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Perspectives on fracking from the sacrifice zone: young people’s knowledge, beliefs and attitudes

Lynda Dunlop, \* Lucy Atkinson and Maria Turkenburg-van Diepen

Fracking is a controversial process that requires both chemical and political knowledge in order for young people to make informed decisions and hold industry and government to account.  It does not appear in the English chemistry curriculum and little is known about young people’s beliefs about fracking, nor of their attitudes towards it. In this study we focus on young people in schools or colleges within a 20 mile radius of the nearest urban area to a fracking site in England. An in-depth qualitative focus group study was used to investigate the knowledge, beliefs and attitudes of 84 young people aged 16-19 in 4 schools and colleges.  Young people reported knowledge about the process of fracking and to a lesser extent its social, economic and environmental impacts and associated regulation. Formal education was an important, if limited, source of information that tended to be trusted by young people. Negative and ambivalent attitudes towards fracking dominated, with the use of economic, environmental and social frames used by young people to inform their responses to fracking. Support for fracking hinged mainly upon energy supply and energy sovereignty. Fracking was opposed because of detrimental environmental and economic impacts, the impacts of associated protests and because of the political handling of decisions about fracking. The exclusion of young people, and the population of the area more broadly, from participation in decision-making has led to young people’s disaffection with political processes and cynicism about the relationship between government and industry.  The case of fracking demonstrates the importance of creating space for attention to political processes in chemistry education, and for engaging with young people about energy interventions in their community.

Introduction

As conventional energy resources appear to be near exhaustion, there has been a move towards less traditional methods of energy extraction (Patterson & McLean, 2017). Hydraulic fracturing or ‘fracking’[[1]](#footnote-1) 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 (99.50% by volume), acid, friction reducer, surfactant, salts, scale-inhibitor, pH-adjusting agent, iron control agent, corrosion inhibitor and biocide (Gregory, Vidic and Dzombak, 2011). The process requires large volumes of water, a large fraction of which returns as wastewater to the surface. Wastewater contains metals such as iron, manganese, barium, strontium, calcium and sodium (thousands of mg/L), oils and greases (tens to hundreds of mg/L) and bromides and sulfates (up to hundreds of mg/L) (Gregory et al, 2011). A recent review of shale gas environmental impacts from scientific literature (Costa et al., 2017a) found a relatively high degree of consensus that migration of methane and salts to groundwater as a result of fractures is rare, but that contamination of surface of water as a result of poor wastewater treatment is common.

The contemporary origins of hydraulic fracturing are dated to the late 1990s (Downie & Drahos, 2017) when George P. Mitchell developed a process combining horizontal drilling with hydraulic fracturing, at the same time as oil and gas prices were rising, making hydraulic fracturing more economically viable. Fracking is seen by some (controversially) as important in the transition to a low carbon economy (Priestly, 2018), and is viewed by some as a transitional fuel where it substitutes coal in the generation of heat and electricity (Costa et al., 2017a). However, it has been argued that methane emissions must be minimised if promises that shale gas will produce lower greenhouse emissions than coal are to be realised (Hirst et al., 2013). Fracking has been described as a current event which can be a good vehicle for introducing chemical ideas (Ryu et al., 2018).

Fracking in school education

Fracking is the subject of much public debate and decision-making, but at the same time, there is no requirement for young people in England to study hydraulic fracturing during school chemistry education.  Few research studies about fracking in education have originated from the UK, and there is little known about young people’s attitudes towards fracking. Given the long-reaching, intergenerational local and global consequences of fossil fuel extraction and consumption, and of fracking in particular, it is important to understand young people’s views. The aim of this study is to find out what and how young people believe they know about fracking, and to understand their attitudes towards fracking.  The findings will be of use in highlighting priorities for public communication and science education to young people in relation to fracking, and also to identify the types of support and objection to fracking that might be useful to policymakers.

Fracking is a concern for chemistry educators because of the contribution the discipline makes to understanding fracking and its impacts. The UN Sustainable Development Goals (SDGs) include ensuring access to affordable, reliable, sustainable and modern energy, taking urgent action to combat climate change and its impacts, ensuring availability and sustainable management of clean water for all, building resilient infrastructure and promoting inclusive and sustainable industry (UN, n.d.) – all of which are of relevance to fracking. It has been argued that chemistry education can contribute to meeting the challenges of sustainability by promoting scientific literacy (Eilks and Rauch, 2012). This implies that young people not only have chemical knowledge but also know how to apply this to make informed choices and how to participate in debate about chemistry, industry and the environment, and to take part in democratic decision-making. Sjöström, Rauch and Eilks (2015) argue that chemistry knowledge in the context of socio-scientific and sustainability issues is necessary but not sufficient for developing competencies for understanding and participating in societal debate: young people also need to learn how societal debate about chemistry, industry and the environment functions and to develop skills to position themselves in the decision-making process. Sjömström and Eilks (2018) distinguish between three visions of science education: I (focused on scientific content and processes), II (focused on contextualising science for application and meaning in life) and III (focused on politicisation and global citizenship), connecting Vision III to sustainability and transformational learning. Vision III scientific literacy is required for societal change to occur through education.

There is a wealth of literature associated with the teaching of socio-scientific issues. A recent review by Sadler (2009) which refers to “socio-scientific issues” as “real‐world, social issues with substantive associations to science” (p. 13) found convincing evidence for the positive impacts of socio-scientific issue related curricula and interventions on students’ attitudes towards science. Whilst hydraulic fracturing may be considered a suitable socio-scientific issue for compulsory science education, in this article we focus primarily on the political dimensions of the issue.

It is important to understand how young people understand and respond to fracking because decisions about fracking are taken in the political sphere, at both local level (local authorities grant permission for drilling to occur at named sites) and national level (through mineral rights, taxation and licenses). Hay (2007) defines politics as a social activity based on deliberation that happens in situations of choice where there is capacity for agency, describing different forms of participation (identification with a party or candidate, and habit) and non-participation (protest and apathy or disinterest), depending on whether participation is political or not. Fracking is a therefore a political issue: there are alternatives (to allow or not to allow fracking regionally, nationally or internationally; to regulate and monitor to varying degrees); it is possible for actors (in this case activists, industry, politicians and other stakeholders) to make a difference; public deliberation about hydraulic fracturing can (and indeed does!) occur in the private and informal to public and formal contexts; and hydraulic fracturing is social because it is an activity that has consequences for people and communities now or in the future. Similarly, education about hydraulic fracturing is a political issue: there are alternatives (to teach or not to teach), actors (teachers, school leaders, curriculum developers, examiners) can make a difference, deliberation can occur in formal and non-formal contexts and it is social: fracking education can have consequences for people now and in the future. At age 16-19, young people are approaching the age of first participation in formal political processes, but are less likely to participate than other age groups (Henn and Foard, 2012). If young people understand fracking and the associated impacts, they are potentially better able to interpret and respond to political messaging on the subject.

The absence of fracking from science curriculum documents does not mean that students do not experience teaching and learning about fracking. The international peer-reviewed literature makes reference to fracking in school science education. For example, In the high school and university context, Zowada et al, (2018) describe the use of a Prezi presentation and role play discussion about fracking in a general chemistry course in the USA. They found an improvement of scores relating to fracking knowledge at a highly significant level using pre-post test measures of knowledge about fracking in their evaluation, reporting similar results to when the approach was used in German high schools. They argue that there is a positive perception of fracking in general chemistry education when framed in a broad context of its ecological and societal impacts.

