SP1541
Exploring Science Communication through Popular Science

Students' Book

AY 2022/2023 Semester 1

Table of Contents

General instructions for inquiry-based learning

1. Your tutor will divide your class into groups and share a discussion template on MS Teams with you and your group members for recording group responses.

2. Your tutor will join your discussion and provide input where necessary.

3. Your group will present your group responses to the rest of the class with your tutor facilitating the whole-class discussion as necessary.

4. All classes are meant to be collaborative and interactive so what you and your group members type on the template will be made available to the whole class.

Key icons

Learning Outcomes	Discussion	Peer Review	Self-reflection	Task Reminder	Wrap up

Week 2

Tutorial 2.1. Introduction to science communication

Learning Outcomes

By the end of the tutorial, you should be able to:

- understand and appreciate the need for and importance of science communication; and
- understand what popular science means as a genre and appreciate its value for exploring science communication.

Pre-class Preparation

A. Reading
Read the following 5 articles before coming to class:

Article 1
Gould, J. (2014, September 4). The importance of science communication? *Nature Jobs.* http://blogs.nature.com/naturejobs/2014/09/04/the-importance-of-science-communication/

Article 2
Santhanam, L. (2015, January 29). Study reveals wide gaps in opinion between scientists and general public. *PBS Newshour.* http://www.pbs.org/newshour/rundown/study-reveals-wide-opinion-differences-scientists-general-public/

Article 3
Pelger, S. (2017, November 21). New research shows explaining things to 'normal' people can help scientists be better at their jobs. *The Conversation.* https://theconversation.com/new-research-shows-explaining-things-to-normal-people-can-help-scientists-be-better-at-their-jobs-84619

Article 4
Leeming, J. (2016, November 4). The "black box" effect in science communication. *Nature Jobs.* http://blogs.nature.com/naturejobs/2016/11/04/the-black-box-effect-in-science-communication/?WT.mc_id=FBK_NatureJobs

Article 5
Khew, C. (2015, November 25). Get public to start 'liking' science?. *The Straits Times.* http://www.straitstimes.com/singapore/get-public-to-start-liking-science-ntu

I. Exploring the importance of science communication

Why is science communication important and how is it relevant to you?
Your tutor will assign you to work in groups of 3 to 4. Based on the articles you have read, try to respond to the prompts. Use the questions below to guide your discussion. You will present your group's responses to the class.

a) Why do scientists need to communicate to the public and their peers from different disciplines?

b) Do you think science communication skills are important to you as a science student and future scientist? Please explain.

II.   Exploring popular science writing

The following information, taken from the Duke University website, defines the genre of **popular science writing:**

Scientific writing for a popular audience takes scientific findings and translates them into a form both comprehensible by and captivating to a general audience of non-specialists. Sometimes written by scientists, sometimes by historians, sometimes by biographers, this genre de-mystifies the results of scientific research.

This genre can be particularly difficult to work with, as it requires the ability to unify scientific knowledge with a humanistic voice. Often those with the expertise to understand the details of scientific research are unfamiliar with writing outside of the confines of that style, and as a result have some difficulty transforming their prose into something more approachable to the layman.

Downloadable pdf version:
https://twp.duke.edu/sites/twp.duke.edu/files/file-attachments/scientific-for-popular-audience.original.pdf

In her book *Communicating Popular Science: From Deficit to Democracy,* Dr. Sarah Perrault, Associate Professor of rhetoric and writing at the University of California, explains what popular science writing is:

'Popular science writing' refers to all written forms of science popularization. Popular science texts are published in books and in a range of shorter genres, including newspaper and magazine articles and essays, and on online forums, such as scienceblogs.com. By 'science popularization' I mean science-related communication directed at non-specialist audiences. Note that I am not saying 'the public' or even 'non-scientists'. While commonly used to describe readers of popular science texts, those terms imply a sharp divide between scientists and non-scientist others, whereas, in reality, there are, on any given scientific issue, a multitude of degrees and kinds of expertise. Even scientists in one area read as

amateurs in other areas of science; a high energy physicist will not be an expert reader when the topic is microbiology, and the average microbiologist comes to a text about the effects of climate change on predator–prey interactions in a given habitat with no more professional experience in the area than I do" (Perrault, 2013, p. xiii).

"In terms of information, popular science writing, by definition, tells readers about scientific findings. For example, Trevor Corson's 'Stalking the American Lobster' informs readers about the life cycles and reproductive habits of Maine lobsters. Popular science writing also informs readers about the nature and working of sciences themselves. Corson's article, in addition to sharing lobster-related facts, also talks about the advantages and drawbacks of field-based versus laboratory-based research methods, and about how a scientist's choice of tools will influence what he or she learns. Additionally, popular science writing can help readers—scientists, non-scientists, and scientists working outside their areas of expertise— understand how a given area of research affects and is affected by other social institutions. In Corson's case, the expertise of the Maine lobstermen turned out to be essential to developing a more accurate understanding of changes in the lobster populations. Here, the text functions discursively by providing readers with a story about the nature of knowledge production in a particular area of research " (Perrault, 2013, p. 8).

Perrault, S. (2013). Communicating popular science: from deficit to democracy. London: Palgrave Macillian UK. Downloadable pdf version: https://sg1lib.org/book/2609583/a552df

Discuss the following questions in your groups. You will present your group's responses to the class.

a) According to the above extracts, what is the purpose of popular science writing?

b) Do you think that the popular science writing genre is easy or difficult to accomplish? Explain your response.

Task Reminder: Pre-course News Article

If you have already completed your Pre-course News Article, you may re-read your work to see if you have communicated scientific concepts and ideas effectively to non-specialist readers. Remember to submit your work by Wednesday, 17 August, 11:59pm.

Tutorial 2.2. Critical reading and analysis: Research articles

Learning Outcomes

By the end of the tutorial, you should be able to:

- distinguish the different types of scientific papers;
- distinguish the different sections of a research paper and explain the different roles of different sections of a paper; and
- reflect on your Pre-course News Article and construct ideas on how to ensure that the news article is appropriate to the given context, purpose and audience.

Pre-class Preparation

A. Reading

1. If you are new to reading scientific papers, you should start with the information presented in the presentation slides that explores 4 key topics:

   - Types of scientific papers
   - Organization of a scientific paper
   - How to read a scientific paper effectively
   - Difficulties faced in reading scientific papers

   Research4life (2014, June). *How to read a scientific paper* [PowerPoint slides]. Research4life.https://www.research4life.org/wp-content/uploads/2014/06/Part_A_How_to_Read_a_Scientific_Paper_2014_06.ppt

2. Learn the **four steps to reading a scientific paper**: i) Skim; ii) Re-read; iii) Interpret; and iv) Summarize.

   Rodriguez, N. (2015, April 5). *Infographic: How to read scientific papers* [Infographic]. Slideshare.https://www.slideshare.net/ElsevierConnect/infographic-how-to-read-scientific-papers

3. Understand **how a science journalist reads journal articles** to prepare to write a popular science article.
   Hayden, T. (2013, May 22). Reading the journals: From new science to science news. National Association of Science Writers. https://www.nasw.org/article/reading-journals-new-science-science-news

   Reflect on how you read the selected journal article for your Pre-course News Article.

   Did you follow the four steps listed in the infographic? Why/why not?

B. Critical reading

When reading your selected research article for the Pre-course News Article, answer the following questions.

- What problems does the study address?
- Why is it important and what are the reasons for the research? How was it introduced?
- How did the author try to address the problem?
- What did the researchers find out and how did they introduce it?
- What do the results mean regarding what was already known about the subject? How did the researchers move the body of scientific knowledge forward?

Reflect on whether it was easy for you to answer these questions. Try to think of why it was/was not easy for you to answer these questions.

I.   Discussing your selected research article

In a group of 3-4, report your answers to the questions in **Section B, Critical Reading** to your group members. If more than 1 group member chooses the same article, you can help one another answer those questions.

As a group, discuss whether each of the selected articles is suitable to be reported as 'science news'. Explain why or why not based on your own opinion. Identify a list of criteria to select an appropriate research article for writing your science news article.

II.   Reflecting on your own news articles

Share what you have done in writing your news articles with your group members. Please include the following points when sharing:

- The significant changes that you have made to the research article and the reason for making those changes.
- The effectiveness of those changes in relation to the context, purpose and audience of popular science communication.
- The feedback from your non-scientist family and friends after reading the articles.

Based on what everyone has shared, discuss what you as a writer can do to ensure that the science news articles you write are appropriate to the given context, purpose and audience.

III.   Analysing reflective commentaries

After you have discussed the choices that you have made to tailor your science news article to the given context, purpose and audience, it is now time to learn how to reflect those decisions in a form of a reflective commentary.

