ENGLISH FOR SCIENCE COMMUNICATION

Student's book

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Scope and Sequence

UNIT	Lesson Outcome	SciComm Lexis	Reading
1 **WHAT IS SCIENCE COMMUNICATION?**	Understand the foundations and importance of science communication	*deficit model, dumbing down, impact, information overload, inspiration, ivory tower, outreach, scientific literacy, popularization, dissemination, lay society, public awareness of science (PAwS), participation*	The Golden Age of Science Communication
2 **KNOW YOUR AUDIENCE**	Tailor your message to the knowledge level, interests, and concerns of your audience	*accessibility, attitude, audience interests, barrier, cultural intelligence, culturally relevant, empathy, focus group, intentionality, jargon, (prior) knowledge, plain language, worldview*	Analysing science communication
3 **BUILD TRUST AND PROMOTE CRITICAL THINKING**	Foster credibility through transparency, evidence-based communication, and encouraging inquiry	*accountability, accuracy accessible, appeal, backfire effect, cherry-picking, churnalism, cognitive bias cognitive dissonance, consensus, conspiracy credibility, critical thinking echo chamber, ethical honesty, prebunking, transparency*	Why Some People Don't Trust Science – and How to Change their Minds
4 **TELL A STORY**	Use stories and storytelling techniques to make science interesting and engaging	*analogy, callback, character, hero, metaphor, narrative, narrative arc, relatable, rising action, storyboard, villain, climax, denouement, exposition, genre, plot twist, protagonist, setting*	Narrative warmth and quantitative competence
5 **MAKE IT VISUAL**	Use visual communication to enhance and simplify your message	*animation, balance, colour palette, contrast, creativity, data visualization, figure, font, icon, infographic, layout, legibility, proportion, SciArt, STEAM, table, visual story*	Mixing Science and Art to Make the Truth More Interesting than Lies

Watch and Listen	SciComm Skills	Communicative Activity	Video Project
What is Science Communication? - The EU Guide to Science Communication	Identifying the purpose and intended outcome of the communication	Explaining scientific concepts	Selecting a research topic and defining your goal
How people see science	Understanding words with different meanings in science and everyday language	Jargon-busting	Creating a profile of a typical audience member
Science's Dark Side: 10 Science Secrets That Destroyed Public Trust!	Identifying cognitive biases	Creating a safe space for discussing controversial issues	Framing and call to action (CTA)
Talk Nerdy to Me	Following a narrative arc	Telling a personal anecdote	Scriptwriting and storyboarding
Infographics	Creating an infographic	Sci-Art exhibition	Video assembly and editing

1
WHAT IS SCIENCE COMMUNICATION?

Lesson outcome: Understand the foundations and importance of science communication.

Lead-in

If you enjoy watching documentaries, reading popular science books, attending science festivals, visiting museums, or following scientists on social media, then you are actively engaging with science communication.

1 Work in groups. Discuss these questions:

1 How do you find out about science and technology outside your specialist field?
2 Can you name any famous science communicators working in English or other languages?
3 Discuss an instance of science communication that you feel was particularly memorable. What do you remember about it?

Watch and Listen EU Guide to Science Communication

2 Watch a video from the EU Guide to Science Communication.[1] Find out who the speakers are and what topics are covered in the video.

3 Listen to the speakers again. Then answer these questions:

1 What does the first speaker say "doesn't wash it any more"?
2 Why does the second speaker say scientists "need to sell" what they are doing?
3 What is the difference, formalized in the (EU Horizon 2020) Grant Agreement, between "dissemination" and "communication"?

SciComm Lexis

4 Match the definitions (A–J) to the words in the box.

impact, inspiration, ivory tower, outreach, popularization, scientific literacy, lay society, participation, dissemination, deficit model

A Activities that engage and educate the public on scientific topics.
B The significant effects of scientific research on society.
C Sparking interest and curiosity.
D A metaphor for academic isolation from the real world.
E The ability to find, understand, and apply scientific information.
F Making science accessible and engaging to the public.
G Spreading scientific information widely.
H An approach to science communication which assumes that the public lacks scientific knowledge.
I Involvement in science-related activities.
J The general public without specialized scientific training or expertise.

5 Use the terms from Exercise 4 to complete these sentences:

1 Science fairs are excellent for encouraging _____ in science and engagement with scientists.
2 University scientists are often criticized for staying in an _____ and not engaging with the public.
3 The _____ of new research is commonly achieved by publications in professional academic journals and presentations at specialist conferences.
4 Successful _____ efforts can boost public interest in scientific fields.
5 Science communication that showcases research can provide _____ to the next generation of scientists.
6 Developing _____ is crucial for informed decision-making in daily life.
7 Effective science communication bridges the gap between experts and _____.
8 The _____ of science involves making complex topics more relatable to non-experts.
9 A key goal of science communication is to amplify the _____ of research beyond academia.
10 In the _____, scientists assume that the public is simply uninformed and needs experts to fill the gaps in their understanding.

6 Work in groups. Respond to these questions:

1 I'm a member of the public. What are the benefits of science communication for society?
2 I'm a scientist. How can science and scientists benefit from increased science communication?
3 I'm not a scientist. How can learning about science communication benefit me in my career?

SciComm Skills Identifying the purpose and intended outcome of the communication

The AEIOU framework[2] highlights five key responses that effective science communication can elicit:

A – Awareness of science, including about specific scientific issues or advances.

E – Enjoyment and appreciation for science, e.g. as entertainment or art.

I – Interest in science, encouraging individuals to explore scientific topics further.

O – Opinion-forming, developing positive attitudes towards science and science-related topics.

U – Understanding science topics and processes.

7 Which of the five responses in the AEIOU framework do you think is the main intended outcome of these science communication interventions?

- Public service announcement (PSA)
- Science policy briefing
- Science fiction
- Science fair
- Health warning on cigarette packaging

8 Think of real-life examples of science communication. Which responses from the AEIOU framework were they trying to elicit? Were they successful? Why?

Reading A Golden Age of Science Communication

9 Read the article. Then answer these questions:

1 Why were scientists traditionally discouraged from communicating with the public?
2 What is the main difference between the way science communication is practiced today and in its early years?
3 Why is science communication more important than ever?
4 Why is this a 'golden age' for science communication?
5 What challenges remain for science communicators?

