phase in order to **develop a scientific protocol to address the subjects and commonplaces that each team had previously analyzed**.

Start by gathering the groups and explain to them that they will initially work **without internet access for the first 20 minutes**. This will encourage them to use their prior knowledge and discuss among themselves to formulate initial ideas, particularly hypotheses.

After the first 20 minutes, the groups will be able to access the internet to **research more specific elements and complete their protocol**. They can use this resource to refine their hypotheses, design more rigorous experiments, and collect relevant data.

Each group must ensure that their protocol is **detailed and follows the steps of a real and structured scientific approach**. They will need to precisely describe the observed phenomenon, formulate specific questions, propose testable hypotheses, and design experiments with controlled variables.

Reminder: The protocols proposed by the students are not intended to be implemented so students can explore complex and rich solutions. However, if simple and feasible protocols emerge, don't hesitate to consider an additional step to implement these experiments.

Conclusion & Further Reflexion

To conclude this phase and promote reflection on learning outcomes, it is important to conduct a collective discussion with the students. Invite each group to present their scientific protocol to the class. Encourage students to explain each step of their approach, from initial observation to formulating hypotheses and designing experiments. After each presentation, facilitate a collective discussion where other groups can ask questions, provide constructive feedback, and suggest potential improvements. You can guide the discussion through the following questions:

- **How did you formulate your hypotheses and what were the bases for these hypotheses?**
- **What criteria did you use to design controlled and reliable experiments?**
- **How did the group discussion help refine your protocol?**
- **What are the essential elements of a rigorous scientific protocol that you learned during this phase?**
- **How could you improve your protocol if you had more time or resources?**

Provide constructive feedback on the presented protocols, highlighting well-executed aspects and suggesting possible improvements, particularly to prepare for the next phase (optional)

Step 3 - Disseminating scientific culture (optionnal)

Background and description of the problem to be solved in this step: This final phase aims to address the issue of scientific popularization with students. By developing their skills in scientific communication, students will not only strengthen their own understanding of the concepts covered, but also contribute to a wider dissemination of scientific culture within their community.

Learning Objectives: Learn to popularize and present scientific facts in a clear and understandable manner. Develop skills in scientific communication and pedagogy. Raise awareness among students about the importance of scientific rigor in fact-checking. Encourage informed and responsible citizenship.

Conceptualisation

Scientific popularization is essential in the fight against commonplaces and pseudo-sciences, as it makes scientific knowledge accessible and understandable to all. By clearly explaining scientific facts and methods, students participate in promoting a better-informed and more critical society. This is crucial for an enlightened citizen approach, as well-informed citizens are better equipped to make responsible decisions and contribute positively to society. By demystifying misconceptions and promoting verifiable facts, students help build an environment where scientific truth is valued and decisions are based on solid evidence.

Scientific popularization must be accurate, accessible, and engaging. Students will discover that infographics and videos are effective tools for disseminating scientific information. The presentation of facts must be structured, argued, and based on solid evidence. It is essential to make scientific concepts understandable to a non-specialized audience while maintaining the rigor and accuracy of the information.

Among the famous science communicators who do remarkable work with citizens, particularly young people, we can mention personalities like Neil deGrasse Tyson, an American astrophysicist who often uses humor and simple analogies to explain complex concepts. New media also play a crucial role in this popularization work. Platforms like YouTube, podcasts, and social networks allow reaching a wide audience quickly and interactively. For example, YouTube channels like "Kurzgesagt – In a Nutshell" use graphic animations to explain scientific ideas in a visually appealing and easy-to-understand way. These new formats allow capturing young people's attention and providing them with knowledge in a fun and engaging manner.

Students Investigation

To start this phase well and bring dynamism, you can introduce students to several productions by different science communicators, particularly those adapted to a young audience. Propose several resources (podcasts, YouTubers, animated infographics) to collectively analyze the techniques used by these popularizers to make information accessible and engaging. This analysis will allow them to draw inspiration from best practices and improve their own communication methods.

