

Developing students' scientific knowledge and skills through the lens of COVID-19

Hello and welcome to this webinar.

The teaching of school subjects is often done in isolation from the real world. There are topics to cover in a syllabus on which students are to be examined, and knowledge and skills are, for the most part, only applied in abstract.

The tragedy of the Covid-19 pandemic has allowed us to pause and reflect on what and how we teach. It also gives us a current and shared context through which we can teach.

In the last few months we have all seen or heard a lot of new scientific vocabulary and had much greater exposure to how science works in practice. Covid-19 presents an opportunity for a new generation of scientists to understand, learn and talk about science as it happens - and perhaps also be inspired to be future medics and virologists.

In this webinar we are going to look closely at how we can develop students' scientific knowledge and skills through the lens of Covid-19.

My name is Paul Ellis, and I am Head of Teaching & Learning at Cambridge Assessment International Education.

It is my pleasure to introduce you to Dr Karen Angus-Cole, who will be presenting this webinar.

Karen studied Molecular and Cellular Biochemistry at the University of Oxford before completing her PhD in Immunology at the University of Cambridge. She qualified as a teacher and has been a writer and advisor on science education. She is currently a Curriculum Development Officer and Lecturer in Science Education at the University of Bath in the United Kingdom.

Welcome, Karen.

Thank you Paul.

The COVID-19 pandemic has affected everyone across the world in many ways, including socially, emotionally and economically. It is relevant to all of our lives in one way or another.

However, as science teachers it is particularly pertinent to recognise that there has already been a huge amount of work done by scientists across the globe aimed at fighting this strain of coronavirus. This has led to unprecedented advances of global knowledge and understanding of the science behind COVID-19 in a very short time frame. Although we are responding to a terrible crisis situation, the field of science and its scientists have a lot to celebrate in terms of their determination and commitment to combatting COVID-19 and making the world a safer place for us all.

As teachers of science, we should therefore take time to reflect on how to effectively use the COVID-19 pandemic in our classrooms to support our students' scientific studies, and highlight to them the importance of science for tackling global issues.

This webinar has a number of aims. First, we will address how we can use COVID-19 as a lens for developing students' knowledge and understanding of the concepts embedded within the Cambridge science curricula. Then we will look at ways in which you could use COVID-19 to support your students to develop scientific skills, such as criticality, that equip them to become scientifically literate consumers of science. Finally, the webinar will share strategies that you could adopt to empower your students to tell their story of the COVID-19 pandemic from a scientific perspective.

Let's address our first webinar aim.

-how can COVID-19 be used as a lens for teaching Cambridge science curricula.

Before we focus in on the content areas where COVID-19 could support delivery of the syllabus, it is very important to reflect on why we would even want to use COVID-19 as a context.

I therefore like to think of the approach by using three key questions to inform lesson planning.

Number 1. Why am I bringing COVID-19 into the science lesson?

Number 2. What syllabus material will be supported by using COVID-19 as a lens?

And number 3. How will I use COVID-19 as a lens to support active learning in the lesson?

A key question is 'Why use COVID-19 in my lesson?' Research literature has highlighted the importance of using hooks in science education to motivate and engage students, and therefore promote learning.

For example, a recent study into lesson hook design for science teachers states that:

"If a 'hook' of a lesson is defined as a short introductory pedagogical moment that captures what is interesting and engaging about the material to be covered and puts it out front, and if we understand that lesson hooks draw upon elements of student emotion and/or interest in an effort to entice the learner into the lesson and engage them in the topic, then we come to see that the 'hook' of the lesson can function as a powerful pedagogical tool on several levels."

The article then reminds us how powerful this can be for learning in school, but also for motivating students to take their learning beyond the classroom:

"Teachers can appeal to a wide range of emotions through their science teaching – curiosity; anticipation; uncertainty; surprise; wonder; sense of imagination; amusement and amazement. There is a need to incorporate these affective qualities into science education because 'by increasing the emotional reward pupils gain from learning science, they will be more motivated to study science in school and also more likely to engage with science in their everyday lives'."