In Sweden, Solli et al. (2017) make connections between interdisciplinarity and dialogic teaching in their investigation of high school students’ controversy mapping in relation to fracking during a three week unit in natural sciences. Students were assigned a task to identify key actors the fracking controversy, describe tensions between different perspectives, justify their claims with evidence, and challenge claims. Much of the dialogue centred around a controversy map created using digital tools and as a result of online research. Rather than analyse individual student learning or belief formation, the authors examined dialogue in transcripts of video recordings between twelfth grade ‘inquirers’ and eleventh grade ‘rapporteurs’. This approach presents a dynamic account of how students engage in discussion about socio-scientific issues - in this case fracking - and how they handle multiple perspectives, refer to and evaluate sources, distance themselves from the message and provide evidence. This study positioned fracking as a political issue and enabled students to explore multiple perspectives on fracking: economic, environmental, ethical, legal, political and social. The competences developed, including those relating to dialogue and argumentation relate closely to the types of activity required to participate in public discussion about fracking.

Beyond science, Hendrickson’s (2015) middle school mathematics students used mathematical models to present answers to their own questions about fracking. Questions they dealt with included *how much fracking fluid would be lost underground in the USA if it was not controlled*? and *what percentage of the US uses fracking methods?* These models demonstrate how fracking can be used to understand reasoning in mathematics, and how students’ own questions about fracking can be used in the classroom to do real life maths to help them come to a view on fracking – particularly relating to questions about economic, political, environmental and scientific issues. Similarly, Stoddard and Chen (2018) reported on their use of a virtual internship for middle school students to teach about media and politics in the context of fracking. Their aim was to develop young citizens who are able to engage with civic action. The virtual internship was evaluated using a pre-post questionnaire. Details of the questions asked are not provided, but the findings suggest that the internship was associated with gains in knowledge about fracking and understanding of fracking as a controversy, as well as reported gains in students’ self-efficacy for political engagement and ability to identify an intended audience and political message from a video. This study suggests that fracking can be used to promote learning in science and politics. However this took a substantial amount of class time: 10 hours.

Beyond the formal curriculum, Monaco et al. (2016) detail real-world problem solving in the context of fracking during a week-long interdisciplinary engineering residential summer programme for female high school students. In this study, the students designed a hydraulic fracturing site and deal with engineering problems. There are no reports of how students address problems relating the political, social and environmental aspects. However, they found perceived gains in project management skills, improvement in communication skills, with teamwork being more challenging for students.

The approaches to fracking education presented here draw on a range of pedagogical approaches: presentation, role play, discussion, modelling, controversy mapping and virtual internships, drawing on the social and political dimensions to different degrees.

**Fracking in England**

Fracking has been opposed in England for several reasons: the 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, Hiller & Comfort, 2013). The concerns surrounding fracking are not unique to England: similar responses have been found in Spain (Costa et al., 2017b), and fracking has been banned by governments in several countries including France (Stokstad, 2019), Ireland (Steger & Drehobl, 2018) and Scotland (Stephan, 2017). There also exists a moratorium in Germany (Zowada et al., 2018).

In the UK, a government Office for Unconventional Gas and Oil (OUGO) was established in the Department of Energy and Climate Change in 2013 in order to “enhance our energy security, provide economic growth and be an important part of our transition to a low carbon future” (OUGO, 2019). As fracking has become increasingly economically viable, it has brought new types of development to previously unexploited areas. It has been promoted on the assumption that there is a strong regulatory system in place to control impacts, although this has been demonstrated not to be the case (Hawkins, 2015), with ‘stringent’ as applied to descriptions of UK policy used comparatively in relation to the regulatory environment in the USA.  Further, the consideration of risks to date has been restricted to seismic risks - avoiding those risks relating to air and water pollution, climate change and land use (Cotton, 2017). There are sites across England, including Lancashire, Nottinghamshire, Surrey and West Sussex where seismic surveys and exploratory fracking is or has been underway; however fracking in England does not currently contribute to domestic gas supply.

A 2014 survey (Andersson-Hudson et al., 2016) found that just over 43% of the public were in support of fracking in the UK, with just over 29% opposed and just under 28% unsure.  There has been opposition to the development of fracking in the UK for a number of reasons. These include the contribution of leaked methane to climate change, and negative impacts of fracking on air emissions and health, communities, groundwater and river pollution, geological integrity, habitats and biodiversity, seismic activity, and water supply and quality (Jones, Hiller & Comfort, 2013). The perception of fracking as an environmental issue has been found to be influential in people’s responses to fracking (Sarge et al., 2015).  Some of the challenges faced in assessing claims in relation to the economic, environmental and social impacts is the lack of an evidence base relating to fracking in the UK, and the appropriateness of extrapolating evidence from studies from the USA. In November 2019 (at the time of data collection in this study), the UK government announced a moratorium on fracking in England following an earthquake measuring 2.9 on the Richter scale associated with fracking activity at Preston New Road. In the UK, seismic events measuring above 0.5 halt fracking. The Oil and Gas Authority concluded that “it is not possible with current technology to accurately predict the probability of tremors associated with fracking” (Department for Business, Energy and Industrial Strategy, 2019).

The emerging stage of research into fracking and its impacts in the UK means that arguments in support of or opposition to fracking tend to be based on, or underpinned by ideological assumptions.  Hilson (2015) observed that the pro-fracking movement emphasised economic and climate frames, and that the anti-fracking movement emphasised the local environment and global climate change frames, and in the associated analysis of policy it was found that global climate change frames were excluded from policy considerations. Recent research studies have attempted to analyse the extent of scientific consensus around the environmental impacts of shale gas extraction (Costa et al., 2017a) and to understand the social impacts (Short and Szolucha, 2019). Cotton (2017) observes that in the UK context, methods of economic compensation have been used to redress environmental injustices, which have the potential to be both coercive (to some of the poorest communities) and divisive within communities (where some people might receive a higher proportion of benefits and fewer burdens).  Short and Szolucha (2019) identified a number of harms that impacted upon communities in Lancashire during the planning and approval stage. At one site (Preston New Road), the local council refused planning permission, a decision which was appealed by the company (Cuadrilla) resulting in the Secretary of State informing the council that he would make the final determination (Szolucha, 2016). Short and Szolucha argue that as a result of this, the community experienced collective trauma.

Knowledge and beliefs about fracking

Although problematic (see for example Gettier, 1963) knowledge is typically understood to be justified true belief. Knowledge as it relates to fracking is problematic given that there are unknowns, uncertainties and disputed knowledge relating to fracking and its social, economic and environmental impacts.

Few studies about knowledge about fracking focus on young people: Andersson-Hudson et al. (2017), Bullock and Vedlitz (2017), Choma et al. (2016) and Costa et al (2017b) focus on the general population aged 16+; and Evenson (2017) focuses on a university undergraduate population but does not provide the age range of participants.