10 Replace the words in italics with 1–3 words from the text with a similar meaning.

1 In the past, there was a *shame* associated with the *popularization* of science.
2 Carl Sagan's Cosmos series from 1980 is considered an *influential and foundational* example of early science communication.
3 The rise of *incorrect and misleading information*, especially during crises like the coronavirus pandemic, has made science communication more crucial.
4 The rapid pace of scientific advancements contributes to *a state of being overwhelmed by the amount of information*.
5 Professional science communication services can help scientists with *the process of generating material for digital platforms*.
6 A crucial skill for scientists is making complex subjects accessible without *oversimplifying*.

Communicative Activity Explaining scientific concepts

Step 1: Preparation

On a scale of 1–5, rate your understanding of the following scientific concepts and your ability to explain them in English:

- Relativity
- Photosynthesis
- Nuclear fusion
- The scientific method
- Genetic inheritance
- Tectonic plate movement
- Cell division (Mitosis and Meiosis)
- Chemical reactions

Scale:

1. Awareness
2. Basic understanding
3. Medium level understanding
4. Good understanding
5. Expert level understanding

Step 2: Partner Matching

Walk around the room and find someone who gave themselves a lower score than you for at least one of the concepts.

Step 3: Explanation and Feedback (10 minutes each)

1 Explain the concept to your partner, making sure not to oversimplify it. Tailor your explanation to match their current level of understanding.
2 After explaining, ask your partner if they have any questions or need further clarification.
- Switch roles and repeat the process with a different concept where your partner has a higher score than you.

A Golden Age of Science Communication

In 2003, John Durant, a pioneer in the field and the founder of the first ever science communication Masters course in the UK, heralded a 'golden age' of science communication in Europe.[3] Engaging with the public had largely shed the stigma of 'vulgarization' and had ceased to be treated as an extraneous distraction from the serious work of research, becoming something that governments, research funders, and elite institutions actively encouraged and valued. With the rapid pace of technological innovation powering social, cultural and economic change, science was attracting the attention of the public as never before, and scientists themselves were becoming increasingly interested in promoting the understanding of their subjects. A huge gap still separated scientists and society, due to the process of specialization that accelerated in the twentieth century. And the public still derived most of its attitudes and understanding of science from the mass media, such as crime series on television, on top of formal education. But there was a general trend towards increased science communication across Europe, and Durant felt positive that such initiatives could make a difference—highlighting the exploding number of science centres.

Twenty years on, it can be argued that science communication has become even more established and embedded in society, influencing public policy, education, and media narratives. Science communication is no longer the preserve of big-budget documentaries like Carl Sagan's seminal *Cosmos* series from 1980, print books and magazines, or physical locations like museums and libraries. It has never been easier to create high quality content, including blogs, videos, and podcasts, which can be easily shared via digital platforms like Facebook and YouTube. Social media also give unprecedented possibilities for dialogue between scientists and the public, which has become an important dimension for modern science communication. This has moved science communication beyond the lingering 'deficit model' that reinforced separation between the 'experts' and a 'deficient' public, lacking knowledge. Citizen science projects and festivals also invite public participation in scientific activities.

At the same time, however, there has been a collapse of trust in traditional media. Misinformation and disinformation are on the rise, with conspiracy theories flourishing during the coronavirus pandemic. Recent developments in AI are fuelling the production and spread of fake news.

Scientists seem uniquely positioned to stem the flood. According to a survey on 'European citizens' knowledge and attitudes towards science and technology' published in 2021,[4] 61% of EU citizens think scientists working in the public sector are most qualified to explain the impact of scientific and technological developments—in stark contrast to how journalists are viewed (16%). The vast majority of EU citizens (86%) think that the overall influence of science and technology is positive. They also express a high level of interest in science and technology (82%). When asked in which areas research and innovation can make a difference, respondents most often mention health and medical care and the fight against climate change.

Communicating about science with public audiences, however, poses several perennial challenges. There isn't a single, homogenous audience, which can be the target of a single, univocal message. People have varying backgrounds and levels of understanding. Scientific methods and concepts can be hard to simplify without losing accuracy—so-called "dumbing down". The pace of scientific progress means that there is information overload, and it is hard to keep up with the latest developments in science and technology. Clear messaging can be especially difficult when the science is controversial or there is substantial disagreement about the findings within the scientific community.[5]

Communicating with the public requires a broad tool-kit of skills, encompassing writing, public speaking and presenting, collaborating and active listening, as well as, increasingly, technical skills such as graphics creation, sound editing and video editing. An often overlooked aspect is the need for scientists to communicate in a foreign language—which may for many be English, the predominant language of science and international communication. However, there are also clear benefits to being able to communicate with publics in multiple languages.[6]

Luckily, science communication has itself become a fertile field of research. Since the early 1990s, there has been a considerable increase in the number of scientific studies on science communication.[7] Drawing on the disciplines of psychology, sociology, public relations and communication studies, among others, this research provides evidence-based strategies for science communication and data assessing its impact. The 'science of science communication' has gradually evolved to become a separate specialism itself. In addition, there is a diverse group of professional science communicators working to help scientists with content creation, and to acquire the necessary communication skills for themselves.[8] There is more work needed, to bridge the gap between research and practice, and make science communication training and services available more widely. But the benefits not only to society but also to science itself should be worth it.

We may well be living in a 'golden age' of science communication. But science communication is also more important than ever.

Step 4: Reflection and Group Discussion (10 minutes)

After completing the explanations, gather as a group and discuss the following:

- What strategies did you use to explain the concepts clearly?
- What challenges did you encounter while explaining?
- How did you ensure that your explanation was neither too simple nor too complex?

| Video **Project** Selecting a research topic and defining your goal

Video platforms like YouTube have become important ways to share information, including about science.[9]

In this project, you will present the latest research on a topic of your choice in an engaging video.

The project is divided into six key steps:

1. Selecting a research topic
2. Creating a profile of a typical audience member
3. Framing and call to action (CTA)
4. Scriptwriting and storyboarding
5. Video assembly and editing

Let's get started with the first step.

1 Brainstorm ideas:

- Think about recent scientific articles, news reports, or trends in science that have caught your attention.
- Consider topics within your field of study or areas you are passionate about.

