Science Communication for Astrophysics

Summer Semester 2026

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Course Summary

Science communication is a vital part of being a researcher today.

Astrophysics, with its exciting discoveries and complex concepts, has a unique role in inspiring the public and fostering trust in science.

This course equips researchers and academics with the skills to communicate their science effectively, engage diverse audiences, and advocate for clear, accurate science in the public sphere.

Course Aims

By the end of this course you will be able to:

- Understand the **principles, purposes and responsibilities** of science communication as a researcher
- Develop and deliver effective **spoken presentations** for diverse audiences
- Design and run interactive **hands-on activities**
- Understand clear and compelling **written and digital science content** including for press releases, infographics and mixed media
- Critically **evaluate science communication strategies**, considering accessibility, inclusivity and feedback
- Build a personal **science communication portfolio** that showcases your skills across multiple formats to use beyond your masters degree

Course Outline and Criteria

Module 1 - Spoken Communication
Talks, presentations and audience engagement
Assignment: Write and deliver an outreach talk

Module 2 - Written & Digital Communication
Press releases, infographics, mixed media and online content

Module 3 - Visual & Interactive Communication
Hands on activities and interactive experiences
Assignment: Develop and deliver a hands-on activity

These two assignments **must be completed** to pass this course

Logistics

Seminars will he here in room 0.034 at 12:15 every week

Many of these seminars will be hands on and interactive - this course has been designed to have enough time within the seminars to complete (at least most of) the assignments to pass.

On the **5th of June** we will visit the Urania Planetarium in Potsdam for an interactive planetarium show.

We will also be delivering hands on science outreach on the University campus.

01
Introduction to Science Communication

“Nothing in science has any value to society if it is not communicated, and scientists are beginning to learn their social obligations”

Anne Roe, The Making of a Scientist (1953)

What is Science Communication?

Science communication is the practice of sharing scientific knowledge, methods, and values with non-specialist audiences in clear, engaging, and accessible ways.

Explaining	Engaging	Building Trust
Making complex ideas clear and accessible	Sparking curiosity and dialogue with different audiences	Showing the relevance and reliability of science in society

Forms of Science Communication





Spoken	Written	Visual	Interactive	Digital
Public Talks	Articles	Infographics	Hands-on activities	Social Media
Lectures	Blog posts	Animations	Citizen science	Youtube
Podcasts	Press releases	Data visualisation	Science Festivals	Webinars
Interviews	Books	Art	Workshops	Online Materials

Your Experiences of Science Communication

Why is science communication important for… **researchers?**

- **Increases research impact**
  - Reach wider audiences & gain recognition
- **Attract funding & collaborators**
  - Secures grants and partnerships
- **Understand concepts outside their niche**
  - Scientists require science communication as well
- **Enhanced reputation**
  - Strengthens personal and institutional credibility
- **Personal fulfillment**
  - Connecting your work to society is motivating and rewarding

Credit: University of Oxford

Why is science communication important for… **students?**

- **Develops transferable skills**
  - Presenting, writing, engagement
- **Gain confidence**
  - Personal development increase
- **Learn by teaching**
  - Deepen your own understanding
- **Expand your portfolio**
  - Great to put on your CV for future jobs and opportunities

Credit: Irina Logra

Why is science communication important for… **policy makers?**

- **Supports evidence-based decision making**
  - Helps policy makers understand scientific findings
- **Highlights social relevance**
  - Demonstrates how research addresses real world challenges
- **Builds trust between scientists and government**
  - Fosters credibility and confidence in decisions
- **Informs funding priorities**
  - Clear communications can influence research investment and policy agendas

Why is science communication important for… **the general public?**

- **Improves scientific literacy**
  - Links complex ideas understandable to people's daily lives
- **Promotes critical thinking skills**
  - Empowers individuals to make choices based on evidence
- **Inspires curiosity**
  - Keeps people inspired by scientific findings
- **Builds trust in science**
  - Open communication fosters credibility and reduces misinformation
- **Supports democratic society**
  - Informed citizens can better engage in debates and policy

Why is science communication important for… **the media?**

- **Provides accurate, reliable sources**
  - Information comes for scientists themselves
- **Creates compelling stories**
  - Science communication allows engaging narratives
- **Bridges expertise gaps**
  - Most journalists are generalists even in science
- **Encourages responsible journalism**
  - Reduces hype and builds public trust in science coverage
- **Helps maintain audience engagement**
  - Long term funding often required long term engagement

Why is science communication important for… **education?**

- **Enhances STEM teaching**
  - Provides teachers with content and resources
- **Inspires the next generation**
  - Encourages children to consider scientific study
- **Supports curriculum enrichment**
  - Practical applications brings concepts to life
- **Encourages diversity in science**
  - Engages underrepresented groups and promote equity
- **Compliments other subjects**
  - Connects science to maths, technology, engineering, and even art (STEAM)

Why is science communication important for… **industry?**

- **Facilitates technology transfer**
  - Connects scientific discoveries to commercial applications
- **Highlights innovation opportunities**
  - Communicates research that could drive new products or services
- **Builds partnerships and collaborations**
  - Strengthens links between companies and research institutions
- **Supports corporate social responsibility**
  - Demonstrates commitment to science and education
- **Enhances workforce development**
  - Industry-science collaborations provide training and skills for employees

Why is science communication important for… **science itself?**

- **Improves research quality**
  - Explaining work clearly can reveal gaps or flaws in reasoning
- **Encourages interdisciplinary approaches**
  - Sharing findings widely sparks cross-field collaborations
- **Fosters a culture of accountability**
  - Scientists are motivated to communicate accurately and ethically
- **Supports open science practices**
  - Encourages sharing of data, code and methods
- **Encourages replication and validation**
  - Well-communicated methods and results invite scrutiny and confirmation

Perception of Scientists in the General Public

Scientists' Responsibility to Society

Important decisions about research and its applications are **no longer made by scientists alone**.

Funding agencies, policymakers, lobbyists, and interest groups **rely on public attitudes** to guide decisions.

Scientists therefore carry a **responsibility to communicate their research, its motivations, and implications clearly and accurately**.

Science Communication: Bridging the Gap

Technocratic Drift

Decisions are made primarily by experts, often without meaningful input from the public or consideration of societal values.

Science Communication

Ensures decisions are evidence-informed and socially responsible

Populist Drift

Decisions are made primarily in response to public opinion, sometimes ignoring scientific evidence or expert recommendations.

A History of Science Communication

1632

Galileo Writes in Italian

Galileo's Dialogue *Concerning the Two Chief World Systems* was written in Italian and as a dialogue, making heliocentric ideas accessible to the public. Its bold style sparked debate and led to his trial.

1806

Jane Marcet Expands Access to Science

Through Conversations on Chemistry (1806), Marcet used dialogue and experiments to teach chemistry to women and general audiences, helping broaden participation in science.

1825

Michael Faraday's Christmas Lectures

Faraday's Christmas Lectures used experiments and clear explanations to make science accessible to young audiences and the general public. The lectures continue today at the Royal Institution, inspiring new generations.

1845

Scientific American

The first science magazine was founded, marking the rise of science journalism and outreach through print media.

1921

First Science Radio Broadcasts

Early programs in the US and UK brought science to mass audiences via radio, expanding public engagement beyond print and lectures.

1923

First Planetarium is Built in Munich

The Zeiss Planetarium allowed the public to experience a realistic night sky indoors, making astronomy accessible and inspiring planetariums worldwide.

A History of Science Communication

1940s

Science on Television

Science began reaching mass audiences through television programs in the 1940s. Shows combined demonstrations, interviews, and discussions to make science accessible such as the Johns Hopkins Science Review (1948–1955)

1969

The Moon Landing

The first Moon landing was broadcast live worldwide, watched by millions. NASA's coverage, including launches and astronaut updates, made space exploration tangible and exciting, inspiring public interest in science and technology.

1980

Carl Sagan's Cosmos

Cosmos combined storytelling, visuals, and accessible explanations to introduce astrophysics to millions worldwide, showing the power of TV for science communication.

1990

Launch of HST

Hubble's high-resolution images transformed astrophysics and public engagement. Iconic views like the Pillars of Creation showcased the power of visual science communication.

2007

Citizen Science

Galaxy Zoo invited the public to classify galaxies, engaging thousands directly in astrophysics research and demonstrating the power of participatory science communication.

2010s

Social Media for Scientists

Platforms like Twitter, YouTube, and Instagram enabled scientists and institutions to communicate discoveries directly, creating interactive, real-time engagement with global audiences.

The Reputation of Science Communication

In 1838 Lancelot Hogben asked a colleague to pretend to be the author of his popular science book "*Mathematics for the Million*", so as not to risk his nomination as a Fellow of the Royal Society.

In 1992 Carl Sagan was denied membership to the National Academy of Sciences, due to his involvement in science communication. They reconsidered two years later.

Today public engagement is not only respected, but a requirement of grants for many funding agencies.

Why me?

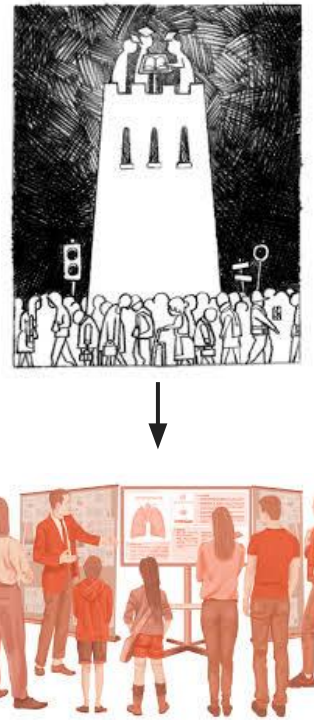
- Professional communicators have a valued, complementary role, but scientists bring first-hand expertise.
- Scientists understand the theory, methods, and implications at a depth no professional can fully replicate.
- Direct communication prevents the ‘Ivory Tower’ perception, strengthening public trust.
- Scientists are best placed to deliver accurate, nuanced explanations, including uncertainties and context.

Communicating your research effectively is a learned skill, not a gift; with thoughtful planning and reflection, any scientist can do it.

Models of Science Communication

Leaving the Ivory Tower

- The days of science as elite knowledge confined to universities are over
- In the 20th century, science shaped war, technology, and health, drawing public interest and scrutiny
- By the 1960s, “science” carried negative connotations, and public knowledge was low (e.g. in 1983 only 34% of UK citizens knew the Earth orbits the Sun once a year)
- Investigations such as the Bodmer Report (1985) urged to increase the public perception and knowledge of science



Scientists can no longer stay in the ivory tower. We need to explain, justify, and dialogue with society, and take accountability.

The Deficit Model

‘Top down’

‘Disseminating’

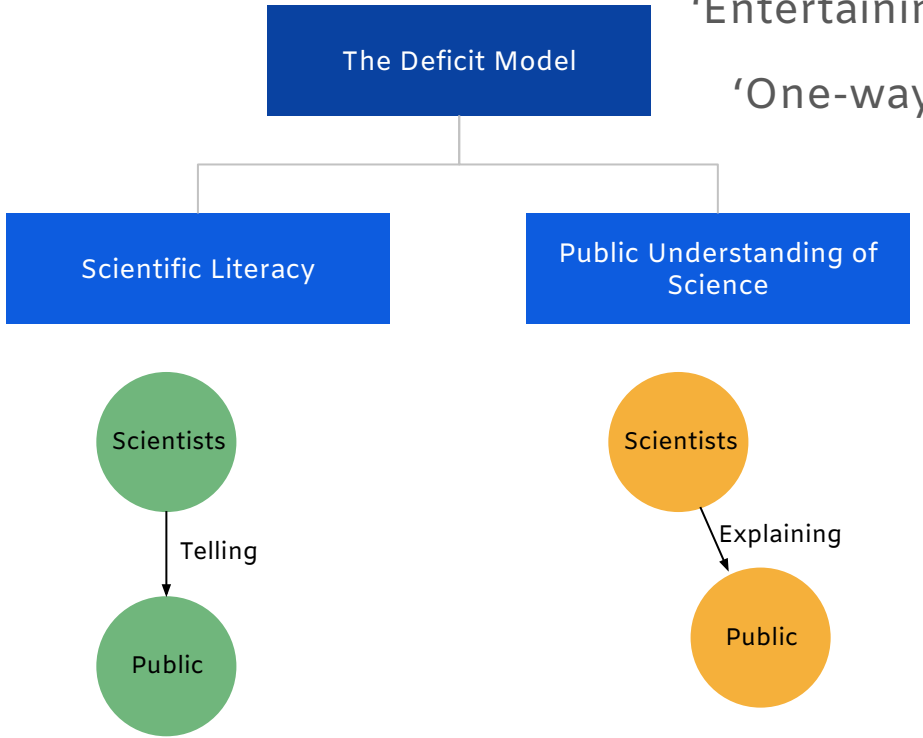
‘Entertaining ‘

‘One-way’

The Deficit model is built on the foundation that the public are lacking scientific knowledge and thus have a knowledge *deficit* that scientists need to fill.

This is done by relaying information from the scientist to the public.

The idea is that if the public gain this knowledge, trust in science and rational decision making will naturally follow.



The Deficit Model: Strengths

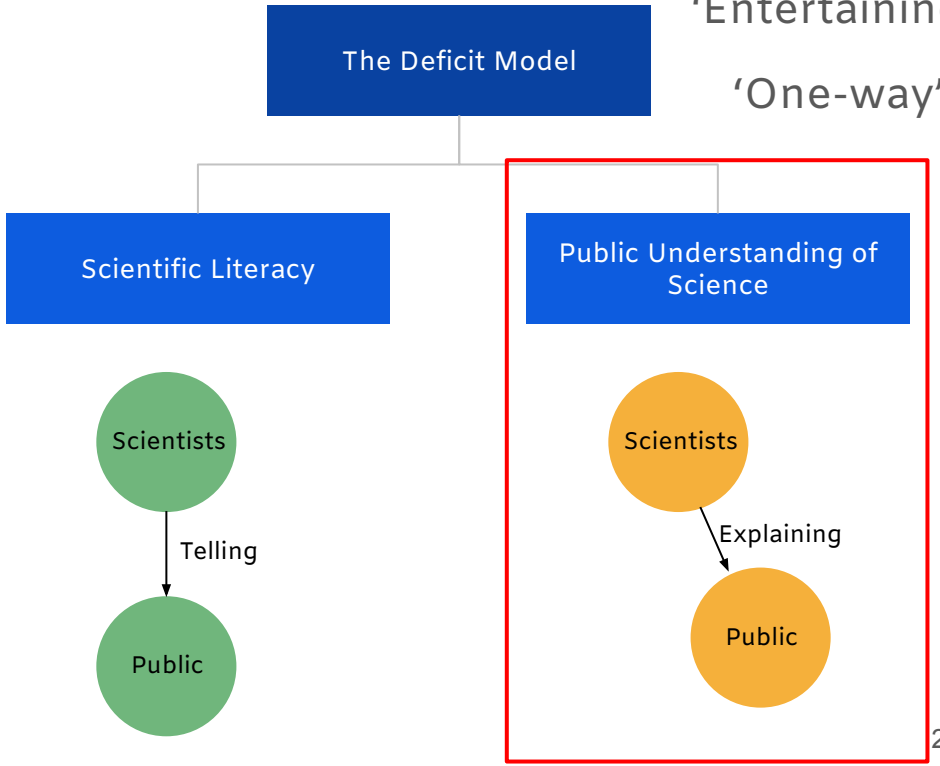
‘Top down’

‘Disseminating’

‘Entertaining ‘

‘One-way’

- Efficient knowledge transfer
- Can build a narrative and motivation which may not have been clear before
- Builds foundational understanding for future engagement or dialogue
- Reduces misconceptions and fights misinformation
- Can inspire interest and motivate curiosity
- Accessible and easily scaled up



The Deficit Model: Limitations

- The public doesn't follow the same logic as the scientific method
- They simply cannot know everything, there's too much information
- There is lack of sufficient motivation
- Decision making is personal, with many factors people take into account
- Studies show that scientific literacy doesn't necessarily correlate with the attitudes and opinions towards science

Many times it not really a question of **knowledge** but a question of **trust**

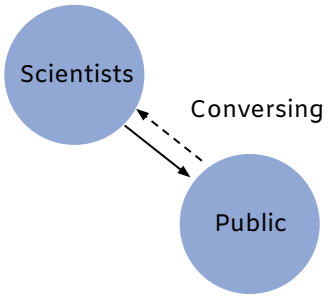
The deficit model plays a necessary, though not sufficient, role in science communication → **Alternative models were proposed in the 2000s**

The Dialogue Model

The Dialogue model focuses on two-way communication between scientists and the public, recognising that the public has values, knowledge, and concerns scientists must listen to.

Here the emphasis is on listening, consultation, and engagement.

The goal isn't just to "educate" but to exchange perspectives.



'Two way'

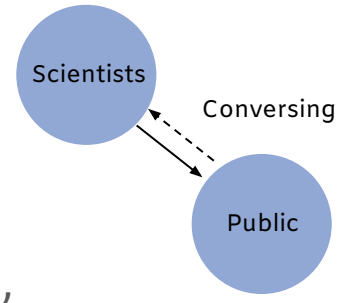
'Consulting'

'Knowledge sharing '

'Deliberation'

The Dialogue Model: Strengths

- Acknowledges public concerns, addressing fears, ethical issues and societal values
- Encourages reflection by scientists
- Improves mutual understanding
- Facilitates early identification of concerns
- Makes content flexible and can be easily tailored to specific communities and issues
- Supports iterative communication and feedback loops



‘Two way’

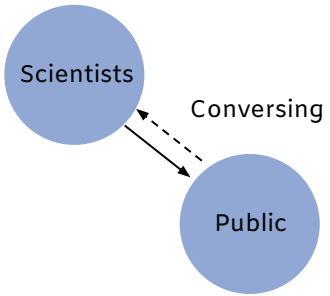
‘Consulting’

‘Knowledge sharing ‘

‘Deliberation’

The Dialogue Model: Limitations

- Not always practical - takes time, resources and trained facilitators
- Risk of a ‘box ticking’ exercise where voices are heard but not acted upon
- Assumes equal footing in the conversation and possibly excludes certain groups
- The power imbalance between scientists and the public is lessened but still remains
- Science still defines the boundaries and context



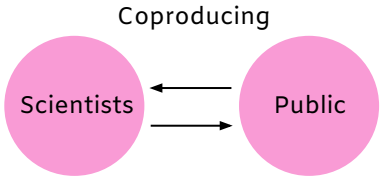
How do you feel about X technology?” or What science should we prioritse together?”

The Participation Model

The Participation model takes the dialogue model a step further and brings the public into active participation of science and scientific decisions.

This can involve citizen science projects and involving the public in funding decisions and priorities.

The participation model aims to redistribute power regarding scientific policy.