> A **reflective commentary** is a piece of writing that articulates the thinking during the construction of your writing. It is, generally, accepted that all good writing is *not accidental*, but the result of writers making sound choices or decisions in the composing process. A reflective commentary thus serves two purposes: (1) to nudge you into thinking more deeply about your writing by drawing attention to choices and effects; (2) to convince your teacher-assessor that you have done solid, insightful thinking that led to the production of your writing, i.e. Science news articles for this module. Read the task instructions in the *Course Information*.

Study the three sample reflective commentaries. **Which would you regard as the most well-constructed, and which the least? Explain your reasoning.**

Based on your discussion, highlight parts of the text that provide evidence for you to explain why you regard the reflective commentary as well-constructed or not so well-constructed. Be prepared to explain your responses to the class using your annotated document.

Sample 1

I explain the currently used HIV tests because I think most readers are only aware of HIV/AIDS and how it is transmitted. The explanations serve as a comparison to the ADAP test (a new oral HIV test) and also as a build up to the explanation of the ADAP test. I intentionally adapt the explanation from a website intended for the public instead of textbooks to make sure readers understand it. [Supplementary source]

Explaining the ADAP (Antibody Detection by Agglutination–PCR) test is not easy. Even the descriptions in news articles also require some technical knowledge, such as the existence of another protein called antigens, or the structure of antibodies and DNA. Because of this, I decided to use a metaphor of 'fishing' because that was how I imagined the process to be like while I was researching this topic *(Antibodies behave like fish searching for food, in this case, virus.)*. With this analogy, I sacrificed some accuracy; fishing rods only have one end for the baits, while the ADAP test attach HIV baits to one or two ends of the DNA strings. However, this is an acceptable sacrifice because this metaphor still encapsulates the mechanism of this new test and enhances readers' understanding of the reported discovery.

Sample 2

As it is unavoidable to first introduce to the reader that the main study or discovery would be pertaining to death, the article may appear somewhat gruesome or sadistic at first glance. As such, it was paramount to adopt a writing style that was socially light-hearted and yet practical and reasonable at the same time. The phrase "almost everyone fears death" was written with 2 objectives in mind – to assure the reader that we're all in this together, and that this is a topic that we shouldn't be afraid to delve further into.

Next, I made sure the explanation of unfamiliar was always clear. For example, I explained what chronic conditions were in paragraph 2, as well as in paragraph 3 "What this means is...".

I implemented booster language throughout to increase significance of the study, such as "results were alarming", "hugely complex," "undeniably crucial" etc.

Pronouns were also used in paragraphs 3 and 7, along with rhetorical questions. These strategies help readers feel engaged and at ease when reading my article.

Lastly, I made sure I captured and maintained the reader's attention. Some instances where I did so are in paragraph 3 where I made readers put themselves in a real-life situation, and in the final paragraph where I closed the article using the same attention-grabber at the start.

Sample 3

In this article, I followed the moves which my tutor used to teach in class, from the main finding and the significance of the finding to explain and evaluate the result. My goal was to enhance the understanding of the readers with no logical gaps, so that they do not make link by themselves. This was very useful for me because I cannot make the article flow very well, and this method helped me deal with the organization by logically presenting them and establishing a clear link between sections.

For the significance of the key finding, I wanted to entice and engage the readers by using evaluative language and some appeals. I also consistently employed questions and second person pronouns in order to engage the readers.

Week 2 Wrap up

Read the Post-lesson Students' Notes for this week.

Week 3

Tutorial 3.1. Critical reading and analysis: Life Science book chapter

Learning Outcomes

By the end of the tutorial, you should be able to:

- identify the choice of **argumentative writing style** made by a popular science writer (Richard Dawkins) and describe its impact on readers; and

- identify and explain **deontological appeal** used in popular science writing to secure and sustain readers' interest.

Required Reading

Dawkins, R. (2006). The replicators. In *The selfish gene* (30th anniversary ed., pp.12-20). Oxford University Press.

Further Reading/Viewing

Conquer Imagination (2020, December 1). *The selfish gene Chapter 2: The Replicators (by Richard Dawkins) Animated Summary.* [Video]. YouTube. https://youtu.be/fzvSTv_hf5c

Ridley, M. (2016, January 27). In retrospect: The Selfish Gene. *Nature, 529,* 462-463. https://doi.org/10.1038/529462a

I.   Exploring ideas in popular science

Discuss the following questions with your group members. Your group will be selected to share your insights with the rest of the class.

1. The account of the origin of life that I shall give is… probably not too far from the truth." Is it?

2. Is there a paradox in the idea of an evolutionary trend towards higher accuracy of replication in molecules?

3. "They have come a long way, those replicators. Now they go by the name of genes, and we are their survival machines." How has this chapter altered your understanding of the gene (or of the way you think about it)?

4. "Human suffering has been caused because too many of us cannot grasp that words are only tools for our use." Why is the author saying this? What point is he making?

II.   Exploring science communication

Discuss the following questions with your group members, and then share your insights with the rest of the class. Make suitable references to your reading to support your answer.

5. How would you describe Dawkins's writing style as seen in this chapter? Discuss the impact of his stylistic choice on readers. To do this, consider the following:
    *   Is his writing best described as narrative, descriptive or argumentative?
    *   What effects on the reader are achieved by his choice?
    *   What is gained, and lost, as a result of his choice?

6. Examine carefully the opening paragraph. How does Dawkins arouse the interest of the reader? Make suitable references to the paragraph and discuss the effects of the author's choices on readers.

7. How is the reader's interest sustained in the body of the chapter? Make suitable references to specific parts of the chapter and discuss the effects of the author's choices on readers.

III.   Group reflection

In your groups, you will work on a 100- to 150-word reflection using the template provided. Essentially, your group reflection should focus on:

*   whether your group found Dawkins' use of the deontological appeal effective and why; and
*   one interesting fact your group learnt about genes which you had not known before.

Tutorial 3.2. Critical reading and analysis: Life Science News Article

Learning Outcomes

By the end of the tutorial, you should be able to:

- analyse and describe **Moves 1- 2** that are conventional to introducing a news article;
- analyse and apply the use of **explanatory strategies and clarifying techniques** to explain scientific concepts and ideas for non-specialist readers;
- analyse and evaluate the use of **evaluative language** to engage readers; and
- apply your learning to review your Pre-course News Article.

Required Reading

Connor, S. (2013, November 7). The more we looked into the mystery of Crispr, the more interesting it seemed. *The Independent.* http://www.independent.co.uk/news/science/the-more-we-looked-into-the-mystery-of-crispr-the-more-interesting-it-seemed-8925328.html

Background Reading

Jinek, M., Chylinski, K., Fonfara, I., Hauer, M., Doudna, J. A., & Charpentier, E. (2012). A programmable dual-RNA-guided DNA endonuclease in adaptive bacterial immunity. *Science*, *337*(6096), 816-821. http://genetics.wustl.edu/bio5491/files/2013/03/Jinek-et.-al.-2012.pdf

Further Reading

Fessl, S. (2022, June 28). Ten years of CRISPR. *The Scientist.* https://www.the-scientist.com/news-opinion/ten-years-of-crispr-70171

Le Page, M. (2022, June 16). Children to get CRISPR treatment for sickle cell disease in trial. *New Scientist.* https://www.newscientist.com/article/2324518-children-to-get-crispr-treatment-for-sickle-cell-disease-in-trial/

I. Analysing communicative moves

1. Study the headline and lead of the news article. What do you think the author is trying to achieve? What did the author do to achieve those goals? Was he successful in achieving those goals?

2. Study the headlines and leads (or the first section) of these two popular science news articles. Based on these 3 examples, identify the roles of the headline and lead in science news genre.

Article 1

We've been wrong about the origins of life for 90 years

August 16, 2016 12.40am AEST

NOAA Photo Library/Flickr, CC BY-SA

Email
Twitter   140
Facebook
LinkedIn   25
Print

For nearly nine decades, science's favorite explanation for the origin of life has been the "primordial soup". This is the idea that life began from a series of chemical reactions in a warm pond on Earth's surface, triggered by an external energy source such as lightning strike or ultraviolet (UV) light. But recent research adds weight to an alternative idea, that life arose deep in the ocean within warm, rocky structures called hydrothermal vents.

Article 2

We need to rethink the origins of life on Earth, study suggests

We might not have come from primordial soup after all.

ARUNAS L RADZVILAVICIUS, THE CONVERSATION   18 AUG 2016

3. "Her findings could transform medicine." In what ways? Where do you find this information? Why do you think the author included this information in the lead? What did he assume about the readers?

II. Analysing explanatory strategies

4. In the paragraphs reproduced below, Connor (2013) explains the concept of Crispr.

   Underline the words, phrases or sentences that 1) help you understand Crispr if you had not known about it before, and 2) help non-scientist readers understand the concept of Crispr. Explain 'how' these words, phrases or sentences may help you or non-scientist readers understand Crispr. Discuss the answers with your group members and share your answers for 1) and 2) with the class.

   Crispr stands for "clustered regularly interspaced short palindromic repeats", a devilishly contrived acronym which just about sums up why it was ignored for so long. For nearly two decades after Japanese researchers first discovered Crispr in bacteria in 1987, scientists mostly dismissed it as "junk DNA".