Most studies involving measures of knowledge about fracking involve a survey design, and few attempt to find out directly what the young people know.  Instead, self-reported measures of perceived knowledge are common (Bullock and Vedlitz, 2017; Costa et al, 2017b; Evenson, 2017). Survey studies typically attempt to look for associations between knowledge about fracking and other variables (such as support or opposition to fracking), but a reliance on perceived knowledge weakens claims made on this basis as research from psychology indicates that both novices and experts in a field can have biased perceptions of their own expertise, which leads to over-confidence (Dunning, 2011; Fisher & Keil, 2015).

Two studies have attempted to measure knowledge directly in survey design research.  In one study, Choma et al. (2016) used a four point knowledge test which required the selection of correct definitions of shale gas, hydraulic fracturing unconventional gas and fracking liquid, and Andersson-Hudson et al. (2017) asked a multiple choice question to determine whether respondents knew the name of the fossil fuel extracted using fracking.  There is limited scope for testing participants’ knowledge within surveys, and perhaps as a result of this, these studies use narrow definitions of knowledge about fracking, focusing on definitions and naming products, and excluding knowledge associated with environmental, political, social or health impacts of fracking, which also rely on the collection, analysis and evaluation of scientific knowledge. In this study, we use ‘beliefs’ to refer to what young people reported knowing about in relation to fracking, whether or not it was true or justified.

Attitudes towards fracking

An attitude is taken here to be a favourable or unfavourable evaluative response towards something (here, fracking), exhibited in beliefs, feelings, or intended behaviour (DeLatamer Myers and Collett, 2018).  In common with studies relating to knowledge about fracking, the majority of studies about attitudes have focused on adult groups and used correlational designs. These have limited scope for understanding why people think the way they do: correlation does not imply causation.

In correlational studies, political ideology has been found to predict attitudes of the adult population (Choma et al., 2016).  Andersson-Hudson et al. (2016) found that fewer than half (43.11%) of their adult respondents in a national UK survey supported fracking, with women, non-Conservative party supporters and people in lower income brackets less likely to be supportive. In studies from the USA (where the majority of research on fracking education originates), Republicans tend to support fracking for economic reasons, whereas Democrats tend to oppose fracking for environmental reasons.  These designs nudge respondents towards simplifying, at times dichotomously (support/oppose), their stance on fracking, and are often devoid of contextual considerations. Some studies (Burger et al., 2015, who studies 19-21 year old undergraduate students’ views) have attempted to identify support or opposition to specific arguments, for example “I support fracking because I believe it will have economic benefits/reduce energy costs/promote energy independence/reduce carbon emissions OR I do not support fracking because I believe it will have no benefits.”  but do not draw on a comprehensive range of responses or arguments. For example, it is possible to believe that fracking brings economic benefits (for some) but remain opposed.

Support for fracking has been found to be associated with the belief that fracking is an economic issue and opposition with the belief that it is an environmental issue (Sarge et al., 2015), however, there was no measure of participants’ knowledge of the economic and environmental impacts of fracking. Evenson (2017) measured attitudes before and after an undergraduate module on fracking, and found little change in attitudes to fracking, despite a change in self evaluated knowledge, suggesting that perceived knowledge gains do not necessarily lead to changes in support or opposition towards fracking.

Surveys about attitudes towards fracking tend to focus on fracking as an isolated issue (Andersson-Hudson et al., 2016; Raimi & Leary, 2014) rather than contextualised in the wider energy landscape.  Choma et al (2016) asked respondents to compare fracking with other non-renewable and renewable energy resources and processes, and found that knowledge and political stance were associated with attitudes towards fracking, and that political stance predicted support for fracking relative to renewables such as wind and solar power.

In contrast to the surveys reported above, Williams et al. (2017) conducted deliberative focus groups with an adult lay public, including parents, allotment owners, former miners and local history and wildlife associations.  They used stimulus material (newspaper headlines, images, quotes and diagrams) and focus groups to understand responses to fracking and found that their participants framed the issue much more broadly in terms of trustworthiness of government and industry, and inclusiveness of policy making (i.e. the extent to which they are - or are not - heard by decision-makers). They found this to contrast with the views of policymakers who saw the public as lacking knowledge or understanding about risks and benefits - primarily in relation to safety.

These attitudinal studies position fracking as a political issue.  Hay (2007) defines politics as a social activity based on deliberation that happens in situations of choice where there is capacity for agency.  Hay argues that depoliticisation occurs when issues are demoted from the government sphere to the non-governmental (public and private) spheres, with the extent greatest when issues are relegated to the ‘realm of necessity’ where they are perceived to be non-changeable. For individuals, Hay notes that non-participation can be both political (protest) or non-political (apathy and disinterest).  Malmberg and Urbas (2018) draw attention to the trend towards depoliticization in science education in recent decades. In their analysis of health education in Swedish textbooks, they found stress to be depoliticised to the extent that is was positioned as an individual issue, and its political dimensions rendered invisible. These concepts (politicisation and depoliticization) are important in understanding the attitudes of young people living near fracking sites.

The present study: young people’s beliefs and attitudes towards fracking

We have found a lack of attention to young people in the fracking research literature, with most studies focusing on adult populations (Andersson-Hudson et al., 2016; Choma et al., 2016).  Many studies have drawn on quantitative methods with the aim of drawing correlations between support for fracking and other variables such as knowledge and political ideology, for example Raimi & Leary (2014) and Sarge et al. (2015). Our focus is on providing a rich description of knowledge and reported knowledge (we refer to this as ‘beliefs’ because reported knowledge was not always justified and true) and attitudes to identify key themes that are likely to be useful to educators and policy-makers, and to contribute to knowledge about how young people view fracking and its impacts.

Research questions

An important site for education about fracking is school science, which is compulsory to the age of 16 and requires students to learn about the applications of science, to evaluate associated implications and to make decisions based on the evaluation of evidence, arguments and risk (Department for Education, 2015).  A recent review of fracking education identified an absence of literature on young people’s knowledge, understanding and attitudes towards fracking, and also an absence of fracking from curriculum documents and teaching resources in England, suggesting that it is rarely included in school science. In the research literature, there tends to be a very narrow definition of ‘knowledge about fracking’, limited to scientific or technical aspects, rather than to the broader economic, environmental, legal, political, and social dimensions of fracking that are required to weigh up risks and make evidence-informed decisions. The overarching research question we are interested in is ‘what are young people’s perceptions of fracking?’  The subsidiary research questions are:

* What do young people believe about fracking? ‘Belief’ is used to include to both knowledge (as justified true belief) and perceived knowledge (which may or may not be true and/or justified).
* What are young people’s attitudes towards fracking?

Methodology

Study design

Given the scarcity of studies that have focused on young people’s beliefs and attitudes towards fracking, and the dominance of quantitative methods in existing approaches, an in-depth qualitative approach using focus groups and interviews was used to understand what young people (aged 16-19) know (and how they know) about fracking and its impacts, and how this shapes their attitudes towards fracking. Focus groups allow for a better understanding of young people’s lived reality than questionnaires (Hillcoat et al., 1995). Ethical approval to conduct the study was granted from the relevant university departmental ethics committee, and all participants granted their informed consent to take part in the study. All names of young people, schools and colleges used in the report are pseudonyms.