‘Upstream’

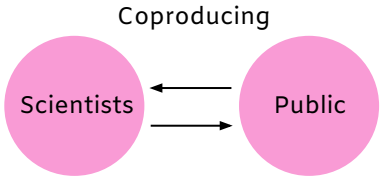
‘Coproduction’

‘Negotiation ‘

‘Knowledge Building’

The Participation Model: Strengths

- Public shapes questions, methods, outcomes
- Open, transparent, responsive science which builds trust
- Science reflects public values and priorities
- Empowers communities and includes marginalised groups
- Active involvement makes science meaningful and motivating
- Public contributions reveal new patterns and generate insights



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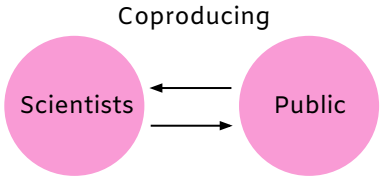
The Participation Model: Limitations

- Resource intensive, requiring time and funding
- Full participation is rarely feasible for large or highly technical projects
- Balancing scientific goals with public priorities isn't easy
- Scientific complexity can limit the depth of engagement
- Can blur boundaries on what counts as an "expert"
- Participants may lack understanding to make fully informed choices



'Upstream'

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'Knowledge Building'

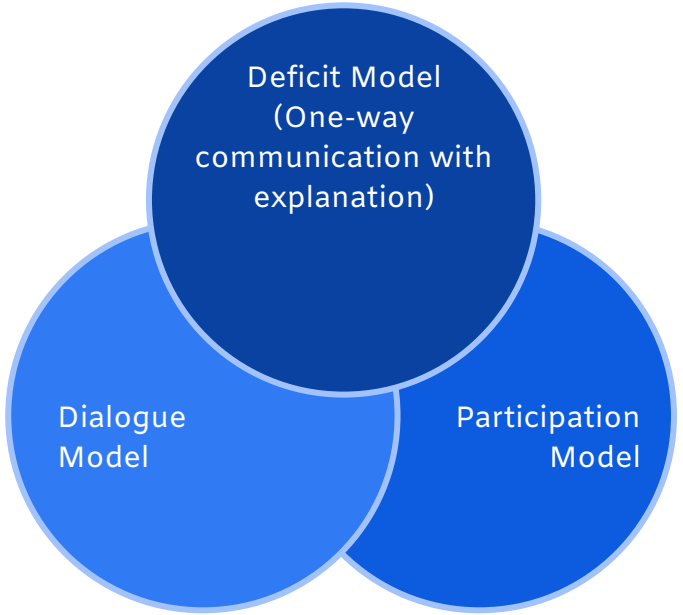
Beyond Single-Mode Communication

The fundamental ideas of the deficit model are clearly flawed.

However delivering understandable and accessible information in a one-way style is still a key part of science communication.

In reality, these three models are informative, but also vague and overlapping.

In effective science communication often aspects of each of these models are combined.



For example: A public outreach talk with a Q&A segment and a hands on activity

Case Studies

Consider these science communication examples:

1. Carl Sagan - The 4th Dimension
2. Galaxy Zoo
3. Infographics of gravitational wave event GW231123

Consider these questions:

1. What model(s) of science communication do these follow?
2. What is the intended audience?
3. How effective is the example?
4. Is the aim to inform, inspire, or involve? Does it succeed?
5. How accessible is it for diverse audiences (age, background, ability)?
6. How does it make you feel about science? Would you share it or recommend it?

02
Knowing Your Audience

"Know thy audience. Know thyself. Know thy stuff."

- Stephen Schneider (2013)

Climate science

Artificial Intelligence

Vaccination development

Paleontology

Climate science

Artificial Intelligence

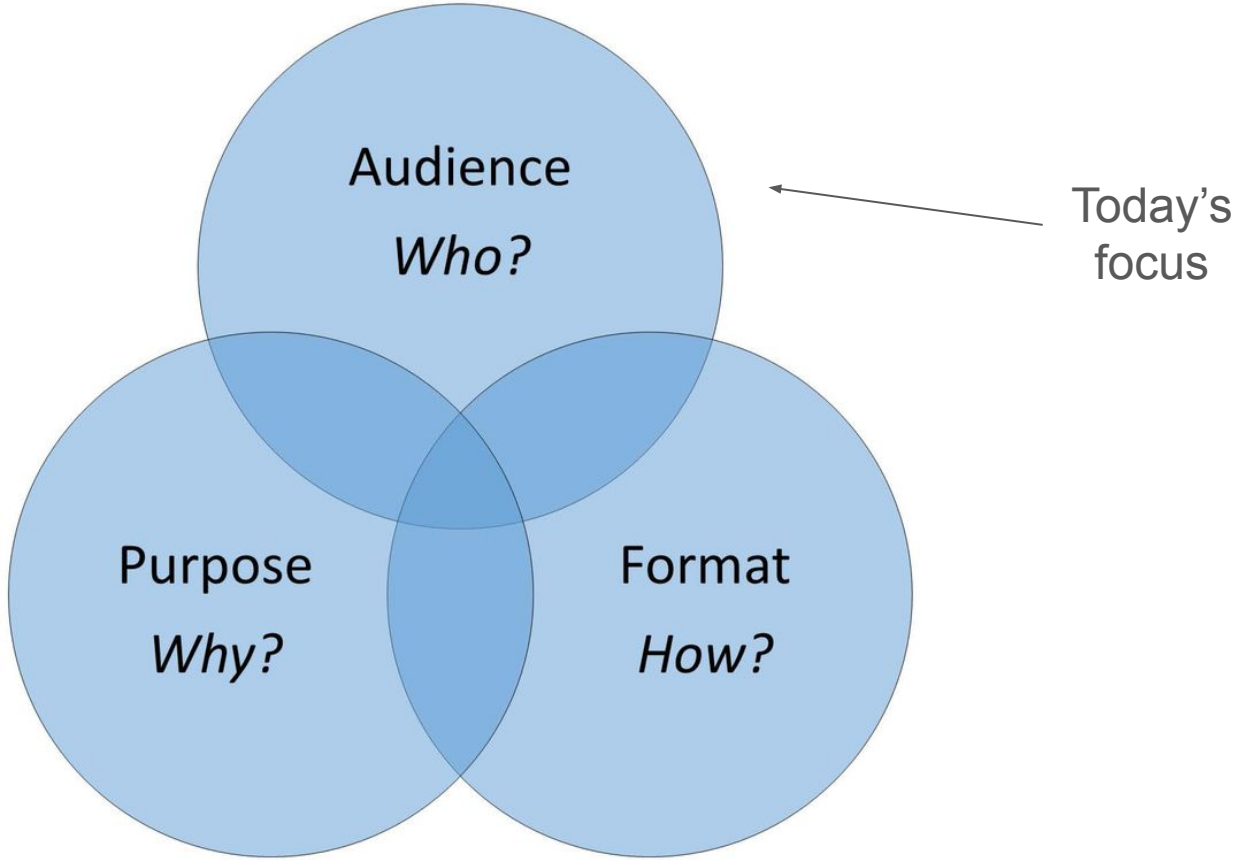
Vaccination development

Paleontology

Discuss with a partner for the topic you are most familiar with and the topic you are least familiar with:

1. How interested are you in this field?
2. How did you first encounter this topic?
3. Have you sought out any information on this topic independently?
4. What emotions and experiences do you attach to this topic?
5. Do you feel like this topic is accessible to you?
6. Do you recall any science communication that impacted you on this topic? Did it affect how you feel or your interest?

Key Factors In Science Communication



An Audience Centered Approach

People are not blank slates but come with their prior knowledge, attitudes and wants. Communication is only effective if it connects with those starting points - otherwise it risks being irrelevant, confusing or mistrusted.

Understanding your audience's helps you:

- Decide the level of detail to go into (scientific depth vs. overview)
- Choose the tone or style (formal, conversational, humorous)
- Anticipate misconceptions or sensitive issues (e.g., astrology vs. astronomy, or funding controversies)
- Select formats that fit their context (short video vs. long lecture, hands-on activity vs. article)

Scientists must meet audiences where they are, rather than waiting for them to come to them

Types of Audiences

Educators

Scientific Community

Students & Young Learners

Underrepresented Communities

General Public

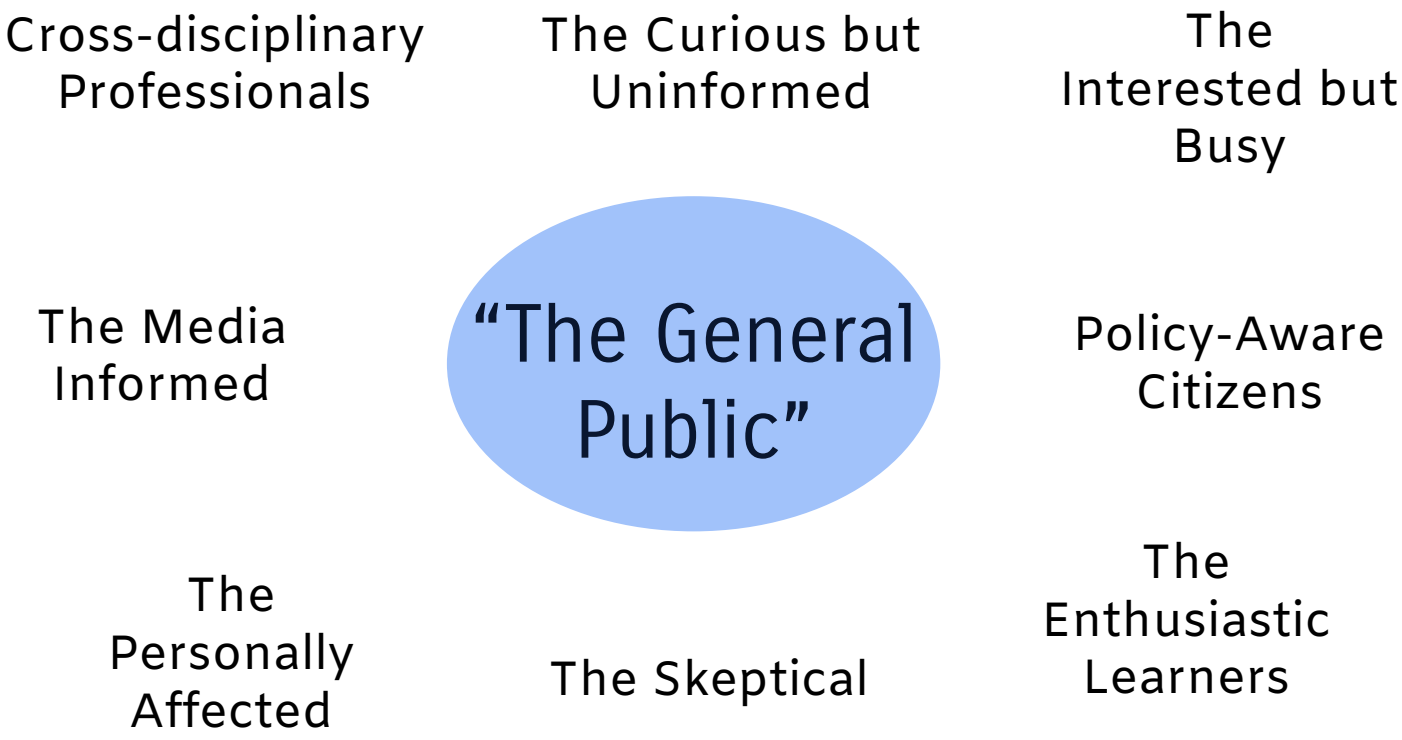
Policymakers & Funders

Industry

Enthusiastic Communities

Specialist Peers

Media & Journalists


Cross-disciplinary Professionals
The Curious but Uninformed
The Interested but Busy
The Media Informed
“The General Public”
Policy-Aware Citizens
The Personally Affected
The Skeptical
The Enthusiastic Learners

Who am I?

Instructions:

- Work in pairs where each pair gets a broad astronomy concept.
- One person is the scientist, the other a member of the public.
- The scientist receives the audience profile secretly.
- 3–5 minutes: Scientist explains the concept to their partner.
- Afterward, the “audience” guesses their profile.

Reflection Questions:

- For the scientist: How did you tailor your explanation for this audience?
- For the audience: How detailed or complex did the explanation feel for your profile?
- Did your perception match the scientist’s intention?

Who am I?

Profiles:

- Primary school student (age 6–7)
- Junior secondary student (age 12–13)
- High school student (age 16–17)
- Parent visiting a planetarium with children
- Retired engineer
- High school physics teacher
- Amateur stargazer
- Undergraduate physics student
- Funding agency representative

Reflection Questions:

- For the scientist: How did you tailor your explanation for this audience?
- For the audience: How detailed or complex did the explanation feel for your profile?
- Did your perception match the scientist’s intention?

Expedite Paradigmatic Phenomenological Delineate Instantiate Elucidate Concomitant Synthesise Empirical

Why is science “difficult”?

1. **Complexity an limited prior knowledge**- Science *is* difficult, and people vary in education and exposure
2. **Language** - Technical jargon and visualisation of quantities hold a barrier between the public and scientist
3. **Maps** - Science is an interconnected web of concepts built over many years of study, where a scientist sees concepts as part of a map the public sees as an island
4. **A lack of meaning** - Some research feels irrelevant to people
5. **Conflicting information** - Media or social media can oversimplify or sensationalise findings, or worse spread misinformation
6. **Cultural/Psychological barriers** - pre-existing beliefs, values, or ideological stances may conflict with scientific evidence
7. **The unnatural nature of science** - Science can be often counterintuitive

Science Capital

Science capital is the combination of:

1. **Science knowledge & skills** (factual, eduational, problem solving)
2. **Science attitudes** (interest, confidence curiosity)
3. **Science social contacts** (family, friends, mentors)
4. **Science behaviours** (visiting museums, reading science news, participating in activities)

The more science capital you have, the more likely you are to feel that STEM is useful and important in your life, something you have a stake in, and which is 'for you'.

Our goal in science communication is often to increase people's science capital, not just their scientific knowledge.

Science Capital

People with **high science capital** may be easier to engage, understand concepts quickly and confidently ask questions.

People with **low science capital** may struggle with concepts or to follow explanations, and engage less.

Studies suggest the of 11-15 year olds 5% have high science capital, 68% have medium science capital and 27% have low science capital.

Science capital is not the only factor in how people interact and have experiences with science, socio-economic factors such as race, gender, class - and science capital is heavily influenced by these factors

Science Capital Ladder

Rate these profiles by how much science capital you perceive each one to have:

Nurse who follows popular science podcasts

Local Councilor who supporting science funding

High school student who watches youtube science videos

Retired engineer in an astronomy club

Medical researcher

High school chemistry teacher at a science fair

Parent attending a planetarium with children in school holidays

Community member with limited access to verified scientific sources

8 year old child who is really really into dinosaurs

Does your ordering change if you consider capital on the Big Bang vs Rainforest conservation vs cancer research?

Key Questions to Ask About Your Audience

Audience centered communications means centering their perspectives. Hence we should ask questions about them to understand them better.

1. **Who are they?** - Age, profession, cultural context
2. **What do they know already? -** Educational background, science exposure
3. **What do they think about the topic?** - Cultural, social, political factors & prior experience with science institutions
4. **What do they care about?** - Linking research to the things they care about
5. **What are they looking to gain?** - Knowledge, curiosity, advocacy
6. **What barriers might exist?** - Accessibility needs, trust in science, language

Assessing Science Capital

Prior to your science communication, you could assess the science capital of your audience by:

- Conducting a survey - if it's an event with registration this can be a great time to gauge the audience
- Social media - look at audience comments and questions on a similar topic online
- Consult with gatekeepers - ask the teacher/community leader/event coordinator about the audiences prior exposure and confidence levels
- View public data and research on your audiences science capital - for example this worldwide study

Using Questions to Gauge Science Capital

Often it is more useful to assess the science capital of your audience *during* the communication by asking questions, then adapting the content and approach.

Type of Question	When to use	Strengths	Examples
Closed Questions	Large audiences	- Quick check - Polls, show of hands	"Who has ever used a telescope?"
Open Questions	Smaller audiences	- Reveal attitudes and scene identity	"When you hear the word galaxy, what do you picture?"

Both styles of questioning can be used together, for example asking a closed question and following up with an open question

"Who here has heard of dark matter?" → **"What do you think dark matter is?"**

Addressing Multiple Audiences

Umbrella approach
Frame your message under a unifying factor all audience members share

Buffet approach
Include multiple targeted messages for each audience

Bullseye approach
Prioritise an audience and center your message around them

Mix and Match Approaches

Different Mediums for Different Audiences

Different audiences engage with science through different communication mediums — effective science communicators adapt not just their message, but the mode of delivery.

Audience	Effective Mediums	Why It Works	Example
General public	Talks, planetarium shows, exhibits, YouTube videos	Visual, experimental, accessible	TED talks
School students	Workshops, interactive demos, social media	Relatable, social, participatory	“Build your own comet” activity
University students	Lectures, seminars, podcasts	Depth. flexibility	“Ask an astronomer” discussion panel
Policy makers/funders	Press releases, infographics	Concise, actionable	Infographic on findings
Underrepresented groups	Workshops, local radio, citizen science	Trust building, relevant	Night-sky observation nights

Who is it for?

Review these forms of science communication from the Event Horizon Telescope's first image of a black hole.

1. Article "*At Last, a Black Hole's Image Revealed*" from Scientific American
2. YouTube video "*First Image of a Black Hole!"* by Veritasium
3. TED talk "*Inside the black hole image that made history*" by Sheperd Doeleman
4. Instagram image from the NSF
5. Infographic on Interferometry by the Event Horizon Telescope

What audience is each one is aimed at? Why do you think this?

03
Writing a Science Outreach Talk

“You can always edit a bad page. You can’t edit a blank page."

- Jodi Picoult

Potsdam Day of Science

Tomorrow (9/5/26) is the Potsdam Day of Science running from 12pm-6pm here in Golm.

I will be running a stall for the theoretical astrophysics group - we will have lots of outreach activities!

Feel free to come check out the campus for examples of public outreach!

Common Outreach Talk Formats

From conference halls to pub nights, science is shared in many contexts.

- TED talks (10-20 mins)
- Public lecture (45-60 mins)
- Science slam (5-10 mins)
- PechaKucha (20x20 sec slides)
- Ignite talk (20x15 sec slides)
- 3 minute thesis (3 min, one slide)
- Lightning talk (5 mins)
- Pint of science (15-20 min)

Outreach Talk: Example

Outreach Talk Assignments - **22/05/16**

You will each give a 5 lightning talk aimed at the general public at a science festival, suitable for ages between 7 and 70. You may choose:

1. A concept in astronomy (*"What are black holes?", "How do we detect exoplanets?", "The James Webb Space Telescope"*)
2. A recent paper/astronomy news story (This newly discovered exoplanet which has an unusual atmosphere, this paper which speculates if a gravitational signal resulted in a supernova)
3. A project that you have done /are undertaking (Bachelors/Masters project, internship)
4. Answer the question *"What development do you think will change how we understand the Universe and why?"*

The main thing is to choose something you are passionate about!

Step 1: Define your Purpose and Audience

Before writing anything, clarify **why you're giving this talk** and **who it's for**. Remember: good science communication is audience centred.

Choosing a topic, write a one sentence purpose statement that centers the audience:

"At the end of this talk, I want the audience to understand/feel/care about....."

I'll talk about black holes ❌ ⟶ I want the audience to understand how black holes warp space and time. ✅

Make sure someone unfamiliar with astronomy understands your aim

Step 2: Choose One Take Home Message

Scientists have many things to say, but a clear outreach talk focuses on one take-home message.

Topic: Black Holes - Possible Messages:

Black holes form when massive stars collapse.

Black holes reveal the extremes of physics in the universe.

We can observe black holes indirectly by studying how they affect nearby stars.

Black holes are mysterious and exciting.

Write down a 3-4 possible messages relating to your chosen topic

Step 2: Choose One Take Home Message

Scientists have many things to say, but a clear outreach talk focuses on one take-home message.

Topic: Black Holes - Possible Messages:

~~Black holes form when massive stars collapse.~~

Black holes reveal the extremes of physics in the universe.