   In fact, the apparently nonsensical sequences within Crispr, which were repeated in palindromic order (the same backwards as forwards), did have a purpose and were far from junk. About six years ago, scientists discovered that these DNA sequences matched the genetic sequences of various viruses that attack bacteria, which led to the discovery of a sophisticated bacterial immune system.

   Far from being junk, Crispr was actually a way of storing the genetic information of an invading virus in the form of a palindromic DNA sequence. The bacteria used this genetic memory to target the viral invader by chopping it up with powerful "Crispr-associated" (CAS) enzymes capable of "cleaving" its DNA molecule, just like a pair of molecular scissors.

III. Analysing evaluative language

5. Revisit the headline and lead of the news article. What makes Jennifer Doudna's discovery newsworthy?

IV. Evaluating the effectiveness of explanatory strategies

6.   Look at the following examples taken from students' new articles. Consider the following prompts as you read the examples.

- **How effectively has the strategy been used in each example?** [Focus on the part highlighted in red]
- **When do you think it would be appropriate to use a particular strategy?**

a) Description and Definition

Example 1

The shortening effect of the telomere by the sugary drinks is due to the disruptions on several metabolic **(breaking and formation of essential molecules)** pathways that are required for growth.

Example 2

The telomere is repetitive sequences that are found at the end of a chromosome **(condensed form of DNA).**

Measurement of telomere length is done by subjecting the participant's blood which was collected by NHANES, through a quantitative polymerase chain reaction **(amplification of DNA).**

Example 3

The first step involved turning carbon dioxide into **methanol – a less useful, basic molecule –** before further processing. The reaction, however, inadvertently produced **ethanol – the more desirable and complex sister molecule –** all on its own!

b)   Metaphor and Analogy

Example 1

This is thought to be linked to increased deaths of smell sensors. **The process may be likened to the wearing out of winter car tyres.** In cold countries, studs are often found on tyres to improve the tyres' grip on slippery snow, therefore preventing road accidents. However, these studs wear out over time, eventually rendering them non-functional. Similarly, a spherical structure called the olfactory bulb exists in the nose. Tiny hairs on the bulb act as smell sensors. When we breathe in, air enters the nasal

cavity through these hairs. But with ageing, cumulative air influxes gradually but irreversibly damage these hairs. Hence it becomes significantly harder to sense familiar smells.

Example 2

Basically, **carbon dioxide gas acts as a screen that allows incoming solar radiation – heat from the Sun – to reach the Earth's surface, but blocks it on its way out,** therefore preventing the heat from leaving our planet. **Just like a one-way mirror, people can see through one side but not from the other.** This is known as the greenhouse effect.

V.   Reviewing your pre-course news article (Post-class activity)

Review your Pre-course News Article, paying special attention to the way it is introduced, i.e. headline, lead and opening section(s). Essentially, your self-review should focus on whether you have used:

- any of the two communicative moves to **raise readers' interest** in the headline, the lead or the first section;
    o **Move 1:** Introduce the key finding
    o **Move 2:** Describe the significance of the key finding

- any explanatory strategies **(definition, description, analogies and metaphors)** to **explain scientific concepts and ideas for non-specialist readers**; and

- any evaluative language **(expectedness, possibility)** to **engage readers.**

Week 3 Wrap up

Read the Post-lesson Students' Notes for this week.

Week 4

Tutorial 4.1. Critical reading and analysis: Mathematic book chapter

Learning Outcomes

By the end of the tutorial, you should be able to:

- analyse the choice of **narrative writing style** made by a popular science writer (Marcus du Sautoy) and describe its impact on readers; and

- identify and explain **teleological appeal** used in popular science writing to secure and sustain readers' interest.

Required Reading

du Sautoy, M. (2003). Who wants to be a millionaire? In *The music of the primes: Searching to solve the greatest mystery in mathematics* (pp. 1-18). HarperCollins.

Further Viewing

du Sautoy, M. (Host). (2014, January 14). Maths in music: The secret mathematicians - Marcus du Sautoy. [Video podcast episode]. In *The Secrets of Mathematics*. University of Oxford Podcasts. https://podcasts.ox.ac.uk/maths-music-secret-mathematicians-marcus-du-sautoy

I.   Exploring ideas in popular science

1. What point is the author making by referring to the cosmic prime number beat and the prime number twins?

2. Why do you think the book is titled "The Music of the Primes"?

3. "Some philosophers might take issue with such a Platonist view of the world... but to my mind that is what makes them philosophers and not mathematicians "(p.7). Explain the difference in the two world views and why it matters.

II. Exploring science communication

Discuss the following questions with your group members, and then share your insights with the rest of the class. Make suitable references to your reading to support your answer.

4. Describe the dominant writing style that is characteristic of this chapter, and discuss the impact of these choices on readers. Make suitable references to your reading to support your answer.

5. Last week you learned how Dawkins used **deontological appeal** to capture the reader's attention. Examine page 1 of *The Music of the Primes* and explain how deontological appeal is used to capture the reader's attention here. What could be a possible impact on the readers?

6. Deontological appeal alone may not be able to sustain readers' interest to finish the chapter or the book. In this chapter, **another type of appeal** was used to highlight the novelty of the central subjects- both the primes and the Riemann Hypothesis. Examine pages 10 and 11, describe what makes you want to continue reading and what is so novel about the primes and the Riemann Hypothesis? Discuss among your group members whether you think the writer has succeeded in capturing readers' attention using this strategy.

III. Group Reflection

In your groups, you will work on a 100 to 150-word reflection using the template provided. Essentially, your group reflection should focus on:

- whether your group found du Sautoy's use of the teleological appeal effective and why; and
- one interesting fact your group learnt about prime numbers which you had not known before.

Tutorial 4.2. Critical reading and analysis: Mathematics news article

Learning Outcomes

By the end of the tutorial, you should be able to:

- analyse and describe **Moves 3-5** that are conventional to introducing a news article;
- analyse and apply the use of **explanatory strategies** to explain scientific concepts and ideas for non-specialist readers;
- analyse and apply the use of **cohesive devices** to present ideas coherently and logically;
- analyse and evaluate the use of **evaluative language and appeals** to engage readers and;
- apply your learning to review your Pre-course News Article.

Required Reading

Buchen, L. (2009, May 18). Cicadas primed for defense. *Wired*.
http://www.wired.com/2009/05/primecicadas/

Background Reading

Tanaka, Y., Yoshimura, J., Simon, C., Cooley, J. R., & Tainaka, K. I. (2009). Allee effect in the selection for prime-numbered cycles in periodical cicadas. *Proceedings of the National Academy of Sciences*, 106(22), 8975-8979.
http://www.pnas.org/content/106/22/8975.full.pdf

Further Reading

Baron, S. (2021, November 22). Pythaogras' revenge: humans didn't invent mathematics, it's what the world is made of. *The Conversation.* https://theconversation.com/pythagoras-revenge-humans-didnt-invent-mathematics-its-what-the-world-is-made-of-172034

Weiss, I. (2018, January 12). Why do we need to know about prime numbers with millions of digits? *The Conversation.* https://theconversation.com/why-do-we-need-to-know-about-prime-numbers-with-millions-of-digits-89878

Pre-class Preparation

Identify the moves in the science news article. Your tutor will go through the answers in class.

Moves	Paraphrase or quotes from the article
Move 1 **Introduce the key finding**	
Move 2 **Describe the significance of the result**	

I. Analysing communicative moves

1. What role does section 2 (*The noisy winged critters* …) play in this news article? Can you locate the same information in the corresponding research article? Why is it necessary for the author to include this information?

2. What do you think the author is trying to achieve by quoting one of the co-authors of the research article in Section 3? Discuss the use of quotations in news articles as well as the content of this particular quote. what inspired them? their thought process

3. A leading theory that has been used to explain the cicada's bizarre life cycle is introduced in Section 4. What role does it serve in this news article?

4. You may have noticed that the author used direct quotes from Cooley and Web. Did you notice any differences in the citation format between academic essays and news articles?

II. Analysing explanatory strategies and cohesive devices

5. Compare how the problem of hybridization is explained in the news article (Buchen, 2009) and its source article (Tanaka, et al., 2009). Describe the changes in vocabulary, syntax and text that occur, and discuss the effects of these changes on readers.

From the research article (Tanaka, et al., 2009)	From the news article (Buchen, 2009)
In *Magicicada*, the fitness costs of hybridization may be elevated by predation; periodical cicadas suffer heavy mortality at low population densities because they rely on mass numbers and a strategy of "predator satiation" for survival (9, 10). (p.8975)	This is a problem, Cooley said, because periodical cicadas find strength in numbers. They're easy to catch and don't bite or sting, so they easily become snacks for hungry predators. But by buzzing around with hundreds of thousands of other cicadas, the probability of any one being eaten is close to zero. (Section 6)

6. Examine Sections 4 – 6, how does the author ensure that the ideas are presented coherently and logically?

III. Analysing evaluative language and appeals

7. You have learned about the two types of appeals; discuss the use of appeals in this news article. You can discuss the type(s) of appeals that the author includes, the evidence to support your answer, your evaluation of the effectiveness of the use of appeals in capturing readers' attention.

