Science Beyond the Boundaries

**Fracking**

**Teacher notes**

**Intended learning outcome**

Students understand that science and technology are applied in a social, political, and cultural context, and that applications of science can have positive and negative impacts on people’s lives and the world we live in; and that these impacts might be different for different groups of people, in different places, and over different timescales.

Applications of science (for example, to the extraction of shale gas by hydraulic fracturing or ‘fracking’) prompt us to consider who has access to, and influence over, decision-making processes which determine what risks are acceptable, and who they affect. Science only takes us so far in making these decisions – it is useful and necessary to consider ideas from other disciplines.

This unit focuses on the connections between the sciences, geography, and politics.

***Commentary:***

As conventional energy resources are being used up, there has been a move towards less traditional methods of energy extraction (Patterson and McLean, 2017). ‘Fracking’ is a method for extracting previously inaccessible natural gas from shale, which involves drilling into and fracturing layers of rock, and injecting highly pressurised fluid containing water, sand, and chemical additives to release fossil fuels, primarily methane. Fracking fluid consists of water, sand, acid, friction reducer, surfactant, salts, scale-inhibitor, pH-adjusting agent, iron control agent, corrosion inhibitor and biocide (Gregory et al., 2011). The process requires large volumes of water, a large fraction of which returns as wastewater to the surface. Wastewater contains metals, oils and greases, and bromides and sulfates (Gregory et al., 2011). A recent review of environmental impacts of fracking (Costa et al., 2017) found a relatively high degree of consensus that contamination of surface water as a result of poor wastewater treatment is common.

Fracking has been opposed for several reasons: seismic activity, use of water and potential release of hazardous chemicals into the environment, as well as the problems associated with development of non-renewables during the climate crisis (Jones et al., 2013). The concerns surrounding fracking are not unique to England: similar responses have been found where fracking is operational, for example in Canada, Spain, and the USA (cf. Costa et al., 2017).

We know that young people tend not be involved in environmental decision-making (Thew, Middlemiss and Paavola, 2020), despite the provisions made under the UN Convention on the Rights of the Child (UN, 1989) which recognises that current day political decisions impact children and young people more than any other group due to the long-term effects of decisions. So, what happens when there is widespread disagreement amongst young people about environmental decisions and decision-making processes which have excluded them? This is a live question for all young people, but particularly those living near sites associated with fossil fuel extraction which will not only result in increased greenhouse gas emissions, but also changes to the local environment. This resource teaches young people about different methods of participating in political decisions relating to science and technology.

**Outline of teaching unit**

During this unit students will take part in, and report on, a model Select Committee which is overseeing decisions made about hydraulic fracturing. They will take on a range of perspectives in the unit (researcher, expert witness and journalist) and will research and contribute evidence on the economic, environmental, and human rights impacts of fracking and will prepare a summary position statement which could be communicated in the media.

**Bold sections are classroom-based activities**, those not in bold can be completed either in or out of the classroom.

**Phase 1.**

**Engage students with real-life examples of young people informing decisions about controversial environmental interventions in the context of fossil fuel extraction.**

**Note that whilst the video relates to coal mining in Australia, young people and communities in other contexts are similarly affected by fossil fuel extraction in their community. In the UK, change in legislation to allow the extraction of more gas using fracking is currently (in 2022) a real possibility.**

**Research groups are set up to research the positive and negative impacts caused by fracking on an aspect of the environment, economy and community. Each group will become experts on one area and develop a considered opinion to present to a ‘Government select committee’.**

**Introduce the task for phase 2**

Phase 2.

Students explore online materials – scientific explanations, campaigning websites, newspaper articles, videos etc. to find out about the positive and negative impacts of fracking on one aspect of the environment, economy or community. They can record their observations and thoughts using a recording proforma, that is provided, which can help them focus on developing a clear record of key pieces of information.

**Phase 3.**

**Students review their individual findings in their groups, script a three-minute presentation of key information and prepare answers to questions they predict might be asked about their field of expertise by the ‘Government select committee’.**

**In turn each group of expert witnesses explain their findings to a ‘Government select committee’ set up in the classroom. Other members of the class take part as members of the committee and ask follow-up questions under the supervision of a rotating committee chair.**

Phase 4.

Students elaborate on the knowledge and they have gained from the ‘Government select committee’ by creating individual opinion pieces to present the view they have gained from listening to the evidence, and their recommendations for action.

**Phase 5.**

**Students evaluate the attributes of effective media outputs for an issue such as fracking and peer review each other’s work against these criteria.**

**The unit concludes with a short discussion about the impact and effectiveness of political activism on influencing government policy and practice.**

***Activities for each of the five phases of learning***

Phases 1, 3 and 5 are classroom based; and *phases 2 and 4* can be completed either in the classroom or independently out of the classroom.