Once this discovery phase is complete, invite students to reflect on the best ways to present their fact-checking protocols. This may include creating visual aids, such as infographics and explanatory videos. Encourage them to use digital tools like Canva (Canva exists in a free format for teachers) for infographics and even for videos (the tool is quite easy to use, with examples and image banks), Genially or video editing software such as Animaker. Choose a tool you are comfortable with to facilitate students in their creations. **Examples of tools and associated features are available in the "Going Further" section of this protocol.**

In groups (identical to the previous phases), students can then create their **infographics**. They will include graphs, explanatory diagrams, and statistics to illustrate the facts in a visual and engaging manner. Subsequently, they can produce short videos explaining their discoveries, using storytelling and visualization techniques to make the information attractive and easy to understand.

Finally, encourage students to **share their work beyond the classroom**. For example, they could organize an exhibition within the school, present their projects during an open house, or even publish their work on the school's website or on a **dedicated YouTube channel**. These initiatives will help raise awareness among a wider audience about the importance of fact-checking and the scientific approach.

Conclusion & Further Reflexion

To conclude this phase, lead a collective discussion with students on the importance of disseminating scientific knowledge. Organize presentation sessions where each group of students can showcase their work in front of their peers. These sessions will allow for exchanges on the different approaches and methodologies used, while developing students' public speaking skills. Encourage students to use simple and direct language, explain technical terms, and illustrate their points with concrete examples. After each presentation, facilitate a collective discussion where other groups can ask questions, provide constructive feedback, and suggest potential improvements.

Discuss with students the ethical responsibilities related to scientific communication, particularly the importance of objectivity, transparency, and rigor. Encourage them to consider how they can continue to use these skills in their daily lives to become informed and responsible citizens.

By following this dissemination phase, students will become ambassadors of scientific culture. By giving them the tools to effectively communicate their discoveries, you contribute to creating a more informed and critical community, capable of navigating a complex and interconnected world.

Explore design and creative digital tools

Canva

Creation of graphics, videos, infographics... with real-time collaboration

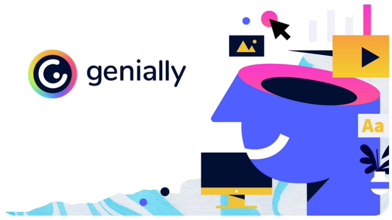
Resources provided: Images, graphics, videos, audio elements

Accessibility: Very accessible

Free features: Access to thousands of templates, basic graphic elements, limited cloud storage

Education Plan available freely for teachers

Genially



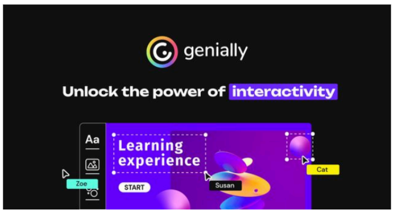
Creation of interactive presentations, infographics, games, animated content

Resources provided: Images, graphics, animations

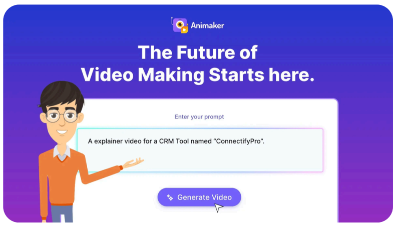
Accessibility: Accessible

Free features: Access to basic templates, limited interactive features, public publications

Reduce fee for professional account access for educators



Animaker



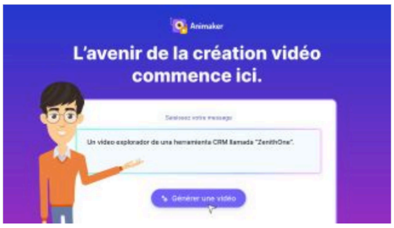
Creation of animated videos, video infographics, video presentations, animated GIFs

Resources provided: Images, graphics, audio elements, animations

Accessibility: Moderately accessible

Free features: SD video export, limited access to resources, watermark on videos

No plan for education



Powtoon

Creation of graphics, presentations, videos, infographics, real-time collaboration