8. When stating the results, popular news authors often use language of certainty. However, the author of this story uses hedging when stating the result. Can you identify it, and discuss the rationale behind this language choice.

9. Consider the last section of the article. Discuss its role and significance in the larger news story as well as the language used to highlight that role.

IV. Evaluating the effectiveness of explanatory strategies

10. Look at the following examples taken from students' news articles. Consider the following prompts as you read the examples.

   • **How effectively has the strategy been used in each example?** [Focus on the part highlighted in red]
   • **When do you think it would be appropriate to use a particular strategy?**

c) Non-technical terms

Example 1

The researchers monitored the composition of air leaving the cinema through **sensors attached to the ceiling vents.**

(A spectrometer = sensors attached to the ceiling vents)

Example 2

When our organs receive this oxygen, they can then be **'powered'** to function.

d) Exemplification

Example 1

A group of researchers from the National University of Singapore thus postulated that blue light, specifically from an LED bulb – **which is the light in your smartphone or computer screen**, could kill bacteria in raw food products.

Example 2

This is much like what we would expect **one of those holograms from the Star Wars films** to look like, a 3D image in the air created by light coming from a flat surface, except that this 3D image is invisible and created by sound, not light.

V. Reviewing your pre-course news article (Post-class activity)

Reflect on and revise your Pre-course News Article in light of the learning points you gained in this tutorial. Pay special attention to the way **the context of the study** is introduced. Remember that the context of the study states the important background information for your audience to understand the topic of the study, and the rationale for the study (why the study has been conducted; what objective(s) has/have been accomplished).

The context of the study helps readers understand **why this particular study is needed** (what is the gap?) or **what has led the researchers to conduct the study**. This context includes, but is not limited to, the general background (Move 3) and the rationale of the study (Move 4).

- The explanations of the context are appropriately tailored to the assumed knowledge base of potential readers through use of explanatory strategies, suitable and sufficient information, and appropriate word choice.

- All ideas are presented coherently and logically which leads to an understanding of the objective(s) of the study.

- The writing is fluent; the author shows good control of language use.

Essentially, your self-review should focus on whether you have used:

- any of the three moves to provide **adequate information about the context of the study;**

    o **Move 3:** Provide general background for non-specialist readers
    o **Move 4:** Provide the rationale of the study
    o **Move 5:** Provide the source

- any explanatory strategies and clarifying techniques to **explain scientific concepts** and ideas for non-specialist readers; and

    o **definition**
    o **description**
    o **analogies and metaphors**
    o **non-technical words**

- any appeals (deontological and/or teleological) and evaluative language to **engage readers**.

    o **expectedness**
    o **importance**
    o **possibility**

Week 4 Wrap up

Read the Post-lesson Students' Notes for this week.

Week 5

Tutorial 5.1. Critical reading and analysis: Chemistry news article

Learning Outcomes

By the end of the tutorial, you should be able to:
- analyse and describe **Moves 6 - 8** that are conventional to introducing a news article;
- analyse and apply the use of **explanatory strategies and clarifying techniques** to explain scientific concepts and ideas for non-specialist readers;
- analyse and apply the use of **cohesive devices** to present ideas coherently and logically;
- analyse and apply the writer's use of **evaluative language and appeals** to engage readers; and
- apply your learning to review your Pre-course News Article.

Required Reading

Nield, D. (2016, May 13). Your Hunger Hormones Can Affect the Way You Make Decisions. *ScienceAlert*. http://www.sciencealert.com/your-hungry-hormones-can-affect-the-way-you-make-decisions

Background Reading

Anderberg, R. H., Hansson, C., Fenander, M., Richard, J. E., Dickson, S.L., Nissbrandt, H., Bergquist, F.& Skibicka, K.P. (2015). The Stomach-Derived Hormone Ghrelin Increases Impulsive Behavior. *Neuropsychopharmacology, 41*(5), 1199-1209. http://www.nature.com/npp/journal/v41/n5/full/npp2015297a.html

Further Reading

Pennington Biomedical Research Center (2022, April 7). Chemical compound promotes healthy ageing, study finds. *ScienceDaily.* https://www.sciencedaily.com/releases/2022/04/220407101053.htm

Sherrell, Z. (2022, July 14). Could the 'anti-hunger' molecule be the miracle weight loss cure of the future? *Healthnews.* https://healthnews.com/news/could-the-anti-hunger-molecule-be-the-miracle-weight-loss-cure-of-the-future/

I.   Analysing communicative moves

1. In Section 2, the author begins the article with previous research (Move 4: Provide the rationale of the study). Why do you think he omits Move 3 (Provide general background for non-specialist readers) and what does he assume about the readers?

2. What do you think the author is trying to achieve in Sections 3 - 4 (In the study, …). Compare these two sections to the research article. How are they different? How much information did the author include and what could be a possible reason for doing so?

3. Examine Section 5 ("Our results showed that …"). What do you think the author is trying to achieve in this section, and where can you find the same information in the research article?

4. Examine Section 8 (So we're probably …), what do you think the author assumes about the readers, and what is he trying to achieve?

5. In Sections 9 – 11, why is another study introduced and how does the author try to resolve the contradicting findings in the last section?

II.   Analysing explanatory strategies and cohesive devices

6. In Section 4, what strategy is used to explain 'impulsiveness'? Is it effective?

7. In Section 7, what technique is used to explain 'dopamine-related genes and enzymes'? Is it effective?

8. Examine Sections 5 – 6, how does the author ensure that the ideas are presented coherently and logically?

III.   Analysing evaluative language and appeals

9.   How did the author highlight the significance of the study?

10. How did the author try to engage the readers?

11. How effective is the use of the picture at the top of the page?

IV. Reviewing your pre-course news article (Post-class activity)

Reflect on and revise your Pre-course News Article in light of the learning points you gained in this tutorial. Pay special attention to the way the reported study and significance of the key findings are introduced.

Identify **aspects of the reported study (method and results of the study and explanation of the results) and significance of the key findings (evaluation of the results)** in your Pre-course News Article. Remember that these aspects of the reported study are necessary so the reader is clear about how the study was conducted, how the results are connected to the method used, and how these results can be understood in relation to the rationale and aims of the study.

The reported study

The reported study refers to information about the study that **supports the key finding or the main claim introduced in Move 1**. The reported study includes, but is not limited to, (the methods and the results (Move 6), and (the explanation of the results (Move 7).

- The explanations of the reported study are appropriately tailored to the assumed knowledge base of potential readers through use of explanatory strategies, suitable and sufficient information, and appropriate word choice.

- All ideas are presented coherently and logically which support the key finding introduced in Move 1.

- The writing is fluent; the author shows good control of language use.

Significance of the key finding

- The implication of the key finding and/or how the key finding advances the field is specific and clearly linked to the context of the study.

- The author's evaluation of the finding **supported by sufficient evidence or logical explanation** clearly helps readers appreciate the significance of the finding.

- The author's appraisal of the significance of the key finding demonstrates **balanced views with effective use of evaluative language** for the context of evaluation.

After reviewing those two aspects, review the entire article to see whether reader engagement is achieved consistently throughout the text.

Reader engagement

- The writing style (tone and register) is appropriate for the popular science news genre.

- Appeals are used successfully to entice readers to read the news article.

- A range of language features such as use of questions, pronouns, unexpectedness, and asides is used to show dialogic involvement and immediacy with readers throughout the article.

Essentially, your self-review should focus on whether you have used:

- any of the three moves to provide **adequate information about the reported study and significance of the key findings;**

   - **Move 6:** State the methods & findings
   - **Move 7:** Explain the result
   - **Move 8:** Evaluate the result

- any explanatory strategies and clarifying techniques to **explain scientific concepts** and ideas for non-specialist readers; and

   - definition
   - description
   - analogies and metaphors
   - non-technical words
   - **exemplification**
   - **functional recontextualisation**

- any appeals (deontological and/or teleological) and evaluative language to **engage readers**.

   - expectedness
   - importance
   - possibility

Tutorial 5.2. Critical reading and analysis: Statistics news article

Learning Outcomes

By the end of the tutorial, you should be able to:

- review and evaluate the explanation of the '**Context of the study'** in helping readers understand why this particular study is needed or what has led the researchers to conduct the study;
- review and evaluate the explanation of '**The reported study'** in supporting the key finding introduced in Move 1;
- review and evaluate the '**Significance of the key finding'** through the author's appraisal, evaluation and implication of the study;
- review and evaluate the '**Reader engagement'** through the author's writing style, appeals and language features; and
- apply your learning to revise your Pre-course News Article.