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| **Phase** | **Activity** | **Reason for it** | **Activity summary** | **Estimated time** |
| **Phase 1 – Engage and explore**  **Introduction to political action and some methods that could be used in response to (controversial) applications of science and technology, using an example from Australia.**  **The process of fracking is introduced along with the two main tasks that students will be working on during this unit. To prepare for the first task, students find out about the work of House of Commons select committees.** | **1 Introduction** | **To build interest and curiosity about environmental decision making in the context of fossil fuel extraction.**  **To demonstrate the power that young people have to influence decisions about resource extraction – and how they can use existing legal and political structures.** | **Watch video footage of Youth Verdict describing their court case against fossil fuel extraction.**  **Class discussion about young people’s political action in the context of Youth Verdict and their campaign.** | **20-30 minutes** |
| **2 Project task** | **To introduce students to the research task they will need to carry out; and, to support this, provide a brief introduction to fracking and the work of a Government select committee.** | **The two main tasks for this unit are introduced.**  **Students are shown a brief description of what fracking is, and shown what that looks like on a schematic diagram.**  **A UK Government website video describes the work of a House of Commons select committee.**  **Students decide how to split up the class into six defined research groups and organise themselves ready for the next task.** | **30-40 minutes** |
| *Phase 2 – Explore*  *Students each prepare for the role of an expert witness by researching one of six defined aspects of the impact, both positive and negative, of fracking.* | *3. Research task* | To prepare students to take on an expert witness role in order to present oral evidence to the model Select Committee and to answer follow-up questions from a position of knowledge and understanding. | *Students carry out individual research, perhaps using proforma sheets to focus their thinking and to record their findings.* | *1 hour or more* |
| **Phase 3 –Explain**  **Students explain their research to each other in order to work as a team to identify and summarise their key points of information for a clear explanation.**  **They continue to work as a team to prepare for possible questions at the hearing and rehearse suitable answers in advance; modelling some key skills necessary for participating successfully in meetings in a professional capacity.**  **During the ‘Government select committee’ hearing, students each take on the roles of expert witness and committee member, with several also having the opportunity to act as the chair of the committee.** | **4. Expert witness preparation** | **For students to prepare written statements in their expert groups to be presented to the ‘select committee’. For them to consider possible follow up questions and to prepare key points for their answers.** | **Students are introduced to the remit of the Environmental Audit Select Committee, who are examining the impacts of fracking in order to advise the Government.**  **The preparation is split into two consecutive tasks:**   * **Each group combines their research to identify key points for their presentation, which they write together, with a three-minute (360 word) limit.** * **Each group identifies possible follow-up questions that might be asked on or around their presentation; and prepares and rehearses appropriately considered answers.** | **1 hour**  **(20-30 minutes for each task)** |
| **5. Select committee hearing** | **To take part in a structured and focused debate from both sides and to experience the processes of asking and answering questions for a purpose.** | **Each expert group present their statement to the committee with one of their number reading it out.**  **Committee members (the rest of the class) jot down questions during the delivery, which are designed to move the discussion forward – although the questioner may ask questions in such a way as to attempt to direct the argument towards their own opinions.**  **A chair of the committee (different for each presentation) controls questioning in order to prevent a few members of the committee from dominating.**  **Each member of the expert group is encouraged to answer one or more questions.**  **Timers on the PPt slide for this activity can be used to limit discussion to allow all groups time to present and to answer questions.** | **1 hour** |

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| *Phase 4 – Elaborate*  *Students individually write opinion pieces to put forward their own views on the proceedings of the ‘Government select committee’.*  *Taking the role of journalist, gives practice at summing up wide ranging arguments and discussion to form and communicate clearly personal opinions on a matter.* | *6. Influencing policy* | *To summarise and communicate complex and wide-ranging arguments into actionable opinions.* | *Individuals produce an opinion piece that is ready to be included in one form of media: a newspaper opinion piece; a video for sharing online; an email or letter to a person of influence; an infographic poster; or some other appropriate format.*  *These pieces will later be peer reviewed for their effectiveness.* | *1 hour or more* |
| **Phase 5 – Evaluate**  **The class reflect on the factors that make an opinion piece effective at influencing policy and practice and peer-review each other’s work against these criteria.** | **7. Changing the world** | **The effectiveness of a range of media interactions are judged on their effectiveness for influencing policy and practice – and for making a positive change.** | **In groups, students sort a set of ‘effectiveness cards’ in order to determine how a person’s opinions can best be communicated in a way that influences others.**  **Against these criteria, each student identifies two positives (stars) and a point for improvement (a wish) on the work of several of their peers.**  **Students reflect on the feedback they receive.** | **20 minutes**  **15 minutes** |
| **8. Political activism** | **Opportunity for a broader discussion around political activism to be explored.** | **The unit ends with a discussion about the broader effectiveness of political activism and its place in a well-functioning society.** | **20 minutes** |