~~We can observe black holes indirectly by studying how they affect nearby stars.~~

~~Black holes are mysterious and exciting.~~

Make sure your message aligns with your audience and purpose

Cross out all but one to be your take home message

Step 3: Scope Control

Once you have your take home message, you need to decide what content supports it and what doesn't given your time frame.

Take home message: *Black holes reveal the extremes of physics in the universe.*

Possible content:

How black holes form

What happens inside a black hole

Gravity bending light and time

Observational evidence from stars

First photo of a black hole

Supermassive black holes in galaxy centers

Write a list of content for your topic

Step 3: Scope Control

Once you have your take home message, you need to decide what content supports it and what doesn't given your time frame.

Take home message: *Black holes reveal the extremes of physics in the universe.*

Possible content:

~~How black holes form~~

~~What happens inside a black hole~~

Gravity bending light and time

Observational evidence from stars

~~First photo of a black hole~~

~~Supermassive black holes in galaxy centers~~

Less is more, clarity > content

With your take home message in mind, cut down your content list to 2-3 points

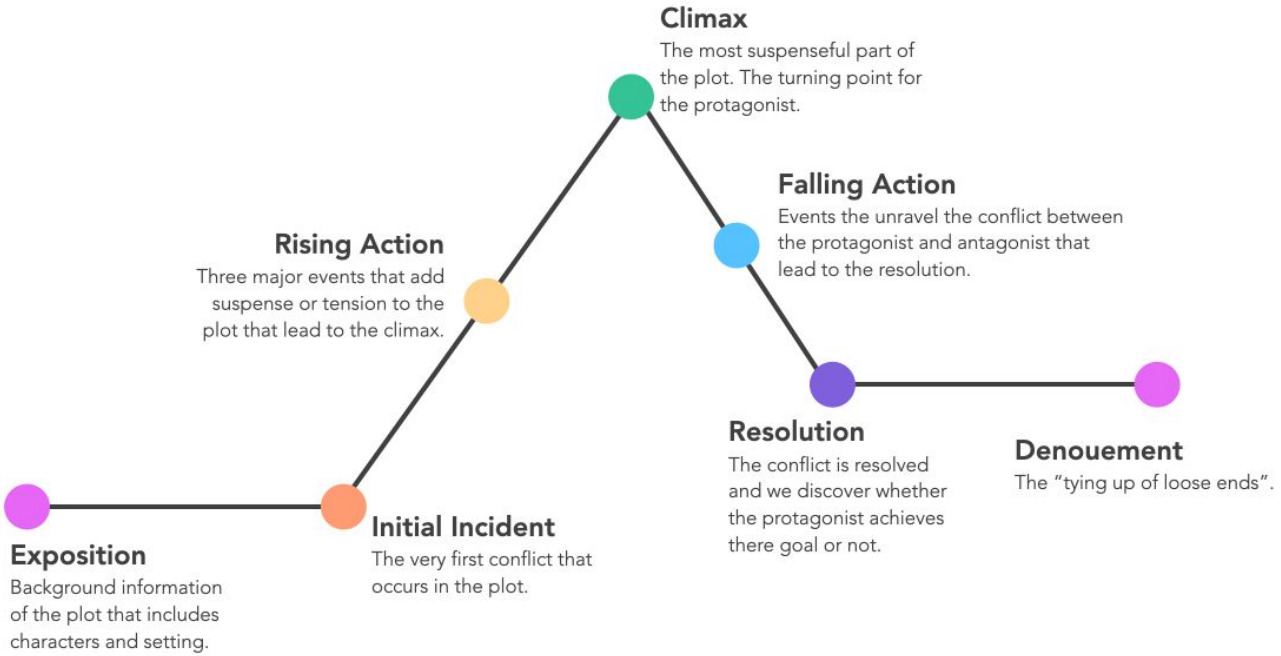
Step 4 :Storytelling for Science Communication

Storytelling aligns with how humans process, remember, and evaluate information.

- Humans make sense of the world through narratives – stories activate multiple brain systems (language, emotion, memory), leading to deeper processing.
- Information embedded in stories is remembered significantly better than isolated facts.
- Stories link logic with emotion, increasing attention, empathy, and long-term recall.
- Storytelling provides a natural structure and flow

Storytelling is not about adding fiction - it’s about choosing a structure

Structure of Storytelling



And, But, Therefore

Randy Olson - *“Houston, We Have a Narrative”*

And

Establishes the known

We understand gravity well here on Earth and in most of the universe.

But

Introduces conflict or tension

When a star collapses into a black hole, gravity becomes so extreme it warps space and time.

Therefore

Shows action, discovery or resolution

By studying black holes, we can explore the absolute limits of physics.

Storytelling Structures for Science

Question/Mystery →	**Exploration** →	**Resolution**
What happens if something gets too close to a black hole?	Gravity warps space, objects stretch, light bends	Crossing the event horizon is one-way and relativity rules extreme physics
Misconception →	**Tension** →	**Reframing**
Black holes suck everything in like cosmic vacuums	Intuitive but misleading idea - how do stars survive?	Gravity is extreme and black holes reveal the limits of physics
Old Idea →	**New Evidence** →	**Current Understanding**
Gravitational waves were unobservable	LIGO and Virgo detect merging black holes.	Gravitational waves let us observe black holes and test physics in extreme conditions.

Create a story structure for your message and place where you would put your content

Storytelling Techniques

In your storytelling you should use:

1. **Hooks** - Fact, image, question, image, knowledge gap. *“What really happens if you fall into a black hole?”*
2. **Tension/Conflict** - Problem, paradox or unknown. *“But why do stars survive?”*
3. **Characters** - Doesn’t have to be people! Could be a star, telescope etc. *“What happens to a photon falling into a black hole?”*
4. **Pacing** - Introduce ideas gradually, build suspense and vary rhythm. *Earth gravity → neutron star gravity → black hole extremes*
5. **Repetition** - Reinforce the core message throughout

Build your storyboard to ensure it has a hook and a moment of tension

Storytelling - what not to do

"Black holes are really dense objects in space. They pull in stars and sometimes planets, and light can't escape from them. Some are small, some are huge. They spin really fast and sometimes emit jets of radiation. Scientists discovered them using telescopes and gravitational waves, and they're really mysterious. Space behaves differently near them, and time slows down. People often say they suck everything in, but actually we don't really understand what happens inside them. Black holes are really important for understanding the universe, galaxies, and physics, and they might be dangerous if you get too close."

Storytelling - what not to do

- Oversimplifying, exaggerating or falsifying information for the sake of a good story - this is still science!
- Overloading with too many facts and numbers - listing exoplanet names or giving too many numbers can be overwhelming and uninformative
- Ignoring uncertainties and limits - instead work with known unknowns and unknown unknowns
- Gaps in the narrative - go through your storyboard with a friend to check there are no random jumps without explanation
- Losing sight of the message - avoid too many tangents that don’t link back

A better example

"Imagine a star so massive that when it collapses, it compresses into a point where gravity becomes unimaginably strong. Near its edge, called the event horizon, space itself curves and time slows relative to the outside universe. Light can orbit in circles, and matter falling in stretches and heats up, creating dazzling flares we can observe. By studying these extreme environments, we see how the universe behaves under the most intense gravity, revealing the limits of physics."

A better example

"Imagine a star so massive that when it collapses, it compresses into a point where gravity becomes unimaginably strong. Near its edge, called the event horizon, space itself curves and time slows relative to the outside universe. Light can orbit in circles, and matter falling in stretches and heats up, creating dazzling flares we can observe. By studying these extreme environments, we see how the universe behaves under the most intense gravity, revealing the limits of physics."

Mystery

Exploration

Resolution

Step 5: Map the Conceptual Spine

The conceptual spine is the sequence of ideas (not facts) that carries your message through the talk. These set waypoints that your talk travels though.

Take home message: *Black holes reveal the extremes of physics in the universe.*

1. Gravity behaves predictably in everyday space
2. Extreme mass bends spacetime dramatically
3. Light responds to spacetime curvature
4. Observing this lets us test physics at its limits

These are the ideas that link to one another, not the explanations

Using your storyboard, create a conceptual spine for your talk which links ideas together

Step 6: Develop Spoken Content

With the framework in place, we can now fill in the content, connecting each waypoint and explaining its meaning.

Avoid jargon where possible or explain it well if required

Conceptual point: *Light responds to spacetime curvature.*

1. Light usually travels straight, but near a black hole, its path curves because space itself is curved.
2. Stars or galaxies behind a black hole appear slightly shifted - that's how we know the light is bending.
3. The black hole doesn't 'suck' light; it just changes the space the light travels through.

For each point in your conceptual spine, expand into sub points to explain and join them together.

Step 7: Develop Metaphors and Analogies

Metaphors allow audiences to map new domains onto existing mental models and offer an opportunity to frame understanding.

Concept	**Good**	**Bad**
Black hole gravity	*A landscape so steep that all paths curve inward*	*Cosmic vacuum cleaner*
Event horizon	*One-way door*	*A point where time stops.*
Light bending	*Like a marble rolling near a steep slope, light follows the shape of space*	*Like a laser on a curved track*

Create up to two metaphors for concepts within your talk, watching out for misconceptions or pitfalls

One Metaphor, One Analogy, One Surprising Fact

Combining approaches allows entry points for different learners.

1. **Metaphor** - what it is

   “Crossing the event horizon is like a cosmic one way door”

2. **Analogy** - how it works

   “Light bending is like a marble rolling across hills - it follows the curve of space.”

3. **Suprising fact** - why it’s cool

   “If you watched someone fall toward a black hole, they’d appear to freeze at the edge - fading from view as time slows to a crawl.”

Step 8: Consider Audience Interaction

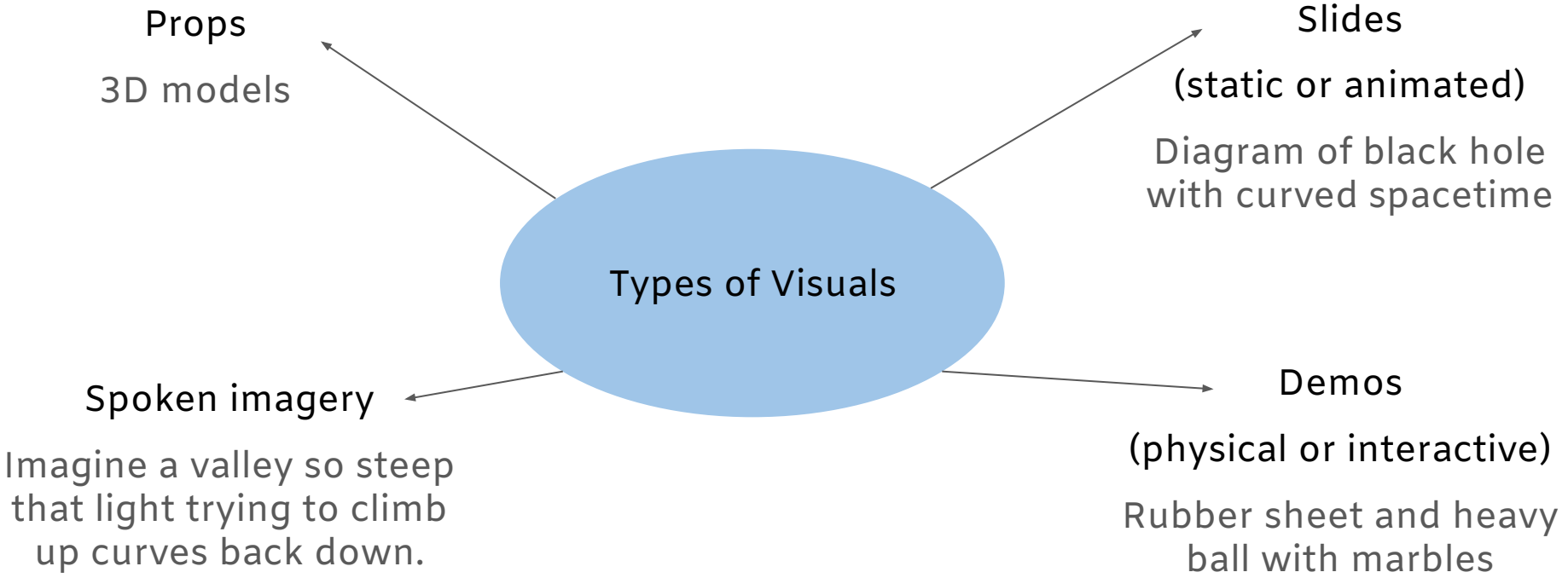
With the right audience/setting, audience interaction is a useful tool to move your communication towards a dialogue or participatory model.

Types of interaction:

- Show of hands - *“Who has heard of the term ‘spaghettification’?”*
- Open question - “*What do you think would happen if we got too close to a black hole?”*
- Demonstration participation - Participant in gravity well
- Guided observation - *“Look at this ring — what do you notice about the way the light bends?”*

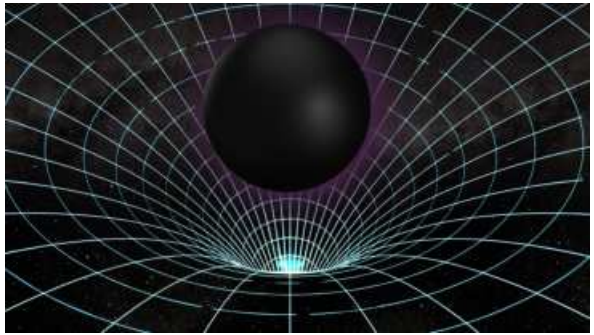
Think about whether an interactive moment would support your message, and add one if appropriate.

Step 9: Plan Visuals

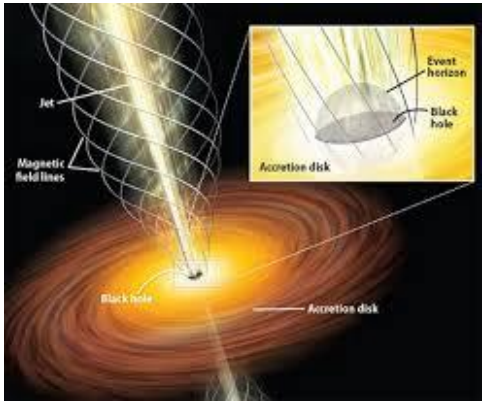


Bad Slide Example

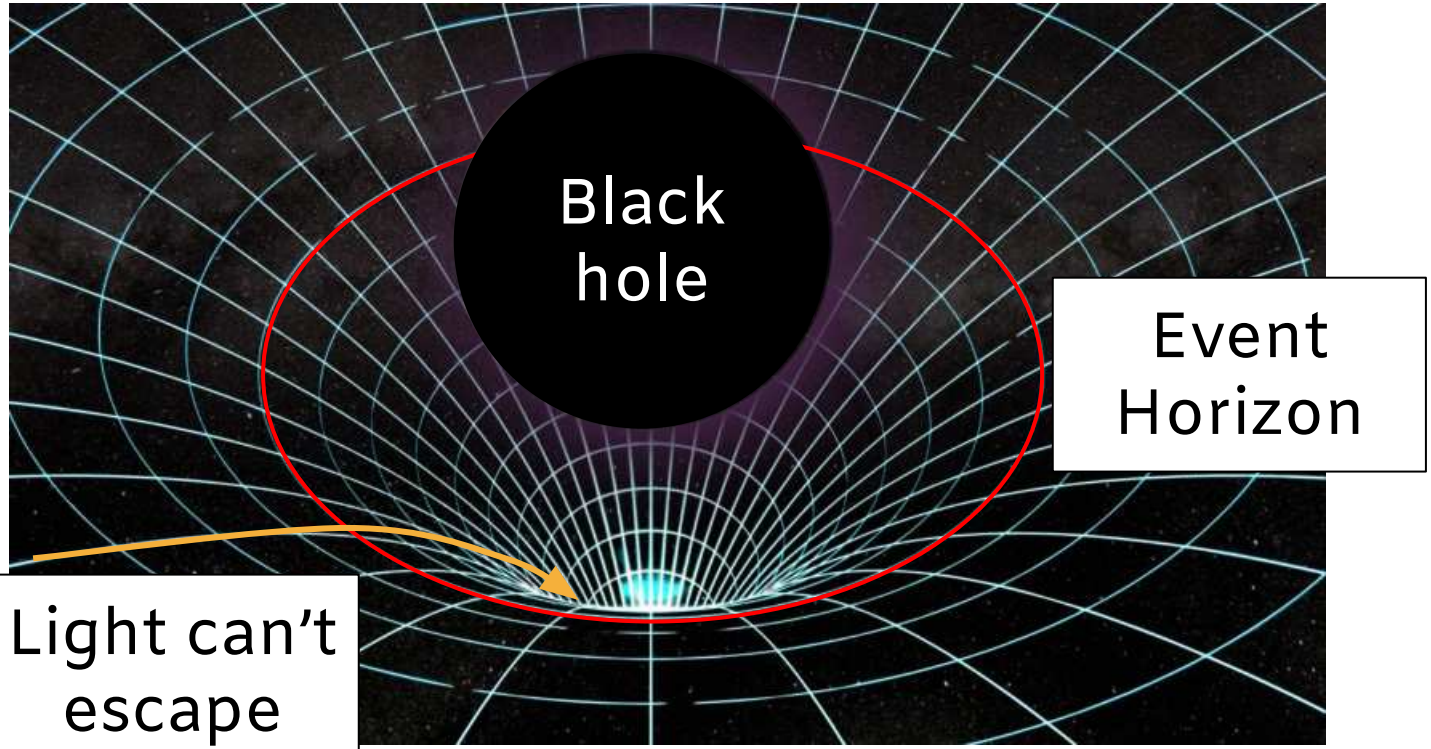
Black holes are extremely dense objects in space
Gravity is so strong that nothing, not even light can escape
They were first predicted by Einstein in 1915
Detected via X-rays, gravitational waves, telescope images



$$R_s = \frac{2GM}{c^2}$$



Better Slide Example

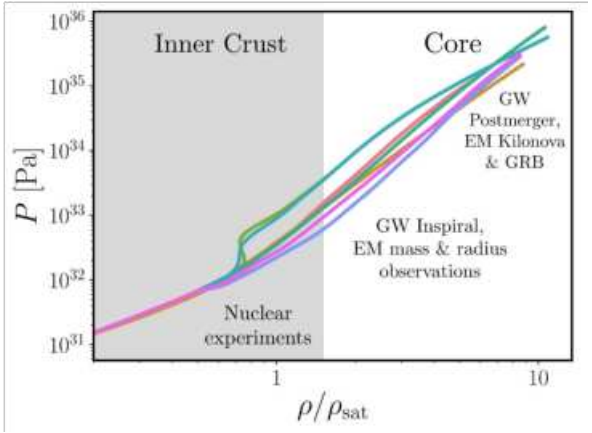


Visualising Data

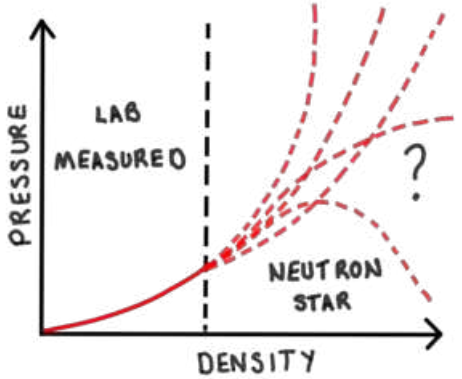
If you would like you can include plots - with a few caveats:

- Simplify the plot for the audience - don't recycle the plot from a paper, instead recreate it for your intended audience (remove unnecessary axes, error bars, legends)
- Highlight the key feature - what may be obvious to you will not be to others
- Consider an alternative such as a cartoon or schematic diagram

In a conference talk:



In an outreach talk:



Creating Effective Slides

Slides can be an effective (but optional) tool.