Required Reading

Derouin, S. (2018, January 3). Satellites Predicts a Cholera Outbreak Weeks in Advance, *Scientific American*.
https://www.scientificamerican.com/article/satellites-predict-a-cholera-outbreak-weeks-in-advance/

Further Reading

American Society for Microbiology. (2022, July 25). New methodology helps predict soil recovery after wildfires. *ScienceDaily*.
https://www.sciencedaily.com/releases/2022/07/220725105601.htm

Reardon, S. (2022, June 28). This AI tool could predict the next coronavirus variant. *Scientific American.* https://www.scientificamerican.com/article/this-ai-tool-could-predict-the-next-coronavirus-variant/

Pre-lesson Preparation

Read the assessment rubric for the Science News Article and analyse the news article based on the assessment criteria.

I.   Evaluating a science news article

To aim and achieve for a higher quality piece of writing, you need to understand the criteria that being used to evaluate your work. You will apply the assessment rubric to evaluate the article. Discuss with your group members, and decide if this work is 'Satisfactory', 'Competent' or 'Advanced' based on the descriptors. Please provide comments or justifications in the Comments column.

Assessment criteria	Comments	Satisfactory	Competent	Advanced
Context of the study				
1. The explanations of the context are appropriately tailored to the assumed knowledge base of potential readers through explanatory strategies, suitable and sufficient information, and appropriate word choice. Both key and supplementary concepts are clear to non-specialist readers.				
2. All ideas are presented coherently and logically which leads to understanding of the study's objective. Links between ideas are always explicit, and achieved through a range of cohesive devices (e.g. determiners, conjunction phrases, synonyms, repetition, transitional words).				
3. The writing is fluent; the author shows good control of language use with few or no sporadic grammar/syntax errors occurring only as 'slips'.				
The reported study				
4. The explanations of the reported study are appropriately tailored to the assumed knowledge base of potential readers through explanatory strategies, suitable and sufficient information, and appropriate word choice. Both key and supplementary concepts are clear to non-specialist readers.				

Assessment criteria	Comments	Satisfactory	Competent	Advanced
5. All ideas are presented coherently and logically which support the key finding introduced in Move 1. Links between ideas are always explicit and achieved through a range of cohesive devices (e.g. determiners, conjunction phrases, synonyms, repetition, transitional words).				
6. The writing is fluent; the author shows a very good control of language use with few or no sporadic grammar/syntax errors occurring only as 'slips'.				
Significance of the key finding				
7. The implication of the key finding and/or how the reported study advances the field is highly specific and clearly links to the context of the study. Readers clearly understand why this study is 'significant' to the field and multiple stakeholders.				
8. The author evaluates the finding effectively by providing sufficient evidence and logical explanation.				
9. The significance of the finding is appropriately appraised with balanced views and effective use of evaluative language for the context of evaluation.				
Reader engagement				
10. The writing style /tone/register (including citation) is always appropriate to the popular science news genre.				

Assessment criteria	Comments	Satisfactory	Competent	Advanced
11. The author successfully employs appeals to entice the readers to read the article.				
12. The author consistently shows dialogic involvement and immediacy with readers through a wide range of language features such as use of questions, pronouns, unexpectedness, and asides.				

II. Describing the statistical method

The extract below is taken from a popular science news article written by a student:

> One method they used to create the group is called stacking. It's a process of inputting data into the first classification model, then the next, and the next until the last model gives us the outcome. Think of it as a sieve stack and the patients who are at risks are the smallest and finest rocks. The sieves have varying hole sizes, and each sieve represents a unique classification model. The first sieve, which has the largest hole size, filters out the bigger rocks and the rest of the smaller rocks goes through the holes to the next sieve with a smaller hole size. This process continues until the last sieve with the smallest hole size. Leaving the finest and smallest rocks at the bottom which in this case are the patients with risks of getting heart disease.
>
> The multiple sieve filtering process represents different groups of classification models to filter out the patients, providing a much more accurate way to obtain the classification as compared to using just a single sieve. Ultimately, achieving the 99.97% accuracy.

- What explanatory strategies and clarifying techniques have been employed to make the statistical method accessible for the audience?

- How effective are these strategies and techniques?

III. Reviewing your pre-course news article (Post-class activity)

Reflect on your own news article in light of the learning points you gained in this tutorial and your peer's feedback. Essentially, your reflection should focus on whether you have used:

- any of the eight moves to provide **adequate information about the context of the study, the reported study and significance of the key findings;**
    - o **Move 1:** Introduce the key finding
    - o **Move 2:** Describe significance/implication of the result
    - o **Move 3:** Provide general background for non-specialist readers
    - o **Move 4:** Provide the rationale of the study
    - o **Move 5:** Provide the source
    - o **Move 6:** State the methods & findings
    - o **Move 7:** Explain the result
    - o **Move 8:** Evaluate the result

- any explanatory strategies and clarifying techniques to **explain scientific concepts** and ideas for non-specialist readers; and
    - o definition
    - o description
    - o analogies and metaphors
    - o non-technical words
    - o exemplification
    - o functional recontextualisation

- any appeals (deontological and/or teleological) and evaluative language to **engage readers**.
    - o expectedness
    - o importance
    - o possibility

Task Reminder: Book Chapter Reflection

If you have already written your book chapter reflection, you may review your work to see if you have effectively explained the author's use of particular strategies. Remember to submit your work by Sunday, 11 September, 11:59pm.

Week 5 Wrap up

Read the Post-lesson Students' Notes for this week.

Week 6

Tutorial 6.1. Critical reading and analysis: Non-assessed peer review

Learning Outcomes

By the end of the tutorial, you should be able to:
- identify issues in the work of your peers that require further explanation or clarification;
- suggest practical recommendations; and
- critically assess and act on received feedback to revise the Pre-course News Article for the second submission.

Conducting Peer Review

Participate in a peer feedback session to give and receive feedback on the Pre-course News Articles using a **feedback rubric.**

You will work in groups of three to evaluate **your revised Pre-course News Article** based on the four assessment criteria. Your tutors will provide instructions about how this peer review activity will be conducted.

Importance of peer review

In academic publishing, peer review is a system used to assess the quality of articles submitted for publication in a scholarly journal. The manuscript will be evaluated based on the criteria for submission. Double-blind review is commonly used in peer review to limit reviewer bias as both the author and reviewers are anonymous.

Peer review in higher education is a **reciprocal evaluative process** through which students review the work of peers and receive peer feedback. Peer review conducted in a higher education context is regarded as **collaborative**, **with both the reviewer and reviewee benefiting from the review experience.**

Peer review in SP1541

Peer review in SP1541 is to help understand the use of a **criterion-referenced assessment rubric** to evaluate one's writing performance. In other words, you will identify criteria and standards to apply to the Pre-course News Article written by your peers and make judgement about the extent to which they have met these criteria and standards.

As a **reviewer**, you are expected to identify issues in the work of your peers that require further explanation or clarification and suggest practical recommendations.

As a **reviewee**, you are expected to critically assess and act on received feedback.

You are strongly encouraged to invest time and effort in the peer review as thinking and reflecting about your writing and that of others can help you refine your understanding and facilitate your learning of the various strategies that will be covered in class. The peer review activity can help you to concretise your understanding and give you a sense of how you are progressing in terms of science news writing.

Tutorial 6.2. Constructing and presenting an infographic:
Statistics book chapter

Learning Outcomes

By the end of the tutorial, you should be able to:

- understand how popular science writers (George Cobb and Stephen Gehlbach) explain scientific concepts;
- use visuals to communicate science knowledge; and
- apply any appeals, explanatory strategies and evaluative language to secure and sustain readers' interest.

Required Reading

Cobb, G. and Gehlbach, S. (2006). Statistics in the courtroom: United States vs. Kristen Gilbert. In R. Peck, G. Casella, G. Cobb, R. Hoerl, D. Nolan, R. Starbuck and H. Stern (Eds.), *Statistics: A Guide to the Unknown* (4th ed., pp. 3–18). Thomson Brooks/Cole.

Further Reading

Denis, D. J. (2017, April 25). How statistical thinking should shape the courtroom. *The Conversation.* https://theconversation.com/how-statistical-thinking-should-shape-the-courtroom-7496

Pre-class Preparation

The goals of this activity are to present scientific concepts and ideas to the audience using a **multimodal approach, i.e. a combination of texts, images, and spoken language.**

You should prepare for this activity in your groups before coming to class.

You will be given the **first 20 minutes of the class** to finalise ideas with your group members. Read through the task requirements to get a sense of what needs to be done. You will work in groups of 4 -5 to create an infographic that **illustrates the use of statistics in real-life scenarios.** Some examples relating to the topic of statistics include the **probability of rainfall occurring in a week** and the **probability of winning the lottery in one's lifetime**. If you cannot think of any new ideas for this, you could always use the example in your required reading.

Your preparation includes:
- the statistical concept you wish to inform your audience about;
- its use in a specific, real-life scenario; and
- an outline of the content your infographic will cover by including 3-4 headings.