  Example Topics:

  - The impact of climate change on polar ice caps
  - Advances in gene editing technology
  - The role of artificial intelligence in healthcare
  - Conservation efforts for endangered species
  - The science behind renewable energy sources

2 Conduct preliminary research:

- Perform a quick search to ensure there is enough recent research and information available on your chosen topic.

3 Define you goals.

- Identify the main purpose and intended outcome of your video. Use the AEIOU framework you learned about in this unit.

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Credits

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2
KNOW YOUR AUDIENCE

Learning objective: Tailor your message to the knowledge level, interests, and concerns of your audience.

Lead-in

Understanding your audience is a crucial first step in planning your science communication strategy.[1] Audiences have different values, beliefs, and attitudes due to diverse cultural backgrounds, personal experiences, and educational levels.

1 Work in groups. Discuss these questions:

1 Think about two people who agree on some issue. What else do they have in common?
2 Think about two people who disagree on some issue. How else are they different?

Watch and Listen How People See Science

2 Watch a video produced by a team of interns at the University of Melbourne (Australia) in 2012.[2]

1 Note the questions asked in the interview.
2 Describe the demographics of the interviewees (e.g. age, gender, ethnicity, education level, occupation, socioeconomic status, and other relevant attributes).

3 Listen again. Then answer these questions:

1 What is the general attitude of the speakers towards science (negative, positive, or ambivalent)?
2 What do the speakers value most about the impact of science in their lives?
3 Which of these opinions (a–e) do they express?
   a) Science reporting should be unbiased.
   b) It's important to hear from the experts.
   c) The public needs to be given more awareness and knowledge about science.
   d) The public should be involved more in scientific discussions and debate.
   e) There is too much information about science.

4 Answer the questions from the interview. Reflect on your own values, beliefs, and attitudes.

SciComm Lexis

5 Match the definitions (A–J) to the words in the box.

accessibility, attitude, audience interests, barrier, cultural intelligence, culturally relevant, empathy, intentionality, (prior) knowledge, worldview

A A person's feelings or beliefs that influence how they perceive, engage with, and react towards ideas, objects, people, or situations.
B Any obstacle that prevents effective communication of scientific information, such as language differences, technical complexity, or preconceived notions.
C The pre-existing understanding or information that an audience has about a topic, which shapes how they interpret new information.
D The ability to recognize, understand, and adapt to cultural differences.
E The ease with which diverse audiences can understand and engage with scientific information, often considering factors like language and format.
F The frame through which an individual or group interprets and interacts with the world, including their beliefs about science and its role in society.
G Tailored to resonate with the cultural values, norms, and practices of a specific audience.
H The capacity to understand and share the feelings and perspectives of the audience.
I The specific topics or aspects of science that capture the attention and curiosity of a particular audience, guiding the focus of communication efforts.
J The deliberate and purposeful planning and execution of science communication to achieve specific goals, such as educating the public or influencing behaviour.

6 Work in pairs. Test each other.

Student A: Read the definitions A–E.
Student B: Read the definitions F–J.

Reading Analysing science communication

7 Choose a recent scientific news article and analyse it using the terms from Exercise 5. Answer these questions:

1. **Accessibility:** How accessible is the article to a general audience? Consider language, format, and physical access.
2. **Attitude:** What attitudes towards science does the article seem to assume or promote?
3. **Audience Interests:** What specific audience interests does the article address?
4. **Barriers:** Identify any barriers that might prevent certain audiences from understanding the article.
5. **Cultural Intelligence:** How well does the article recognize and adapt to cultural differences?
6. **Culturally Relevant:** Is the article culturally relevant to its intended audience? How?
7. **Empathy:** Does the article demonstrate empathy towards its readers? Provide examples.
8. **Intentionality:** What seems to be the intentionality behind the article? What goals does it aim to achieve?
9. **(Prior) Knowledge:** What prior knowledge does the article assume the reader has?
10. **Worldview:** What worldview does the article reflect or challenge?

SciComm Skills Understanding words with different meanings in science and everyday language

The words scientists use can have unintended meanings and emotional associations for non-scientists. Understanding these differences is important to avoid confusion and ensure clear communication.[3][4]

8 Read the list of words in Table 1, with scientific definitions and everyday meanings and associations.

- Notice how the differences could lead to confusion or misunderstanding.
- What strategies could you use to avoid ambiguity?

9 Give scientific definitions of the remaining words on the list, and consider their everyday meanings and associations.

10 Think of other terms that have different meanings and associations in science and everyday language.

Communicative Activity Jargon-busting

Jargon refers to technical vocabulary that is specific to a profession or field. Using jargon can reduce people's ability to process scientific information, increase resistance to persuasion, and lower support for technology adoption.[5]

11 Work in groups. Read these jargon-filled descriptions of common objects. Try to guess the objects being described and write your guesses in the spaces provided.

1 _____

This manually operated device, typically constructed from an elastomeric compound, utilizes differential pressure and volumetric displacement to expel obstructive materials from fluid conveyance systems.

2 _____

This extendable and collapsible apparatus, composed of multiple rigid linear elements, facilitates vertical locomotion and access to elevated planar surfaces via sequential elevation steps.

3 _____

This handheld tool, consisting of a fixed blade and ergonomic handle, employs mechanical leverage to sever or bisect substrates through applied force directed along the cutting edge.

4 _____

This portable electronic gadget harnesses electrochemical energy stored within a compact cell to produce photonic emissions via a solid-state semiconductor source for visibility in low-light environments.

5 _____

This insulated vessel, often featuring a vacuum-sealed double-walled construction, preserves the thermal state of liquid contents by minimizing conductive, convective, and radiative heat transfer.

6 _____

This elongated, flexible material, coated with a pressure-sensitive adhesive on one side, is used to join or repair surfaces by forming a temporary or permanent bond when pressed into place.

7 _____

This peripheral device facilitates user interaction with digital systems by converting manual keystrokes into corresponding electronic signals for data entry and command execution.

8 _____

This personal safety device, often constructed from multiple layers of fibrous material, filters airborne particulates and contaminants to provide respiratory protection in environments with compromised air quality.

9 _____

This handheld device, typically comprising a handle and a series of flexible or semi-rigid bristles, is designed to dislodge particulate matter from surfaces through mechanical friction and sweeping motions.