Using COVID-19 as a lens for developing students' knowledge and understanding of syllabus material is therefore:

Relevant: COVID-19 directly relates to all of our students' lives in one way or another. It is a real-world, current context that all students will recognise and therefore they are likely to see the relevance of learning about it, increasing motivation and engagement.

Emotional: As we saw from the research, evoking an emotional response in our students as part of their learning experience can also support motivation and engagement – and it is very likely that students will be experiencing emotional responses related to the pandemic.

Inclusive: When we choose lenses for developing students' knowledge and understanding of syllabus material, it is important that those lenses are accessible by all students. It is likely that all students will already know something about COVID-19, and they are likely to want to share their experience of the pandemic so far to make sense of it. This therefore allows an opportunity for all students to be able to be involved in the lesson when using COVID-19 as a lens for your syllabus teaching, therefore being inclusive.

COVID-19 can therefore be used as a hook in the science classroom, to motivate and engage your students with their learning.

However, a word of caution. Remain aware that the pandemic may have caused significant distress for some students, and as such, although they may have something to say it might actually be difficult for them to engage with the content and speak out about it. This may still be the case even if the lesson is focussed on the scientific aspects of the pandemic, rather than the social, emotional or economic aspects. Therefore, just as you would approach topics like cancer with care and with empathy, ensure you adopt these attitudes for any of your teaching that relates to COVID-19 too, recognising that students might still be processing the magnitude of the pandemic and its impact.

We have looked at some of the reasons why we might want to bring COVID-19 into a science lesson, so now we come to our second key question:

What syllabus material will be supported by using COVID-19 as a lens?

Here is a map that represents some of the syllabus areas that could use COVID-19 as a lens to support student learning.

You can see that there are a large range of topics, and shortly we will look at a few examples of how we might use COVID-19 as a context for these topics when we address our third key question.

But first I would like to highlight that the mapping of COVID-19 to syllabus materials shown in the map is not exhaustive. I therefore invite you to pause the recording here and reflect on other areas where you think syllabus content could be enhanced by using the lens of COVID-19 in a way that is meaningful and engaging for your students.

Now we have looked at some of the reasons why we might want to bring COVID-19 into a science lesson, and what syllabus content might link to COVID-19, we come to our third and final key question for planning:

How will I use COVID-19 as a lens to support active learning in the lesson?

In planning the how, we need to remain mindful of the attributes of a Cambridge learner, and of active learning philosophy, to ensure that the use of COVID-19 in the classroom is effective in meeting our aim of supporting student learning. Additionally, I recognise that across the world we are all at different stages of the pandemic, and therefore there are different responses and parameters in place. So, for each of the examples we will ensure the activities can be carried out in-person in the classroom, or online via synchronous or asynchronous methods.

One activity is to ask students themselves to map their course to COVID-19.

The benefit of this activity is that it will activate and reinforce students' prior learning and encourage them to reflect on this. It will also help students to make new links that support development of a course-wide view of their studies. This links to the idea of SOLO taxonomy from John Biggs, where students that have a higher level of understanding are able to relate pieces of knowledge together. It also supports Piaget's constructivist theory because students will assimilate and accommodate new knowledge into existing schema – that is, they will extend their current understanding of a concept by linking it to new knowledge.

This activity will also be beneficial for your learning as a science teacher. The outputs of the activity will provide you with an insight into where your students are able, and also less able, to relate and link discrete pieces of knowledge and concepts to one another across the course. This can inform how and where you might support your students to make links between topics and deepen their understanding of the material in future. Consequently, this supports the principles of assessment for learning and acting as a reflective practitioner.

Note that if you are not able to work with students on this activity in the classroom, there are online tools, for example Miro, which will allow students to make mind maps individually or in small groups and share these. Collaborative list and content organisation tools, for example Padlet, could also help to support students with their learning if they are not yet back in the classroom. Both of these methods can be carried out synchronously or asynchronously, allowing for flexibility in your teaching.