- One idea per slide - each slide should support one key idea
- Visuals first - text to a minimum, use labels but avoid sentences
- Use progressive disclosure - adding successive elements to diagrams
- Consistent with storytelling and metaphors - visuals support content
- Minimal slides - roughly one slide per minute
- Reference your slides, don’t leave as a backdrop with no explanation
- Use accessible slide construction to make your slides clear

Don’t let slides do the talking - connect with your audience

Add to your storyboard visuals (slides or otherwise) which support your narrative

Visual Accessibility

High text contrast	**Do this**	**Not this**
Easy to read fonts	**Do this**	*Not this*
Large font sizes	**Do this**	**Not this**
Minimum text amount	• **Do this** • **Or this**	**You really shouldn't do this it's just not ideal it makes following this very cumbersome and confusing**

Visual Accessibility

Combinations of colours, labels and symbols	**Do this**	**Not this**
Reasonable text spacing	**Do this**	**Notthis Or this**
Color Blind friendly		

Step 10: Finishing Your First Draft

You hopefully now have the full structure of a talk - this can be in bullet points or you can rewrite into a full script (just don't hold yourself to it word for word).

- Check your opening and ending - the opening is the hook and the ending reinforces the message and loops back to the opening
- Read through your entire talk and check for flow, clarity and that the take home message is present throughout and clear
- Ask a peer to review your script and check for gaps or confusion
- Read your script aloud and check for timing - cut where needed

Swap your bullet point structure with a partner and give feedback to one another keeping in mind the narrative, flow and clarity

Writing a Science Outreach Talk Checklist

1. Define Your Purpose and Audience
2. Choose One Take Home Message
3. Scope Control
4. Storytelling Structure
5. Map the Conceptual Space
6. Develop Spoken Content
7. Develop Metaphors and Analogies
8. Consider Audience Interaction
9. Plan Visuals
10. Finish Your Final Draft

04
Presentation Skills

““It usually takes me more than three weeks to prepare a good impromptu speech.”

- Mark Twain

The Importance of Effective Presentation Skills

A great script is only as great as how you deliver it - presentation skills determine what the audience actually experiences, remembers and trusts.

Effective presentation skills:

- Ensure the audience take home the take home message you laid out for your talk
- Allow the science content to be digested, understood and motivated
- Increases your personal self confidence and skill set

Public Speaking as A Skill

Public speaking is not an natural ability - it is a learned and practiced skill that anyone can develop.

Extroverts may feel more comfortable being seen or heard initially, but this does **not** translate to being a better speaker. A confident speaker can easily waffle and be unclear as a result.

Introverts often have more trouble getting the confidence to speak, but may be more purposeful and clear in their message.

You don’t need to become someone else to speak well — the most effective presentations come from honing your delivery while staying true to your personality.

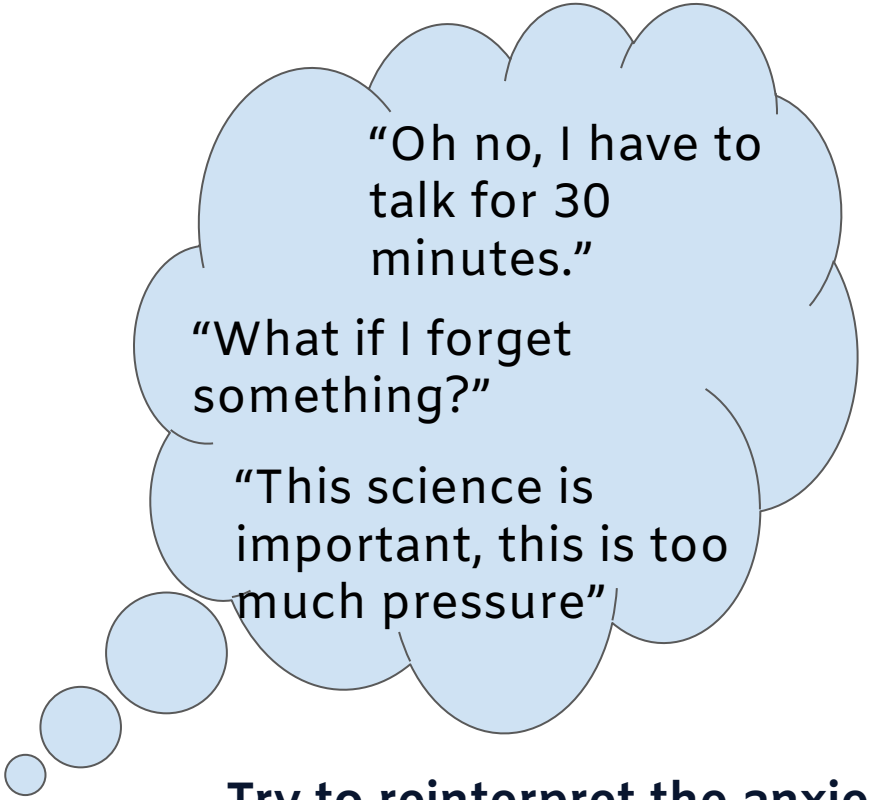
Overcoming Public Speaking Anxieties

Public speaking comes with fear and anxiety - this is natural! You're putting yourself in a vulnerable position.

The goal is not to eliminate fear, but to overcome it.

- Remember public speaking is not a test of your worth or intelligence
- Practice and preparation restore control
- Nerves can be harnessed and used as energy that enhance your presentation
- Focus outwards on the audience, not inwards on yourself
- Be ok with embarrassing yourself - it can work in your favour
- What is worst case scenario? Embarrassment? Is that really so bad?
- Remember: **The audience doesn't know your script!**

Reframing Your Mindset



“I can use these nerves as energy”

“A small slip is human and I can always recover”

“I’m fortunate to be given a platform to talk about the science I love”

Try to reinterpret the anxiety as an engagement, not a threat

Voice

1. **Volume** - Talk to the people at the back. If you're naturally quieter, ask for a microphone. Vary volume to signify importance.
2. **Pace** - Slower than you think, allow for some variation.
3. **Pitch & Tone** - Dynamic pitch/tone to convey contrast & emotion.
4. **Inflection** - Communicate the meaning behind words
   a. Rising intonation - question or continuation
   b. Falling intonation - conclusion or certainty
5. **Pauses** - Allows the audience to process information, signal transitions or importance, and dramatic emphasis.
   a. Pause before key point - builds anticipation
   b. Pause after key point - allows processing and retention

Try and pause instead of using filler words!

Same Line, Different Meanings

“This planet orbiting a distant star might have conditions for life.”

In pairs, choose a context from the list, deliver the line in that style, and have your partner guess which one it is:

1. Concluding fact
2. Opening hook of a talk
3. Transition to another topic
4. Suspenseful moment
5. Warning

How does your volume, pace, tone, intonation and pauses communicate the context? What did your partner pick up on? Would they do it differently?

Body Language

1. **Posture** - Upright, open stance with a slight forward lean. Shapes audience perception and your internal confidence.
2. **Eye Contact** - Share attention across the room (2–3 seconds per person). Helps regulate pace and tone. Foreheads are fine if eye contact feels hard.
3. **Facial Expression** - Natural and aligned with your message. Let curiosity, excitement, or seriousness show.
4. **Gestures & Hand position** - Use gestures to show scale, process, and emphasis. If a gesture adds no meaning, stillness is more powerful. Keep hands relaxed and visible.
5. **Orientation** - Face the audience when speaking, even when referencing slides do not fully turn away.

Using the Space

To move or not to move? This is a debated topic - my opinion? Move!

My reasons for preferring movement:

1. Keeps audience attention - staring at the same spot can be tiring
2. Channels nervous energy out of your body
3. Punctuates ideas: walk on explanation, stop for conclusions/questions
4. Supports story flow: use stage areas for different parts of your narrative, and physical transitions can support story transitions
5. Movement towards the audience can improve connection, i.e. for Q&A
6. Makes the talk appear more natural and conversation

Don’t pace, fidget, or overdo it - movement should add not distract

Rehearsing Your Talk

1. **Use an outline** - Practice from bullet points, not a full script. Focus on ideas, not exact wording. Avoids you sounding robotic, fixating on mistakes and swallowing flexibility. Try changing wording each time.
2. **Spread practice over time** - Multiple sessions build memory, reduce anxiety, and let your brain process between sessions.
3. **Focus improvements** - Work on one or two adjustments per session.
4. **Practice under realistic conditions** - Add noise, distractions, or different environments.
5. **Learn your edges first** - Memorize the first and last sections — the middle flows more easily.
6. **Record yourself** - Not in a mirror! Focus on your talk in the moment and how you can improve after.
7. **Time your talk** - If given a time allowance, ensure you stick to it!

Impromptu Speaking

Here I have a bag of notes with random things written on them, passing this bag around, each person will pick a note and speak uninterrupted for 30 seconds on it.

Practice confident, clear vocal delivery and body language under pressure. Choose one main idea and angle such as:

- Describe it as if you love it
- Describe it as if you don’t trust it
- Describe why it matters
- Describe how it makes you feel

Don’t worry if it’s not perfect or you mess up! This exercise is meant to be practiced over time to build these skills. Start by talking with intention and over time build in structure and flow.

Frameworks

Frameworks help structure your thoughts when speaking on the spot. Some common frameworks are:

Point → **Reason** → **Example** → **Point**

This exoplanet could support life → It's in the habitable zone where water can exist → Telescope data shows water vapour → So it's a candidate for supporting life

What? → **So what?** → **Now what?**

A comet is passing close to Earth → It's moving faster than expected → Grab your binoculars tonight and look up

1 thing → **2 types** → **3 steps**

Not all habitable zone planets are truly habitable → There are two main kinds of exoplanets: gas giants and rocky planets → How we find exoplanets: 1) Watch stars dimming, 2) Measure velocity shifts, 3) Analyze atmospheres

Answering Questions

Answering questions can seem daunting, as you can't always plan for them:

- **Anticipate questions** - purposefully leave question traps!
- **Listen to the full question** - don't interrupt, even if you think you know
- **Repeat the question** - this allows for everyone to hear, you to have time to think and that you make sure you have correctly understood the question
- **Acknowledge the question** - "*That's a great question*" gives you time and them confidence
- **Pause before answering** - try not to waffle into an answer, think clearly
- **Don't be afraid to say "I don't know"** - maintains accuracy and breaks the myth that scientists know everything, humanising science
- **Check for understanding** - *"Does that answer your question?"*

Outreach Talk Opportunities

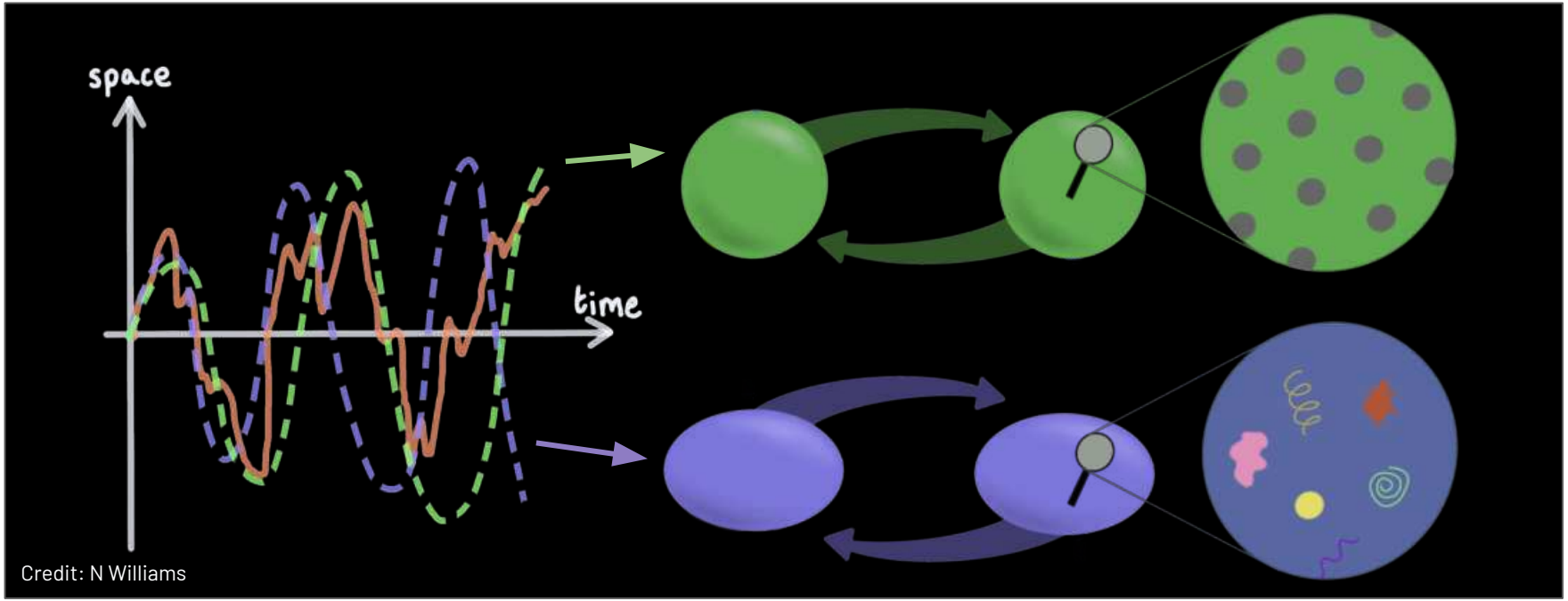
- Science Slam Potsdam - 16th July 2026, Golm
- Pint of Science - 18th-20th May 2026, Potsdam & Berlin
- Berlin Science Week - November 2026
- Long night of Astronomy - September 2026, Potsdam
- Science Slam Zeiss Planetarium - Throughout Year, Berlin
- Science Slam Berlin - Throughout Year, Berlin

Outreach Talk Assignments

Next week you will be giving your own 5 minute lightning talks as per the guidelines last week:

- I will give a 1 minute, 30 second and 10 second warning to keep to time.
- There is a space to upload any slides if you would like them (PDF only).
- There may be questions if time allows.

Example Outreach Talk



05
Digital Science Communication

“The medium is the message”

- Marshall McLuhan

Planetarium Trip Logistics

Urania planetarium @ 12:30-13:30 next Friday, the 5th of June

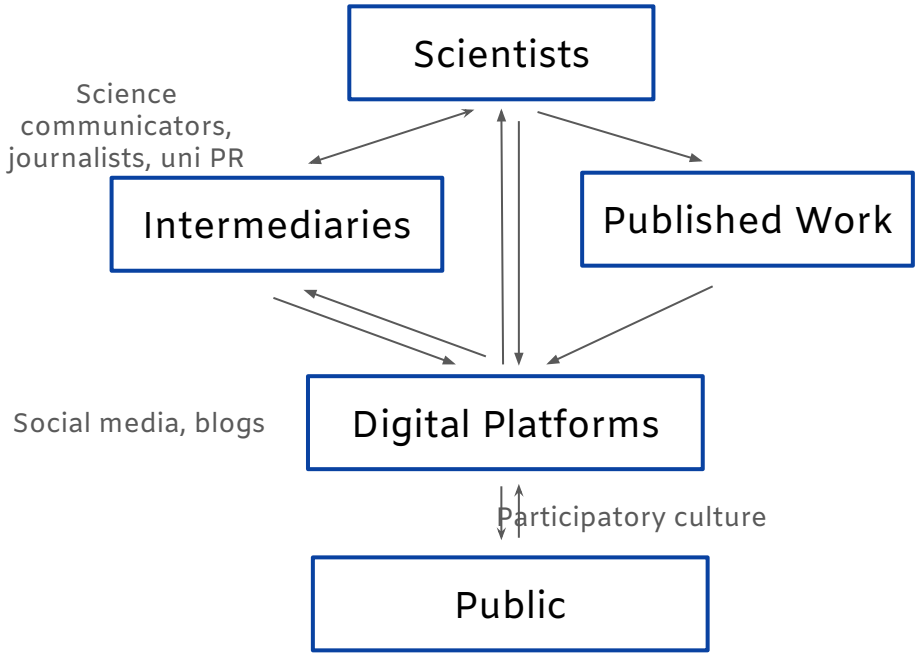
Transport

Outward:
X5 - Science Park/Universität @ 11:51 to Platz der Einheit/West
or
695 - Science Park/Universität @ 11:52 to Jägertor/Justizzentrum

Return:
X5 - Platz der Einheit/West @ 13:48 (arrive in Golm 14:06)

Digital Science Communication

- Digital science communication allows scientists to interact directly with their (sometimes hard to reach) audience
- In turn the audience is not passive but *active*, with the ability to comment, share and interpret what they see
- This means that the flow of knowledge online is non-linear
- In addition, online platforms are not neutral - algorithms amplify some content and suppress others



Deficit ⟶ Dialogue/Co-Producing

Influence, credibility and authority vary dramatically

Social Media for Science Communication

Social media can be used for:

- Personal science communication
- Institutional science communication (university, collaboration etc)

Personal	Institutional
Human identity	Abstract authority
Dialogue	Deficit
Adaptive	Controlled
Harassment	Brand protection
"Views are my own"	Collective voice & risk averse
Higher trust	**Higher credibility**

Social Media Platforms

Platform	Audience	Content	Best use	Examples
Twitter/X	18-49, professionals, journalists	Text, threads, images	Rapid updates, myth-busting, expert commentary	EHT black hole threads, live tweeting conferences
Instagram	18-35, visual oriented	Images, reels, stories	Lab life, infographics	NASA planetary science infographics
TikTok	16-35, entertainment	Short videos, duets, stitches	Quick explainers, myth-busting	#PhysicsTikTok
Youtube	18-45, education focussed	Long-form videos, shorts, livestreams	Deep explainer videos, series	Veritasium, Kurzgesagt
Reddit	18-35, niche communities	Text, images, articles, AMA	Q&A, public consultation	r/AskScience AMAs, r/space discussions

Forms of Science Content on Social Media

Microcommunication

Short form explainers

Myth-busting posts

Threaded explanations

Images of lab work or experiments

Infographics

Macrocommunication

Long form explainers

Educational series

Webinars & livestreamed talks

Podcasts

Participatory

Q&A sessions (AMA, instagram lives)

