



## Inviting the petrochemical industry to the STEM classroom: messages about industry–society–environment in webinars

Maria Andrée & Lena Hansson

To cite this article: Maria Andrée & Lena Hansson (2023): Inviting the petrochemical industry to the STEM classroom: messages about industry–society–environment in webinars, Environmental Education Research, DOI: [10.1080/13504622.2023.2168623](https://doi.org/10.1080/13504622.2023.2168623)

To link to this article: <https://doi.org/10.1080/13504622.2023.2168623>



© 2023 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group



Published online: 19 Jan 2023.



Submit your article to this journal [↗](#)



Article views: 85





View related articles [↗](#)



View Crossmark data [↗](#)

# Inviting the petrochemical industry to the STEM classroom: messages about industry–society–environment in webinars

Maria Andréa<sup>a</sup>  and Lena Hansson<sup>b</sup> 

<sup>a</sup>Stockholm University, Stockholm, Sweden; <sup>b</sup>Kristianstad University, Kristianstad, Sweden

## ABSTRACT

This article reports from a study of what messages concerning *industry–society–environment* are communicated to secondary students when they participate in webinars with representatives from the petrochemical industry. The webinars are conceptualised as part of an arena for governing science education and the messages as companion meanings. Empirically, the study is set in a context of online webinars on the topic of careers in the petrochemical industry. The webinars target students across the European Union (EU). The analysis reveals two main themes of companion meanings concerning what relations between industry–society–environment are communicated: a) the petrochemical industry as safeguarding modern life, and b) the petrochemical industry as essential for the solving of environmental problems. The companion meanings conveyed are not at all neutral but instead a means to influence the attitudes and choices of young people. The themes are discussed in relation to the overall democracy and citizenship aims of education. That the webinars claim to address the topic of careers and that they are part of an initiative sanctioned by a governmental authority (the EU) might contribute to teachers and students lowering their guard in relation to potentially biased messages.

## ARTICLE HISTORY

Received 16 June 2022  
Accepted 11 January 2023

## KEYWORDS

environment; industry;  
STEM education;  
education policy;  
educational governing;  
European Union

## Introduction

This article concerns the engagement of industry in education and what follows in respect of narratives on the relationships between industry, science, society, and the environment. More specifically, the focus is on the participation of the petrochemical industry in education. The article is thus positioned within a line of research concerned with the participation in education of private actors whose main objective is not profit from the selling of educational resources. Rather than selling products or services to schools, these actors are interested in influencing the content of education in ways that sustain the interests of the industry (Molnar 2006; Andréa and Hansson 2020, 2021). In line with such interests, teaching resources are commonly provided free of charge.

In *Environmental Education Research*, a series of research articles have been published targeting the involvement of the petrochemical industry in education and proposing the notion of

**CONTACT** Maria Andréa  [maria.andree@su.se](mailto:maria.andree@su.se)  Stockholm University, Stockholm, Sweden

© 2023 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

'petro-pedagogy'. The research suggests that fossil fuel industry narratives are reproduced in the teaching of science (Eaton and Day 2020; Tannock 2020; Skarstein 2020). In the Canadian context, the fossil fuel industry provides teachers with narratives on energy and climate change that are then reproduced in science teaching (Eaton and Day 2020). In the United Kingdom, Tannock (2020) scrutinised the involvement of BP, formerly British Petroleum, in primary and secondary education and his conclusion was that petro-pedagogy constituted a core part of a corporate education reform network promoting a neoliberal model of STEM (Science, Technology, Engineering and Mathematics) education in schools. In Norway, Skarstein (2020) conducted a survey of students with a university degree in science who attended a one-year programme to qualify as science teachers. His results suggested that groups of students with prior associations with the oil industry tended to express mixed attitudes towards the concept of human-induced climate change and a reluctance to teaching about it. As a conclusion, Skarstein proposed that oil-dependent economies might be expected to have more climate contrarian populations than others. These previous studies have been conducted in contexts where oil industry presence is extensive. However, products from the petrochemical industry are entangled with almost every part of everyday life in all parts of the world. In addition to the use of oil as fuel for transport and as a source of energy, an abundance of synthetic products (e.g. plastics and lubricants) are derived from petroleum. Petrochemicals are used to the extent that they have, as Hanieh (2021, 28) argues, become 'almost invisible to our everyday consciousness' and have become 'the means through which oil has become woven into the very fabric of our social existence'. This expansion of petroleum-based commodity production has most often been disregarded in the literature even though it has become the largest factor in the growth of demand for oil (Hanieh 2021). But, as Hanieh argues, when discussing the problem of oil dependence (such as in the current public debate on the energy crisis in Europe), the problem is framed as an issue of replacing oil as *fuel* and as a *source of energy*, 'we implicitly confirm the invisibility of petrochemicals' (Hanieh 2021).