10 _____

This vessel features an ergonomically designed handle, a spout for precise liquid dispensation, and often a perforated insert for the infusion of botanical extracts. It is employed to steep and dispense heated aqueous solutions, predominantly for the preparation of *Camellia sinensis* infusions.

Table 1. Words with different meanings and associations in science and everyday language.

Words	Scientific Definitions	Everyday Meanings and Associations
Theory	An idea developed over years of experiments, fact collection, and data synthesis	A hunch or speculation without substantial evidence
Significant	Statistically meaningful results that are unlikely to have occurred by chance	Important or noteworthy
Model	A simplified representation or simulation of a system used to explain and predict its behaviour	A person who displays clothing, or an ideal to be imitated
Control	A standard for comparison in an experiment, unaffected by the experimental treatment	To exercise authority or influence over something
Work	The product of force and the distance over which it acts	Tasks or activities one engages in, often for employment
Radical	An atom, molecule, or ion that has an unpaired valence electron	Extreme, fundamentalist, or revolutionary.
Element	A substance that cannot be broken down into simpler substances by chemical means	A part or aspect of something larger, especially one that is essential or characteristic
Stress	The force per unit area applied to a material	Mental or emotional strain resulting from demanding circumstances
Well	An energy minimum	A deep hole filled with liquid (usually water or oil).
Basic	A substance with a pH greater than 7.	Simple, fundamental, or essential.
Positive feedback		
Tolerance		
Conductor		
Organic		
Error		
Noise		
Culture		
Volatile		
Objective		
Benign		

12 Now read these simplified descriptions of the same objects as in Exercise 11. Try again to guess the objects.

1 A piece of rubber on the end of a stick, used to clear blockages in pipes by creating suction pressure.
2 A tool made of several connected steps that can be folded and extended to climb up or down.
3 A tool with a sharp blade and a handle used for cutting things.
4 A small battery-powered device that produces light, commonly used in dark places.
5 A container that keeps drinks hot or cold for a long time, often using a vacuum seal.
6 A sticky strip used to join or repair things.
7 A device with keys that you press to type and input data into a computer or other electronic device.
8 A protective mouth covering that filters the air you breathe to protect you from dust and pollutants.
9 A brush used to sweep dirt and dust from floors.
10 A vessel with a handle, a spout for pouring, and sometimes a built-in strainer. It is used to brew and serve tea.

13 As a group, discuss these questions:

1 How did you feel when you read the jargon-filled descriptions?
2 What made the simplified descriptions easier to understand?
3 How can you learn from this experience?

14 Make a list of specialist words in your field. Make a second list of general words or simple descriptions that might replace them.

15 Analyse your lists using the De-jargonizer, which rates the accessibility of texts, and the Flesch-Kincaid readability scale. Modify your lists if you need to, to make them more professional or accessible.[6]

| Video **Project** Creating a profile of a typical audience member

In this step of the Video Project, your group will create a profile of a typical audience member. This activity is crucial for tailoring your video content to meet the needs and preferences of your intended viewers.

By understanding who your audience is, what they know, and what they care about, you can present the research in a way that is engaging, accessible, and relevant.

This targeted approach will enhance the effectiveness of your communication and ensure that the key messages of the video resonate with your viewers.

16 Identify the target audience:

- As a group, discuss and decide who the primary audience for your video will be. Consider factors such as age, education level, professional background, interests, and attitudes related to the topic of your research paper.

17 Research the audience:

- Gather information about the chosen audience to understand their preferences, knowledge level, and how they consume information. Look for relevant articles and infographics that provide insights into your audience's characteristics.

18 Create an audience profile:

- Develop a detailed profile of a typical audience member. Include the following elements:
  - Demographic information: Age, gender, occupation, education level, etc.
  - Interests and preferences: Hobbies, preferred information channels, topics of interest related to the research paper.
  - Knowledge level: Existing knowledge about the subject, familiarity with technical terms, etc.
  - Motivations and Goals: Reasons for interest in the topic, what they hope to gain from watching the video.
  - Challenges and pain points: Potential difficulties in understanding the content, misconceptions, or barriers to engagement.

19 Use the profile to guide content development:

- Refer to the audience profile throughout the project to ensure the content is tailored to meet their needs and preferences. This will help in making the video more engaging and accessible.

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Further Reading

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Credits

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3
BUILD TRUST AND PROMOTE CRITICAL THINKING

Learning objective: Foster credibility through transparency, evidence-based communication, and encouraging inquiry

Lead-in

Because of the knowledge gap between experts and non-experts, trust is very important in science communication. However, there can also be a risk in trusting science without critical thinking.[1]

1 Work in groups. Discuss these questions:

1 Why do you trust certain people and sources of information more than others?
2 Have you ever shared an opinion or information you later found to be untrue? Why did you trust it?

Watch and Listen Science's Dark Side: 10 Science Secrets That Destroyed Public Trust!

2 You are going to watch a video about factors that are contributing to scepticism and loss of faith in science.[2] First, discuss these questions:

1 What are some reasons you think people might distrust science and scientists today?
2 Have you ever doubted a scientific study or finding? What made you sceptical?

3 Watch the video. How does the choice of stock footage affect your perception of the source?

4 Check you understand these terms from the video:

1 Misinformation and disinformation
2 Poor science communication
3 Replication crisis
4 Conflicts of interest and bias
5 Media sensationalism
6 Scientific complexity
7 Cultural and ideological factors
8 Accessibility of scientific information
9 Perceived elitism
10 Historical mistrust

5 Listen to the audio and take notes. Then discuss these questions:

1 What do you think is the most significant reason for the growing distrust in science? Why?
2 What solutions are proposed to rebuild trust in science?

6 Choose one of the ten reasons for distrust discussed in the audio. Find a recent example or case study that illustrates the issue. Prepare a short talk on your findings.