Duets, stitches, reaction videos

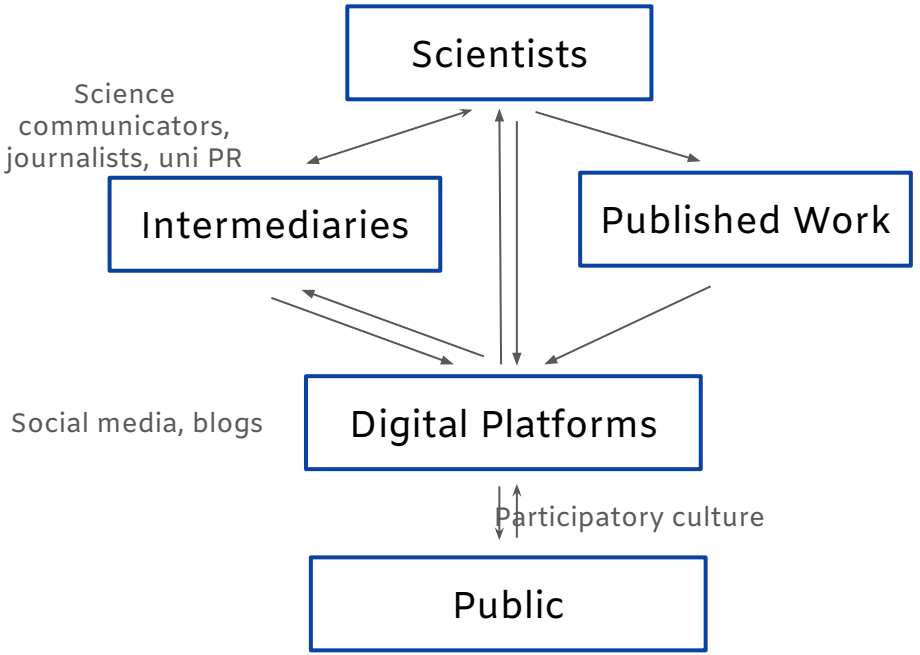
Polls & quizzes

Citizen science

Hashtag campaigns

Misinformation and Mutation

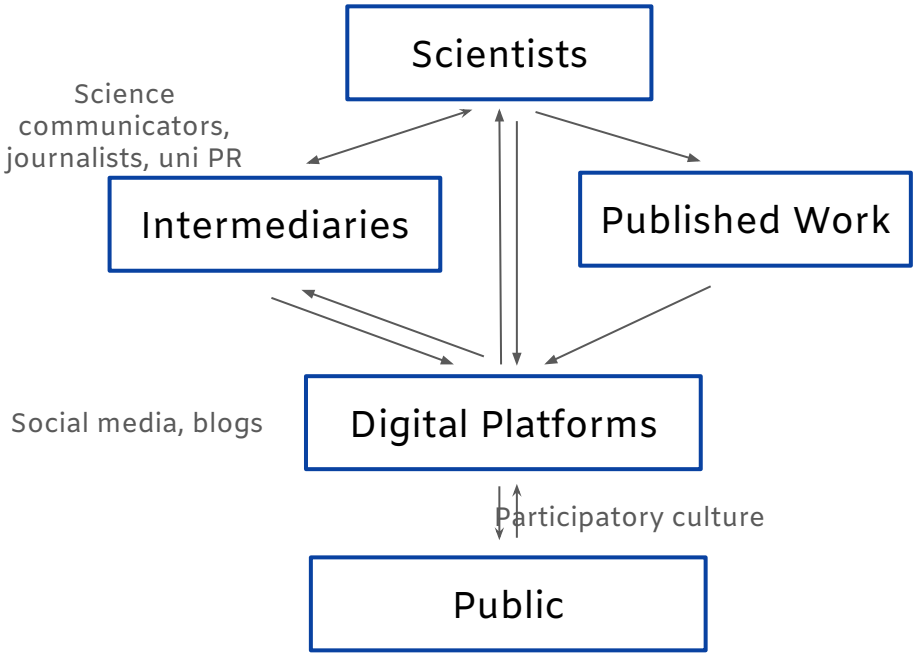
- Mutation is the changing of a scientific message as it moves through platforms, communities and formats
- Causes can be platform constraints, audience reinterpretation, algorithmic etc
- This is often not malicious and even positive, but in worst cases can lead to misinformation



Misinformation and Mutation

Exercise: Science telephone
Each of you has the UP press release from a recent paper. You will rewrite and pass along this as:

1. A popular science journalist (3-4 sentences)
2. An online science communicator (2-3 sentences)
3. A member of the public (1 sentence)



WHAT NO ONE HAS SEEN BEFORE: GRAVITATIONAL WAVEFORMS FROM WARP DRIVE COLLAPSE

KATY CLOUGH[1,2], TIM DIETRICH[3,4], AND SEBASTIAN KHAN[5]

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Version July 25, 2024

ABSTRACT

Despite originating in science fiction, warp drives have a concrete description in general relativity, with Alcubierre first proposing a spacetime metric that supported faster-than-light travel. Whilst there are numerous practical barriers to their implementation in real life, including a requirement for negative energy, computationally, one can simulate their evolution in time given an equation of state describing the matter. In this work, we study the signatures arising from a warp drive 'containment failure', assuming a stiff equation of state for the fluid. We compute the emitted gravitational-wave signal and track the energy fluxes of the fluid. Apart from its rather speculative application to the search for extraterrestrial life in gravitational-wave detector data, this work is interesting as a study of the dynamical evolution and stability of spacetimes that violate the null energy condition. Our work highlights the importance of exploring strange new spacetimes, to (boldly) simulate what no one has seen before.

Misinformation and Mutation

WHAT NO ONE HAS SEEN BEFORE: GRAVITATIONAL WAVEFORMS FROM WARP DRIVE COLLAPSE

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Version July 25, 2024

ABSTRACT

Despite originating in science fiction, warp drives have a concrete description in general relativity, with Alcubierre first proposing a spacetime metric that supported faster-than-light travel. Whilst there are numerous practical barriers to their implementation in real life, including a requirement for negative energy, computationally, one can simulate their evolution in time given an equation of state describing the matter. In this work, we study the signatures arising from a warp drive 'containment failure', assuming a stiff equation of state for the fluid. We compute the emitted gravitational-wave signal and track the energy fluxes of the fluid. Apart from its rather speculative application to the search for extraterrestrial life in gravitational-wave detector data, this work is interesting as a study of the dynamical evolution and stability of spacetimes that violate the null energy condition. Our work highlights the importance of exploring strange new spacetimes, to (boldly) simulate what no one has seen before.

↓ Informative

What no one has seen before – simulation of gravitational waves from failing warp drive

Warp drive, gravitationa

YouTube · Astro-Tim

04.05.2025

↑ Cool!

COSMOLOGY | RESEARCH UPDATE

What happens when a warp drive collapses?

14 Sep 2024

Simulations of space–times that contain negative energies can help us to better understand wormholes or the interior of black holes. For now, however, the physicists who performed the new study, who admit to being big fans of Star Trek, have used their result to model the gravitational waves that would be emitted by a hypothetical failing warp drive.

Erm...

Engage warp drive! Scientists say Star Wars-like travel between galaxies could be a reality in the next 100 years

- **READ MORE:** How humans could travel millions of light years to distant planets

By WILIAM HUNTER, SENIOR SCIENCE & TECHNOLOGY REPORTER
PUBLISHED: 07:51, 4 May 2025 | **UPDATED:** 16:24, 5 May 2025

Share 23 shares 199 View comments

Anyone who grew up obsessed with **Star Wars** will know the thrill of seeing Han Solo and Chewbacca launch the Millennium Falcon into hyperspace for the first time.

In the films, hyperdrive engines allow ships like the Falcon to leap around the Universe faster than the speed of light to reach distant planets in just minutes.

But as fans celebrate 'Star Wars Day' this May 4, experts have said that this futuristic tech isn't entirely science fiction.

↓ No

JamesOf The PalmerDivide @CBDCisSlavery · Dec 20, 2024

I would bet the government has working gravity wave detectors that can read these type craft.

203

If misinformation occurs, react fast to clarify the facts!

Videos for Science Communication

- Video formats for science communication have been shown to lead to better information retention due to the multiple sensory channels
- Creating videos allows multiple content depths, non linear learning (pause, replay etc), and layered explanations
- Framing effects such as tone and emphasis allows shaping of audience interpretation

What if a star explodes near Earth?
Veritasium
11m views • 3 years ago

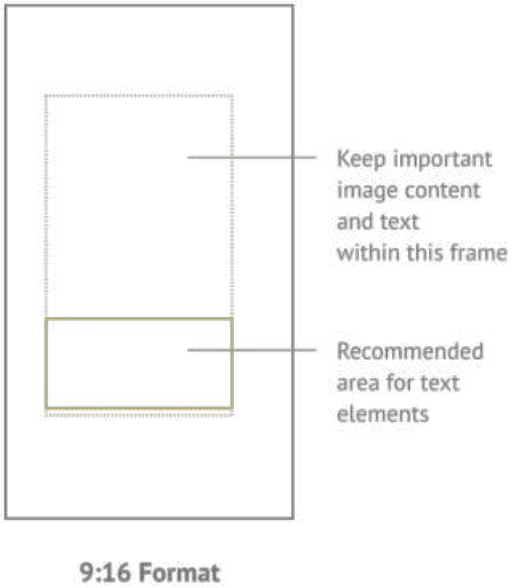
The Unreasonable Efficiency of Black Holes
minutephysics
4.3m views • 7 years ago

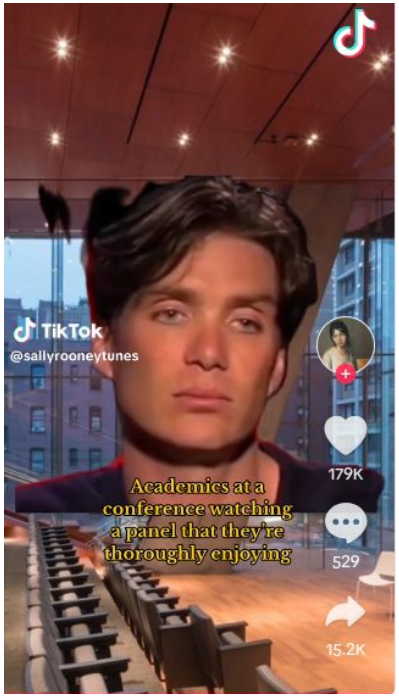
Theoretical Physicist Brian Greene Explains Time in 5 ...
WIRED
3.7m views • 2 years ago

Creating Videos

1. **Aims** - define a topic & a main message
2. **Decide a communicative form** (Educational, entertaining, visually satisfying, behind the scenes)
3. **Write a script**
    a. **Hook** - grab attention at the start
    b. **Educate** - elaborate accurate but coherent science
    c. **Call to action** - where to learn more (from you!)
4. **Storyboard** - a visual plan for each scene (Are you there? What background? Where are the captions? Other visuals?)
5. **Record** - lighting, noise levels and energy! Look 1 cm below the lens, use your hands, avoid verbal pauses
6. **Edit** - Trim silence, add captions & multimedia (music, visuals)
7. **Post** - Use multiple platforms, create a caption
8. **Engage** - Reply to comments, address misunderstandings etc

Creating Videos





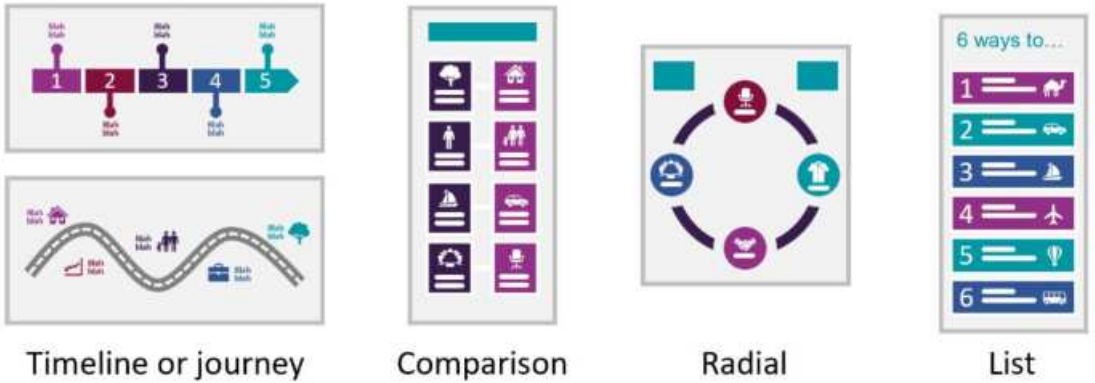
Layout tips

Infographics

Infographics allow easily shareable and digestible concepts and statistics - less likely to devolve into misinformation. After understanding your aims and audience:

- Decide how to visually communicate the data
- Decide on a structure and flow

Applications:
Canva
Adobe Illustrator
Piktochart
Inforgram
Inkscape
Google slides



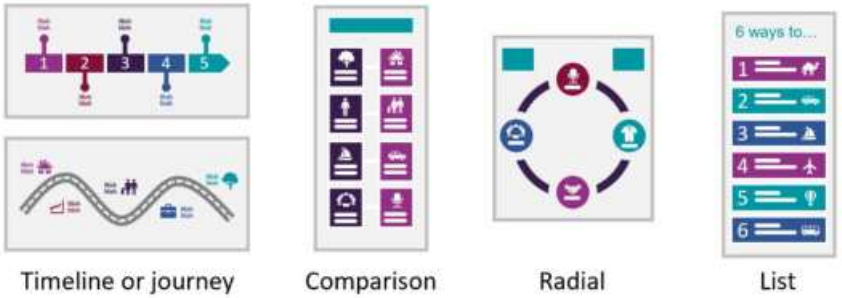
Timeline or journey | Comparison | Radial | List

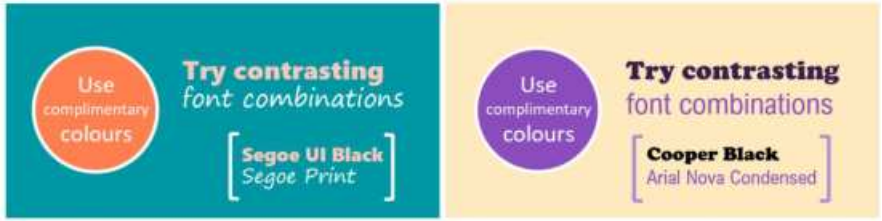
Consider the size for the format!

Infographics

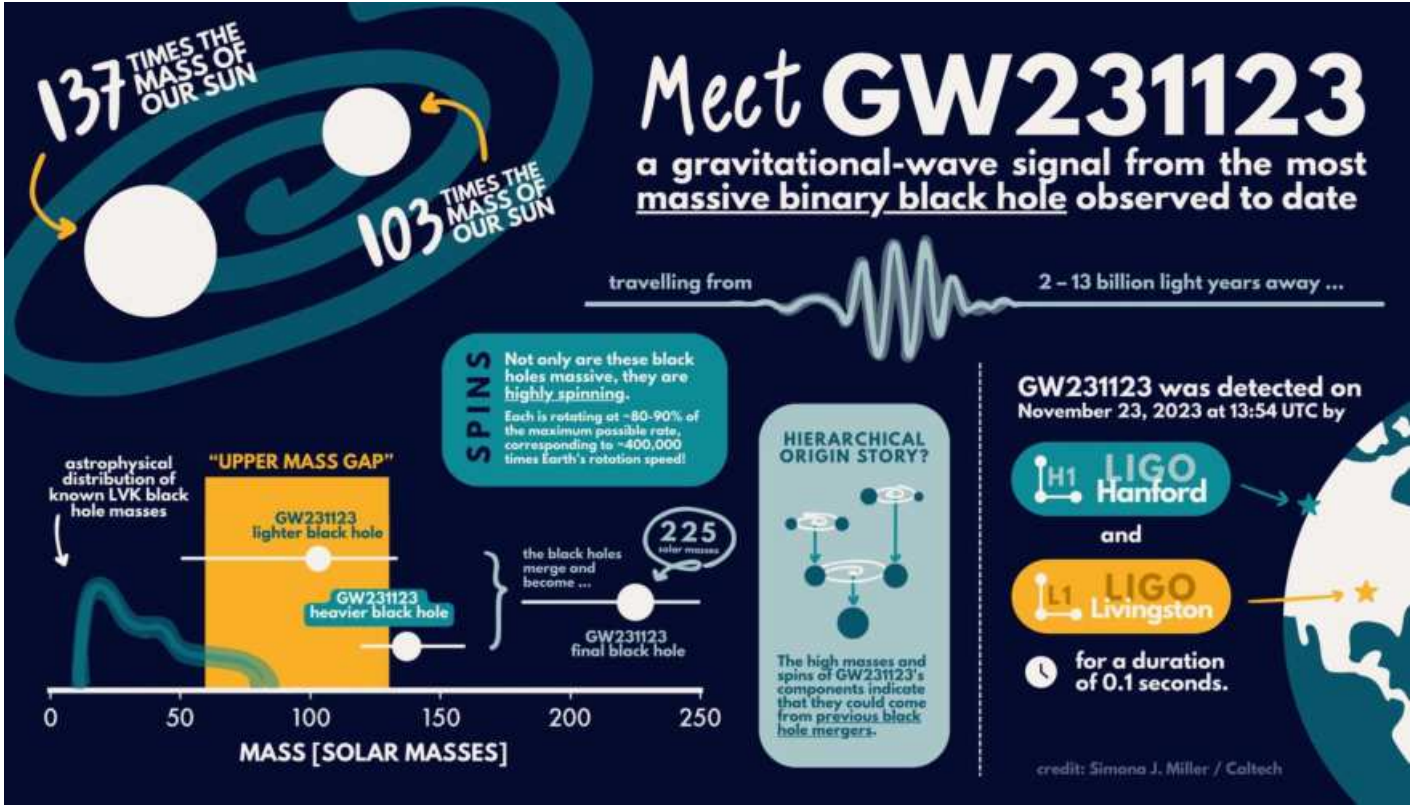
Infographics allow easily shareable and digestible concepts and statistics - less likely to devolve into misinformation. After understanding your aims and audience:

- Decide how to visually communicate the data
- Decide on a structure and flow
- Incorporate clear labels
- Work on your style & colours
- See visual accessibility guide





Infographics



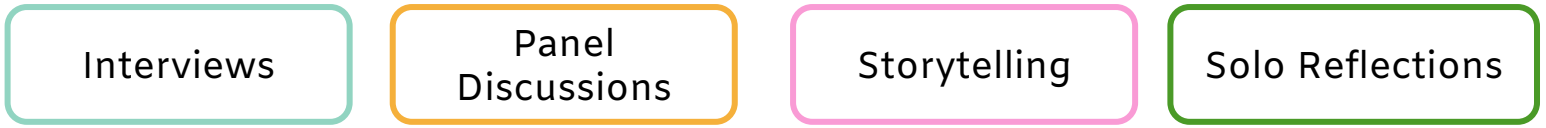
Blogs

- Though some would argue outdated, blogs provide a middle ground between science communication and academic writing
- As an academic, a blog can be a place for your CV, publication list, code, and outreach activities (great on job applications)
- You can link social media posts to your blog posts, where you give more in depth and nuanced details on your research such as uncertainty and assumptions - whilst still keeping simple language
- Blogs can centralise content - linking to videos, infographics etc
- Blogs often provide a valuable resource for journalists and other scientists

Example: Christopher Berry's blog on gravitational-waves

Podcasts

Podcasts involve long form communication with interested audiences, allowing a deeper dive and more nuance



Unlike scripted meda, dialogue allows for turn-taking, clarification, scientific reasoning in real time and even healthy disagreement. This makes the podcast format well suited to communicating not only scientific findings, but *how it works,* giving authenticity.