In this article, we scrutinise webinars on careers in the petrochemical industry which target secondary students. In addition to messages concerning for example the variety of tasks and career paths in the industry there are also messages concerning industry–society–environment. Such messages might be conceptualised as companion meanings (Östman 1998, 2010), referring to collateral forms of learning or meta-learning accompanying teaching. In this study, the messages concern the role of the petrochemical industry in society and its role in addressing environmental issues and sustainability. This study is thus concerned with the hidden environmental education curriculum (cf. Jackson 1968) enacted as part of webinars on careers aimed to be used in science education. We argue that these companion meanings constitute part of a hidden environmental education curriculum, and that there is a risk of them passing unnoticed and unscrutinised.

The European Union (EU) has supported these webinars and provided a space, in the context of the EU, where industrial representatives from the petrochemical industry meet with secondary students and their teachers. The study contributes to previous research on petro-pedagogy in that it provides an analysis of how petro-pedagogy might unfold in a context where the presence of the oil industry is not as extensive as it is in oil-dependent economies such as Canada and Norway. In addition, the companies involved in the webinars represent a broader range of petrochemical companies from the business organisation *The European Petrochemical Association* (EPCA). The member companies of EPCA include not only energy and fuel companies but also companies that manufacture petrochemical goods such as plastics and lubricants as well as companies whose core business is services such as petrochemical transportation. With this study, we seek to continue the critical discussion on the engagement of private interests in schools and further our understanding of what petro-pedagogy might look like and imply in less overtly oil-dependent contexts.

## Industry–school collaborations and the governing of school

The petrochemical industry is one industrial branch of many with an interest in education. For example, companies and business organisations in areas such as forestry, energy, and mining are also offering science and technology teaching resources to schools and teachers (cf. Andrée and Hansson 2020). Many of these resources deal with environmental issues in some way or another. For example, a Swedish mining company justifies their engagement in schools as a means to influence young people to ‘understand why there are mines’ (SVT 2021), and assume a positive attitude towards the establishment of new mines. In any case, involving for-profit external actors in educational initiatives carries potential tensions between public and private interests.

The production of teaching resources works as a means to enter and act on an arena of education which governs and influences the aims and content of educational practices. However, previous research that scrutinises industry–school initiatives is scarce. There are some examples of studies that point to the benefits of school–industry collaborations – for example, in terms of being a means to challenge stereotypical perceptions of the industry as a workplace (Parvin and Stephenson 2004) and stereotypical perceptions of scientists and engineers (Henriksen, Dillon, and Ryder 2015), to increase students’ motivation for science (Loukomies 2013), and as a context for teaching environmental and societal issues (Kousa, Aksela, and Ferk Savec 2018). There is also some research on educational policy that points out tensions between public and private interests. Such tensions might concern relationships between messages communicated by external actors and curricular goals such as objectivity, democracy, and sustainability. Scholars have warned that increased participation by the private sector might imply a risk of decreased citizen perspectives in education (cf. Robertson et al. 2012; Spring 2015; Giroux 2019). Giroux (2019) argues that loss of ‘civic engagement, critical thinking, civic literacy, and the capacity for democratic agency’ (p. 149) might follow if commercial interests, rather than pedagogy, is at the centre of educational politics.

From an economic perspective, Spring (2015, 5) argues that schools can be seen as appendages of the global economic system, and the knowledge and skills taught in school as ‘capital to be utilized in economic activity’ (Spring 2015, 5). In our own previous research on industry–school collaborations, we have found that such an economic rationale is frequently employed by industrial actors, alongside rationales about increasing interest and knowledge in science, when industrial actors describe their engagement in science education (Andrée and Hansson 2020). More specifically, industrial actors draw on discourses around securing competent labour, securing economic growth (e.g. for a country), and improving the public image of the sector or of the company/organisation when justifying their engagement in education. The overall picture is that the industry often expresses very explicit intentions with their engagement in science education and that some of these aims tend to include a desire to influence education to better suit their needs. In addition, citizen-oriented and critical perspectives, for example, on the role of science in society, tend to be absent (Andrée and Hansson 2020).