Participants

A purposive approach to sampling was used.  Schools and colleges within a 20 mile radius of the nearest urban settlement to a fracking site with onshore wells which have been operational were identified.  Heads of sixth form(members of staff with responsibility for students post-16) and heads of sciences in these schools were contacted. A total of 4 schools and colleges responded and consented to participate. Within schools and colleges, teachers invited young people to participate.  Some young people reported that they had not personally been affected by the fracking site, whereas others reported a range of personal impacts. In three schools, young people reported living near fracking sites. The study therefore relates to a specific population.  We do not aim for generalisability to the wider population. The knowledge and attitudes of the young people who participated are likely to be useful in informing policy and decision-makers and educators about the interests and needs of young people in response to energy and other industrial interventions.

A total of 84 young people took part, with males over-represented in the sample (Table 1), and most participants aged 16 or 17 (Table 2), under voting age. Young people were studying a range of subjects, with 22 (26%) taking chemistry at A level. The same proportion were studying geography, and the only subject more popular was mathematics (40%). Although the locations were chosen to be close to a fracking site, not all young people we spoke to were aware that there had been drilling in the area.  Young people described being familiar with some of the issues associated with fracking because of their proximity to sites. SC1-SC4 represent the four schools and colleges in which the research took place.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | female | male | Not stated | Total |
| SC1 | 8 | 14 | 1 | 23 |
| SC2 | 2 | 7 | 0 | 9 |
| SC3 | 10 | 8 | 4 | 22 |
| SC4 | 10 | 20 | 0 | 30 |

Table 1: Participants by sex (number)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | 16 | 17 | 18 | 19 | Not stated | Total |
| SC1 | 5 | 10 | 3 | 3 | 2 | 23 |
| SC2 | 5 | 3 | 1 | 0 | 0 | 9 |
| SC3 | 5 | 12 | 1 | 0 | 4 | 22 |
| SC4 | 17 | 12 | 1 | 0 | 0 | 30 |

Table 2: Participants by age (number)

Methods of data collection

Focus group interviews were used to collect data. The focus group guide included questions on knowledge about fracking and its impacts, the perceived reliability of sources of information, attitudes towards fracking, comparison of fracking with other methods of producing energy, a decision-making scenario including questions about the political process, and an activity asking young people to prioritise questions about fracking.  We facilitated using questions like ‘would anyone like to disagree?’ and ‘are there any different views?’ in order to avoid consensus amongst the group, and to avoid listening only to views with which we also held.

Focus groups consisted of 4-8 students, and lasted between 30 and 60 minutes (the majority lasted 60 minutes), depending on the schedule of the school or college. Teachers were present at the back of the room where they completed other tasks, and they did not participate in the focus groups with young people. Voluntary informed consent was obtained from teachers and from the young people in accordance with approvals gained from our departmental ethics committee. Focus groups were transcribed verbatim.

Methods of data analysis

Focus groups and interviews were analysed in NVivo using a reflexive thematic approach (Clarke et al., 2019) to identify patterns in the dataset.  Following familiarisation with the data, we first coded semantically, according to the focus group questions, then according to the research questions, and finally using the concepts of politicisation and depoliticization as defined by Hay (2007). This involved looking for where young people perceived fracking as existing in social situations of choice where there was capacity for agency and for public participation (p.65). We refer to politicisation when issues became the subject of deliberation and decision-making where

previously they were not; and to depoliticization to the reverse (Hay, 2007). Depoliticisation may be associated with shifting of responsibility to individuals, or with rendering the political dimensions of an issue invisible (Malmberg and Urbas, 2018).

Coding was reflexive, and refined during analysis as a result of discussions within the project team. As a result, codes were added, removed and changed during the process with the final themes (presented as the subheadings in the findings section)- a combination of both semantic and latent themes - checked against the complete dataset.

Findings are presented according to research question below. We avoid quantifying responses because number does not indicate value, and because every focus group progressed in a particular way, the same issues were not discussed in all focus groups to the same degree, we cannot be sure that the absence of discussion of an issue indicates anything.

Findings

The findings are presented according to research question, with the first section focusing on knowledge about fracking and the second on attitudes towards fracking.  Quotes are attributed to young people using SC1 - SC4 to represent the schools and colleges in Table 1.

Young people’s beliefs about fracking

In the focus group discussions, young people at times reported urban myths, and unsubstantiated and disputed claims.  We report young people’s views and reasoning in their own words, without prejudice, because whether true or untrue, the claimed knowledge influences their attitudes towards fracking.

Beliefs about the process of fracking There were some young people who reported knowing nothing about either fracking (‘never heard of it’), or its impacts, sometimes ‘sensing about it being bad’ but not being able to say what it is, or why it might be thought of as ‘bad.’ However, in all focus groups there was at least one student who had knowledge about the process.  Young people were able to describe the process to a greater or lesser extent, with little variation in the definition given, for example:

*They pump water down with chemicals and it brings up shale gas...like fracture it and then the sand keeps the joints open.* Male, SC3

*We looked at the fact it involves the use of extremely tiny plastic balls, sand and water and the water is pushed down to crack the rocks and then it’s two miles deep and two miles across.* Male, SC2

*It’s where they drill into the ground and, like, they almost shoot water at rocks really quickly so they get the methane which is stored in the rocks and they use that as natural gas...to make electricity.* Male, SC1

Key components of the definitions included drilling, pumping water with the fracking fluid, and the extraction of natural gas.  Few explicitly mentioned horizontal drilling, and there was no mention of acid fracturing. Some had tried to find out further information, for example about the contents of the fracking fluid, but had found information difficult or impossible to access.

The transcripts revealed no evidence of disagreement amongst young people about knowledge of the process: this was presented as unproblematic and uncontroversial.  Confidence and competence in terms of describing the process of fracking contrasted with knowledge of impacts. The following section sets out what young people reported in terms of their knowledge of the impacts.

Beliefs about the impacts of fracking Table 3 presents young people’s knowledge about the impacts of fracking Here, we present the words and impacts that the young people reported, regardless of the evidence base supporting these claims, because what the young people claimed knowledge of informed their attitudes.

In contrast with uncontested knowledge about the process of fracking, knowledge of the impacts of fracking was seen both missing or inaccessible, and as contestable.  Knowledge about the impacts was more tentative and there was more disagreement than there was in discussions about knowledge of the process.