**Guidance notes: pedagogical approaches**

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Role-switching is used in this sequence of lessons. Rather than ask students to take and defend a specific position which risks false balance and attention to personality rather than argument, this approach asks students to take on different roles and reflect on the roles and responsibilities of different people (expert witnesses, Parliamentarians, journalists, the public) in political processes.

Models are “simplified representations of a system which concentrates attention on specific aspects of the system” (Gobert and Buckley, 2000, p. 891). Political models have been used to support learning about fracking (Rinfret and Pautz 2015; Stoddard and Chen 2018). These have included simulated political processes (stakeholder groups, drafting policy papers, and preparing for a congressional hearing). Through these approaches, students reported gains in learning about environmental policy making and fracking, as well as enjoyment of the process. Whilst a more robust treatment of learning gains (in different disciplinary dimensions) is needed, political models appear to be engaging for students and the existing evidence suggests that they bring about learning across disciplines.

**Key information**

#### What is fracking?

Hydraulic fracturing is the extraction of shale gas and/or oil (fossil fuels) from underground reserves by drilling into rock and pumping, a pressurised mixture of water, sand and other chemicals into the rock to displace the fuel. ‘Fracking’ is a controversial term, with advocates of the process preferring ‘unconventional shale gas development’ or ‘hydraulic fracturing’. Controversies about fracking arise due to differences in priorities relating to environmental justice, the need for a transition from fossil fuels to renewables to respond to the climate crisis, how best to achieve energy security and disagreements about the economic and social impacts. In the UK, the Environmental Audit Select Committee identified concerns associated with fracking in relation to groundwater quality, waste, water supplies, air emissions and health, habitats and biodiversity, geological integrity and noise and disruption.

#### Why is fracking an interdisciplinary issue?

Fracking is an example of a context in which scientific and technological knowledge comes into contact and conflict with economic, political, social and other forms of knowledge, and which requires critical scientific literacy in order to make well-justified decisions about the desirability of actions relating to fracking.

#### Impacts of fracking

Fracking was promoted by the UK government for its potential to provide greater energy security, economic growth and jobs, and for its potential to support a transition to net zero emissions by 2050 (Department for Business, Energy and Industrial Strategy 2019). However, research suggests that these claims are problematic, with concerns that shale gas extracted by fracking will supplement rather than replace coal, as has been seen in US patterns in coal usage (POST 2011), and that investment in fracking will disincentivise investment in renewables (Johnstone, Stirling, and Sovacool 2017).

Potential benefits of fracking (done well) have been identified to include the provision of a source of energy, affordability, lower greenhouse gas emissions than other fossil fuels, and economic gains for suppliers and exporters (Sovacool 2014). Arguments in favour of fracking often rely on the promise of economic development (Hassett and Mathur 2013; Scanlan 2017), but research to date seems to suggest that this does not always play out in the favour of local communities where the extraction occurs (Cotton 2017). Furthermore, research has also identified a range of short and long-term negative impacts of fracking. In their review, Costa et al. (2017) identified negative impacts associated with water resources and atmospheric emissions, occupational and public health and safety, land use and induced seismicity.

The impacts of fracking extend beyond the environment. Sangaramoorthy et al. (2016) found that fracking also affected residents’ sense of place and identity which created social stress. The per- sistent negative impact on communities as a result of psychosocial conflict has been described as ‘collective trauma’ (Hirsch et al. 2018), and has been found to impact communities even at the planning and exploratory stage (Short and Szolucha 2019). Hirsch et al. (2018) found that although residents of fracking communities might experience initial benefits through the lease of land and development of infrastructure, these are minimal, and they might also experience a range of nega- tive mental health impacts including anxiety and depression about lifestyle, health, safety, and financial security.

#### Fracking in the UK: how decisions are made

(from <https://commonslibrary.parliament.uk/research-briefings/sn06073/>)

Licensing of natural gas extraction is a devolved issue and there is currently a presumption against issuing any further hydraulic fracturing consents in each of the jurisdictions in the UK. Prior to the November 2019 moratorium, operators intending to use fracking had to obtain a number of permissions at different levels prior to drilling, including an application for a license from the Oil and Gas Authority, a lease or access rights from landowners, planning permission from the local authority, permits from the relevant environment agency and consent from the Department for Business, Energy and Industrial Strategy. The decision whether or not to permit fracking is therefore a political decision.