SciComm Lexis

7 Choose the correct option, a, b, or c.

1 Which term refers to the ethical responsibility for one's decisions and actions?
a) transparency b) honesty c) accountability

2 What is it called when journalists repurpose existing material instead of conducting original reporting?
a) cognitive bias b) churnalism c) prebunking

3 The act of selecting only the data that supports one's argument is:
a) critical thinking b) cherry-picking c) cognitive dissonance

4 Which term describes the quality of being convincing or believable?
a) credibility b) consensus c) accuracy

5 Using plain language, alt-text, and other inclusive practices ensures that information is:
a) accessible b) appeal c) ethical

6 The situation where people are only exposed to opinions that mirror their own beliefs:
a) conspiracy b) backfire effect c) echo chamber

8 Check you understand the meanings of the other options in each question in Exercise 7.

9 Fill in the blanks with words from Exercise 7.

1 The idea that the moon landing was faked is a popular _____ theory that has been debunked multiple times.
2 Individuals may experience a feeling of mental discomfort, known as _____, when they are presented with new information that challenges their current behaviour and beliefs.
3 Communicating levels of scientific _____ (e.g. the percentage of scientists who agree about evolution, climate change, or the safety of GMOs) can shift public opinion toward the dominant scientific opinion.
4 Messages can have both emotional and rational _____.
5 Simply giving people scientific information may not change their attitudes, and can even strengthen their beliefs. This is known as a _____.
6 Most people in the US have high levels of confidence in scientists' _____. A survey showed 84% of respondents trusted scientists to provide the public with trustworthy information.
7 Scientific _____ involves being open and clear about research methods and findings.
8 A _____is a mental shortcut that can influence judgements and decisions.
9 Science communicators should try to anticipate objections and prepare people for misinformation. This is called _____.

Reading Why Some People Don't Trust Science – and How to Change their Minds

10 Read an article published in *The Conversation*.[3] Then answer these questions:

1 What traditional belief about distrust in science was challenged by recent findings?
2 What was identified as a strong predictor for distrust in science during the pandemic?
3 What role does overconfidence play in shaping people's distrust of science?
4 What makes conspiracy theories appealing to some people?
5 Why is it difficult to change the minds of people who are sceptical about science?
6 How can the strategy of clarifying scientific consensus help in science communication?
7 What role does the messenger play in communicating science effectively?
8 What is the 'continued influence effect,' and how does it relate to misinformation?
9 How can emphasizing the provisional nature of scientific results help in science communication?
10 Why does the author mention the debate about PCR tests for COVID?

13

SciComm Skills Identifying cognitive biases

Many pseudo-scientific and sceptical beliefs are based on cognitive biases.[4] Understanding these mental shortcuts can help scientists identify gaps in what people know, understand their doubts, and design more effective communication strategies.[5]

11 Match the cognitive biases and logical fallacies (1–10) to their descriptions (A–J).

1	Bandwagon effect	E | iv
2	False cause	____ | ____
3	Confirmation bias	____ | ____
4	Dunning-Kruger effect	____ | ____
5	Commitment bias	____ | ____
6	Cherry-picking	____ | ____
7	Anecdotal evidence	____ | ____
8	False dichotomy	____ | ____
9	Slippery slope	____ | ____
10	Availability heuristic	____ | ____

A Believing a statement is true because it is advocated by an expert or authority figure, without considering the actual evidence or qualifications of the authority.
B Selecting only data that supports a particular stance or opinion, while ignoring data that contradicts it.
C The tendency to use information that comes to mind quickly and vividly.
D Assuming that two events are causally linked because one follows the other, without sufficient evidence of a causal relationship.
E Believing or supporting an idea simply because it is popular or widely accepted.
F The tendency to overestimate one's competence in a field far above actual ability, especially when the individual is of low ability in that field.
G Presenting two opposing options as the only possibilities, ignoring other viable alternatives.
H Using personal experiences or isolated examples instead of sound arguments or compelling evidence.
I The tendency to seek out and interpret information in a way that reinforces our preexisting opinions.
J Suggesting that a relatively small first step will lead to a chain of related events culminating in some significant impact, often used in argumentation as a fear tactic.

12 Now identify the cognitive biases in these statements (i–viii). There are two biases you do not need.

i "Ever since they passed the new environmental regulations, the economy has been slowing down. These regulations must be bad for business."
ii "Every time I read about a cold wave or a snowstorm, it just proves that global warming isn't a serious issue."
iii "There are a lot of people who say vaccines are linked to autism. There must be some truth to it if so many believe it."

iv "I don't need a bunch of scientific studies to tell me about climate change. I can look out the window if I want to know the weather."
v "Just look at the record snowfall this winter. Doesn't seem like global warming is real to me."
vi "My aunt smoked two packets of cigarettes a day for seventy years. So much for smoking being harmful."
vii "We can either have a strong economy or strict environmental laws. You can't have both."
viii "If we start banning plastic bags, what's next? They'll start telling us we can't buy bottled water or use plastic at all."

13 Discuss these questions:

1 Can you think of any recent situations where you or someone you know fell victim to cognitive biases?
2 How can understanding and recognizing cognitive biases help improve your critical thinking skills and decision-making in everyday life?
3 In what ways can awareness of cognitive biases influence your interactions and communication with others, both personally and professionally?

| **Communicative Activity** Creating a safe space for discussing controversial issues

Science communication can be particularly challenging when the issue being discussed is controversial.[6] A safe space is an environment in which participants feel comfortable expressing themselves without fear of judgment or harm.

14 As a class, make a list of controversial issues related to science and technology you feel comfortable and competent to discuss. Examples include:

- artificial intelligence
- psychedelics / cannabis
- climate change
- nuclear energy
- vaccinations
- autonomous vehicles
- the origin of the universe

15 Identify the two sides of the debate on each issue.

16 Take sides on each issue. Decide if you are more on one side than the other.

- Remember, you are not expected to be a scientific expert on every topic. Your viewpoint may be informed by personal experiences, ethical beliefs, and emotional responses.

17 As a class, agree on guidelines for creating a safe space for discussing controversial issues.

18 Find someone who took a different side to you on an issue.

- If you prefer, you can work in pairs with someone who takes the same side as you.

19 Discuss the issue. The Supplementary Material gives useful language for discussing controversial issues.

- Remember, the purpose of this activity is not to prove someone wrong, or even to reach consensus, but to try to understand the other person's perspective, engage in respectful dialogue, and build trust.
- If you don't feel safe discussing a topic, move to another one, or discuss something else.