Ask students to create a poster that shows and labels the structure of the coronavirus that causes COVID-19 (SARS-CoV-2) and its mechanism of action. This encourages students to draw on the key concept of structure-function which appears throughout Biology.

You could put students into small groups where they could present their posters to one another. This will help to develop students' oral communication skills. If the class work together to create success criteria for this task first, then they could use this criteria to provide feedback to their peers.

Supporting students to create success criteria that highlight the importance of accurate science in the poster, not just attractive presentation, can ensure that students don't spend a disproportionate amount of time on presentation at the expense of learning about the science. Depending on the level at which students are studying, you could emulate a scientific conference and require students to add references to their posters.

This activity can still work well if students are working fully online or in a blended way. For example, they can create posters digitally and share them through your online learning platform, either synchronously or asynchronously.

Now we are going to focus on how COVID-19 could be used as a lens for the study of gas exchange in human lungs.

After revising the need for gas exchange in the human body and the role of the alveoli, provide students with an application of knowledge question related to COVID-19. e.g. In moderate cases of COVID-19, fluid accumulates in the alveoli, which can cause alveolar collapse. Explain why this could lead to the symptom of shortness of breath.

Ask students to work in pairs to come up with their written answer to the question, either online or in the classroom.

Students could then compare answers with another pair to see if they are able to add anything to their own original answer.

Depending on your students' ability, you may need to provide scaffolding to support them, for example, references to textbook pages to find information, key words or sentence starter phrases. Ensure the activity focusses on collaborative learning via social constructivism, rather than a focus on accumulating marks in an exam.

In summary, by explicitly using COVID-19 as a lens for syllabus materials, students will begin to recognise the relevance of their previous learning and the content of their course as interconnected. The use of COVID-19 as a lens also takes their learning beyond the classroom to something that is happening globally right now. This is likely to lead to student motivation as the context of their learning becomes meaningful. So although COVID-19 itself is not recognised syllabus context, using COVID-19 as a lens for the course can really allow students to practice applying existing knowledge to a new situation.

There are a range of resources that already exist to help you to use COVID-19 in your science teaching. Here are a few examples:

Mark Levesley has created worksheets which cover content that would support teaching of lower secondary students, but the worksheets could give you ideas for teaching IGCSE content and how you might design activities that challenge students to situate their curriculum knowledge and apply it within the context of COVID-19.

Imperial College London's Lockdown lessons are recorded webinars that aim to extend students' knowledge and appreciation of science beyond school, highlighting the role of scientists in the fight against COVID-19.

Compound Interest also has a range of infographics related to COVID-19. You could challenge your students to make their own infographic.

So now we have looked at the first aim of the webinar, we will go on to consider how COVID-19 provides an opportunity to develop students' scientific literacy.

What does scientific literacy mean?

Millar and Osborne published a paper back in 1998, recognising the need for all students to have a level of scientific literacy in order to engage with scientific advances. They stated that:

"The science curriculum should provide sufficient scientific knowledge and understanding to enable students to read simple newspaper articles about science, and to follow TV programmes on new advances in science with interest. Such an education should enable them to express an opinion on important social and ethical issues with which they will increasingly be confronted."

Their statement remains incredibly appropriate today.

Echoing Millar and Osborne's beliefs, the Royal Society – (a Fellowship of many of the world's most eminent scientists based in the UK) - also considers scientific literacy to be vitally important in their Vision, stating:

Our Vision aims to raise the general level of mathematical and scientific knowledge and confidence in the population. Scientific discovery and technological innovation can provide solutions to challenges such as scarcity of food and water, energy supply and security and climate change, but they also raise social and ethical dilemmas. All citizens need the skills and knowledge to be able to make informed decisions about how society handles these issues.

If we are looking for a formal definition of scientific literacy, we can draw on that put forward by the Organisation for Economic Co-operation and Development, which defines scientific literacy as being: “the ability to engage with science related issues, and with the ideas of science, as a reflective citizen. A scientifically literate person, therefore, is willing to engage in reasoned discourse about science and technology”.

