Teaching the process of science through COVID-19 pandemic themes

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Abstract
Several predominant themes have emerged during the COVID-19 global pandemic that intersect with the nature and process of science. This paper identifies three such themes and briefly explores how they can be used as case studies and narrative cornerstones in teaching and learning. The themes include: (1) the understanding that science is cumulative and ever-changing, meaning that new findings may cause us to reconsider previous understandings; (2) the importance of citation tracking in the process of science; and (3) the need for accessible and purposeful science communication.

Keywords
case studies, case-based learning, COVID-19, process of science

Case studies are a valuable tool in education, as they provide real-world context and examples of course material. Here we explore how themes emerging from the COVID-19 pandemic can be used as case studies or narrative cornerstones to learn about the process and nature of science. The COVID-19 pandemic can be used to highlight three foundational elements of science: (1) the understanding that science is cumulating and ever-changing, and that new information may overturn previous understandings; (2) the importance and value of proper citations and citation tracking; and (3) the importance of accessible and purposeful science communication.

1 | EVER-CHANGING SCIENCE

Science is a process of looking at the world and gaining new knowledge; thus it is constantly changing. This is seen in how new evidence about SARS-CoV-2 is being published at a record rate.¹ As the COVID-19 pandemic continues on, we have seen health officials and politicians changing their health and safety recommendations.² For example, in the first week of April 2020, Dr. Theresa Tam, the Chief Public Health Officer of Canada stated that masks were to be worn only by those who were (1) symptomatic for COVID-19 or (2) caring for an infected individual.² By the second week of April 2020, Dr. Tam’s recommendations shifted, stating that wearing a mask can reduce the risk of contracting and spreading COVID-19 between asymptomatic people.² When questioned about this change, Dr. Tam attributed her decision to new scientific evidence being published.² Similar changes in health recommendations were seen in the USA,³ France⁴ and the United Kingdom.⁵ The changing health recommendations showcase the normal scientific process of new information resulting in the reconsideration of previous knowledge.

2 | CITATION TRACKING

Citation tracking is a core component in science. Inaccurate or outdated citations can lead to large-scale misunderstandings, as seen during the COVID-19 pandemic. Keeping a distance of 6-ft between individuals was recommended because SARS-CoV-2 was
assumed to be contagious via droplets, not airborne particles.\(^6\) This assumption stemmed from research published in the late 1900s, claiming that any particle >5 \(\mu m\) (a size range that includes SARS-CoV-2, which ranges from 4.7 to 42 \(\mu m\) in size, average = 32 \(\mu m\)) immediately falls to the ground in droplet form, and is not contagious via airborne particles.\(^5\) However, academic forensic work by Katie Randall revealed that this 5-\(\mu m\) distinction was made in error in the 1950s.\(^9\) The original publication claimed that any particle >100 \(\mu m\) falls to the ground in droplet form, but that particles <100 \(\mu m\) can remain airborne and travel over 6 ft.\(^10\) If these health recommendations had been verified through citation tracking upon initial publication, it is likely that the COVID-19 health and safety guidelines would have included mandatory masking at an earlier date, in addition to social distancing and increased hand washing.

### 3 | SCIENCE COMMUNICATION

During a global pandemic, effective and rapid communication between scientists, health officials, politicians, and the general public is essential. The COVID-19 pandemic has highlighted the need for the general public to understand the basic principles of science, including realistic timelines for research and vaccine production, and the normal process and evolution of research and evidence.\(^11\) Science communicators should avoid sharing research out of context and should refrain from publishing and sharing misleading headlines.\(^11\) Accessible and purposeful science communication is at the core of accomplishing these goals. Accessible science communication includes creating and sharing various formats of your research including visual and verbal presentations, physical handouts (i.e., informational pamphlets and infographics), videos, and publications.\(^12\) The material being shared should have purpose; *how* and *why* material is communicated is just as important as *what* is being communicated.\(^12\)

These aforementioned themes that have emerged which intersect between the global COVID-19 pandemic and how science works can be used as educational case studies and narratives to teach students about the core processes of science, including (1) the understanding that new information may overturn previous knowledge, (2) the importance of proper citations, and (3) the importance of reliable science communication.

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### CONFLICT OF INTEREST

The authors confirm that they do not have any conflicts of interest.

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