The impacts identified included economic, environmental and social impacts and related to both local and global and short- and long-term impacts of fracking, as well as differential impacts on different groups of people. Young people saw chains of consequences of fracking, stretching across different domains, for example, environmental impacts having social and health consequences. Young people could identify ways in which knowledge about impacts could be contested and saw a need for more access to independent (of government and industry) scientific knowledge about the impacts.

|  |  |  |  |
| --- | --- | --- | --- |
| Impact | Local | | National/Global |
| Economic | | * Lowers land and property value * Damage to housing and possessions * Creates employment * Incentivises purchase of bottled water * Contributes to economic inequalities * Increased costs (e.g. buying water rather than using tap water; council taxes) * Detrimental to tourism * Fracking companies compensate community | * Energy produced from fracking enables economic activity * Tax revenue for government * Comparatively cheaper to produce than other methods of energy production. * Creates dependency on fossil fuels rather than stimulating movement to renewables. * Creates profit for companies and investors * Lower energy costs |
| Environ-mental | * Groundwater supplies * Drinking water contamination * Seismic events * Instability of land - landslides, sinkholes * Production of hazardous waste * Petrochemicals in water table. * Air, noise and light pollution * Increased traffic * Creation of brownfield sites * Non-renewable, non-sustainable * Visual impact  - less green, more urbanised and industrialised area * Damage to crops, wildlife, food cycle * Land no longer suitable for farming | | * Greenhouse gas emissions * Shale gas cleaner burning than coal. * New infrastructure needed. |
| Social and political | * Less water available for farming. * Protest movements * Social divisions (e.g. between young and old, rich and poor, pro- and anti-fracking). * Redirection of resources to manage protesters * Disruption of transport to school and work causing unplanned absences. * Noise disrupts study. * Difficulty in moving out of fracking area * Increased police presence. * Disruption to travel associated with protests and industrial traffic. * Protesters disrupt transport for people moving past sites. | | * Greater energy security * Reduced reliance on overseas energy providers. * Makes it difficult to meet Madrid Climate Conference and Paris Climate Accord goals. * Companies permitted to carry out their own health and safety estimates undermines trust in regulatory processes. * Central government overturning local planning decisions undermines democracy. * Commercial confidentiality of fracking fluid contents undermines trust in safety claims |
| Health and safety | * Exposure to carcinogens used in the process. * Combustible gases present in tap water. * Increased rates of cancer. * Disruption to emergency services. | |  |

Table 3: Young people’s beliefs about the impacts of fracking

Young people perceived that they had limited knowledge about the impacts.

I don’t really know what it is, I know the process but not really impacts. I know that it does like have impacts in terms of earthquakes but not really, not much more into it. Male, SC4

Whilst they were confident to give the big picture impacts, they were often uncertain about mechanisms and evidence. This was attributed to a lack of research for example:

there’s not really a lot of research into the global environmental impacts…there’s no, like, hard facts about, “this amount of shale gas will do this, this and this,”... they know what coal does to the environment really well because it’s been used for ages, but with shale gas….there’s not as much data or information about it. Male, SC1

The answers need to be available for the people that want it. Female, SC2

Some of the answers that young people wanted were likely to be very hard to calculate. Much of the academic research literature on fracking is behind paywalls, so it is likely that young people and teachers will have difficulty accessing this research.

Where young people had knowledge about impacts, they were often uncertain about this, and about the reliability of their knowledge. Young people recognised impacts that were both positive and negative in each of the different thematic areas. For example, in the case of economic impacts, young people recognised that gas was less expensive than other energy sources, which could be beneficial to energy companies (they were sceptical about these benefits being passed on to consumers), but also that fracking had a negative economic impact on people living in the area.

It's an efficient source of energy and it’s cheaper than a lot of sources. Male, SC1

Young people also saw impacts as having consequences across different domains. For example, the economic impact (depreciation of property values), leading to social impacts (immobility), for example:

It’s a bit of a gamble at the moment. I know a few people who’ve been trying to sell up from where they are near [fracking sites], and they’re finding it quite difficult to sell because nobody wants to buy near a fracking site. Anybody that doesn’t risks losing money, and possibly at some point, even their property or the integrity of it. Male, SC1

In terms of environmental impacts, there was a view amongst young people that burning gas was preferable to burning coal, but that burning gas nevertheless contributed to climate change, and furthermore ‘the process of getting it is awful’ (Male, SC1).

So like it is cleaner so they’d rather use gas rather than coal...Male, SC4

Well obviously there’s the carbon dioxide emissions, which are just bad for the environment and makes the greenhouse gases...greenhouse effect, causes global warming. Male, SC1

How young people weighed up these different impacts is discussed further in the section on attitudes towards fracking. The following section deals with the sources young people report provide their knowledge of fracking and its impacts.

Sources and trustworthiness of knowledge Reported sources of knowledge about fracking are presented in Table 4. The young people were sceptical about the extent to which any of the sources of information they identified could be trusted, but the focus groups revealed a background of trust in institutional authority.

 I don’t feel like the high school sources were very informative.  They were kind of just like, ‘Whatever you need for GCSE[[2]](#footnote-2), here’s the basics’... we talked about it for like … yeah.  Basically five minutes. I don’t think they're there to actually teach you the impact, maybe just it’s like case studies or whatever the exam board has set as is important to know.   Female, SC3

This criticism from some that education focused only on facts about fracking was appreciated by other young people because they felt they could trust what they learnt and make up their own mind.   They perceived that textbooks to be neutral about fracking. Most young people trusted the information they had learnt at school, even when they recognised that teacher may have personal biases. For example:

I’ve mainly found out fracking from geography at GCSE level and some bits of biology and stuff in the media.  I don’t trust a lot of the stuff from the media mostly but the stuff I learned from GCSEs I do trust completely.   Male, SC3

However, some were more sceptical of the role of government in deciding what happens in schools.  As one participant put it:

the government can influence what’s put into the education to not include certain things which might make them look bad. Male, SC4

|  |  |
| --- | --- |
| **Source** | **Examples** |
| School/college  BTEC Applied Science  Environment days  Extended Project Qualification (EPQ)  GCSE lessons | GCSE English, Geography, Sciences (Chemistry and Physics)  Teachers  Textbooks  Assignments  Exam questions  Debate  Research projects |
| Media  Film  Newspapers  Social media  TV | BBC and ITV local news  Documentaries, e.g. Gasland  The Simpsons  YouTube  Twitter |
| Personal experience | Living nearby, educated nearby - experience of tremors, compensation from industry and protests |
| Personal contacts  Friends  Parents  Protesters | Parents encouraging conversations with protesters  Work experience in MP |
| Internet | News headlines on browser launch  National Geographic website  Website of British Geological Survey  Royal Society |

Table 4: Sources of knowledge about fracking

There was a call from young people for the inclusion in education of research on fracking, particularly by independent (of the government and industry) scientists, resulting in ‘facts and figures’ that would allow them to make up their own mind.  It was important for research to be independent: young people were sceptical about research conducted by the fracking companies:

*I think it’s important to know where your information’s coming from. If you’re getting information on the safety of fracking from the big petrochemical companies that have got a vested interest anyway, it’s…your information is compromised.* Male, SC1

Whilst not all participants had direct experience of the impacts of fracking, those who did were a trusted source of ‘first hand experience’ of fracking, although the young people more frequently described personal contacts as being more reflective of strong views either way.  Personal experience was an unavoidable source of knowledge for some.