Therefore, in all of the cases we have just considered, the idea of scientific literacy goes beyond just knowing scientific facts and concepts. The scientific knowledge is of course vital, but scientific literacy also encompasses an awareness of how this knowledge was generated and an ability to critically evaluate the validity of data and scientific claims being presented.

The COVID-19 pandemic has led to us being bombarded with a wealth of new information which, due to technology, is at our fingertips all day, every day. Some of this information may not be reputable or accurate, it could be ‘fake news’... Addressing this head on in our science lessons provides us with an opportunity to develop students’ scientific literacy and ensure our students are equipped to remain scientifically critical of this information, acquiring a more accurate understanding of the pandemic.

Let's have a look at how we might do this. You could show students some statistics from the pandemic, like these shown in the slide for Latvia. Ask students what questions they have about the data. You could ask students to write these on post-it notes and then collate them on a question board. If students are not in the classroom, they could post their questions to a forum or a chat in your online learning environment. Students might want to know, for example, how were the people tested? What is the accuracy of the test? When did the total count commence and how often is it updated? Where did the data come from- could there be a bias or an alternative agenda? Did those that are reported as deceased die WITH COVID-19 or FROM COVID-19? Depending on their ability, you may need to guide your students with open questions, or model the process of critiquing the data first, particularly if they have not engaged with data in this way before.

You could also ask big open questions to get your students thinking deeply about the data generated from the COVID-19 pandemic. For example: How far can we compare the death rates between countries to understand which country has managed the outbreak better?

The fact this is an open question should stimulate discussion - students cannot just answer ‘yes’ or ‘no’. This discussion could begin as a think, pair, share activity and then open out into a whole class discussion, either in-person or online. It should get students to start thinking about what it means to ‘manage the outbreak better’. Is deaths the only measurement we need to consider? What about the breakdown of those deaths e.g. proportion of young and older people? How has social class or ethnic background had an impact? What about the length of time each country has been in the throes of the pandemic? The list goes on... Students should also be prompted to think about whether

two countries test for COVID-19, record and report COVID-19 deaths in the same way and how any differences reduce the validity of a comparison.

You could also ask stimulating questions that do not necessarily have a right or a wrong answer and don't relate directly to data, but more the moral and ethical dilemmas that scientists can encounter. Students could be invited to debate their views in small groups, within class or online, or they could write an essay on the subject. It can be worthwhile assigning students a stance so that they get to practice arguing and reasoning from a different point of view. You could then pair up individuals who were arguing for the opposite opinion so that students get to share their thoughts with a peer. When answering the question shown on the slide, students might argue that COVID-19 is infecting and killing thousands of people a day and has impacted almost every country across the globe and so should be the number one priority for research. However, others might argue that if we focus only on COVID-19 then progress in other research areas will stagnate and this could also have knock-on consequences for the health of the global population. Encourage students to employ their scientific literacy skills and critically evaluate and draw on data to support their argument.

It is also worthwhile uncovering the hidden curriculum around scientific literacy. Explicitly enter into discussions with students about what scientific literacy is and ask them to reflect on how scientifically literate they are, and what they could do to improve this. Relate these discussions to their learning in the activities that you have designed that are aimed at developing these skills. This will help to boost their metacognitive awareness, empowering students to take ownership of their scientific literacy and put these skills to good use beyond their learning of science in the classroom.

Take a moment to reflect on how, in supporting your students to become scientifically literate, you will also be supporting them towards developing the Cambridge learner attributes shown in this slide. You may pause the recording at this point if you wish.

Returning to the aims of the webinar, we will finally discuss strategies that will empower your students to tell their COVID-19 story as scientists.

The COVID-19 pandemic has been a frightening and unprecedented situation for everyone. Our students are going to need time to reflect on it and process it. As science teachers, we can provide opportunities to empower our students to tell their version of the COVID-19 pandemic by inviting them to create stories that bring together their knowledge and understanding of the pandemic with their scientific literacy skills. This approach can support them to regain agency in a situation where they have had very little control, hopefully boosting their confidence and outlook on the situation, as well as also developing their communication skills.