In the UK, Parliament’s role is to represent the interests of the people and ensure that the Government takes these into account when making decisions. Parliament is made up of members of the House of Commons and the House of Lords, and it holds the Government to account through Questions, Prime Minister’s Questions, Debates and Committees. Whilst Select Committees are not involved directly in decision-making, they monitor and report on the work of the Government. Some have a remit matching a Government department, whereas others (such as the Environmental Audit Select Committee) cross departmental boundaries. The results of Select Committee inquiries are public and may require a response from the Government.

**AS/A level specification links**

### **AQA Biology content**:

Students should be able to:

* show understanding of the need to manage the conflict between human needs and conservation in order to maintain the sustainability of natural resources

### **AQA Environmental Science content:**

AS level 3.2.4.2 The carbon cycle including human influences.

The processes in the carbon cycle that are affected by human activities, e.g. biomass movements, increased atmospheric concentration of CO2, increased atmospheric concentration of methane.

A level 3.3.3 The sustainability of current energy resource exploitation.

Impact of resource exploitation before the use of the energy: fuel extraction: coal mines, oil extraction; fuel processing: coal, crude oil; equipment manufacture: all energy resources; site development/operation: all energy resources; transport: combustible fuels; embodied energy in equipment: all energy resources.

Impact as a consequence of use, e.g., atmospheric pollution caused by fossil fuels; habitat damage, e.g. fuel extraction; pipelines and cables; depletion of reserves, e.g. non-renewable energy resources.

3.3.4 Strategies to secure future energy supplies

Students should analyse and evaluate key issues and quantitative data to evaluate the potential future contribution of each energy resource.

3.3.4.1 Evaluation of improved extraction/harnessing/processing technologies related to a range of energy technologies

Students should understand how specific technologies increase the usability of each energy resource. For fossil fuels this includes secondary/tertiary recovery of oil, directional drilling; oil shales/tar sands; hydraulic fracturing.

### **AQA Politics content:**

3.1.1.2 The structure and role of parliament

Students should analyse and evaluate:

* scrutiny of the executive and how effective scrutiny of the executive is in practice
* the roles and influence of MPs and peers
* the significance of Commons and Lords including the work of committees.

Relevant key concepts, among others: individual and collective rights, legislation, debate, redress of grievances, campaign

### **AQA Geography content:**

3.2.5 Resource security

This optional section of our specification focuses on the large-scale exploitation of unevenly distributed natural resources, which is one of the defining features of the present era. Increasing demand for water, energy and minerals and their critical role in human affairs leads to massive local and regional transfers of water and massive global transfers of energy and minerals.

In this section students contemplate the fundamental relationships between the physical environment and human activities and wants and the relationships between people in their local, national, and international communities involving themes of sustainability and conflict. They engage with these themes in relation to energy, water and minerals but may concentrate on one or other in their case studies.

Study of this section offers the opportunity to exercise and develop observation skills, measurement, and geospatial mapping skills, together with data manipulation and statistical skills, including those associated with and arising from fieldwork.

3.2.5.1 Resource development

Concept of a resource. Resource classifications to include stock and flow resources. Stock resource evaluation: measured reserves, indicated reserves, infrared resources, possible resources. Natural resource development over time: exploration, exploitation, development. Concept of the resource frontier. Concept of resource peak.

Sustainable resource development. Environmental Impact Assessment (EIA) in relation to resource development projects.

3.2.5.4 Energy security

Sources of energy, both primary and secondary. Components of demand and energy mixes in contrasting settings; Relationship of energy supply (volume and quality) to key aspects of physical geography – climate, geology and drainage; Energy supplies in a globalising world: competing national interests and the role of transnational corporations in energy production, processing and distribution; Environmental impacts of a major energy resource development such as an oil, coal or gas field and associated distribution networks; Strategies to increase energy supply (oil and gas exploration); Sustainability issues associated with energy production, trade and consumption: acid rain, the enhanced greenhouse effect, nuclear waste and energy conservation.

3.2.5.7 Case studies

**Case study** of **either** water **or** energy **or** mineral ore resource issues in a global or specified regional setting to illustrate and analyse theme(s) set out above, their implications for the setting including the relationship between resource security and human welfare and attempts to manage the resource.

**Case study** of a specified place to illustrate and analyse how aspects of its physical environment affects the availability and cost of water **or** energy **or** mineral ore and the way in which water or energy or mineral ore is used.

**References**

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