In the study by Eaton and Day (2020) cited above, they argue that ‘public education is a key site for securing and maintaining the hegemony of the oil and gas industry’ (p. 458) and that petro-pedagogy is ‘designed to insulate fossil fuel industries from criticism and dissuade young people from questioning or understanding the role of corporate power in the climate crisis’. Their study was conducted in Saskatchewan, which is Canada’s second largest oil and gas producing province. In the study, they interviewed teachers, out-of-school education workers and third-party organisations engaged in public education. Their results show that teachers tended to adapt the narratives provided by the fossil fuel industry on energy, climate change, and related problems and solutions. The narratives included the promotion of neoliberal premises for environmentalism focused on individual actions and related beliefs that serve the interests

of the industrial actor. Also, teachers incorporated industry perspectives in their teaching, arguing that it was a necessary component of a 'balanced' teaching about energy and climate that did not disparage local communities. In the study, Eaton and Day also report that one strategy employed by oil-industry actors was to focus on and support local environmental projects targeting issues not related to climate change and fossil fuel emissions. The support of such projects functioned as a means to associate the industry with engagement in environmental issues and to displace local engagement to issues not connected to the oil industry's main business. Eaton and Day describe this as a form of 'greenwashing' (cf. Delmas and Burbano 2011). In short, Eaton and Day show that the classroom practices ended up promoting a neo-liberal environmentalism that centred on individual actions and insulated the fossil fuel industries from criticism. Similar findings have been reported by Chambers (2011) and Hodgkins (2010). In a case study by Hodgkins (2010), he showed how oil corporations and the provincial government enter into partnerships around curriculum and teacher professional development on environmental, energy, and career education.

## Aim

In sum, previous research has pointed to the importance of acknowledging the governing elements associated with teaching resources provided 'for free' to schools from corporate and industrial actors. To date, however, research has not paid much attention to how governing processes involving external actors come into play in education (Simons, Lundahl, and Serpieri 2013). In this article, we seek to continue the critical discussion on the engagement of private interests in schools, and the governing that follows in terms of the industry-influencing content and aims of education in an educational initiative involving companies representing a broader spectrum of the petrochemical industry including, e.g. production of petrochemical materials (e.g. plastics) and chemical products.

The aim is to scrutinise what messages concerning *industry–society–environment* are communicated to secondary students when they encounter industry representatives in industry-produced STEM initiatives. We conceptualise these messages as companion meanings (Östman 1998, 2010). In environmental education at large, such companion meanings might include people's relations to nature (Östman 2010). Here, the companion meanings concern the role of the petrochemical industry in society and its role in addressing environmental and sustainability concerns. Empirically, the study is set in the context of a series of online webinars on the topic of careers in the petrochemical industry targeting students across the European Union (EU). The webinar series is part of a more extensive programme called *Scientix* which aims to promote and support Europe-wide collaboration among STEM education professionals and industry.

## A case study of school–industry webinars

The webinar series was organised by *Scientix* in collaboration with *STEM Alliance* and *EPCA*. *Scientix* is a cross-national European initiative, originally initiated by the European Commission in 2010, which 'promotes and supports a Europe-wide collaboration among STEM (science, technology, engineering and mathematics) teachers, education researchers, policymakers and other STEM education professionals' (<http://www.scientix.eu/about>). The *STEM Alliance* organises industry and the private sector and seeks to bring industry and education together to promote STEM jobs in all industrial sectors and contribute to building a STEM-skilled workforce. Finally, *EPCA* is a business network for the global petrochemical community. The members of *EPCA* consist of chemical producers and their suppliers, customers, and service providers (<http://epca.eu/>). Since 2015, *Scientix* has been organising webinars for science education and many of these, but not all, have been organised in collaboration with *STEM Alliance*.

On a European level, there have been several initiatives over the years in support of strategic partnerships between major industries, ministries of education and STEM teachers. For example, the EU has launched initiatives such as *InGenious* and *Scientix*. The initiatives are based on assumptions that the main challenges of STEM education concern young people's lack of interest in STEM subjects and an anticipated future skills gap, and that those challenges may be addressed by improving the links between science education and industry. The EU-supported initiatives are but some examples of complex configurations of industrial actors working together with academia and various levels of government to impact STEM education (Andrée and Hansson 2020). The network of associations, governmental bodies and companies participating in the webinars on STEM careers and skills in the petrochemical industry (*Scientix*, *STEM Alliance*, *EPCA* and the different companies) can be seen as an example of what Tannock (2020) calls the 'corporate education reform network' with a focus on promoting specific ideas of STEM in STEM classrooms.