Telling stories has been part of human culture for hundreds of years. Notably, stories don't have to be fiction. We can create a story from a real-life event and weave facts and knowns into its narrative. The process of developing our own narrative, expressing the story in our own voice, could help us to

develop meaning in an otherwise chaotic situation, as well as empower us to use our voice when it sometimes feels like it is impossible to be heard.

Taking storytelling into the classroom also provides a way for our students to connect with, relate to and empathise with others, thus developing social cohesion. This is particularly important at this time because one of the consequences of the COVID-19 pandemic is that we might be feeling socially distant from one another due to lacking physical connections with fellow humans.

Importantly, we can tell each other stories through writing, by drawing pictures, orally...by allowing your students choice as to how they tell their COVID-19 story you can be very inclusive in your teaching approach.

Research from the Learning Centre of the Field Museum in Chicago, USA “finds that science storytelling remains a highly effective learning tool”. A quote from their 2018 publication ‘Rethinking Narrative: Leveraging storytelling for science learning’ highlights:

A narrative approach to science learning provides benefits beyond the acquisition of new knowledge. Stories about science and scientists can have important positive affective impacts that inspire future subject-specific learning. While more traditional communication of scientific ideas may be boiled down to a handful of facts or a timeline of discoveries, a narrative approach allows for the true excitement of curiosity to shine through, fuelling children's own curiosity and interest in the process.

So what might students' COVID-19 stories include? It's a good idea to guide students - they might otherwise consider a story as fiction. But here we are talking about developing a narrative to tell a real story of COVID-19 from a science perspective.

Encourage students to include scientific facts and data to support their narrative. I would also suggest welcoming students to include emotional perspectives - good stories are often emotive – but do remind them that one of the main aims of this storytelling activity is to encourage a reflection on their experience of the pandemic and to relate this to their scientific understanding and scientific literacy.

To give an example, students might address the fact that some countries have required people to wear masks – do they have to wear a mask? When? How does this compare to other countries? Why do they have to wear a mask - how does the wearing of masks relate to their scientific understanding of COVID-19 ? How does wearing a mask make them feel - do they feel safe? Do they feel claustrophobic? Do they think there is enough scientific evidence to support the wearing of masks? What would they put forward as a good policy on the wearing of face masks to combat COVID-19?

From a teacher's perspective, engaging with your students' stories can give you a fantastic insight into what your students currently understand about the pandemic and also what they feel is most important to include in their story.... This helps to further build positive relationships with your students and could also help you with your planning of future activities associated with COVID-19 in your science lessons.

We said earlier that there are a diverse range of potential outputs for stories and that we can be inclusive by giving students choice. Here are a few examples of how students might communicate their story:

They might write a story in a very traditional sense. Or they could perhaps create a storyboard, as you might find in the design of the scenes for a film, using words and pictures.

They might want to write a blog post or a newspaper article. Another option would be to write a letter to people of power, such as members of parliament, lobbying for certain actions to be taken and drawing on their skills of persuasion. Students might be more comfortable speaking and therefore prefer to create vlogs or deliver oral presentations.

This is also an opportunity to draw on the idea of needing to know your audience when communicating - how might the tone of their story differ if they were telling it to a younger child at primary school, their grandparents, or a friend of a similar age? How would the tone of the story compare if they were writing a lobbying letter? Or to someone in the future explaining the pandemic situation?

When students are telling their COVID-19 story be aware of the language demand. COVID-19 has brought with it a whole new language, such as social distancing, self-isolation, lockdown, shielding... for which everybody needs a common understanding to allow for correct interpretations of our stories...

...however as we would like our students to bring their scientific understanding into their stories too, we should make sure that we don't underestimate this additional language demand. For example, scientific terms like viral load, immunity and asymptomatic all need to be accurately understood before they can be used by students accurately for communication purposes.

There are many ways in which you can support your students to become familiar with and confident in accurate use of COVID-19 and scientific terminology. Even if students are opting to produce a more visual representation of their story, they still need to be able to understand the words that underpin the associated images so that their images can accurately convey meaning.