Fracking, because we’re so near it, you have to sort of listen, hear about it, and read about it, because it will affect you one way or another.    Female, SC1

Social media and internet sources (other than sites of organisations they trusted such as the Royal Society and British Geological Survey) were generally not trusted, and young people identified the need to read sources that were both pro- and anti-fracking. There were differences in the extent to which the news was trusted, with some seeing the news as not only trustworthy, but also non-biased:

Well the news is pretty balanced, it has to be to a certain extent. Male, SC3

Others perceived news (as well as social media) to be more interested in dramatizing events than reporting information and to place more value on opinions rather than facts.  Young people saw this way of reporting as responsible for driving divisions between protesters and the public, and also between industry and residents in fracking areas. There was also a perception that the news framed arguments in ways that prioritise the economy rather than the environment:

It’s not like you get a news article saying that a fracking place has been opened in such a place, it’s more you say, “There’s protestors protesting against that.” So whether they’re trying to frame the protestors, making them look bad, or the other way round, then…I don’t know, I think it’s a very difficult time, because everybody’s so opinionated instead of looking at the facts around it. Male, SC1

[The news] could be more biased towards the economy than it is but I’m not sure, depending on if it’s like a big one, BBC, they might be a little bit biased to like the economic side.  Male, SC4

Young people’s attitudes towards fracking, as reported in the section below, must be set against this background of what they know or believe to know, and where they have learnt it.

Young people’s attitudes towards fracking

As defined earlier, attitudes relate to beliefs, feelings, evaluations and behavioural predispositions in response to fracking.  Young people used a range of frames: economic, environmental and socio-political, to describe and explain their attitudes. In contrast to other studies that reduce support and opposition to framing, we saw a recognition that fracking is multidimensional, that ‘it’s difficult to weigh up.’

When compared with other ways of producing energy, shale gas extracted using fracking was seen less favourably than nuclear and wind. The criteria that young people used to rank different ways of producing energy are presented in Table 5.  Renewables were perceived most positively, but young people were concerned about the efficiency and the amount of energy that these sources could contribute to meeting needs.

We observed a broad spectrum of attitudes towards fracking.  The attitudes that were identified in the data included uncertainty, support during the transition to renewables, conditional support, ambivalence, and negativity of a range of strengths.  Fracking was seen variously as unnecessary, untested, unjustified, imposed, divisive, complex, an important supply of energy, a way of achieving energy independence, reliant upon robust regulation and monitoring, a local and global economic and environmental concern, a sacrifice to be made, an intergenerational issue, and locally undesirable.  Although we generally reject quantification, it is important to note the strength of feeling in the focus groups, particularly those opposed to fracking, and to report that ambivalence dominated, followed by opposition. The findings are presented below using the semantic codes, with latent themes expanded underneath.

|  |  |
| --- | --- |
| Human needs | Highest priority for present energy needs  Safety  Visual impact |
| Products | Pollution created - type and volume  Climate contributions  Safety and storage of waste products |
| Experience of the technology | Reliability  Efficiency  Safety |
| Economic | Job creation  Profitability |
| Environmental sustainability | Destruction of habitats  Volume of water used |

Table 5: Criteria used to rank energy sources

*Uncertain attitudes* Some young people in the study reported that they needed to know more before taking a position, for example:

I agree about [not knowing enough to] formulate an opinion because obviously you can’t necessarily form an opinion on something you don’t know everything about or enough about because it wouldn’t be right...  Female, SC4

Young people seemed to think the benefits of fracking, but that they did not know about them.  For example:

at the moment it’s kind of like we only know the negatives about the earthquakes and the pollution and global warming; so it’s kind of like how can we have a good opinion on it when we only know the negatives? Female, SC1

These young people believed that information would change, or help them form, their attitudes. The type of information needed included comparative data (e.g. energy produced per hectare of land used), why fracking was favoured over investment in renewables, and questions about local issues These included whether or not it is safe to live near, what volume and what types of chemicals are used, how close the wells are to the water supply, how it contributes to the local economy (for example the impact on local tourism), and which jobs will be created and destroyed as a result of fracking, will it reduce energy bills, and how individuals would be affected.

Whilst some young people were in favour of taking a precautionary approach, preferring investment in renewables and a stand against fracking, others favoured a trial period:

I think...as a world leader, the UK is the sixth biggest economy in the world, we should be saying, “Maybe we shouldn’t be putting loads and loads of money into something that could be awful for the environment. Male, SC1

In my opinion the best thing to do would be to trial for the five years with funding and with the correct equipment, things like that, and study its effects and then see what to do after it. Male, SC1

The need for more, and better quality information about fracking was characteristic of many participants.

Supportive attitudes There were four main types of supportive attitude: support for fracking in a transition to renewables, conditional support, support for economic reasons and support where individuals personally would not be affected.  Most support was acceptance rather than enthusiastic endorsement. A minority of young people were in favour of fracking as part of a move towards more sustainable resources, for example:

Well it’s just like gives us more time to do it.  Like get other energy sorted out really. Female, SC3

The use of fracking to supply energy was seen as reason for optimism:

It’s a big step where it like eases a lot of uncertainty to people and they think we’re running out of sources but they’ve managed to find fracking out of nowhere and get these natural gases found again.  Male, SC2

Others supported on the assumption, or condition, of good supply of gas, a robust regulatory regime, benefit to large numbers of people, it being conducted in unpopulated areas away from drinking water supplies, and there being no known negative impacts, for example:

If it’s done responsibly and in an area of plentiful supplies then I’m not too bothered about it… Male, SC3

I mean I think it’s all right as long as they’re being more careful about it.  Make sure that they’re not going to do massive damage to local areas. Male, SC4

Some young people challenged perceptions of the existence of strong regulation, particularly those who had been affected by fracking who noted that industry can take and analyse their own water samples:

that’s like asking someone to grade their own project, of course you’re going to come out with an A\*  Male, SC1

Conditional support also came for fracking in areas of low population density, which are not important supplies of drinking water, and which are not important wildlife sites:

I guess you can use fracking in like very unpopulated areas where we’re not getting water from. Male, SC3

Another type of conditional support was found where it did not affect the young person involved - a version of the NIMBY (Not In My Back Yard) phenomenon, whereby an individual objects to fracking in their own community but does not object to developments elsewhere:

This might sound a bit selfish, but as long as it’s not affecting me, then it’s fine. Male, SC1

Although Cotton (2013) has recommended dropping the NIMBY label, seeing it as a pejorative term used by developers to undermine opposition inaccurately used to portray opposition, we use it here because no other reasons were provided by the respondent other than impact on them as an individual.

Whilst young people identified economic advantages of fracking, this was seen to be more common amongst older generations; their support was more often linked to political and regulatory frames (energy independence, below):

I think the positive attitudes toward fracking is coming from more of the older generation because a good proportion of them are..have grown up in a time where it’s been a lot more economic-focused...and they don’t think of the other implications it could have...I think in the past the older generations just focused on the present and investment...whilst we’re much more focused on how we are going to live in the future.  Female, SC1

I like the idea of Britain being independent in its energy source.  Obviously I don’t know how much shale gas we’ve got and how long that would last us, but obviously there is constant turmoil and with us being so reliant on fuel that’s imported I quite like the idea of us having independent – obviously ideally a renewable thing – but actually if for the time being we have some non-renewables but we become more independent I think I quite like us standing on our own two feet – not literally but the country being a bit more independent rather than relying on foreign imports.  Female, SC1

Although young people identified economic impacts, they tended to see the benefits being directed towards industry and investors rather than the local economy, and economic perspectives tended to be used to justify opposition to fracking.  Support for fracking was rather based on energy supply and energy independence, NIMBYism, and was conditional upon regulation and monitoring.