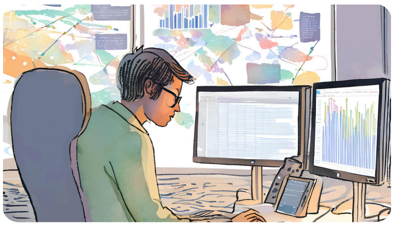
Resources provided: Images, graphics, audio elements, animations

Accessibility: Accessible

Free features: SD video export, limited access to resources, watermark on videos

Reduce fee for professional account access for educators

Piktochart



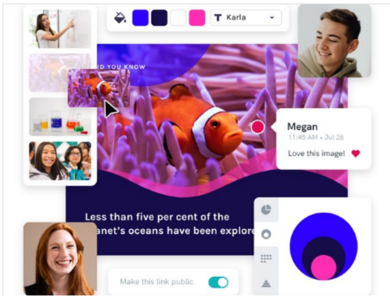
Creation of infographics, presentations, reports, posters

Resources provided: Images, graphics, icons

Accessibility: Very accessible

Free features: Access to basic templates, limited export to certain formats, limited storage

Reduce fee for professional account access for educators



Freepik & Flaticon

Access to free and premium design resources, icons, and illustrations

Resources provided: Images, icons, illustrations

Accessibility: Very accessible

Free features: Free access to basic resources with attribution

No plan for education

https://www.freepik.com

https://www.flaticon.com

Ideas of Complementary Projects

Launch a school debunking club for students & teachers

Create a group where students regularly analyze viral news or videos, apply the scientific method to verify their accuracy, and share findings with peers through presentations or posters.

Create a class blog or a dedicated YouTube channel

Guide students to produce articles, explanatory videos, or infographics to communicate their findings to a broader audience in a simple and engaging way.

Collaborate with local institutions for science projects

Partner with nearby universities, museums, or science centers to organize student visits, workshops, or joint activities, making research and outreach accessible.

Implement interdisciplinary student projects

Connect science students with language students to translate and verify international information or with art students to create appealing visuals for science content.

Organize a school-level science communication event

Challenge students to present their fact-checking work or research projects to classmates and teachers through creative formats like videos, posters, or short talks.

Facilitate problem-solving workshops with the community

Encourage students to tackle local issues using scientific methods, such as measuring pollution levels or analyzing public health trends, and propose actionable solutions.

Bibliography

Books and Guides:

- **"The Skills of Argument" by Deanna Kuhn**
  Explores the development of informal reasoning and argumentation skills, emphasizing their role in critical thinking.
- **"Education for Thinking" by Deanna Kuhn**
  Discusses strategies to teach students how to think critically and engage in thoughtful inquiry.

Scientific Articles:

- **"Improving Students' Scientific Thinking"**
  This chapter offers a framework for understanding and teaching scientific thinking, highlighting its essential aspects and developmental origins. **Cambridge University Press**
- **"Teaching Nature of Science Through a Critical Thinking Approach"**
  Discusses why and how the nature of science should be taught critically in schools, proposing critical thinking as a framework for addressing this. **Springer Link**
- **"Teaching Critical Thinking and Why It Matters: A Transdisciplinary Pedagogy for Teaching Critical Thinking"**
  Outlines a theoretical and practical approach to teaching critical thinking, developed by the University of Queensland Critical Thinking Project. **Academia**
- **"The Scientific Method: Critical Thinking at its Best"**
  An educational video that delves into the scientific method and its role in fostering critical thinking skills. **Grand Canyon University**

Projects and resources:

- **"Fact-Check It!" by the News Literacy Project**
  A classroom activity video where students learn digital verification skills to fact-check and analyze viral rumors. **News Literacy Project**
- **"FactBar EDU: Fact-Checking for Educators and Future Voters"**
  A Finnish initiative adapting professional fact-checking methods for school environments, encouraging critical thinking among students. **Faktabaari**
- **"Tackling Disinformation and Promoting Digital Literacy"**
  Guidelines providing hands-on guidance for teachers on promoting digital literacy and countering disinformation. **Learning Corner**
- **"Fact-Checking Academy: A Helping Hand for Teachers in Fighting Disinformation"**
  An initiative offering resources and methodologies for teachers to develop students' critical thinking skills and counter misinformation. **Media and Learning**
- **"Four Ways to Teach the Scientific Method" by Science Buddies**
  Provides free resources to help teachers instruct the scientific method with tools and examples suitable for the classroom. **Science Buddies**
- **"Fact-Checking and Fake News Lesson Plans: The Ultimate Teacher Guide"**
  Offers lesson plans and fact-checking tips to help students assess online sources for authenticity. **BookWidgets**