20 Reflect on what you learned from this activity:

1 What did you learn about the opposing arguments that you hadn't considered before?
2 Were there any moments when you felt your perspective shifting, even slightly? What prompted that shift?
3 How did you feel when discussing with someone who had a different opinion? Did you feel you were able to maintain respect and openness throughout?
4 What emotions did you observe in others during the debate? How did it affect the discussion?
5 What is one major takeaway from this activity for you personally?
6 How has this activity affected your view on discussing controversial topics in general?

| **Video Project** Framing and call to action (CTA)

Framing involves focusing on those aspects of a scientific issue that are meaningful for the target audience. Framing can be an effective strategy to break through communication barriers.[7]

21 In your group, brainstorm different ways of framing the science topic you chose in Unit 1.

22 Identify 2–3 potential frames that would resonate with the audience you identified in Unit 2.

23 One person from each group presents their research topic, audience, and chosen frames.

- Decide if each group's proposed frames are realistic and relevant for the intended audience. Can you suggest alternative frames?

24 In groups, discuss possible calls to action (CTAs) that align with your chosen frames.

A call to action (CTA) tells the audience what to do next, after receiving the message. A call to action should be tailored to the intended audience and should align with the overall purpose and tone of the message.[8]

25 One person from each group presents their research topic, audience, chosen frames, and CTA.

- Decide if each group's proposed CTA are aligned with the research topic, audience, and chosen frames. Can you suggest alternative CTAs?

| **Supplementary Material** Useful language for discussing controversial issues

Facilitating respectful discussions, especially about complex or controversial topics, benefits greatly from using thoughtful and inclusive language. Here are some useful phrases, sentence starters, and questions that can help maintain a constructive and respectful tone.

Sentence Starters

"I understand where you're coming from, but have you considered..."
"That's an interesting point. It makes me think about..."
"Can you help me understand your position on..."
"I'm still confused about...."
"One thing I find interesting is..."
"I agree with you, but I would also add..."

Questions to Encourage Dialogue

"What makes you think...?"
"Can you explain more about why you feel this way?"
"Why do you think that's important?"
"What do you mean when you say...?"
"What do you think would happen if...?"
"How might we find common ground on this topic?"
"What are some outcomes you hope to see from this discussion?"

Phrases to Validate Others

"I see what you mean..."
"That's a valid point, and it adds an interesting angle to consider."
"Thank you for sharing that; it's important to hear different perspectives."
"I hadn't thought of it that way before."
"Your input is valuable to our discussion."

Phrases to Use When Disagreeing

"I respect your viewpoint, though I might see things differently. Here's why..."
"I appreciate your perspective. My view is slightly different because..."
"Let's explore a different perspective together."
"I understand your reasoning—my concerns are..."
"While I see your point, I think we might also consider..."

Phrases to Clarify and Summarize

"If I understand you correctly, you're saying that..."
"Just to clarify, are you suggesting that..."
"So, in summary, your main point is..."
"It sounds like we both agree on..., although we differ on..."

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4
TELL A STORY

Learning objective: Use stories and storytelling techniques to make science interesting and engaging

Lead-in

Although storytelling is often viewed negatively within science, research suggests that narratives are easier to understand and audiences find them more engaging than traditional forms of scientific communication.[1][2]

1 Work in groups. Discuss these questions:

1 Why do you think scientists are often discouraged from telling stories about their work?
2 Why do you think stories are such a powerful way to communicate?

Reading Narrative Warmth and Quantitative Competence

2 Read two versions of an argument for active learning.[3] Then answer these questions:

1 Which speaker do you personally find more convincing? Why?
2 Which speaker gives a stronger impression of warmth?
3 Which style (narrative or statistical) is more engaging and memorable?
4 Can you think of a situation where one style might be more effective than the other?

These texts were given as part of a larger study into how the nature of the message affects our perception of the person delivering it. Across three variants, the narrative stye was found to increases perceptions of warmth, while statistical evidence increased perceptions of competence. However, combining both styles may provide a more balanced perception, enhancing both the speaker's warmth and competence.

"We do have evidence for a general positive effect," says Melanie Green, a professor of communication in the University at Buffalo and coauthor of the study. "Both qualities—warmth and competence—can increase together."[4]

Speaker 1 (Narrative Style)

"I think active learning is a really great way to help people succeed in the classroom. One of my friends was in a high school science class that used active learning–working in teams together to solve problems in class time, discussing topics rather than just listening to lectures. She told me she learned a lot more in those classes, because it was easier to pay attention and she thought a lot more deeply about the material–and enjoyed it a lot more. She said it was fun getting a chance to work more closely with her classmates and hearing their thoughts on the material. And, at the end of the year, she did a lot better on both her report card and standardized tests. Teachers should definitely try to include more active learning in their classroom planning."

Speaker 2 (Statistical Style)

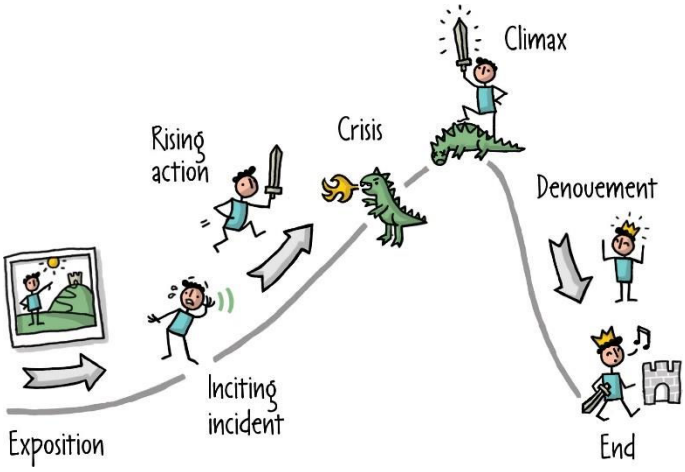
"I think active learning is a tested and proven way to help people succeed in the classroom. Research shows that active learning techniques like using class time to have students work together on problems instead of listening to lectures result in as much as ten percent gains in long-term memory for information. By making it easier for students to pay attention and requiring more thought, they also improve standardized test scores–up to twenty percent–and grades by as much as a letter and a half. Student satisfaction is also significantly improved in every way, from interest to satisfaction to self-reported learning, over more traditional lecture classes. Teachers should definitely try to include more active learning in their classroom planning."

3 Work in groups. Discuss how the narrative and statistical approaches could be effectively integrated in a single presentation or argument.