Giving an Interview

As a researcher you are more often a interviewee on another's platform, and not creating your own content from scratch. Some tips for giving interviews:

- Choose your format - phone/video interview or email interview? Figure out what suits you best and advocate for it.
- Prepare - Research the interviewer.
- Be respectful of deadlines - writing and editing time etc
- Be clear and use simple language - even if they are a science reporter
- Ask for reiteration - gauge understanding and adjust your language
- Steer the conversation - you are in control!
- Do not risk scientific accuracy for simplification, or allow your interviewer to do so *"I wouldn't frame it as X — a better way to think about it is..."*
- Ask for the final result before publication - reduce misinformation risk

Message Control

Mechanisms	What is actually happening?
Limits	What this does not show
Significance	Why this matters

Citizen Science

Citizen science allows public participation across scientific research, including in data collection, observation, analysis and interpretation - **not outreach or engagement but co-production.**

Due to the scalability this is often done online, with scientific rigor balanced with user engagement. Typical tasks given are:

- Classification - often used as machine learning training data
- Data collection - rainfall, temperature etc
- Measurement - e.g. counting in images
- Peer review - cross-validate other contributions

Citizen Science

Exercise: Spend 5 - 10 minutes taking part in one or more of these astronomy citizen science projects

Galaxy Zoo
Classify galaxy types

Gravity Spy
Identify gravitational-wave glitches

Burst Chaser
Find gamma ray bursts from data

How does citizen science change how we experience and understand research compared to other digital formats?

06
Designing an Outreach Activity

"Tell me and I forget. Teach me and I remember. Involve me and I learn."

- Xun Kuang, *Xunzi*

Science Communication Questions

1. **Why am I doing this?**

Are you trying to inform? To inspire? To change minds? To secure funding? To gain visibility?

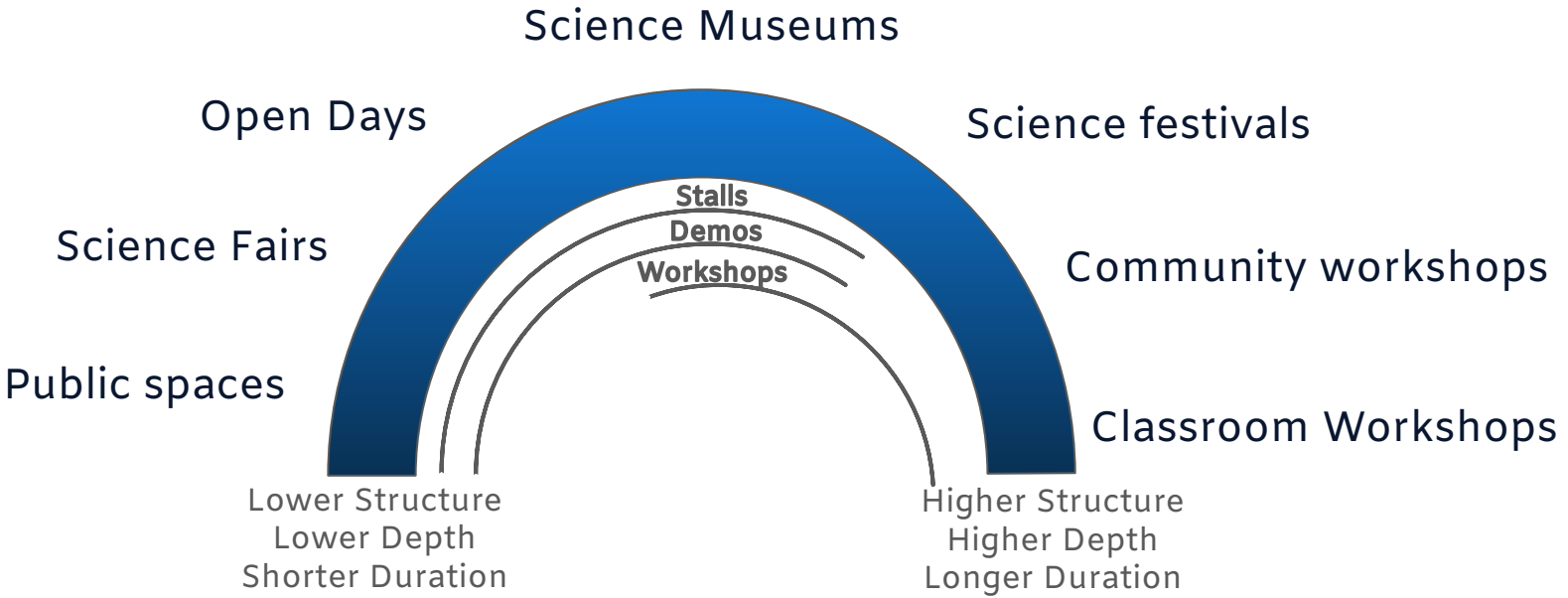
2. **Who is your audience?**

See second

3. **What format will you choose?**

This should follow from the first two questions, what format fulfils both your aims and the audience's needs?

Outreach Activity Formats & Settings



Outreach Activity Formats & Settings

Stalls

Public lead & low audience commitment

Tabletop games, visual posters, maker station

Demonstrations

Facilitator lead & low audience commitment

Gravity well, experiments, live Q&A

Workshops

Facilitator lead & high audience commitment

Crafts & experient building, citizen science, storytelling

Outreach Activity Matching

Given the topic **stars**, as a class come up with a broad idea for an outreach activity that aims to inspire and inform in for format of a

1. **Drop in stall in a science museum**
2. **Demo in a high school science fair**
3. **Classroom workshop for 13-14 year olds**



Logistic Considerations

- **What is the space you will be doing this activity in?**
  - What is the legal capacity?
- **What equipment do you need?**
  - How much do you need for the expected number of people?
  - If electrical is it CE-marked?
- **How many people do you need to facilitate this?**
  - Will you need to factor in breaks?
- **Realistically how much time does this activity take?**
  - How long will it take to reset the activity?
  - How long will it take to set up?
- **How will you transport everything/everybody?**
  - Will the equipment fit in the vehicle? Does it need secured?
  - What is the access like? Will you have help to unload?

Setting up the Space

- **Can people see what is happening from a distance?**
  - Where are you standing? Make sure not to block your visuals!
- **Is it clear where to stand, how to join and how to exit?**
  - Make it a smooth triangle, not a knot. Use floor tape strategically.
- **Hide your clutter to avoid visual noise**
  - Do the venue provide tablecloths or should you bring one?
- **Use vertical space & consider lighting**
  - Add height variation, use clipboards, bring lighting if needed.
- **Is your space accessible?**
  - Can wheelchair users and children fo example reach everything?
- **Manage crowd density**
  - Put read only material to the side so browsers don’t block things.

Setting up the Space

- **Make an outreach ‘survival kit’**
  - Tape, wipes, blu tack, zip ties, water, snacks, batteries, scissors, string.
- **If it is outdoors consider the elements**
  - Weigh down everything, laminate information (matte finish to minimise glare), check weather and prepare for rain.
- **Label everything you can**
  - Avoid anyone taking your equipment.
- **Consider hygiene**
  - Provide hand sanitiser for hands on activities.
- **Consider mess**
  - Provide easy and accessible bins for craft based outreach.
- **Know emergency procedure**
  - Do you know where the first aid contact is and fire assembly point?

What is the hook?

It takes on average 3 seconds for a member of the public to look at your outreach and decide if they're going to stop - it's important to have a hook to draw them in.

Hook → **Interaction** → **Explanation**

Try and make any information and visuals you have link back to your hook

Visual: *Spinning model of a planet on a stick*

Question: *"Can you guess which metal floats on water?"*

Demonstration: *Dropping a ball into a water stream to show turbulence*

Interaction: *"This balloon represents the expanding universe - can you stretch it?"*

Come up with possible hooks for your outreach ideas

Running an Effective Outreach Stall

- **Make it attractive**
  - Height variation, colour, motion - but not too busy.
- **Prioritise multi-purpose materials**
  - A single model illustration multiple concepts.
- **Chat to your neighbours**
  - If you have neighbouring stalls get to know them for toilet cover or emergencies.
- **Have separate areas for observation, interaction and reflection**
- **Initiate interaction**
  - Smile, greet and make eye contact with passers by - use your hook.
- **Ask open ended questions**
  - Let participants experiment, predict, or observe.
- **Energy is contagious - be enthusiastic within the realms of being yourself**

Running an Effective Demonstration

- **Avoid mess as much as is possible**
  - Less reset time means more reach
- **Reel people in the with demo, then explain - not the other way**
  - Use your hook to get them in, repeat the experiment with explanation if possible
- **Be visible**
  - Stand on a box or raised platform if appropriate
- **Where is safe, allow volunteers to help**
  - Bring non volunteers in by asking questions and predictions
- **Explain clearly and use analogies and metaphors**
  - Provide explanations to reach all parts of your audience
- **Rehearse the demonstration**
  - Test in different settings with different audiences

Running an Effective Workshop

- **Consider the story of your workshop**
  - Break the session into segments with a thread tying everything together
  - Ie Hook →Core activity→ Reflection & Discussion
- **Consider timing**
  - Allocate timing for each section, and develop contingency plans
- **Encourage peer discussion**
  - Move around the room to observe, support, and redirect attention
- **Set up the layout of the room to support your format**
  - Horseshoe for discussion, clusters for teamwork, rows for watching
- **Make instructions very clear**
  - In front of them and projected up front
- **Staggered Setup**
  - Have material in ‘kits’ rather than one big pile

Extra tip:
If running a school workshop consult the curriculum for that age group and work in learning objectives

Using Metaphors

“Black holes are like a cosmic vacuum cleaner that nothing can escape.”

- Metaphors help audiences grasp concepts, makes science relatable and memorable, and bridges prior knowledge to new ideas.
- Metaphors will work differently for different audiences - multiple metaphors
- It is important when using a metaphor to pick something the audience comes across in their everyday lives and are familiar with
- Using metaphors can provide a natural starting point for an activity
- It is important when coming up with metaphors to anticipare unintended interpretations, and ensure it doesn’t oversimplify and lead to misconceptions

Come up with a metaphor for one of your outreach activities, share it with your partner and share what works, and possible pitfalls

Engagement Strategies

Common outreach activity strategies and examples are:

- **Demonstrations & Hands on Experiments**
  - Gravity well, infrared camera demo, pendulum
- **Gamification**
  - Match exoplanets to stars for habitation, times quiz stations
- **Crafts & Model Building**
  - Bridge building for engineering, paper planes for aerodynamics
- **Simulations & Role-Play**
  - Modelling orbital dynamics with participants, role play star formation
- **Visuals**
  - Posters, video clips,
- **Data collation & citizen science**
  - Counting sunspots, classifying galaxies

Example: Gamification

How much do you know about dinosaurs?

Example: Demonstrations

“In a flexible linked system, momentum transfer and internal forces determine the motion of each segment under gravity”

Legal Compliances

- If you have staff or volunteers helping **you** are responsible for their safety
- Institutions often carry public liability insurance (*Haftpflichtversicherung*) for outreach activities - check for your institution
- Risk assessments (*Gefährdungsbeurteilung*) are often required (see later)
- You should **never ever** be left alone with minors or vulnerable persons
  - A legally responsible caretaker should be with you at all times - you are **not** daycare
  - Formal safeguarding training is generally required when the facilitator assumes legal supervisory responsibility
- If you plan on taking photographs you **must** have written consent from participants or legal guardians
- Ensure that any images, videos, or materials you use are either created by you, licensed, or in the public domain

Legal Compliances

- Make sure you have written permission to be in the space, and get a permit (*Genehmigung*) if you require one
- Any collection of personal data must comply with GDPR (*General Data Protection Regulation*)
  - Keep data anonymous if possible, and otherwise follow GDPR (see lecture 5)
- Under the Good Samaritan Law (*Garantenpflicht*) you are legally obliged to help in any first aid situation
  - This ideally means informing your closest first aider and dialling 112, but can extend to administering first aid even if you are not a professional
  - First aid training can be accessed through the DRK if desired

Risk Assessments

- Risk assessments identify potential hazards for participants, presenters and the public
- It is often compulsory to undertake a risk assessment for your outreach activity, and if not it is recommended to complete one regardless
- Risk assessments ensure legal compliance and minimise liability
- Firstly hazards must be identified
  - Physical: slipping, tripping, electrical equipment, sharp edges
  - Health: allergies, exposure to chemicals, crowding
  - Environmental: weather for outdoor activities, space layout
  - Behavioral: participants' interaction, children, accessibility needs
- Risks are then evaluated by likelihood, severity, and what measures should be put in place
- Institutions may provide the risk assessment forms to be filled in

Risk Assessments

Activity	Risk	Likelihood	Severity	Mitigation	Responsible
Folding/cutting paper	Minor cuts with scissors	Low	Low	Provide safety scissors, supervise participants and instruct on safe handling	Facilitator & volunteers
Setting up screen	Tripping over cables	Medium	Moderate	Tape down cables, use cable covers, clear walkways	Facilitator

In your pairs complete a risk assessment for one of your activities, then swap with another pair and determine if any risks or mitigations have been missed

07
Accessibility & Inclusion in Science Communication

"We are less when we don't include everyone."

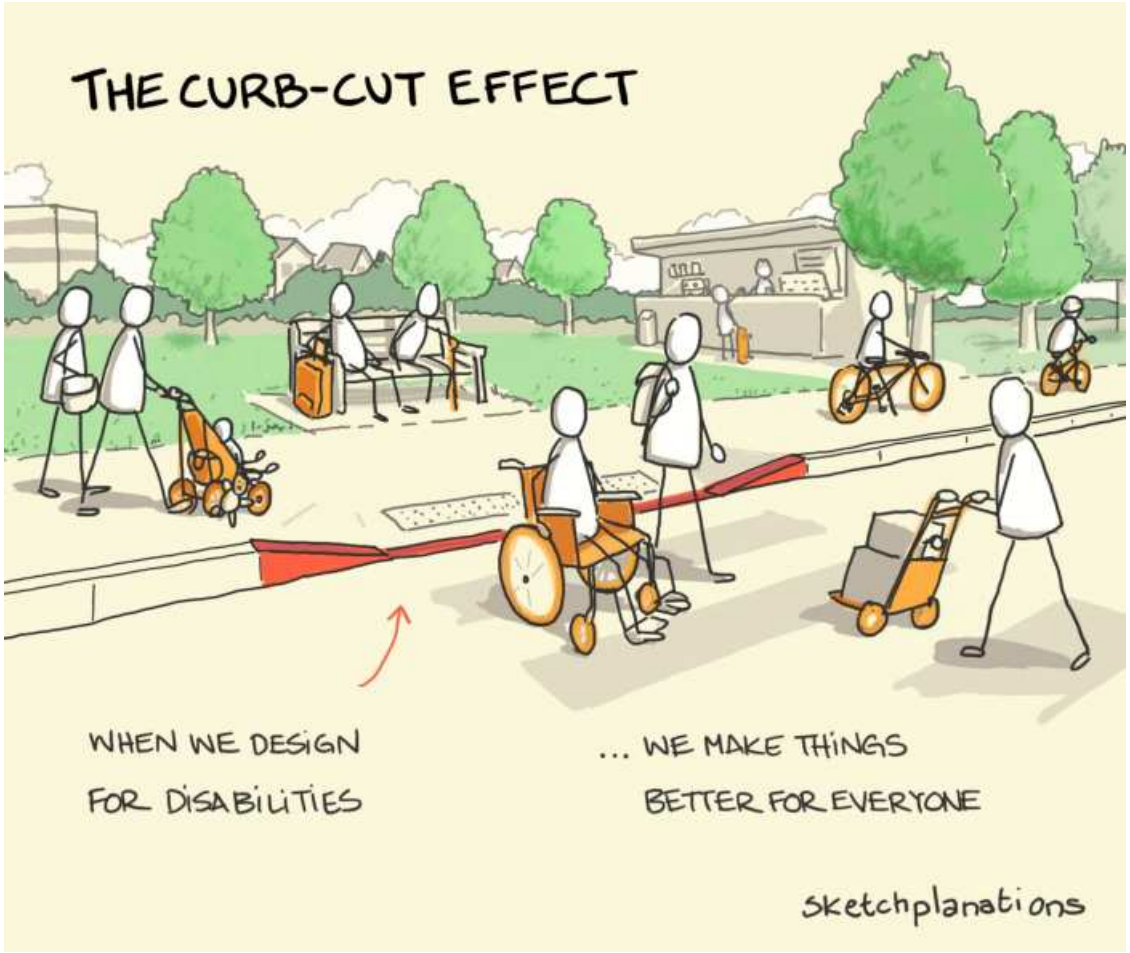
- Stuart Milk

Science for Everyone

Accessibility	Removing barriers so everyone can access, understand, and participate
Inclusion	Making sure all people feel represented, engaged and empowered

Many people face barriers to engaging with science — including the **26.8% of EU adults who report a disability**, as well as **individuals who are underrepresented** due to race, gender, socio-economic background, language, neurodivergence, or other factors.

Not only is accessibility and inclusion a **moral responsibility**, it's also **more practical**. More inclusive communication leads to greater understanding, engagement, and trust **for all**.



And remember than many disabilities are invisible!

Common Barriers in Science Outreach


Physical


Sensory


Cognitive


Communication


Social

Barrier	Solution
Inaccessible venue	Ensure ramps, wide pathways, and accessible entrances
Equipment difficult to reach	Provide adjustable-height tables or adaptive tools
Long standing sessions or uneven terrain	Offer seating, smooth paths, and short activity segments
Toilets not accessible	Verify presence of accessible toilets

Common Barriers in Science Outreach


Physical


Sensory


Cognitive


Communication


Social

Barrier	Solution
Loud or sudden noises	Identify quiet areas, reduce unnecessary noise and give warnings
Bright, flashing or low contrast visual	Use adjustable lighting, avoid flashing lights, high contrast visuals
Reliance on a single sensory channel	Offer multi-sensory options
Overly cluttered or busy environments	Simplify spaces, reduce visual distractions, organise materials

Common Barriers in Science Outreach


Physical


Sensory


Cognitive


Communication


Social

Barrier	Solution
Complex jargon or unexplained terms	Use clear language and define terms
Dense content	Break information into small chunks, use headings/bullet points
Lack of structure	Provide a plan with clear signposting
High information load	Assess your pace, repeat key points, provide summaries

Common Barriers in Science Outreach


Physical


Sensory


Cognitive


Communication


Social

Barrier	Solution
Materials only in one language	Provide translations or bilingual materials
Lack of captions, transcripts or sign language	Include these where possible
Complex websites or online information	Provide easy-to-read, mobile-friendly, and accessible formats
Limited audience communication	Offer multiple ways to ask questions

Common Barriers in Science Outreach


Physical


Sensory


Cognitive


Communication


Social

Barrier	Solution
Examples or imagery that only reflect a subset of people	Use inclusive imagery and examples representing diversity
Ignoring community knowledge or local context	Incorporate local perspectives and invite community input
Use of metaphors, idioms, or references unfamiliar to some	Use simple, universal language and explain cultural references
Implicit bias in framing or language	Use inclusive language and review materials

Inclusive Language

Language shapes who sees themselves in science. To stay inclusive try to

1. **Avoid any assumptions about identity**
   a. Gender - '*This is an engineer, he…*', '*Hello boys and girls*', '*hey guys*'
   b. Family structure - '*ask your mum and dad*'
   c. Background knowledge - '*as we all know from school*'
   d. Cultural norms - '*we all celebrate Christmas*'
2. **Use peoples preferred terms**
   a. Pronouns - '*he, she, they*'
   b. Identity first or person first - '*autistic person*' or '*person with autism*'
3. **Avoid any ableist language such as**
   a. Using disability as an insult - '*crazy*', '*blind to the facts*', '*deaf to criticism*'
   b. Implying suffering - '*suffers from*', '*victim of*', *wheelchair-bound*'
   c. Assuming ability - '*as you can all see*', '*as you all heard earlier*'

It's ok to make mistakes! Don't let that stop you from trying

Visual Accessibility

High text contrast	**Do this**	**Not this**
Easy to read fonts	**Do this**	*Not this*
Large font sizes	**Do this**	**Not this**
Minimum text amount	• **Do this** • **Or this**	**You really shouldn't do this it's just not ideal it makes following this very cumbersome and confusing**

Visual Accessibility

Combinations of colours, labels and symbols	**Do this**	**Not this**
Reasonable text spacing	**Do this**	**Notthis Or this**
Color Blind friendly		

Co-Creation

Next, we'll look at some examples of adapting science communication for specific accessibility needs.