Debunking Channels adapted to Youth:

- **SciShow**
  This channel dives into fascinating science topics and debunks myths in a clear, engaging, and age-appropriate way. Great for curious teens exploring misconceptions in science. **Visit SciShow on YouTube**
- **Veritasium**
  An educational channel that challenges misconceptions in science and explains complex topics in a fun, visual, and accessible manner for teens. **Visit Veritasium on YouTube**
- **AsapSCIENCE**
  Focused on explaining the science behind everyday phenomena and debunking popular myths with animations

and easy-to-follow explanations. **Visit AsapSCIENCE on YouTube**

- **MinutePhysics**
  This channel uses simple animations to explore science concepts and debunk myths, making it ideal for secondary school students. **Visit MinutePhysics on YouTube**
- **It's Okay To Be Smart**
  A mix of curiosity-driven content that tackles science myths, debunks misconceptions, and helps students better understand the world. **Visit It's Okay To Be Smart on YouTube**
- **BrainCraft**
  A science channel that focuses on psychology, neuroscience, and debunking pseudoscience in an engaging way suitable for teens. **Visit BrainCraft on YouTube**
- **Crunch Labs**
  Led by former NASA engineer Mark Rober, this channel debunks myths and explains science with hands-on experiments and creative challenges. **Visit Crunch Labs on YouTube**
- **MythBusters Jr.**
  A spin-off of the popular MythBusters series, featuring teens applying scientific methods to test and debunk myths. **Visit MythBusters Jr. on Discovery+**
- **Debunking Myths**
  Dedicated to uncovering the truth behind popular myths and misconceptions across various topics, including science. **Visit Debunking Myths on YouTube**
- **Science Myths Debunked**
  Focused on dispelling falsehoods in science, this channel illuminates reality by addressing common myths and misconceptions. **Visit Science Myths Debunked on YouTube**

Appendix. Examples of myths

Spinachs contain a high quantity of iron

Spinach contains iron, but not in exceptional quantities. The origin of this belief comes from a decimal point error in a 19th-century study. Spinach contains about 2.7 mg of iron per 100 g, which is less than lentils or beans.

https://www.researchgate.net/publication/331556841_Spinach_in_Blunderland_How_the_myth_that_spinach_is_rich_in_iron_became_an_urban_academic_legend

We are only using 10% of our brain

Brain imaging techniques, such as functional MRI, show that almost all parts of the brain are active at different times, even during sleep. No area is completely inactive.

https://www.psychologicalscience.org/uncategorized/myth-we-only-use-10-of-our-brains.html

Sugar makes children hyperactive

No solid scientific evidence supports this claim. Controlled studies show that sugar has no effect on children's behavior or cognitive performance. Parents' expectations and the context of consumption (parties, etc.) often influence this perception.

https://edition.cnn.com/2019/04/18/health/sugar-hyper-myth-food-drayer/index.html

https://jamanetwork.com/journals/jama/article-abstract/391812

Hair and nails continue to grow after death

Guide students to produce articles, explanatory videos, or infographics to communicate their findings to a broader audience in a simple and engaging way.

https://www.bbc.com/future/article/20130526-do-your-nails-grow-after-death

Lightning never strikes the same place twice

Lightning frequently strikes the same place multiple times, especially tall structures like skyscrapers and towers. For example, the Empire State Building is struck by lightning about 25 times a year. Tall and isolated points on Earth are preferred targets.

https://www.britannica.com/story/can-lightning-strike-the-same-place-twice

Eating carrots improves night vision

Carrots contain vitamin A (in the form of beta-carotene), which is essential for vision. However, they do not specifically improve night vision beyond normal needs. This idea was popularized by a propaganda campaign during World War II to hide the use of radar by British pilots.

https://www.sciencefocus.com/the-human-body/do-carrots-help-you-see-in-the-dark

Antibiotics are effective against viruses

Antibiotics target bacteria, not viruses. Viruses use host cells to reproduce, and antibiotics have no effect on this process. Viral infections require specific antivirals or symptomatic management.