SciComm Skills Following a narrative arc

Stories typically have a beginning, a middle, and an end, with rising and falling action – a structure known as a 'narrative arc'. This structure can be used flexibly in all forms of communication on any topic, including science communication.[5]

4 Look at the schema of a narrative arc below.[6] Discuss stories you know that follow this structure (e.g. fairy tales, films, myths).



5 Work in groups. Use an online random word generator to generate 5 random words (nouns, verbs, and adjectives). Use the words to invent a short story (about 5 sentences) that includes all the words.

- Try to follow a narrative arc.
- You may wish to write your stories down before presenting.
- Avoid potentially triggering or controversial topics.

6 Tell your story to the other groups. Before you start, list the 5 random words you used to create your story.

7 After hearing all the stories, discuss these questions:

1 Which aspects of the stories were good, and why?
2 Were there any stories or parts of stories that didn't "work"? Why do you think that was?
3 What have you learned from this activity about the characteristics of a good story?
4 How could you apply narrative arcs in your scientific presentations and writing projects?
5 In what situations might the use of a traditional narrative arc be limiting or inappropriate for storytelling or presenting information?

Watch and Listen Talk Nerdy To Me

8 Watch Melinda Marshall, a communications expert, give a TED Talk on presenting science.[7]

1 What is the main takeaway from Melissa's talk?
2 How do you feel towards Melissa after watching the talk, on a spectrum of warmth–competence?

9 Listen to the presentation again and read the transcript. Identify storytelling techniques Melissa uses:

- ☑ Personal anecdote
- ☐ Repetition of words
- ☐ Visual imagery
- ☐ Examples and analogies
- ☐ Repetition of sounds
- ☐ Repetition of a phrase
- ☐ Series of three words or phrases
- ☐ Use of humour
- ☐ Use of callbacks
- ☐ Moral of the story / call to action

10 Which of the techniques in Exercise 9 do you think would be easiest and most beneficial to incorporate in your own presentations?

Communicative Activity Telling a personal anecdote

Researchers say that using "I" and first-person narratives can help establish a personal connection with an audience.[8]

11 Talk about a strong interest you have (e.g. in science, music, travel, cooking, etc.). Discuss these questions:

1 Do you remember what first sparked your interest? How did you feel?
2 What challenges or setbacks did you face?
3 How did you overcome your challenges? Did someone help you?
4 What have you learned or gained by pursuing your interest? What are your hopes for the future?

12 Develop your ideas from Exercise 11 into a short personal anecdote. Present your anecdote to the class.

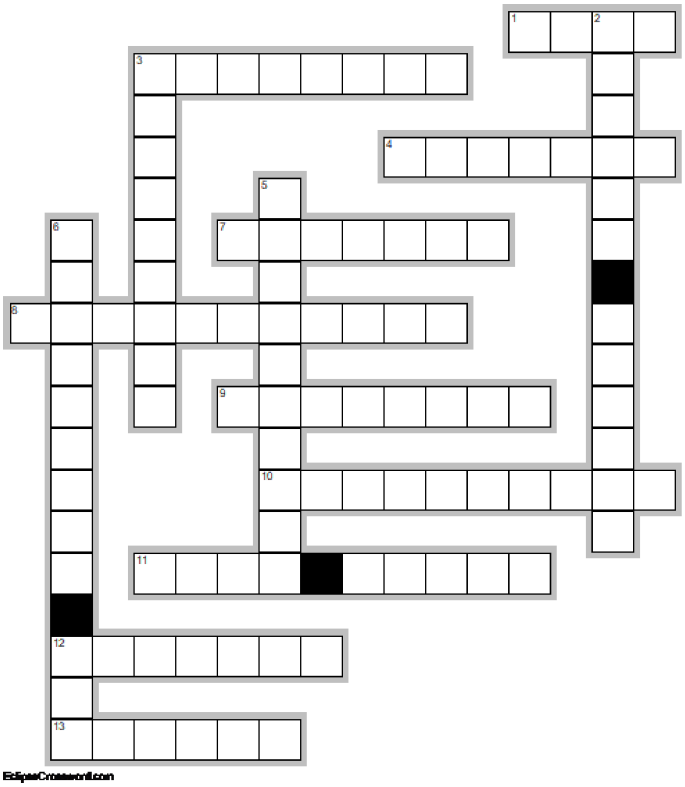
- Use the storytelling techniques discussed in this unit.

13 After each anecdote, discuss these questions:

1 Which storytelling techniques did you notice the presenter using?
2 Was the anecdote engaging and memorable?
3 Give the presenter one suggestion for improving their anecdote.

SciComm Lexis

14 Complete this crossword, using the clues. To have more fun, make it a race!



Across

1 The central figure of a story, often facing adversity
3 A reference to something mentioned earlier in the narrative
4 An antagonist who opposes the hero
7 The time and place of the events in a story
8 The main character in a narrative
9 A figure of speech that implies a resemblance
10 Introductory information setting the scene
11 A sudden, unexpected change in a story's direction
12 A comparison often used to clarify or explain
13 The peak of action in a story

Down

2 The buildup of conflicts and complications in a story
3 A person or entity in a story
5 The resolution or conclusion of the narrative
6 The ups and downs in a storyline

Video **Project** Scriptwriting and storyboarding

In this step of the Video Project, your group will develop a script and create a storyboard. This will guide the production phase of your video, ensuring a well-organized and cohesive final product.

15 Develop the script:

- Ensure the script has a clear structure (beginning, middle, end) and employs storytelling techniques as appropriate for your audience, framing, and purpose.

16 Design the storyboard:

- Create panels that correspond to each segment of the script. Each panel represents a different scene or shot in the video.
- You can hand-draw your panels, find a free template on the internet, or use storyboard software (e.g. Canva, Miro).

17 Review and adjust:

- Review the storyboard with your group. Make any necessary adjustments to ensure it aligns with your script and enhances your message.

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5
MAKE IT VISUAL

Learning objective: Use visual communication to enhance and simplify your message

Lead-in

Images have long been used by scientists to present data and explain new theories.[1] However, the images scientists make were until recently aimed mostly at other specialists.[2]

1 Work in groups. Discuss these questions:

1 Why do you think images have become an important tool with which to communicate science?
2 Can you think of any scientific images that caught the public imagination?
   - Do you know the science behind the image?
   - Do you know the story behind the image?