*Ambivalent attitudes*. Young people frequently held ambivalent attitudes, i.e. recognised both positively and negatively valenced thoughts and feelings towards fracking. Ambivalence worked in different ways. For example, some students were positive about the economic impact but negative about human health and the environment:

I’m quite mixed because there’s half of me that thinks there’s not nearly enough research gone into it...but actually [this area] being an area of deprivation ... having another industry, like an energy industry, that would be great for the local economy.  So, I think that would be really good but I just don’t think that economic benefit outweighs the risks at the moment; I think the risks are more pertinent and therefore my view is more negative because there is so much uncertainty and unknowns that either nobody knows or it’s not been tested or we’ve not been told.  Respondent, SC1

In other situations, students reported both positive and negative impacts within the same frame, for example identifying the economic gains to investors and economic losses to people living near fracking sites, or:

I kind of agree with it, but then again I don’t.  Because, if you import gas from wherever, they have already got quite a bit of infrastructure, and then they will be as efficient as possible.  It will have less environmental impact than if you start fracking here and then you would have to make that infrastructure again. Respondent, SC1

Examples of information that young people identified were needed to resolve ambivalence included the quantification of local economic gains and losses, quantification of greenhouse gas emissions, clarity over the risks in terms of both hazards to human health and safety and likelihood of these being realised, and information about how regulation can intervene to both identify hazards and prevent harm from coming to pass.  These are complex questions, and there is a danger of over-simplification in quantification.

Negative attitudes Negative attitudes towards fracking related to both fracking itself and the political landscape in relation to fracking.  Negative attitudes arose from young people seeing fracking as unnecessary, a local and global economic and environmental concern, an imposition, a sacrifice their community was making, and an intergenerational issue.  A common reason given for opposition was that it was not seen as necessary, and was a distraction from the move towards renewables:

I don’t think it’s a necessity, like if there are other ways then we should use them. Female, SC4

We’re sort of funding our dependency...on natural gas and it just seems like a massive step in the wrong direction  Male, SC1

Concerns included emissions of greenhouse gases, groundwater use and pollution, and earthquakes and damage to local areas.

I don’t agree with the use of fracking as it’s not helping the global environment for all the waste it’s produced and the damage it like creates to the environment around that area. Male, SC4

It can contaminate groundwater. Female, SC3

Young people considered their community sacrificed to fracking:

there’s no way that you could stop the water being polluted or little earthquakes that can happen because of it.  So, it’s a sacrifice zone; it’s like everywhere is becoming a sacrifice zone and it’s like… there’s a point where it goes too far just to get some gas which can be replaced by more green ways of energy. Female, SC1

A key characteristic of much opposition was how young people weighed impacts.  For example, there was opposition to fracking because the environmental and human health risks which were seen to be too high when alternatives existed.

Because safety outweighs economic like gains and stuff like that.  Female, SC3

It can be, like, toxic, if it leaks into, like, a water reservoir or something like that, and then, you know, it can poison all the environment around it, and it’s quite damaging, and for the small amount of gas you get out...It just sounds a bit stupid...Male, SC1

Feelings were most strongly negative in relation to the political and economic landscape in response to fracking.  Young people felt unheard by their local political representatives. On the more strongly negative end of the spectrum, angry (SC3), annoyed (SC4), embarrassed, exploitative, frustrating, stupid, helpless, scary, and unnerving (SC1) were adjectives used to describe feelings towards fracking.

Whilst young people recognised economic gains to industry, they questioned the promised local economic benefits.

I probably think that the negatives outweigh the positives just because like the adverse effects and the environment it has and like does it really benefit the local economy or is it actually privatised and is it going into, you know, a business? Female, SC3

From what I can tell it doesn’t actually bring in a huge amount of jobs...if we were investing in green energy, then that would probably generate more jobs and it would be better for the economy overall.  Male, SC1

Whilst young people accepted the motives of the energy companies - even where they are opposed to them - emotional responses were directed not at the companies but at central government. Young people were concerned about the democratic process, reporting feeling that those in power don’t listen, don’t care, don’t think and don’t protect.

It makes me feel like the government hasn’t really thought this out because they’re promising and claiming all these...big changes and reducing carbon emissions...but then they’re still going ahead with things that will be detrimental to the environment in the future if they continue  So they’re contradicting themselves and that makes me feel annoyed about fracking. Also very confused... Female, SC3

It’s just, like, we try to, like, vote against it and then nothing actually happens, like, we tried a vote and we tried protesting, but if there’s nothing actually coming out of that, then something’s gone wrong somewhere. Male, SC1

Furthermore, regardless of how opposition was expressed - through formal local democratic political processes or through protest - young people perceived that central government pushes the agenda of industry:

I feel that it probably is hard for everyone, while democratically being overruled in the 21st century, but there is also overwhelming evidence stacked against fracking, yet our government still pushes it despite…I feel that’s quite a scary world to live in.  Male, SC1

Protest was seen as an inevitability of fracking. Whether supportive or not of the cause of protesters, young people expressed frustration about disruption caused by anti-fracking demonstrations:

I dislike protests...I just think that protests cause more bad than good and so with fracking, I think it’s a much better way just to talk to the authorities about it.  Female, SC1

I think it’s actually more annoying when I’m trying to drive past it when they roads…because, like, a couple of days last year, when there was major protests, the entire road was closed, and that’s on my bus route to [school/college]. So on those three days, I missed half of [school/college].  Male, SC1

Discussion and conclusions

This study focused on young people educated near fracking sites in England.  Whilst some young people had been directly affected by fracking or the associated protests, the sample included young people with no direct experience. The study gained insights into views of young people living or studying in affected areas.  Fracking is a highly contentious issue in these areas, and as a result young people might have been guarded in their responses to our questions. We found varying levels of knowledge about fracking and its impacts, and also a wide spectrum of attitudes towards fracking.

Many young people in this study were well informed about fracking, being able to describe not only the process but also a range of impacts, although knowledge about the mechanisms leading to impact were less well understood. Just before the December 2019 election, the UK government announced a moratorium on fracking in England.  However, there are concerns from campaigners that the existing UK government definition of fracking is limited as it defines hydraulic fracturing in terms of the volume of fluid used to fracture rocks rather than the intention to fracture the rocks, leaving open the possibility of acid fracturing taking place during the moratorium (Brockham Oil Watch, 2019).  Whilst young people were able to define fracking, most used variations of the UK government definition rather than including acid fracturing. The impacts identified by young people corresponded to the categories of impact and areas covered identified by Costa et al. (2017a) in their review of shale gas environmental impacts from scientific literature, with young people identifying impacts on water resources, atmospheric emissions, the use of land, seismic activity, and health and safety.

Young people’s knowledge was gained primarily from teachers (mainly geography, but also science), the news, parents, personal experience and family friends.  These sources of knowledge were trusted to varying degrees, with young people fairly sceptical overall about the trustworthiness of sources. There was greater trust in institutions (mainstream TV news, learned societies, schools). Our findings indicate a need for greater critical media literacy to support young people to justify their knowledge and assess the validity of truth claims. This includes not only teaching and learning to support students to analyse news and documentary reports but also to understand how information is produced, distributed and used by various stakeholders (Sjöström et al., 2015). The *Newswise* approaches and resources (Jarman & McClune, 2010) are likely to be useful here.