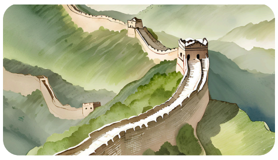
https://www.hopkinsmedicine.org/health/wellness-and-prevention/antibiotics

You can catch a cold exposed to cold weather

Colds are caused by viruses (rhinovirus, coronavirus, etc.), not by cold weather. However, cold weather can weaken the immune system and make a person more susceptible to viral infections. Confinement indoors during cold months can also facilitate the spread of viruses.

https://www.bupa.co.uk/newsroom/ourviews/cold-weather-illness#:~:text=Put%20simply%2C%20cold%20weather%20alone,viruses%2C%20which%20cause%20these%20illnesses.

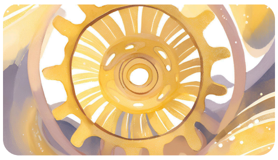
The Great Wall of China can be visible from space



The Great Wall of China is not visible to the naked eye from space without visual aid. It is too thin and blends in with its natural surroundings. NASA astronauts have confirmed that the wall is difficult to distinguish without zoom equipment.

https://www.skyatnightmagazine.com/space-science/can-you-see-great-wall-china-from-space

Perpetual motion machines can produce energy without input



The laws of thermodynamics make it impossible to create a perpetual motion machine. The first law states that energy can neither be created nor destroyed, only transformed. The second law indicates that each energy transfer increases entropy, which implies inevitable energy losses.

https://www.nutshellapp.com/publicsummaries/debunking-the-myth-of-perpetual-motion-machines#:~:text=The%20first%20law%20of%20thermodynamics,producing%20free%20and%20infinite%20energy

The Coriolis effect influences the direction of water in a sink

The Coriolis effect influences large-scale systems like ocean currents and atmospheric winds, but it is too weak to affect the flow of water in a sink. The direction of flow is determined by the shape of the basin and the initial movement of the water.

https://science.howstuffworks.com/science-vs-myth/everyday-myths/rotation-earth-toilet-baseball2.htm

Humans have five senses (sight, hearing, taste, smell, touch)

Humans possess far more than five senses, including abilities such as equilibrioception (sense of balance), thermoception (sense of temperature), nociception (sense of pain), and proprioception (perception of body position and movement). Neuroscience and sensory biology have identified many other sensory systems.

https://medium.com/@joelhuff_54303/the-five-senses-myth-f54c4ca6b09f

Goldfish have 3-second memory

Goldfish can remember things for months. Studies have shown that they can be trained to respond to different stimuli and remember complex tasks. For example, they can learn to navigate a maze or recognize certain visual signals.

https://www.rsb.org.uk/biologist-opinion/three-second-memory-sounds-fishy#:~:text=The%20most%20well%2Dknown%20%27fact,has%20been%20debunked%20many%20times

Flu vaccines can give you the flu

The flu vaccine uses inactivated or attenuated viruses that cannot cause the flu. Mild symptoms after vaccination (pain at the injection site, mild fever) are normal immune reactions and not the flu itself.

https://www.who.int/news-room/spotlight/influenza-are-we-ready/5-myths-about-the-flu-vaccine

There is no gravity in space

Gravity exists in space and keeps planets in orbit. Astronauts float because they are in a constant state of free fall around the Earth. This phenomenon is often called "weightlessness" or "microgravity," but it results from gravity continuing to act.

https://www.yalescientific.org/2010/10/mythbusters-does-zero-gravity-exist-in-space/#:~:text=Similarly%2C%20all%20planets%2C%20asteroids%2C,of%20no%20gravity%20in%20space

You shouldn't swim after eating

There is no solid scientific evidence that swimming after eating is dangerous. Muscle cramps can occur, but they are not directly related to digestion. Moderate physical activity after eating is generally safe for most people.