SciComm Lexis

2 In each group of words, identify the word that does not belong with the others. Explain why the word you chose is the odd one out.

1 *animation, icon, infographic*
2 *font, colour palette, legibility*
3 *data visualization, table, figure*
4 *visual story, SciArt, STEAM*
5 *layout, balance, proportion*

Watch and Listen Infographics

3 Watch a video about infographics made by The Learning Portal, a collection of content from 24 colleges in Ontario (Canada). Then answer these questions:

1 Why are the following numbers mentioned?
   - 80%
   - 20%
   - 10%
   - 60 000
   - 15

2 How trustworthy do you think these numbers are?

Fig. 1. This infographic was designed using resources from Freepik.com. CC-BY Mariella Franker, Franker Medical Communications.[3]

4 Look at a selection of infographics for 2–3 minutes. Then, try to answer these questions:

1 What were the infographics' essential messages?
2 What else do remember about the infographics? E.g.:
   - Colour palette
   - Text sizes and fonts
   - Organisation

- Rate the infographics from best to worst based on their effectiveness, design quality, and clarity of message.

5 What is the process of making a good infographic? Refer to Fig. 1 to help you remember the main points from the video.

SciComm Skills Creating an infographic

6 Using the knowledge gained from the video, analysis of infographics, and the process outlined in Fig. 1, create your own infographic on a topic of your choice.

1 Select a subject that you know about or find interesting.
2 Collect relevant information and statistics to include in your infographic.
3 Use a design tool like Canva, Piktochart, or Adobe Spark.
4 Incorporate elements such as charts, icons, and images to support your message.
5 Share your infographic with peers for feedback and make necessary improvements.

- **Submit your final infographic for evaluation. Ensure it meets the criteria discussed and effectively communicates your chosen topic.**

Reading Mixing Science and Art to Make the Truth More Interesting than Lies

7 You are going to read an article about SCI+POP, a SciArt / STEAM project.[4] Before you read, discuss these questions:

1 Do you like art? Why?
2 What do you know about SciArt or STEAM?

8 Read the article from *The Conversation*. Then choose the correct answers to the questions.

1 What is the main barrier to science communication, according to the author?
   a) There is a lack of interest in science among the general public.
   b) There is a lot of noise and misinformation in popular culture.
   c) People have cognitive biases that prevent them from processing new information.

2 Describe the "backfire effect" mentioned in the text.
   a) It is when people change their opinions after being presented with facts.
   b) It is when people become more entrenched in their beliefs after being presented with contrary evidence.
   c) It is when people ignore information that contradicts their beliefs.

3 Why is an image-focused communication strategy important in today's world?
   a) Visual content is processed faster than text, leading to higher engagement on social media.
   b) Images tend to be shared more frequently on social media than textual content.
   c) Visual storytelling can effectively convey complex ideas in a memorable way.

4 Which of the following is not mentioned as a benefit of using art in science communication?
   a) Encouraging people to contemplate different viewpoints.
   b) Evoking strong feelings.
   c) Attracting a broader audience.
   d) Simplifying complex scientific concepts.
   e) Serving as a form of social critique.

5 What do you think about the SCI+POP project, and other similar projects?
   a) It will likely be successful in engaging new audiences through the use of art and social media.
   b) It may have limited success because it cannot compete with the reach of popular celebrities.
   c) It's unlikely to have any impact, because art is not really effective at communicating complex scientific issues.
   d) The project may only appeal to those already interested in science and art.

Communicative Activity SciArt exhibition

This activity will allow you to explore the intersection of science and art, develop your research and presentation skills, and engage in meaningful discussions with your peers.

9 Find an example of science communication art (SciArt), or an artist who has produced several SciArt works.

- The artwork could be related to any scientific field (biology, physics, astronomy, etc.) and can use any medium (painting, digital art, sculpture, etc.).

10 Reflect on your chosen piece(s) of SciArt.

- What does the work mean to you?
- What feelings and emotions does the work evoke?

11 Compare your interpretation with the artist's intended meaning, if available. Reflect on any similarities or differences.

12 Explore the techniques and materials the artist used. Did the artist collaborate with scientists or use scientific data in their work?

13 Prepare a single presentation slide that showcases your chosen SciArt work.

14 Deliver a 2-3 minute talk to the others in your class, focusing on:

- The artwork's scientific significance and its impact on you.
- The artistic elements of the work and the technical details of how it was made.

15 After the presentations, discuss these questions:

1 Which artworks made the strongest impression on you? Why?
2 Have these examples of SciArt inspired you creatively or intellectually?
3 Did any of the SciArt works challenge your preconceived notions about science or art? How?

| Video **Project** Video assembly and editing

The focus of this phase should be on creating a cohesive, clear, and visually appealing video that effectively communicates your message to the audience.

16 Gathering resources:

- Source high-quality stock videos, images, and any other necessary multimedia elements that align with the storyboard.
- Ensure that all resources used are appropriately licensed or free for use. Websites like Unsplash, Pixabay, and Pexels offer free stock photos and videos.

17 Voice-over recording:

- Make a clear voice-over recording of the script. Use a good microphone and quiet environment to ensure high-quality audio.

18 Assembling visual and audio elements:

- Begin assembling the video using video editing software. This includes syncing the voice-over with the visual elements, such as stock footage and images.
- There are several free and open-source video editing software options that are quite powerful and suitable for various levels of expertise.

19 Editing for clarity and engagement:

- Edit the video for smooth transitions between different visual elements. Add text overlays, subtitles, or other graphical elements to emphasize key points or explain complex ideas.

20 Incorporating music and sound effects:

- Edit the video for smooth transitions between different visual elements. Add text overlays, subtitles, or other graphical elements to emphasize key points or explain complex ideas.

21 Presenting the final video:

- Briefly introduce the topic of your video.
- Explain why you chose your topic and what you hope to communicate about it.
- Describe the intended audience, highlighting their key characteristics, level of knowledge, and interests.

References

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[4] T. Caulfield, "Mixing science and art to make the truth more interesting than lies," *The Conversation*, 2018. Accessed: Aug. 9, 2024. [Online]. Available: https://theconversation.com/mixing-science-and-art-to-make-the-truth-more-interesting-than-lies-100221

Further Reading

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