Important: While these strategies are helpful, they do not replace specialist training. For workshops or events targeting a specific group, you should take a dedicated accessibility training course.

Co-creation is the process in which we design activities and materials alongside your audience to ensure they are accessible and inclusive.

The most reliable way to understand accessibility needs is to consult the participants themselves. Their lived experience is the best guide.

Accessibility in Outreach for Autistic Audiences

Autism is diverse, no two autistic people have the same needs. Always ask about individual preferences directly to the person (or a carer/support person if needed). Do not assume reduced cognitive ability without clear reason.

- **Provide structure** - Share a clear agenda, and if possible share ahead of time. Communicate changes before they happen.
- **Talk *to* the person** - Avoid speaking about them as if they are not present
- **Support sensory needs** - Low sensory overload as default, identify a quiet area
- **Provide clarity** - Use clear, literal language and avoid metaphors, slang and idioms
- **Support communication differences** - Allow extra time, don't require eye contact, respect echolalia (repeating of words/phrases) and stimming
- **Respect non-verbal communication** - Non-verbal ≠non-understanding

Outreach for Deaf & Hard-of-Hearing Audiences

Communication needs vary, people may use spoken language, sign language, lip-reading, captions or a mix. Always ask!

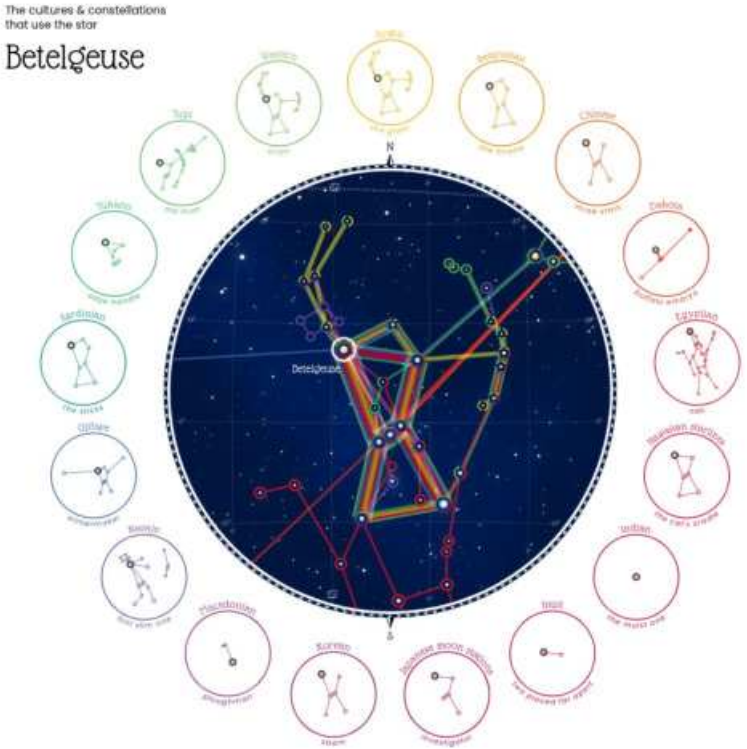
- **Ensure visual access** - Captions/CART/ASR for talks and videos
- **Ensure your mouth is visible when talking** - Face your audience, have good lighting, don't cover your mouth
- **Reduce auditory barriers** - Use a microphone, minimise background noise, repeat audience questions for all
- **Be aware of assistive listening devices or hearing loops** - The audience or venue may provide additional tech
- **Support sign language** - Allow interpreters time and visibility, and if you're in a position to learn some sign language from a verified course then that's a bonus!

Outreach for Visually Impaired Audiences

People vary widely in how much they can see, how they access information, and what adaptations they prefer.

- **Provide accessible formats** - Offer materials in large print, high contrast, audio versions
- **Describe visual information clearly** - Give verbal descriptions of images, graphs, demonstrations, and physical objects
- **Support safe and confident navigation** - Keep walkways clear, if guiding is requested offer your arm, do not grab theirs
- **Use tactile and hands-on alternatives** - Provide tactile models, textured diagrams, or objects to handle when appropriate
- **Communicate accessibly** - Say when you're entering or leaving a conversation, explain sudden changes, use directional language

Inclusion in Astronomy: Figures in the Sky



Additional Resources

Operational good practices for inclusive outreach activities - International Astronomical Union

Astronomy Accessibility Guidelines and Resources - Astronomers Without Borders

Outreach Toolkit for Blind and Low Vision Audiences - Big Astronomy

Office of Astronomy Outreach Activity Toolkit - International Astronomical Union

Women and Girls in Astronomy - International Astronomical Union

Welcoming Autistic People - National Autistic Society & Royal Astronomical Society

08
Outreach Activity Planning Workshop

"If you don't know where you are going, any road will get you there."

- Lewis Carroll, *Alice in Wonderland*

Outreach Logistics

- We will deliver outreach activities on the week of the 13/07
- We will split the class into 3-4 groups, each group will **plan, create and deliver an outreach activity**
- **I expect everyone who is available to come and deliver your outreach** (this is the fun part!)
- You should coordinate with your team on the planning, creation and staffing of your outreach stall

Planning Schedule

26/06/26 (today) - Outreach Activities Examples and Brainstorming Workshop

03/07/26 - Outreach Design Workshop

10/07/26 - Outreach Practice Run & Class Feedback

Week of 13/07/26 - Outreach Delivery

Please remember active participation in the outreach activity module is required to pass this course

Outreach Brief

Event Context:

- Booth
- Largely adult audience from the general public
- Outdoors with cover, electricity available if required
- Each group will have table space for their activity

Activity Guidelines:

- Short, hands-on activity or demonstration
- Drop-in style – passers-by can join as they wish
- No formal budget - small material expenses can be approved if ran by me first! Otherwise you have access to a printer…get creative!

Completion Checklist

You **must** create for your outreach activity (**due 10/07/26**):

1. **Outreach Plan Document**
   a. **Objectives** - Clear aims of your activity
   b. **Audience Assessment** - Assessment of the intended audience for your activity and how you will adapt it for different audiences
   c. **Activity Information** - Step-by-step description suitable for future replication, including materials list, activity plan & scientific interpretation
2. **Outreach Activity Materials** - Anything physical you require for your activity
3. **Risk Assessment** - Follow the example given last week
4. **Information sheets for participants -** In English *and* German

Astronomy Outreach Examples

For inspiration, I have set up four astronomy outreach activity tables that might be suitable at such an event.

1. **Gravitational Wave Matching Activity** - LIGO Collaboration
2. **Bend It Like Gravity: Gravitational Lensing in Action** - Adapted from UoB Outreach Materials
3. **Star Hopping** - N.W. for London Science Museum
4. Where are the Stars Right Now? - Making a star wheel (Sky & Telescope)

After interacting with all these examples, please start brainstorming your own outreach activity in your groups!

Next week will be a design workshop for you to put together materials, make risk assessments and outreach documentation - make sure you plan ahead what you need to bring and how to divide up labour

09
Outreach Evaluation & Activity Design Workshop

"We do not learn from experience... we learn from reflecting on experience."

- John Dewey

Outreach Logistics

- 17/07/26, during this seminar slot
- Meet outside the Mensa
- Cover is available in case of rain
- Power is NOT guaranteed (in communication)
- **Taking part in this outreach activity is one of the necessary modules of this course**

Why Evaluate Outreach?

You just finished an outreach event. People came, took selfies had fun.

But...how do you know what they actually took away? Did they understand the concepts or just like the visuals?

A 2022 German study states only 32-46% of facilitators take evaluation after a science communication events.

Evaluation of science outreach is important to

1. **Know if it worked** - Did it meet goals? Did people learn, feel inspired, take action?
2. **Improve future practice** - What worked and what didn't?
3. **Demonstrate value & accountability** - Show funders the impact
4. **Understand our audiences** - Who it is reaching? Who is it missing?
5. **Build trust and dialogue** - Show audiences we care about their views.

Formative and Summative Feedback

Evaluation is often something done at the end as an afterthought - this is a mistake. Evaluations should be built in throughout the planning and delivery process.

Formative Evaluation

To improve design and cater to real time

Pilot testing, peer review, quick polls

Summative Evaluation

To assess outcomes and impact

Surveys, interviews, analytics, observation

Setting Clear Aims for Evaluation

- **Who is it for?** - You? Funders? Your team? The community?
- **What is achievable in my format?** - Your evaluation should fit into your format.
- **What kind of impact am I aiming for? -** Long term or short term?
- **Who do I want feedback from?** - The audience, the facilitators or both?
- **What is my baseline** - How will I measure change?

Clear evaluation questions should be set for your project to base your evaluation on

Was this exoplanet activity good? ❌

- How many participants took part in the activity?
- Do participants understand what an exoplanet is? ✅
- Did participants enjoy the activity?
- What was the key highlight for the facilitators?

Be SMART

When creating evaluation aims be **SMART** (**S**pecific, **M**easurable, **A**chievable, **R**elevant, **T**ime-bound).

For example "*Do participants understand exoplanets?*":

Specific: Measure understanding of what an exoplanet is

Measurable: At least 60% of participants correctly answer a single multiple-choice or hands-on question during the interaction through random sampling

Achievable: Can be done in a few minutes at the booth using a quick poll, sticker activity, or informal question.

Relevant: Links directly to the activity's learning goals.

Time-bound: Assessed immediately after the activity.

Feedback Methods

When choosing a feedback method, consider:

- **Timing -** Before, during or after the event?
- **Achievability -** What can you realistically get data on without boring people?
- **Match the audience** - Always get feedback from your intended audience!

Feedback methods include:

- **Information from individuals** - interviews, surveys, drawings, voting, comments
- **Information from groups -** graffiti walls, focus groups
- **Observation -** video, pictures, observation by neutral observer
- **Metrics -** postcode data, headcount, gender data
- **Existing records -** planning notes, meeting minutes, personal logs

Feedback can be quantitative or qualitative - or a mix

TOOLS OVERVIEW

TOOL NAME	SUITABLE AUDIENCE(S): PRIMARY SCHOOL	SECONDARY SCHOOL	INTERESTED ADULT	GENERAL PUBLIC	APPROPRIATE ACTIVITY TYPE(S): DROP IN (festivals and demonstrations)	INTERACTIVE WORKSHOP	ONGOING SERIES (clubs, courses etc.)	LECTURE PRESENTATION	ONLINE	BRIEF DESCRIPTION	WORKED EXAMPLE INCLUDED?
Tools best suited to use during an event											
OPEN PALM ON CHEST	✓	✓	✓	✓				✓		A simple, low-tech approach to gauge audience responses to multiple-choice questions during a lecture	Image only
PHYSICAL RANKING SCALES	✓	✓	✓	✓		✓				Participants are asked to physically stand along a line representing different levels of experience / attitude etc. (any ranking type question can be asked).	
GRAFFITI WALL	✓	✓	✓	✓	✓	✓		✓		Colour and artistic freedom combine to allow participants to respond to an event in a highly creative way.	Image only
MENTIMETER	✓	✓	✓	✓		✓	✓	✓		A free online interactive presentation tool that allows presenters to quickly (& accurately) gather audience responses.	Yes
Tools best suited to use at the beggining and/or end of an event or activity											
SNAPSHOT INTERVIEWS	✓	✓	✓	✓	✓	✓		✓		Very brief, focused interviews, which are used in conjunction with an event to gather impressions quickly, like a photo of a moment in time.	Yes
PRE/POST QUIZZES	✓	✓	✓	✓		✓	✓	✓	✓	Brief surveys that are used before & after an event, ideal for helping you understand whether or not your audiences have learnt key aspects of the content you are trying to convey.	Yes
GEOGRAPHIC LOCATION MAP			✓	✓	✓			✓	✓	Where people come from can be really useful information, however isn't always easy to obtain. This simple and inexpensive technique encourages participants to provide their location data in a fun and visual way instead of a standard survey.	Yes
Tools best suited to use at the end of (or after) an event											
DROPPING PEBBLES IN BOXES OR STICKERS ON CHARTS	✓	✓	✓	✓	✓	✓	✓			This process is quick, easy, and highly visual, and also provides an opportunity to participate for people who may find reading challenging.	
3 WORDS	✓	✓	✓	✓	✓	✓	✓	✓	✓	A quick, focused way to get a feel for participants' experiences by asking them to describe it in a few short words.	Yes
TARGET EVALUTION	✓	✓	✓	✓	✓	✓	✓	✓		A visual 'bullseye' approach to rating different elements of an event, or other outcomes of interest.	
POST-EVENT SURVEYS	✓	✓	✓	✓		✓	✓	✓	✓	Self-completion questionnaires that are used immediately after an event, workshop or programme.	Yes
PHOTOGRAPHY DIARY	✓	✓	✓	✓		✓	✓			Inviting individuals to select and discuss images that are especially meaningful to them, in their own words, thus providing insights that are otherwise very difficult to obtain.	
PEER INTERVIEWS	✓	✓	✓			✓	✓	✓	✓	Peer interviews are a great way to encourage honest opinions, especially from teenagers, through involving participants in interviewing each other, and thereby hopefully allowing a more natural and honest conversation.	
TWEET SENTIMENT VISUALISATION		✓	✓	✓	✓	✓	✓	✓	✓	Automatic online analysis of tweets to help identify participants' reactions to a particular key word or phrase. Must be conducted within a week of the event (whilst the tweets are still "live" on Twitter).	

These characteristics are estimates based on extensive previous experience, however they may not hold true for evaluating every outreach activity.
See our dedicated advice to make sure the tool you choose is appropriate to your unique situation:
✓ = especially suitable to this category; ✓ = may be used

[Useful Outreach Toolkit]

Evaluation Method Examples

- **3 Words** - Use post it notes to get audience members to write down 3 words that best describe the activity, or a more specific question. Data can be categorised and shown in a word cloud.
- **Pebbles in boxes/stickers** - Ask participants to vote given a pebble/sticker/token. For example "*I want to follow a career in space science*", with strongly agree to strongly disagree. Think about if you want to make the data visible to all, and keep it statistically sound.

Evaluation Method Examples

- **Graffiti wall** - Pin a large piece of paper on a board or use post its to encourage participants to leave comments, questions, draw and be creative. Add as much structure as you like.
- **And more:** geographical location map, mentimeter, open palm on chest, peer interviews pre-post quizzes, rankings, participation counting, behavioural observation....

Survey Feedback

- **Timing** - Pre-surveys and both short term and long term post-surveys
  - Tips: try to collect pre and post surveys together to match data points, use incentives for long term surveys
- **Question types** -
  - **Closed** - scales, multiple choice, yes/no (quantitative)
  - **Open** - short answer reflection (qualitative)
  - Use a mix, more closed than open, and leave a fully open question at the end (“*Do you have any more comments?*”)
- **Survey formats** - paper, QR code, phone, email, tablet - what works best?
- **Survey length** - rule of thumb 2-6 questions, don’t overload participants
- **Always align with evaluation aims**

Writing Survey Questions

What is wrong with these questions?

Was this the most exciting activity you've ever done?

Are the public well informed about scientific developments or are scientists deliberately keeping them in the dark?

Planetary scientists often use most of their funding on all night parties and illegal drugs. Should the government increase planetary science funding?

Avoid leading questions

Writing Survey Questions

What is wrong with these questions?

Did you learn something new and enjoy the activity?

Should the EU cut spending for planetary science and increase spending for healthcare?

Do you like watching TV documentaries and attending lectures about planetary science?

Avoid asking two or more questions in one

Writing Survey Questions

What is wrong with these questions?

Where have you come from today?

Is it safe for research to be funded by industry?

Was today helpful?

Avoid vague questions

Writing Survey Questions

Also:

Avoid jargon in questions

“Do you understand radial velocity measurements?”

Don’t confuse people with with unnecessary negatives

“Do you agree with this statement: I did NOT find the activity confusing”

Don’t ask about hypotheticals you can’t know the answer to

“Will you go and buy a telescope after this outreach event?”

Considering Ethics & GDPR

If you collect any data that can reasonably lead to personal identification of participants (address, names, email, photographs, health status, ethnicity, date of birth), you must follow GDPR:

- Only collect what is needed
- Tell participants why the data is being collected and how it will be used in a transparency statement
- Get consent from all participants for data collection
- Store data securely, keeping it password protected or physically locked, and only keep data for as long as is needed
- Respect that participants can withdraw consent and request data deletion

Where possible keep all surveys anonymous and you do not have to worry too much about GDPR requirements

Analysing and Interpreting Data

- Separate out data into qualitative and quantitative
  - Quantitative data is easier to analyse and interpret, and can be put into bar charts, pie charts and used with statistical methods
  - Qualitative data might be better as being sorted into broad categories after reviewing patterns and trends, with specific examples picked out to quote or places into a word cloud
- Check for data quality such as incomplete/inconsistent answers, note sample size limitations and biases
- Be careful not to come to conclusions you don’t have the data to support
- Consider the format of the results of your evaluation (report, infographic, presentation) for your audience and make it clear (meta-science communication)
- Again, make sure this links back to your original evaluation questions

Feedback for Our Activities

We will construct both formative evaluation and summative evaluation as part of our outreach activity

For the trial run of the outreach activities on the **next week**, each group will create questions based on clear evaluation aims (up to 5 questions) for a peer survey with the aim of improving the outreach activity.

After the trial run, as a class we will form a summative evaluation for the day of the outreach, which we will review afterwards in the seminar.

Feel free to do this on print outs, or as an online feedback (ie google forms)

Outreach Design Workshop - Completion Checklist

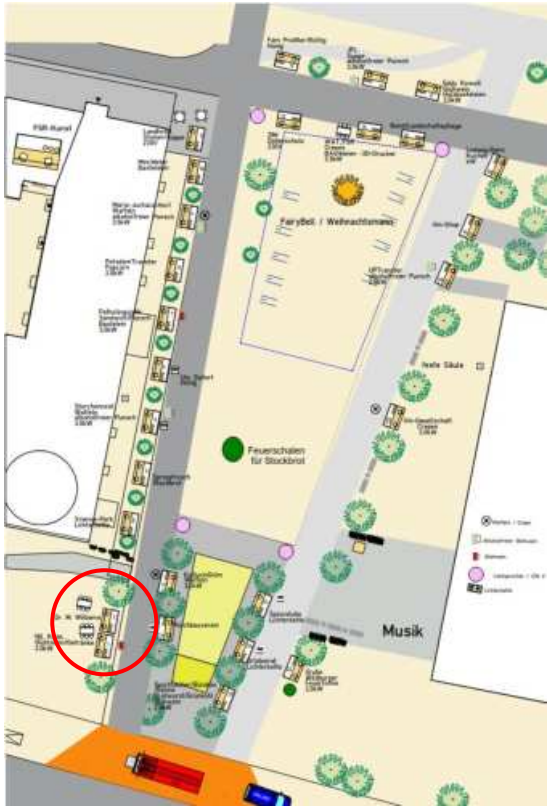
You **must** create for your outreach activity (**due 10/07/26**):

1. **Outreach Plan Document**
   a. **Objectives** - Clear aims of your activity
   b. **Audience Assessment** - Assessment of the intended audience for your activity and how you will adapt it for different audiences
   c. **Activity Information** - Step-by-step description suitable for future replication, including materials list, activity plan & scientific interpretation
2. **Outreach Activity Materials** - Anything physical you require for your activity
3. **Risk Assessment** - Follow the example given last week
4. **Information sheets for participants -** In English *and* German
5. **Evaluation aims and peer evaluation survey** - To be conducted in session

10
Outreach Activity Trial Run & Feedback Session

Logistics

- Fair runs from 2pm - 7pm (we will be there until 6pm)
- Set up starts at 1pm
- If not given enough space outdoors, we have indoor space also
- We must supply our own lighting
- Please organise with your group and make a timetable to be there for whatever times you can commit
- Wrap up!