I. Exploring science communication using a multimodal approach

Your group has been selected to represent the College of Humanities and Science at the '*NUS Science Roadshow*' at Clementi Mall. You will showcase how statistics can be used outside of classrooms or research labs, just like the Gilbert court case. Your target audience are mall-goers, so remember to use **appeals** to attract their attention, **explanatory strategies** to help them understand the content and **evaluative language** to highlight the **significance of statistics**.

Each group will present their **infographic** to the class. Please assign 1-2 members of your group to present on 1 section of your infographic.

In each section of the infographic, please provide:
a)   a brief summary of what the section is about; and
b)   an explanation for the salient design and content choices your group made and why.
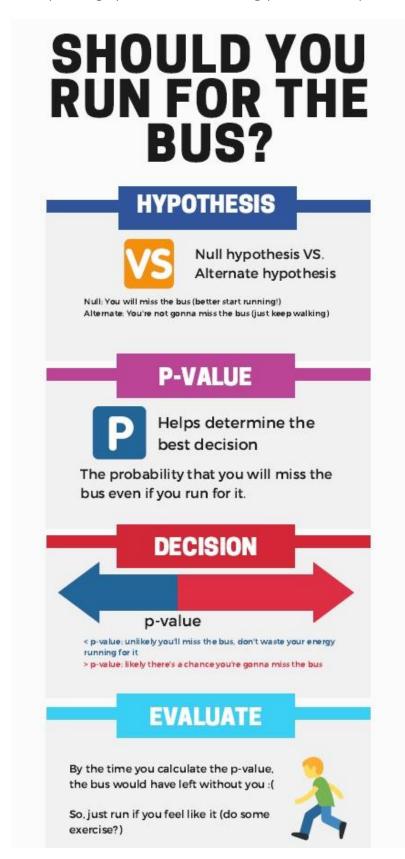
One group member should be responsible for providing an overview of the infographic, i.e. the statistical concept it covers, the real-life scenario it involves and why this statistical concept and scenario were selected. There will be a short Q&A segment at the end of each presentation.

Procedures

1.   Create an infographic using free online tools such as Canva or Piktochart.

2.   As you go through your discussion and design process to create your infographic, assign one member of the group to keep track of the discussion by noting down **what content and design decisions were made and why they were made**. This may be useful later when your group presents your infographic to the class and for the reflective activity at the end.

3.   Present your infographic to the class. Each group should assign one member to briefly explain the purpose of the infographic to the audience and the remaining members should take turns presenting the different parts of the infographic, explaining why certain content and design decisions were made.

4.   During the presentation, the rest of the class should focus on the explanations given by the presenting group and ask questions about the relevance of the infographic to the audience and the rationale for the content and design decisions made.

5.   After the presentations, groups should re-visit their infographic and decide on 2-3 improvements they think should be made to the content and design.

6. If there is time, groups can re-design their infographic and display them to the class to receive feedback as to whether the improvements have been effective.

A sample infographic on communicating 'p-value' to the public has been provided below:

SHOULD YOU RUN FOR THE BUS?

HYPOTHESIS

VS Null hypothesis VS. Alternate hypothesis

Null: You will miss the bus (better start running!)
Alternate: You're not gonna miss the bus (just keep walking)

P-VALUE

P Helps determine the best decision

The probability that you will miss the bus even if you run for it.

DECISION

p-value

< p-value: unlikely you'll miss the bus, don't waste your energy running for it
> p-value: likely there's a chance you're gonna miss the bus

EVALUATE

By the time you calculate the p-value, the bus would have left without you :(

So, just run if you feel like it (do some exercise?)

Helpful tips when designing your infographic

1. Decide on what information you want to present in your infographic and categorise it according to **themes**.

2. **Prioritize these themes** so you know which theme you want your audience to notice first on your infographic.

3. For each theme, decide on the main points you wish to cover and **how you will present them, e.g. in paragraph form, as bullet points**. Think also about how you will present scientific information to your audience that will be accessible to them.

4. Decide if, as a whole, your infographic is to be viewed **top-to-bottom, centre-out or left-to-right**. Then decide within each section that showcases a theme if it should be viewed top-to-bottom, centre-out or left-to-right.

5. Include **helpful, attractive visuals** to capture your audience's attention.

6. **Size, font type, spacing and position of elements (images and text)** in your infographic are important factors to consider – try to play around with these to get an infographic that is both visually appealing and informative.

II. Reviewing your infographic

During the process of designing your group's infographic, you probably had to make some content and design decisions about:

1. what information to include;
2. how to present scientific information;
3. how to best design your infographic, e.g. what images to use, where to position elements (images and text) of your infographic.

Reflect on and discuss with your group at least one of the above points and share a revised version of your infographic on MS Teams.

Task Reminder: Revised Pre-course Writing Task

Revise and finalize your pre-course news article based on peer feedback and self-review. Remember to submit the revised version for tutors' feedback and the self-reflection by Sunday, 18 September, 11:59pm.

Week 7

Tutorial 7.1. Critical reading and analysis: Physics book chapter

Learning Outcomes

By the end of the tutorial, you should be able to:

- identify the choice of the writing style made by a popular science writer (Stephen Hawking) and describe its impact on readers; and

- identify and explain the type of appeal used by popular science writers to secure and sustain readers' interest.

Required Reading

Hawking, S. W. (2011). Our Picture of the Universe. In *A brief history of time: From the big bang to black holes* (pp.1-14). Bantam.

Further Viewing

Hawking, S. W. (2016, January 26). *The black hole* [Video]. BBC Radio 4 The Reith Lectures. https://www.bbc.co.uk/programmes/p03g7hfs

Pacucci, F. (2018, September). *Hawking's black hole paradox explained* [Video]. TED Conferences. https://www.ted.com/talks/fabio_pacucci_hawking_s_black_hole_paradox_explained

I.   Exploring Ideas in Popular Science

1. From geocentric to heliocentric to the big bang models of the universe. What implications do you draw from these for learning and doing science?

2. Hawking believes that our picture of the universe will one day be complete. What grounds his belief? How convincing is his reasoning?

3. As Hawking notes, a theory "exists only in our minds and does not have any other reality." Does this reduce the value of scientific research?

4. Why does Hawking write that "the search for the ultimate theory of the universe seems difficult to justify on practical grounds" (p.13)? How did this statement affect you as a reader?

5. "But there is a fundamental paradox in the search for such a complete unified theory" (p.12). Articulate this paradox, and explain the point that Hawking is making here.

II.   Exploring Science Communication

6. How would you describe Hawking's style of writing in this chapter? Discuss the impact of his stylistic choice on readers. To do this, consider the following:
   - Would you regard his chapter as narrative, descriptive, or argumentative?
   - How effective is his choice? What effects on the reader are achieved?
   - What is gained or lost as a result of his choice?

7. Study closely the first two paragraphs of the chapter. Describe how Hawking goes about securing the reader's interest in what the chapter has to offer.

8. In the following text, Hawking attempts an explanation of the concept of planetary motion. Analyse how he does it in a way that maximizes understanding and interest. (Hint: You may find it helpful to look up conventional scientific explanations of planetary motion on the internet for purposes of comparison).

As far as Kepler was concerned, elliptical orbits were merely an ad hoc hypothesis, and a rather repugnant one at that, because ellipses were clearly less perfect than circles. Having discovered almost by accident that elliptical orbits fit the observations well, he could not reconcile them with his idea that the planets were made to orbit the sun by magnetic forces. An explanation was provided only much later, in 1687, when Sir Isaac Newton published his Philosophiae Naturalis Principia Mathematica, probably the most important single work ever published in the physical sciences. In it Newton not only put forward a theory of how bodies move in space and time, but he also developed the complicated mathematics needed to analyze those motions. In addition, Newton postulated a law of universal gravitation according to which each body in the universe was attracted toward every other body by a force that was stronger the more massive the bodies and the closer they were to each other. It was this same force that caused objects to fall to the ground. (The story that Newton was inspired by an apple hitting his head is almost certainly apocryphal. All Newton himself ever said was that the idea of gravity came to him as he sat "in a contemplative mood" and "was occasioned by the fall of an apple.") Newton went on to show that, according to his law, gravity causes the moon to move in an elliptical orbit around the earth and causes the earth and the planets to follow elliptical paths around the sun.

Tutorial 7.2. Critical reading and analysis: Physics news article

Learning Outcomes

By the end of the tutorial, you should be able to:

- identify gaps in a news article that reduce clarity for general news readers;
- identify information from an additional source that fills a gap in the news article;
- write a paragraph with information from an additional source; and
- acknowledge the supplementary article source appropriately.

