VCE Physics

Approaches to teaching science using
socio-scientific issues

Ideally, students should choose their own socio-scientific issue and the role of the teacher is to support them in developing this into a rich study that can be meaningfully explored. Teachers should check that the chosen issue has a societal dimension that can be explored along with the physics and also that the choice will enhance the student’s physics understanding. The societal issue or application of physics should have significance for the student.

Group work and class activities

Small-group discussion is one of the most effective pedagogies for teaching science using socio-scientific issues. The small groups could be set a variety of tasks, including:

* informal ethical analysis and/or values clarification exercises
* evaluation of a media report
* informal risk-benefit analysis.

Other activities are more appropriate for the whole class. These include:

* role play
* formal debates.

Useful tips for managing classroom discussions involving ethical dilemmas can be found at the [Managing Classroom Discussions webpage](https://www.sciencelearn.org.nz/resources/198-managing-classroom-discussions) of the Science Learning Hub – Pokapū Akoranga Pūtaiao (University of Waikato Te Whare Wānanga o Waikato). Further resources dealing with the ethics in specifically physics-related situations are listed under Useful resources for teaching socio-scientific issues*(link to Word doc)*.

‘Warming up’ and ‘Cooling down’ an issue

Laurence Simonneaux, who has done a lot of research into teaching socio-scientific issues, uses the phrases ‘warming up’ and ‘cooling down’ to describe the ways in which a teacher may present an issue as more or less controversial and confronting. For example, a study of prosthetic devices is an application of physics in the real world. The cooler end of the study would use physics to explain the device and focus on the benefits of the application, while the warmer end would examine sensitive social issues including why these devices are needed, the distribution of resources, funding and who controls the technologies. Ideally the study would acknowledge all these factors, but only go into depth with one or two, and the balance of this choice is what controls the ‘warmth’ of the study.

Because socio-scientific issues deal with real-world situations they are likely to generate different responses in different people. For example, a discussion about the use of X-rays for diagnosis is likely to have a different weight for students who have a family member with an illness. For this reason, it is important to structure lessons so that students have opportunities to debrief and to explore their perspectives with others.

Values clarification and ethical analyses

An ethical issue arises in situations where there are competing ways to respond to a situation and the best course of action is not always clear. An ethical issue becomes an ethical dilemma when it is not possible to act in a way that does not contravene a value or ethical principle, presenting us with a decision about which approach or principle to prioritise over another.

There are three broad approaches to resolving the ethical dilemmas associated with an exploration of socio-scientific issues.

1. Consequences-based approach

Guiding questions when applying or considering this approach may include:

* Who or what is affected by this issue?
* What are the possible benefits for those affected?
* What are the possible harms for those affected?
* Which option(s) will produce the most good and least harm?
* If one is harmed and another benefits, how do you decide who or what matters most?
* What action should be taken?

2. Duty- and/or rule-based approach

Guiding questions when applying or considering this approach may include:

* Who or what is affected by this issue?
* What duties (codes, laws, rules, principles or conventions) relate to this issue?
* What action should be taken?

3. Virtues-based approach

Guiding questions when applying or considering this approach may include:

* Who or what is affected by this issue?
* What qualities make someone a ‘good’ or virtuous person?
* What decisions or actions in relation to this issue would help make you a ‘good’ person?
* Is virtue necessary to do ‘good’? Is it alone sufficient?
* What actions do particular ‘good’ dispositions (for example, honesty, kindness, patience) suggest?
* What action should be taken?
* What personal qualities might be required to undertake this action (for example, courage)?

Using media reports for teaching socio-scientific issues

Socio-scientific issues are frequently reported in the media and this means that the presentation has been shaped to suit the purposes of the communicator. This is not always the journalist: many media reports on science simply report press releases produced by a scientific organisation or interest group. It is important to remember that students may get information about socio-scientific issues from social media sources. The skills to consider the trustworthiness of sources are important in engagement with SSI. Many scientists and scientific organisations are active on social media and students could be encouraged to consider these sources alongside the ones they might already use.

The questions below are useful for guiding student engagement with media reports about science. The questions have been adapted from the work of Mary Ratcliffe and Marcus Grace together with that of Naomi Oreskes.

1. What is being claimed in this article (i.e. what is the conclusion)?
2. Who is making the claims? Are the people who are making the claims experts in this area, or are they operating outside their area of expertise?
3. What evidence is there to support this conclusion?
4. Is the evidence relevant to the claims? Explain your answer.
5. Is this evidence sufﬁcient to support their claims? Explain your answer.
6. What scientiﬁc knowledge have the researchers used in explaining their results and claims?
7. What other factors (social, economic, legal and political) have influenced the conclusions drawn in the article?
8. What further work, if any, would you suggest?

Ratcliffe and Grace found that teachers used media reports in a variety of ways: some were highly structured and had students read the articles and answer questions individually before a class discussion, while others had students read the articles out loud in class and then had a class discussion, followed by small-group discussions to answer the questions before a final whole-class summary. Whichever model is used, it is necessary to practise the skills as a group before students attempt individual critiques of the media.

Risk in socio-scientific issues

Thinking about risk in a socio-scientific issue (SSI) asks the student to engage with the power and limitations of science in social contexts. For the purposes of the *VCE Physics Study Design*, what is important is that the student demonstrate understanding of both sides of this balance; that is, both the power and the limitations. In most cases, a qualitative discussion is adequate, although research shows that secondary school students can handle quantitative risk information where it is available.

Risk assessments should identify:

* whether the proposed solution could cause harm, and to whom
* how likely it is that harm will be caused
* the consequences of the harm.

Sociocultural dimensions of risk should be considered alongside the technical dimensions. These include whether the risk is being taken voluntarily; whether the risk is controllable; the history of the person or group being asked to take the risk and the extent to which the risk will lead to fearfulness. These dimensions link to the ethical question of whether one person can decide risk for another; for example, the choice to develop nuclear power carries with it a risk to the people who live close to the power station, just as the choice to develop a coal-fired power station carries a risk to the people who live and work in its vicinity, and to the broader society through the release of greenhouse gases.

The Precautionary Principle states that if the cost of an activity could turn out to be greater than the benefit, then it makes sense to restrict or stop the activity. However, this is not a straightforward decision to make. What matters is that students demonstrate that they can and will engage with the complexity.

The questions below are useful for guiding student engagement with risk and uncertainty.

1. Is this a situation of risk, uncertainty, ignorance, or indeterminacy?

* 1. *Risk* involves a situation in which the system behaviour is known, and probabilities can be assigned to outcomes.
	2. *Uncertainty* applies to a situation in which important parameters are known, but not the probabilities.
	3. *Ignorance* applies to a situation in which we don’t know what we don’t know.
	4. *Indeterminacy* applies to a situation where causal chains, networks or processes are open and cannot be predicted.
1. How likely is it that harm will be caused?
2. Who might be harmed?
3. What might be the consequences of the harm?

5. Should the precautionary principle apply here? How might it be applied?

6. Could the halo effect be influencing your perception of risk? The halo effect means that people underestimate the risk of doing something they like, or that is of benefit to them.

7. Is the reported risk correlative or has a causal effect been established?

8. Is the quoted risk relative or absolute? Relative risk is where one risk is quoted relative to another without necessarily indicating if the absolute risk is large or small. A four-fold increase in risk has a very different meaning depending on whether the original risk is one in 10 or 1 in 1,000,000.