Feedback

- Today we will assess the activities through formative evaluation with the evaluation questions you have prepared (do I need to print these?)
- On the day we will take quantitative feedback on the number of interactions each activity gets, and I will organise quantitative feedback
- Today we will finish any small remaining task for our activities and deliver them to our peers, who will then fill in feedback forms

Outreach Checklist

Please upload the following to the moodle

1. **Outreach Plan Document**
   a. **Objectives** - Clear aims of your activity
   b. **Audience Assessment** - Assessment of the intended audience for your activity and how you will adapt it for different audiences
   c. **Activity Information** - Step-by-step description suitable for future replication, including materials list, activity plan & scientific interpretation
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11
Outreach Activity Reflection and Feedback

"Wonderful activities followed by very interesting explanations. I especially enjoyed how everything was discussed in very simple terms and was well connected to my very low level of knowledge. Congrats! Well done! I wish I studied physics!

- Anonymous Feedback

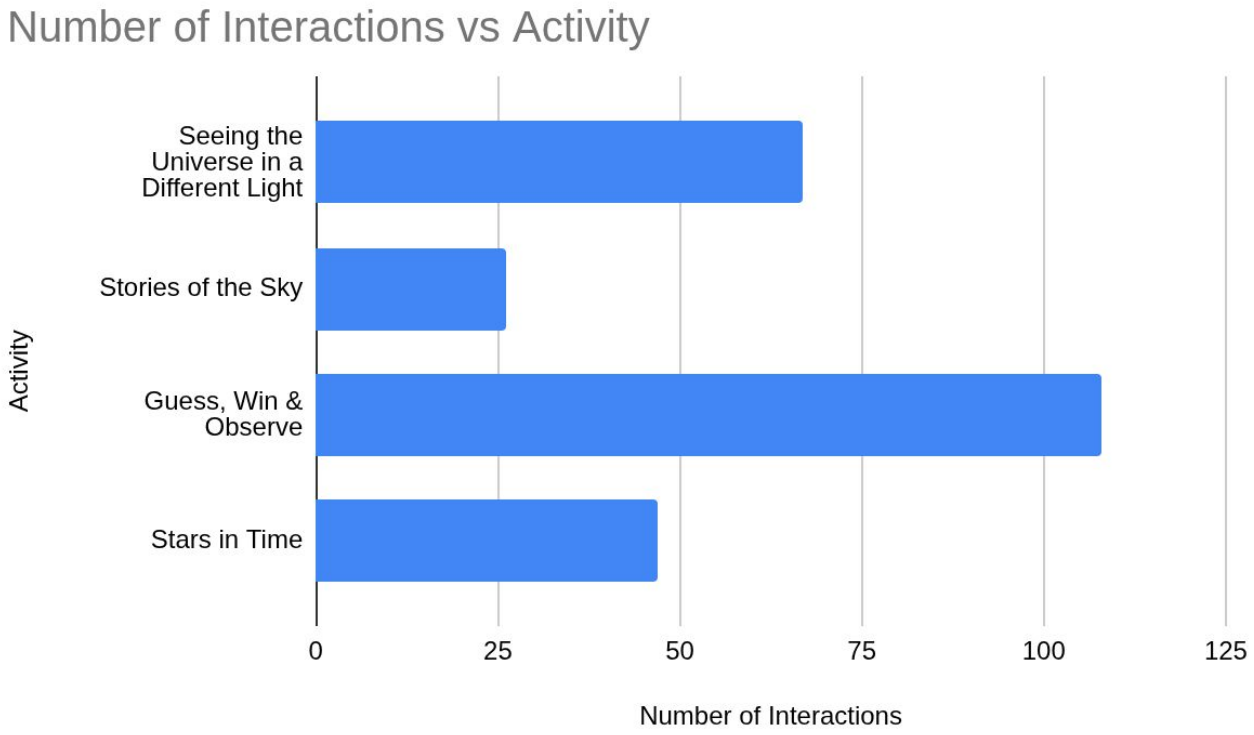
W

General Comments & Outlook

- Thank you to everyone for your time and work - it was clear how much effort and passion was put into the outreach projects
- I have received numerous pieces of positive verbal feedback from staff and the public on how impressed people were with the outreach activities
- Today we will look at the feedback and reflect on the outreach activities, understanding what worked well and what we would improve to round off this module

Independent Reflection

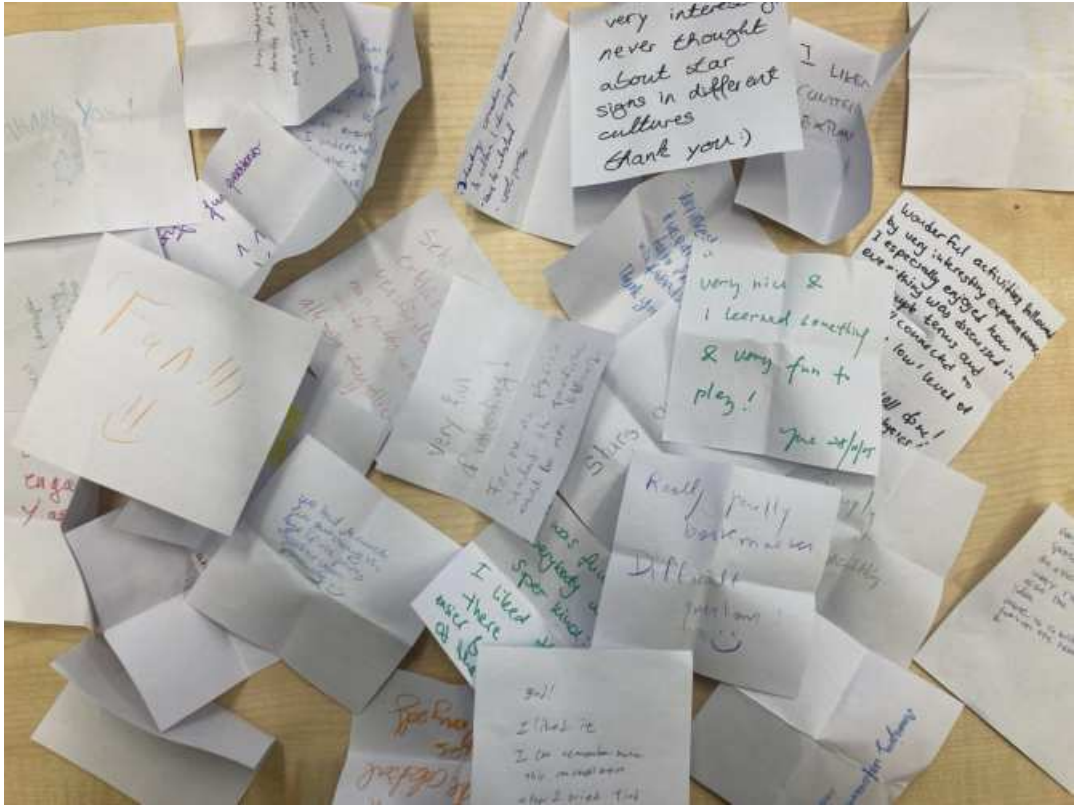
Visitors in Numbers



What might have influenced these results?

How much do we trust these numbers?

Assessing the Feedback



We got 30 pieces of quantitative feedback

12% of total reported interactions

Some Highlights

"Fun!!!"

"Stars are fun :) "

"Simply AMAZING"

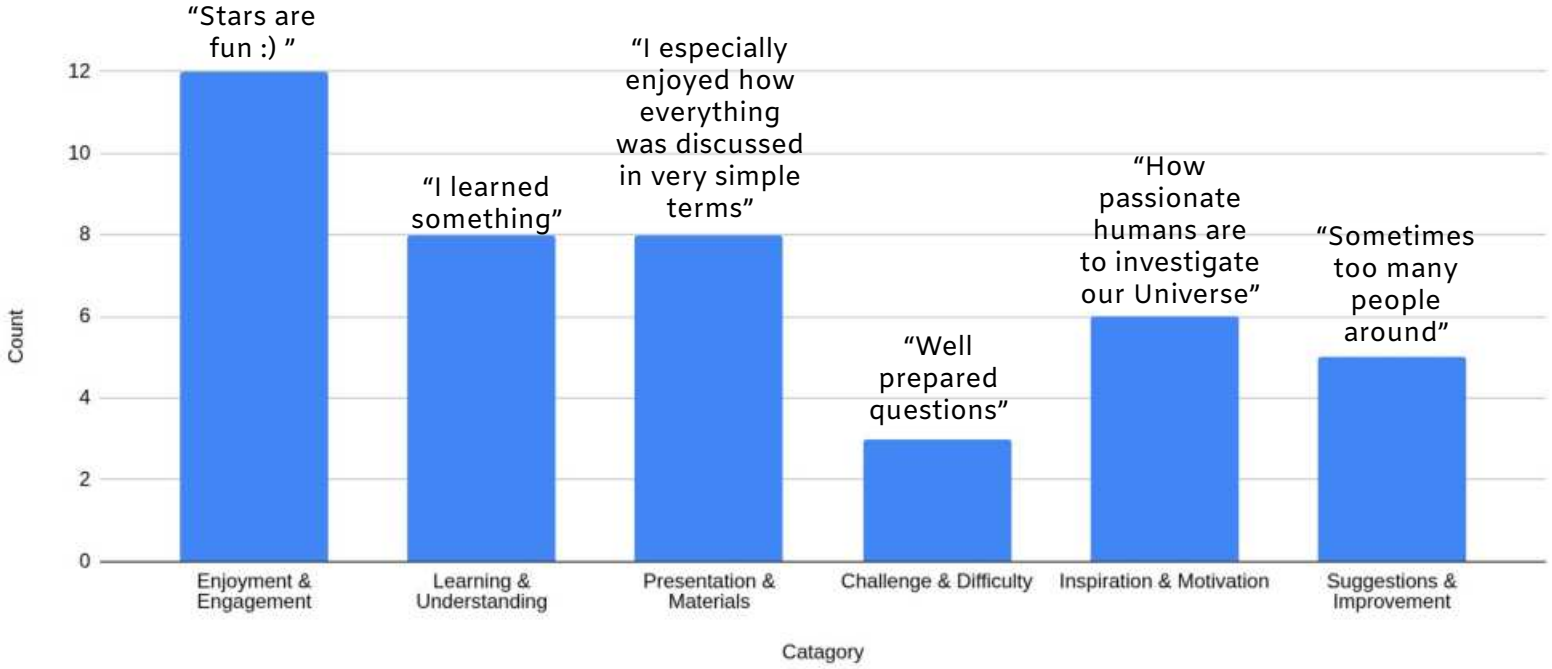
"Amazing experience, quite enriching"

"Great way to engage people with astronomy"

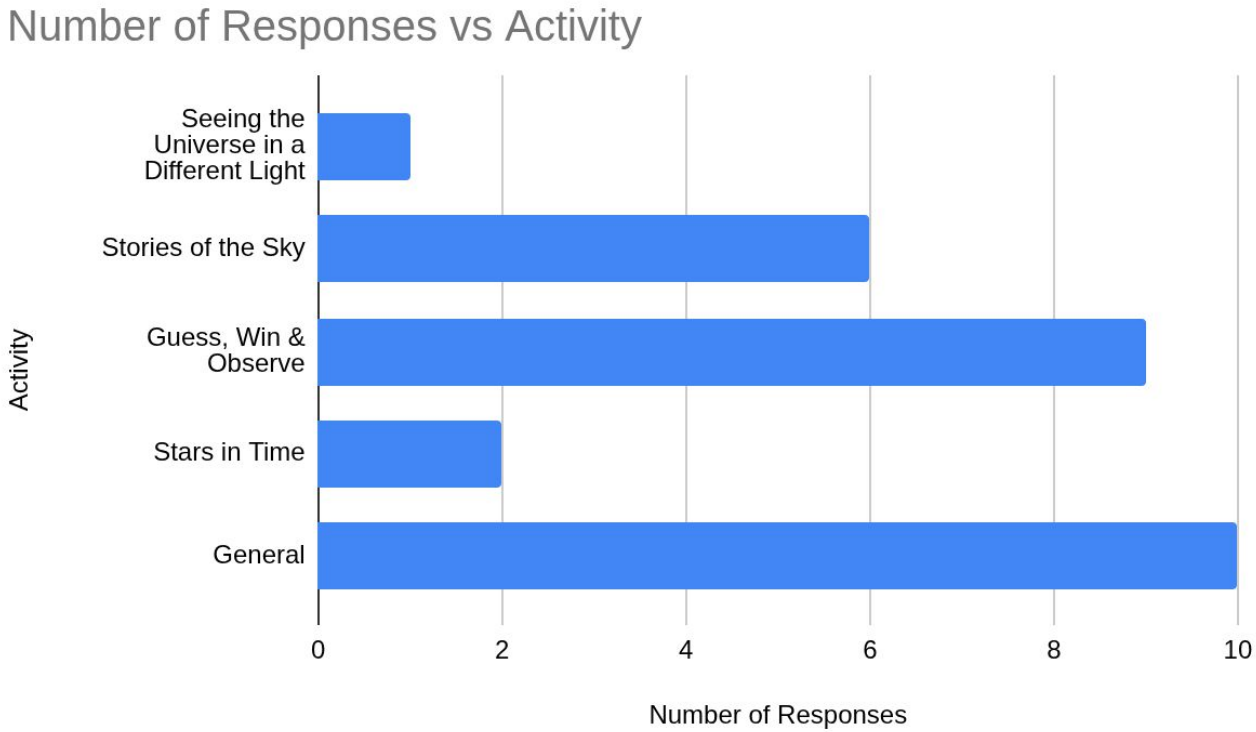
"Thank you!"


pattern
really
great
everyone
thank
find
sehr
liked
guessing
play
different
quiz
even
constellation
fun
stars
game
cultures
people
signs
star
nice
good
interesting
enjoyed
amazing
cool
questions
inspired
understand
tried
difficult
physics
remember
friends
astronomy

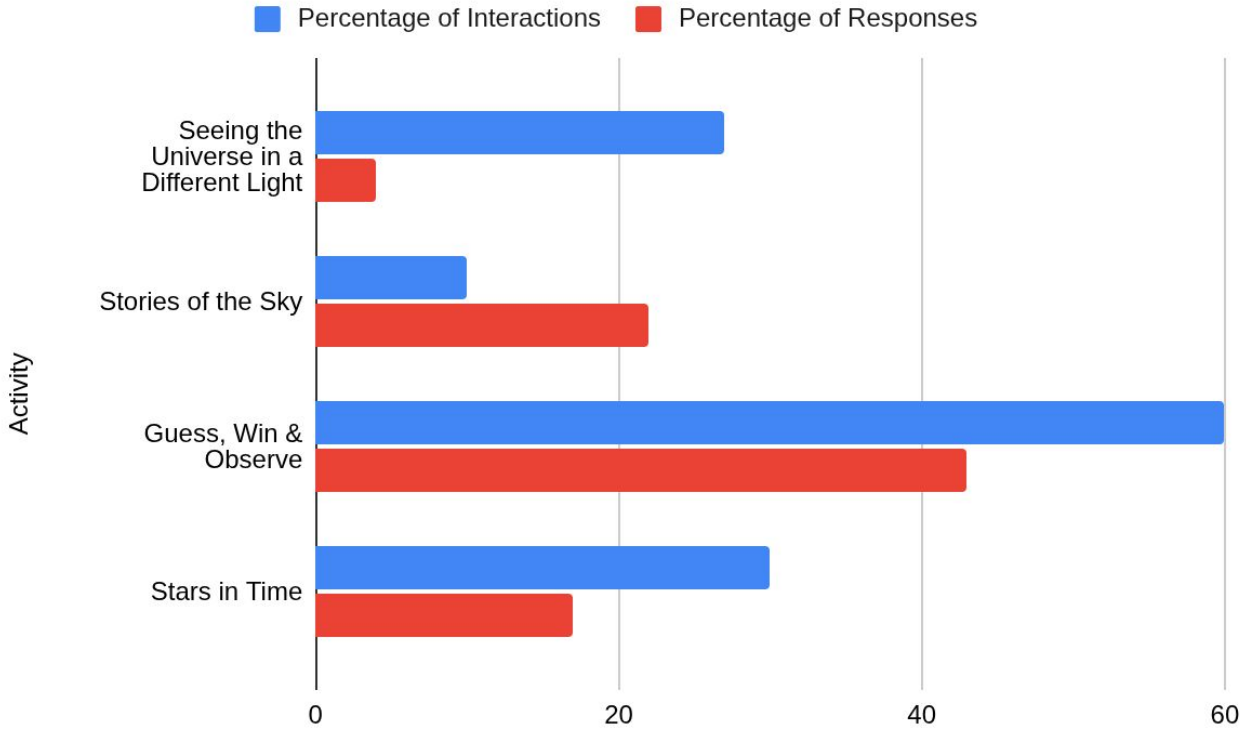
Categorising the Responses



Feedback by Activity



Interactions and Responses



Why do these not follow the same trends?

Seeing the Universe in a Different Light

"Very approachable, sparks interest, the infrared camera is very nice and interesting, also the hot/cold water idea, there is a bit too much text on the handout to read it"

Stories of the Sky

"Good! I liked it. I can remember more the constellation after I tried to find the pattern (and failed), also storytelling is profound"

"Very interesting, never thought about the star signs in different cultures, thank you :)"

"I liked the constellation explanation"

"Cool, Orion has different stories in many cultures, if you can provide the illustration for the constellations that would be good. P.S. if you have the sky map you can show them here also"

"Interesting connection between astronomy and cultures (star signs). Easy to understand."

Guess, Win & Observe

“ It was fun and everyone was super nice :) I liked that there was an easier and a hard version of the same [quiz]”

“Very fun and interesting! For me as a physics student the questions could be more difficult”

“It was well prepared questions, even fun for the people who don’t know anything”

“Great, cool telescope (we were really bad at the game though)”

“Very cool quiz, sometimes too many people around/could not tell the answers directly”

Stars in Time

“Very fun and interesting game, enjoyed a lot that is was compared with events so I understand how old the stars actually are”

“We had so much fun guessing the age of the stars together with friends 🙂

Group Discussion

Gather in your groups, given the individual feedback and the audience feedback discuss:

1. What in person feedback did you receive?
2. How could you make your activity more inclusive and accessible in the future?
3. What unexpected challenges did your group face?
4. What worked well in your activity design and what would you change next time?

Adapting Activities

Assuming the same aims and audience, translate your activity into:

1. A workshop setting
2. An online format (social media post, video, interactive webpage, infographic)

Consider changes to the mode, structure, materials and delivery. In your groups come up with an idea for each of these.

What do you think of these similar resources? How do these compare?

Seeing the Universe in a different Light

Guess, Win & Observe

Stories of the Sky

Stars in Time

Course Evaluation

Please fill in to understand if we should keep running this course and how we can best improve it :)