Required Reading

Butterworth, J. (2016, February 11). Gravitational waves: why it's impossible not to be thrilled by this discovery. *The Guardian.* https://www.theguardian.com/science/2016/feb/11/gravitational-waves-science-thrilled-by-discovery-ripples-in-space-time

Supplementary Reading

Cain, F. (2016, October 5). What happens when black holes collide? *Universe Today.* https://www.universetoday.com/131212/happens-black-holes-collide/

Castelvecchi, D. (2016, February 11). Gravitational waves: 6 cosmic questions they can tackle. *Nature News.* http://www.nature.com/news/gravitational-waves-6-cosmic-questions-they-can-tackle-1.19337

Gravitational waves detected 100 years after Einstein's prediction. (2016, February 11). LIGO Caltech. https://www.ligo.caltech.edu/news/ligo20160211

What are gravitational waves? (n.d.) LIGO Caltech. https://www.ligo.caltech.edu/page/what-are-gw

What is an interferometer? (n.d). LIGO Caltech. https://www.ligo.caltech.edu/page/what-is-interferometer

Optional Background Reading

Abbott, B. P. et al. (2016). Observation of gravitational waves from a binary black hole merger. *Physical Review Letters*, *116*(61102), 1-16. https://physics.aps.org/featured-article-pdf/10.1103/PhysRevLett.116.061102

Pre-lesson Preparation

Read Butterworth's (2016) news article on measuring gravitational waves and prepare a response to the following.

1. Map Moves 1-8 for Butterworth's article. Which moves are missing?

2. Based on Butterworth's explanation of:
   a. binary black holes;
   b. previous gravitational wave research;
   c. the research findings;
   d. the methodology; and
   e. the significance of the results.

   Identify the information gaps in Butterworth's article based on what you felt was clear, unclear and why.

3. Based on the key gaps identified in the previous section, try to identify how the assigned supplementary article(s) you have read fills any of those gaps. Some of the articles can fill more than one key gap.

I.   Identifying information gaps

1. Map Moves 1-8 for Butterworth's article. Which moves are missing?

2. Based on Butterworth's explanation of:
   - binary black holes;
   - previous gravitational wave research;
   - the research findings;
   - the methodology; and
   - the significance of the results.

   What are the information gaps?

II. Identifying sources to fill information gaps

3. How can the supplementary article you read fill any of those gaps?

III. Application: Using Supplementary Sources

Each group will write a paragraph to address the questions in the assigned key gap(s). Use the assigned supplementary article as a resource.

In the interest of time, you will NOT need to search for additional supplementary articles. Your paragraph **should appropriately acknowledge the supplementary source**. You may wish to review how to acknowledge sources in news articles.

Your group will present your paragraph to the class and explain:

- what the information gap(s) are from Butterworth's article that are relevant to your assigned article; and
- how your paragraph plugs these gaps.

Please also provide peer feedback to help other groups to enhance their performance.

Task Reminder: Science News Article

Remember to submit your Science News Article and view the similarity report after your Turnitin submission by Sunday, 2 October, 11:59pm.

Week 7 Wrap up

Read the Post-lesson Students' Notes for this week.

Week 8

Tutorial 8.1. Critical analysis of Life Science talks: Accessibility and visual aids

Learning Outcomes

By the end of the tutorial, you should be able to:

- analyse strategies in delivering a science talk for the general public;
- analyse visual aids in supplementing a science talk; and
- recognise features of a question and answer section in a science talk.

Pre-lesson Preparation

A. Watch **Jennifer Doudna's two science talks** and identify the differences in terms of purpose, audience, level of technicality, use of explanatory strategies and use of visual aids. Make specific references to what the speaker says.

Dounda, J. (2015, March 24). *Genome Engineering with CRISPR-CAS9: Birth of a Breakthrough Technology* [Video]. iBiology Science Stories. http://www.ibiology.org/ibiomagazine/jennifer-doudna-genome-engineering-with-crispr-cas9-birth-of-a-breakthrough-technology.html

Doudna, J. (2015, October 20). *How CRISPR lets us edit our DNA* [Video]. TED Conferences. https://www.ted.com/talks/jennifer_doudna_we_can_now_edit_our_dna_but_let_s_do_it_wisely?language=en#t-169578

B. Watch a **TED talk by Melissa Marshall**, a communications teacher from Pennsylvania State University, as she outlined key strategies that scientists and engineers can use to communicate their work effectively. Take notes and think of how you plan to apply these strategies to make your science presentation more accessible.

Marshall, M. (2014, March 12). *Talk nerdy to me* [Video]. TED Conferences. https://www.ted.com/talks/melissa_marshall_talk_nerdy_to_me/transcript?language=en#t-187223

C. Watch the three videos to understand the key principles of an **assertion-evidence presentation.**

Alley, M. (2020, January 18). *Build your scientific talk on messages, not topics* [Video]. Vimeo. https://vimeo.com/385725653

Alley, M. (2020, January 18). *Support your presentation messages with visual evidence, not bullet lists* [Video]. Vimeo. https://vimeo.com/385729603

Alley, M. (2016, November 11). *Delivering a scientific presentation* [Video]. Vimeo. https://vimeo.com/191129969

D. Watch the video which explains **how images are licensed** and **how to attribute images licensed for reuse.**

UniSA Library (2018, August 2). Attributing images licenced for reuse [Video]. YouTube. https://www.youtube.com/watch?v=uhgihySJyHk

I. Analysing Accessibility and Visual Aids

Based on Jennifer Dounda's two science talks, discuss the following questions with your group members. Your group will be selected to share the insights with the rest of the class.

	iBiology talk	TED talk
1) What is the **purpose** of each talk?		
2) Who do you think is the **target audience** of each of these two talks?		
3) What are the differences between these two talks in terms of **level of technicality and use of explanatory strategies**?		
4) What are the differences between these two talks in terms of **visual aids**?		

II.   Exploring Science Presentation Strategies

In her TED talk, Melissa Marshall introduced key strategies that scientists and engineers can use to effectively communicate their work to a wider audience. Share these strategies with your group members and discuss how you plan to apply these strategies to make your mock presentation more accessible. Give specific examples.

Science Presentation Strategies

III.   Using Visual Aids

One of the strategies Melissa Marshall mentioned is to **drop the bullet points... because bullets kill.** She introduced the **assertion-evidence slide design** which can be used as an alternative to PowerPoint's default structure. Based on the three videos, identify the key principles of an assertion-evidence presentation and illustrate the assertion-evidence format using an example.

Key Principles of an Assertion-evidence Presentation

Apply this slide design to create 1 slide to introduce a key scientific concept for your mock presentation based on the revised pre-course news article. You will be given no longer than 15 minutes to finalize the slide and rehearse your presentation.

After you are done with your slide, take turns presenting the concept with the slide and giving feedback in groups. Nominate one person from your group to present their slide to the rest of the class.

Finding and Citing Images

Refer to NUS Libraries' guide on how to find and use free online images such as free stock images in Microsoft 365 or images from certain databases.
https://libguides.nus.edu.sg/freesources/Images

If the image used is not yours, please check the license and give credit to the creator with a citation, known as **attribution.** The three objectives of providing image attribution on presentation slides are to:
- acknowledge and credit the creator;
- allow readers to trace the source; and
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Common attribution formats for images are as follows:
- Creative Commons attribution guidelines:
  https://libguides.nus.edu.sg/freesources/attribution
- APA style copyright attribution and reference list entry: https://apastyle.apa.org/style-grammar-guidelines/references/examples/clip-art-references

You can provide **appropriate attribution** next to the photograph or close by (e.g. on the edge or bottom of the page) if that is too obtrusive. Read the American Psychological Association's guide on clip art or stock image references to attribute images in APA style appropriately and provide a **reference list entry** for the image used.

American Psychological Association (2022). *Clip Art or Stock Image References.*
https://apastyle.apa.org/style-grammar-guidelines/references/examples/clip-art-references

IV.   Asking and Answering Questions

For your oral presentation assessment, there will be a 3-minute Q&A session at the end of your presentation. This is a common practice for a science talk to allow the audience to engage with the speaker. As an audience participant, it is important that you ask helpful questions. Discuss with your group members the following question:

What do you think makes a question helpful or unhelpful for the presenter/ presentation?

Tutorial 8.2. Critical analysis of a Physics talk: Delivery and audience engagement

Learning Outcomes

By the end of the tutorial, you should be able to:

- engage audiences using features of non-verbal and vocal delivery;
- recognise features of spoken language that contribute to a lively and engaging science talk; and
- understand the assessment criteria for the assessed Oral Presentation.

Pre-lesson Preparation

A. Watch a science talk by Allan Adams and observe his verbal and vocal elements of delivery and identify evidence of what makes it an effective science talk. Pay attention to what you **see** as well as what you **hear**.

Adams, A. (2016, February 18). *What the discovery of gravitational waves means* [Video]. TED Conferences. https://www.ted.com/talks/allan_adams_what_the_discovery_of_gravitational_waves_means?utm_campaign=tedspread&utm_medium=referral&utm_source=tedcomshare

B. Watch a TED talk by David JP Phillips, a communications expert who has spent 7 years analysing 5,000 public speakers to identify effective body-language tips.