Independent scientists were trusted, but young people were often not aware of the findings of research. There is a case to be made for ensuring that findings of research on contentious scientific and technological interventions are open access.  Whilst studies have suggested that education does not influence attitudes (Evenson, 2017), these young people believed that information would change, or help them form, their attitudes. There was a desire for more knowledge about fracking and its impacts from school, with some complaints of outdated, irrelevant curriculum content. Whilst fracking is not explicitly stated in the curriculum, the teachers in these areas were adapting or applying the curriculum content in order to meet local and individual needs.  However, experience was varied. It has been argued for a topic to be justified in formal education, it must be relevant for the learner both in the present and in future, and should have potential for developing students’ capacities for self-determination, participation in society and solidarity with others (Sjöström, Auch and Eilks, 2015, p.165). Fracking – at least in contexts where it is not banned – meets these criteria. The approaches discussed in the literature review (presentation, role play, discussion, controversy mapping, mathematical modelling and virtual internships) are means why which students’ capabilities can be developed.

Our findings on attitudes towards fracking suggest a broader range of reasons for support of or opposition to fracking in England than have been identified elsewhere.  This makes it possible to understand where knowledge from education or research on the impacts of fracking are likely to influence decisions. Support for fracking was often contingent upon there being strong regulation and monitoring of fracking and its impacts, and upon there being moves within the sector more broadly to more sustainable sources.  However, Hawkins (2015) has argued that the regulation of fracking has been transposed from conventional oil and gas extraction, which may be inappropriate. Outright support was seen only where it did not affect the individuals concerned, and in relation to energy supply and independence. Support for fracking then, did not tend to link to economic frames, as has been suggested in previous literature (Sarge et al., 2015).

We identify ambivalence as an important attitude towards fracking, and suggest that the articulation of ambivalent views is productive in identifying what information is needed in order to resolve ambivalence. Conner and Sparks (2002) note that ambivalent attitudes are often considered weak and less stable over time, less likely to predict behaviour and more susceptible to change as a result of persuasive evidence.  Certainly young people in this study reported needing to know more to take a position. However, their ambivalent attitudes were productive: they recognised the complexity of fracking, and ambivalence allowed them to find common ground and where they differed, and to identify where more, and better quality information was needed.

Whilst it has been observed that support for fracking tends to emphasise economic and climate frames, and opposition tends to emphasise local environment and global climate change (Hilson, 2015), we found that opposition also emphasised economic and political frames. In common with Sarge et al. (2014), opposition to fracking emphasised environmental frames, considering both local and global impacts.  In this study, opposition to fracking was associated with risks to the environment and human health and safety (particularly in relation to drinking water supplies), and with economic concerns. Economic benefits were thought to be felt by industry and investors whilst at a local level people saw depreciating property values, disruption to work and study, and the degradation and industrialisation of the landscape which was felt to have a negative impact on existing industries including tourism.  Thus, fracking was seen as an unsustainable development.

Young people in this study were angry about how central government had overturned local democratic decisions, and their negativity about this was more emotionally expressed than their views towards fracking itself. Young people feel unheard in political processes, and there is evidence of a lack of trust in government and industry.  This is likely to be difficult to undo given their experience. These findings correspond to those of Williams et al (2017) who found that a lay adult public framed the issue of fracking in terms of trustworthiness of government and industry, and the extent to which they are - or are not - heard by decision-makers. The experiences of young people correspond with Cotton’s (2017) observation of the policy context that the power of local communities to take action against environmental harm has been weakened.  This part of the story on fracking is significant because it demonstrates the erosion of young people’s ability to participate in decision-making, leading to feelings of helplessness and pessimism about political processes, which is likely to undermine trust in democracy. This feeling of powerlessness - where matters are seen as unchangeable - is a depoliticisation of the issue in Hay’s (2007) terms and contributes to disaffection with politics, whereby young people dissociate themselves from political institutions and political life.  Further, we see evidence that supports the argument by Marsh, O’Toole and Jones (2007) that the central problem of contemporary participation is ”a problem of political exclusion which many alienated from a political system which they experience as unequal and unfair” (Marsh, O’Toole and Jones, 2007, p5). The data supports, in common with Cotton (2017) the need to re-localise decision-making about fracking, and a role for the provision of information - including access to cutting edge research - about fracking and its impacts. There also needs to be a space in chemistry lessons for attending to young people’s concerns, particularly where these are new, contentious and locally relevant, and for considering what happens when democratic decisions are undermined.  Chemistry teachers may find working with citizenship educators useful in working with chemical topics which have political dimensions. The theoretical model presented by Juntunen and Aksela (2014) may be useful here. This presents the view that teaching for sustainable development must first involve presenting the socio-cultural context, followed by the chemistry context and finally opportunities for action as an approach for empowering students. However, the effectiveness of young people’s actions also depends on the conditions in the world beyond the school.

In terms of sustainability, chemistry education has a role to play in meeting not only the quality education goal, but also in contributing to the other goals, e.g. affordable and clean energy (SDG 7), clean water (SDG 6), decent work and economic growth (SDG 8) and climate action (SDG 13). Education about fracking can contribute to the ability of the population to make informed decisions about how best to meet these goals. This necessarily involves learning about new technologies which have the potential to combat or contribute to the climate crisis, and understanding how to contribute to public debate and influence policy makers. Learning about fracking can enable young people to make informed decisions, and hold politicians to account for their decisions, about clean energy and water and climate action. There is a need for further attention to partnership for the goals, recognising and involving young people in decision-making.

The study suggests a number of implications for chemistry educators.  Young people’s reported feelings of impotence in opposition to the development suggest a place for Vision III scientific literacy, or critical scientific literacy. Young people had scientific knowledge, and were able to apply it, but what was missing was educated socio-political action, according to Sjömström and Eilks (2018), ‘*a politicised science education aiming at emancipation and ecojustice’* (p.67). Examples of approaches that may be useful can be found in the STEPWISE project (Bencze, 2017) which educates young people for activism.

There is a place for scientists to play in fracking education, by communicating their research beyond academic journals in a way that is open and accessible to young people and their teachers.  There is also a role for non-science subjects to play, for example in helping young people to understand existing regulation, and how to obtain the information they seek, where it exists.

This study is limited to a specific geographical context, and to young people aged 16-19. Whilst our findings might not be generalisable beyond the context, sample and time, we suggest a broader range of reasons for support or opposition to fracking based on our data, which are likely to be useful to inform the design of large-scale surveys of fracking.

Conflicts of interest

There are no conflicts of interest to declare.

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1. ‘Fracking’ is a controversial term. Technically, fracking (hydraulic fracturing) refers to the fracturing of the rock (which takes only a few days to weeks) after a well has been drilled. However, it is often used to refer to the process and impacts of unconventional shale gas development.  Advocates tend to use ‘unconventional shale gas development’ or ‘hydraulic fracturing’, perceiving negative connotations associated with fracking. We use fracking in this article as it is a familiar term: young people are likely to have heard it, and less likely to be familiar with alternatives. [↑](#footnote-ref-1)
2. GCSE is the General Certificate of Secondary Education, a qualification in a wide range of subjects typically taken by young people at age 16 (the minimum school leaving age). [↑](#footnote-ref-2)