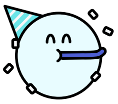
https://www.dignityhealth.org/articles/is-swimming-after-eating-really-dangerous#:~:text=Debunking%20the%20Myth&text=Swimming%20right%20after%20you%27ve,severe%20that%20you%20could%20drown

Appendix. Printable Forms

You will find below the two forms used in this protocol with the objectives of:

1. Analysing the resources provided in terms of credibility, fact checking and reliability enabling the approach to the following concepts:

- **Diversity of sources:** Multiple independent sources help verify facts and reduce biases. Cross-checking by different experts enhances data veracity. Evaluating source reliability is crucial; look for recognized authors with peer-reviewed work and established credibility. Checking institutional affiliations and past contributions aids in assessing reliability.
- **Coherence and clarity of presentation**: Clear presentation is crucial for understanding the verification process.It aids in communicating results and allows researchers to replicate steps. Well-structured information is easier to analyze and compare, enhancing credibility.
- **Objectivity and neutrality of the source:** It ensures information is free from personal, financial, or ideological bias. Objective sources present impartial facts based on empirical evidence, crucial for scientific credibility. Recognizing potential biases is important; seek sources that disclose conflicts of interest and follow ethical standards.



2. Developing a scientific experiment or protocol enabling the validation of hypotheses based on the commonplaces and myths which will be analysed. This form helps students to position themselves in the scientific approach, ensuring:

- **Rigor**: refers to the precision and accuracy with which research or an experiment is conducted. A rigorous approach minimises errors and biases, thus ensuring that the conclusions drawn are robust and based on solid data.
- **Transparency**: involves making all steps of a research or experimentation process clear and accessible. Transparency allows other researchers to understand exactly how results were obtained, reproduce experiments, and verify the integrity of conclusions.
- **Reproducibility**: is the ability of research or an experiment to be reproduced by other researchers following the same methods and conditions. Reproducibility is a pillar of the scientific method, as it allows verification that discoveries are not the result of chance or biases specific to the initial researcher.

Date: .../.../......

Group: ....

Subject analyzed: ....

Analysis of the Information Source	
Source title:	
Author:	
Publication date:	
Type of source (article, video, image, etc.) :	

Content Analysis	
Content summary	
Hypothesis(es) formulated by the source	
Methodology used in the source	

Source Credibility - *Answer Yes or No and Justify*	
Is the author recognized and credible?	
Is the source published by a recognized institution?	
Does the source cite reliable research or sources?	

Fact Checking - *Answer Yes or No and Justify*	
Are the presented facts verifiable?	
Are the facts supported by empirical evidence?	
Is the methodology rigorous and reproducible?	

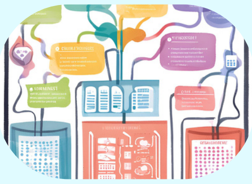
Evaluation Criteria - *Answer Good, Average or Poor and Justify*	
Diversity of sources	
Perception of the coherence and clarity	
Perception of the objectivity and neutrality	

Conclusion	
Is the source perceived as reliable and why?	
Improvements can be made to the methodology	
How does this analysis influence your perception of the subject?	

Date: .../.../......

Group: ....

Subject analyzed: ....



Observation - Precise description of the observed phenomenon or problem

Question - Formulation of the specific question to explore

Hypothesis - Proposal of a testable and verifiable hypothesis

Experimentation	
Description of the experiment	
Controlled variables	
Comparison groups	
Detailed procedures	

Data Analysis	
Data analysis methodology	
Statistical tools and analysis methods	

Conclusion	
Results obtained	
Interpretation of results in relation to the hypothesis	
Acceptance or rejection of the hypothesis	

Publication and Replication	
Summary of conclusions	
Suggestions for future studies or replications of the experiment	