Phillips, D.J.P. (2019, February 2). TEDxZagreb: *The 110 techniques of communication and public speaking* [Video]. Youtube. https://youtu.be/K0pxo-dS9Hc

C. Watch a sample presentation video from Canvas. **DO NOT** record and distribute the videos as they are used solely for teaching purposes.

I. Analysing key aspects of delivery

Discuss your observations and evaluation of Allan Adams' non-verbal and vocal aspects of delivery. What aspects make his science talk engaging? Provide specific examples to support your answers.

Aspects		Observations and Evaluation
Non-verbal elements of delivery	Eye contact and facial expression	
	Posture and gesture	
Vocal elements of delivery	Pitch, pronunciation, and volume	
	Fluency (spontaneity) and pace	

II. Analysing strategies used to engage audiences

Apart from **effective non-verbal and vocal delivery**, you should aim to engage the audience in your science presentation. Asking questions and taking a poll at the beginning of the presentation are two of the most popular strategies used by SP1541 students. Though they help engage the audience at the start of the talk, they are not sufficient to help them remain engaged throughout the presentation.

In his TED talk, Adams does not use these two strategies, but he still manages to engage the audience. How did he accomplish this? Complete Task 2.1 and 2.2 using the following transcript.

It's worth pausing here to think about what that means. Two black holes, the densest thing in the Universe, one with a mass of 29 Suns and one with a mass of 36 Suns, whirling around each other 100 times per second before they collide. Just imagine the power of that. It's fantastic. And we know it because we heard it… And there's a lot out there that we can't see -- in practice or even in principle. So supernova, for example: I would love to know why very massive stars explode in supernovae. They're very useful; we've learned a lot about the Universe from them. The problem is, all the interesting physics happens in the core, and the core is hidden behind thousands of kilometres of iron and carbon and silicon. We'll never see through it, it's opaque to light. Gravitational waves go through iron as if it were glass -- totally transparent. The Big Bang: I would love to be able to explore the first few moments of the Universe, but we'll never see them, because the Big Bang itself is obscured by its own afterglow. With gravitational waves, we should be able to see all the way back to the beginning. Perhaps most importantly, I'm positive that there are things out there that we've never seen that we may never be able to see and that we haven't even imagined -- things that we'll only discover by listening.

Task 2.1:

One of the reasons for Adam's effective science talk is his **use of language cues** to engage listeners. Identify the instances of speech from the transcript above that serve the following functions. Also consider how these cues help the speaker interact with their audience and evaluate their effectiveness.

Functions of language cues	Instances of speech and its effectiveness
Cue listeners to think or feel in a certain way.	
Signal the status of information.	
Share a personal perspective to inspire or encourage interest.	
Create shared reference or common ground to help listeners feel included.	

Task 2.2:

Adams does not speak as though he is recalling a memorized script. This is because he employs **features of spoken language** rather than written language. Examine typical features of both types of language in the following table, and discuss how Adams employs these features to make his science talk sound lively. Refer to specific instances of the talk to illustrate your answer.

Typical features of spoken and written language

Written language	Spoken language
Basic unit is the sentence	Basic unit is the clause (utterance)
Clauses linked by subordination (*who, which, when* etc) to build the text	Clauses linked by conjunction (*and, but, so* etc) to build the text
Formal language preferred (*commenced*)	Informal language preferred (*we used to get together*)
Few/no noticeable performance effects	Range of noticeable performance effects (hesitations, pauses, repeats, false starts, incompletion)
Little use of ellipsis	Frequent use of ellipsis (omission of grammatical elements e.g. *started at the same time*)
Little use of personal pronouns	Frequent use of personal pronouns (*I, we*)

Instances of features and their effectiveness

III. Exploring audience engagement through body language

In his TED talk, David Phillips introduced body-language tips that help engage his audience. Share these strategies with your group members and discuss how you plan to apply these strategies to make your mock presentation more engaging to an audience. Give specific examples.

Body-language Strategies

IV.   Evaluating a sample video

In groups, discuss how you would rate the presentation in terms of the four assessment criteria using the assessment rubric. Your group will then present your findings for your assigned criterion category of the rubric to the whole class.

Assessment criteria			Comments	Satisfactory	Competent	Advanced
Accessibility	1	Explanations of the scientific concepts and processes are appropriate for oral communication. Explanations are scaffolded to achieve a logical development of successively more complicated ideas.				
	2	Visual aids (both graphic and language-based) are used tactically to explain the scientific concepts and processes.				
	3	The presenter uses clear choice of language that is highly appropriate for the audience.				

Assessment criteria		Comments	Satisfactory	Competent	Advanced
Organization of ideas	4	The presentation has a coherent structure and flows conceptually from the context to the reported study and the conclusion.			
	5	Clear connections are made between various parts of the presentation; signposting is used well.			
	6	The speaker does not present irrelevant or superfluous concepts. The presenter demonstrates a good balance between various parts of the presentation.			

Assessment criteria			Comments	Satisfactory	Competent	Advanced
Significance of the finding	7	The implication of the key finding to science and/or the public is explicitly stated at the beginning of the presentation and clearly elaborated on during the presentation. The presenter augments the presentation with examples of real-life application or implication for the field and multiple stakeholders.				
	8	The rationale of the study is clearly stated (the background to the problem is clearly stated along with present solutions and their limitations).				
	9	The significance of the key finding is appropriately appraised.				
Assessment criteria			Comments			

Assessment criteria			Comments	Satisfactory	Competent	Advanced
Delivery & audience engagement	10	The speaker demonstrates the ability to communicate in a spontaneous, unrehearsed manner.				
	11	Vocal elements of delivery (e.g. pace, pitch, pronunciation and volume) are used effectively to enhance communication of the overall message.				
	12	Non-verbal elements of delivery (e.g. eye contact, gesture, posture and facial expression) are used strategically to demonstrate the presenter's confidence and passion for the topic.				
	13	The presenter refers to the visuals consistently and directs the audience's focus strategically.				

Week 9

Tutorials 9.1 & 9.2. Mock presentation sessions 1 & 2

Learning Outcomes

By the end of this week, you should be able to:

- deliver a mock presentation based on your revised pre-course news article;
- evaluate your peers' performance using the Oral Presentation assessment rubric; and
- practise asking questions during a Q&A session.

You are expected to deliver **a 3-minute presentation that covers the context and rationale of the study reported in your revised Pre-course News Article** and take part in a Q & A session.

Do not present a summary of the study. This would take too long and impact the time others have for their mock presentation and feedback. Think about how you are going to present information to your audience that will give them an idea about the relevant background of the study and its aims and rationale (research 'gap').

Peer Review

All students are expected to be present for the Mock Oral Presentation sessions to provide feedback to presenters using the criterion-referenced assessment rubric.

1. Make a copy of the peer review template found in a folder 'Mock OP Peer Review' on MS Teams and rename your file by adding your full name.

2. Each student will be assigned to evaluate mock oral presentations based on one assessment criterion.

3. Please insert your brief comments into the appropriate boxes.

Week 10

Tutorial 10.1 & 10.2. Individual conferencing sessions 1 & 2

Week 11

Tutorial 11.1 & 11.2. Individual conferencing sessions 3 & 4

Learning Outcome

By the end of this week, you should be able to:

- identify strengths and areas for improvements based on your Science News Article.

Your tutor will arrange a time to meet you individually to discuss the feedback on *your Science News Article.* The conferencing session is not an editing session. You should prepare a few specific questions based on the written feedback you received. Each session lasts 20 minutes. The conferencing format adopted may differ between tutors based on individual styles.

There will be tutorials on Friday, 21 October 2022 (NUS Holiday – NUS Well-being Day) and Monday, 24 October 2022 (Public Holiday - Deepavali). The make-up classes will be scheduled in Week 10 of Week 11. You tutors will inform you of he make-up conferencing sessions.

Week 12

Tutorials 12.1. Critical reading and analysis: Assessed peer review

Learning Outcomes

By the end of this tutorial, you should be able to:

- understand assessment criteria and standards by providing criterion-referenced peer feedback on the revised version of Science News Article;
- identify your own strengths and weaknesses by analysing the received feedback;
- critically assess and act on received feedback to revise your Science News Article for the second submission.

Your tutors will provide instructions about how this peer review activity will be conducted.

Tutorial 12.2. Assessed oral presentation session 1

Week 13

Tutorial 13.1 & 13.2. Assessed oral presentation sessions 2 & 3

Learning Outcomes

By the end of the week, you should be able to:

- present scientific concepts and ideas in a coherent and engaging manner to non-specialists; and
- ask meaningful questions and provide feedback to encourage presenters to think more critically.

Refer to the Task Instructions for the Individual Oral Presentation in the Course Information.

Task Reminder: Revised Science News Article and Reflective Commentary

Remember to submit your Revised Science News Article and Reflective Commentary 2 by Sunday, 13 November, 11:59pm and view the similarity report after your Turnitin submission.