Some approaches you could adopt are:

Ask students to explain to you what they think the key terms mean and to give you examples. This gives you an insight into their prior learning and gives you an opportunity to identify any misunderstandings or misconceptions and act on these.

Model the use of the terms yourself, both in writing and in speaking, and even via pictorial representations. Be explicit about when you are doing this so that students know that you are supporting them with developing their use of language.

Provide students with the opportunity to use new terms in discussions with one another. This will help them to build confidence. Talk is normally not recorded, so it provides a safe environment for students to explore and make mistakes without having to 'erase' work. Developing talking skills often translates to students being able to communicate clearly and effectively via other means e.g. writing. Co-create class glossaries with your students - these can even be accompanied by pictures.

What other ways can you think of? Feel free to pause the recording here and reflect on ways in which you have previously supported students to overcome the language demand of science lessons.

The COVID-19 pandemic has been a huge moment globally – it is an historic time and so we are likely to be referring to it for years to come. Tell students this. Make it explicit so they are not going

to be surprised. People are going to ask us - what did you do during the pandemic? What did you learn?

For example, considering that many of our students might want to take their scientific studies beyond high school, it is likely that Universities will be interested in prospective students' perceptions and understanding of the pandemic. Similarly, in job interviews, perhaps we will be asked what we learnt from the pandemic, both in a disciplinary context and more personally. By giving our students the opportunity to formulate their own story about the pandemic, they will be prepared for such conversations.

Additionally, by linking our classroom explicitly to what is going on in the outside world we are helping students to recognise that their knowledge, understanding and scientific literacy skills have roles beyond the science classroom. We can inspire and motivate them as lifelong learners who appreciate the value and necessity of science. We can highlight their role as active citizens who advocate good science and challenge poor science. And we can hope that by having a deeper understanding of the key issues facing society, and the role of scientists in working to address these, our students will come to recognise a desire to join our much-needed next generation of scientists.

In this webinar we have looked at how COVID-19 can be used as a lens for teaching the curriculum, how we can use it to support the development of students' scientific literacy, and how telling their COVID-19 story can help to empower your students, both now and in the future. Before we finish, I will summarise the key considerations for using lenses in your science lessons, and then invite you to engage in one final reflection.

Sometimes teachers are really keen to integrate a specific lens into their lessons. So much so that they can forget the bigger picture – why will that lens help students with their learning? Without a clear purpose for including a lens, unfortunately that lens can become meaningless, with students unable to see why it is being used. The lens therefore distracts students from what they are intended to learn. We must be cautious and, as always, plan carefully, being ready to accept when a lens we thought we might use will not be useful in our lesson.

To avoid the situation where a lens is unsuccessfully used to develop students' learning, here are a few prompts:

Consider why you are bringing the lens to your classroom teaching of science? How and what will it help your students to learn? Is it a hook to develop curiosity and engagement? Does it allow students to build on prior knowledge? Perhaps it prepares them for future learning? Will it help students to develop specific skills e.g. scientific literacy and communication? And very importantly, if you incorporate the lens, will you still be able to design your lesson in a way that draws on active learning and supports the development of Cambridge learner attributes?

COVID-19 as a lens for our science teaching is just the beginning. There are many issues relating to science that are relevant right now. For example, climate change, food poverty, drought, disease burden... The United Nations Sustainable Development Goals are a good global starting point, and importantly highlight how many issues we are facing are not necessarily mutually exclusive.



However, you could also draw on local and/or national issues – choose lenses that are meaningful and relevant for your students in your context. Knowledge and understanding of these issues can inspire students to become the change agents that we need. We obviously don't want to send students into a spiral of despair – rather, we need to be positive and show them that the more they know and understand about a situation, and the more questions they are willing to ask to further their understanding, the more equipped they will be to act and also persuade others to also act. To close, I therefore invite you to take some time to reflect on the issues relevant to your students, and how these could be related to their science education.

Thank you, and keep safe.