In the webinar series targeted in this study, representatives from the petrochemical industry meet teachers and students from across Europe. Whereas this specific webinar series on careers in the petrochemical industry targets science teachers and their students, there are other activities within the *Scientix* programme targeting, for example, study counsellors. In our case study, we have analysed six webinars with public chats or so-called question-and-answer sessions. All sessions are moderated by a representative from *the European Schoolnet* and in each session one to two experts from the petrochemical industry talk about careers and skills from a personal and company perspective (the experts change between sessions). Five female and six male experts participated in the webinars. The companies represented by the experts included global chemical companies with their core businesses in energy and petroleum products as well as trading, manufacturing, packaging, transporting and selling chemical products. The sessions were held in English, each lasting between 45 and 90 min.

While the school classes participating in the webinars came from across Europe, we did not have access to the lists of participants and can refer only to the information provided in the webinars. During one of the webinars, the moderator stated that they were expecting to reach 'more than 220 students and their teachers, connected from at least... twelve countries'. The students were expected to be between 12 and 19 years old. Examples of countries mentioned during the webinar conversations were Greece, Ireland, Italy, Moldavia, Poland, Romania, Serbia, Turkey, and Ukraine. It may be of importance to note that the webinars were conducted before the start of the war in Ukraine in 2022. The webinars were announced, and later published, on the webpages and in social media channels of both *Scientix* and *STEM Alliance*. *Scientix* hosts a Facebook group for science teachers in Europe with more than 20,000 followers where webinars and other *Scientix* activities are announced. *STEM Alliance* hosts a Facebook group for teachers with more than 9000 followers. For a class to attend the live webinars, the teacher had to register as a participant beforehand and, after having participated in a webinar, the teachers were offered a certificate of attendance. During one of the webinars, one teacher wrote in the public chat that the school principal had also participated in, and had appreciated, the webinar. In addition, the webinars were recorded by the organisers and the recordings, along with other documentation, were provided on the *Scientix* and *STEM Alliance* websites. Thus, the webinars were made readily accessible after the live events as resources for teaching and professional development.

The participating classes could either write questions and comments in a public chat visible to all participants (in three of the webinars) or submit questions to the moderators via a Q/A-window (in three of the webinars). Since registration was required and certificates of participation were awarded to the teachers, it is likely that teachers controlled what was posted in the chat. Thus, the questions were not likely to be submitted by individual students but rather after moderation in a class. Also, the total number of questions asked during the sessions (N=67), can be seen as an indication of questions being formulated collectively.<sup>1</sup> Most of the questions asked concerned careers and education, but there were also 14 questions that

concerned the relationships between the petrochemical industry, society, and the environment – including responsibility for environmental issues. The experts answered 7 of these 14 questions. In addition to responding to questions from the participating classes, the webinars focused on presenting the professional lives of the experts, their career paths and the businesses they represented.

In sum, the data analysed in this study included screen recordings of the webinars (including video, voice and text messages) published on the Scientix webpage, and documentation associated with the webinars on the Scientix web page, including information about the organisers, the aims and target groups of the webinars, descriptions of the participating experts and webinar presentations. We (researchers) did not participate in any live events and thus did not interact with the participants when collecting the data. For the sake of analysis, all screen recordings were transcribed verbatim with notations of chat messages inserted in the transcripts.

The digital resources included in this study may be seen as documentation of digital interactions which might invoke concerns regarding netnographic methodology (cf. Kozinets 2002). One issue is the fact that the participants in digital fora do not necessarily intend to participate in research or welcome the use of digital interactions for research purposes. In this study, however, the webinars are not simply traces of digital interaction on the Internet; rather, the organisations STEM Alliance and Scientix have documented, framed and combined the recordings of the webinars with other resources on their respective public webpages. Thus, the webinars have been used to target an external audience. On the webpages, the webinars are presented as resources for teachers; explaining and providing additional detail of the resources to make them comprehensible to an external audience. Thus, the resources analysed in this study have been published by Scientix and STEM Alliance and made public to a broad audience after the webinars were conducted. Therefore, we argue that the resources may be seen as examples of STEM teaching resources in relation to which there is public interest in critical examination. In conducting this study, measures have, nonetheless, been taken to protect the integrity of the participating individuals – we do not provide the specific titles or dates of the webinars included in this study, nor have we provided the names or pseudonyms of people (moderators and experts) or companies, nor do we indicate which expert said what in the transcripts. This information is not important given the aim of the study. Instead, all experts in the excerpts included in the article are labelled ‘expert’. Also, to further protect the integrity of the participating individuals, we do not provide references to the origin of quotes in terms of specific webinars. As researchers, we also did not have access to information about the school classes (participating teachers and students) asking questions in the chat fora which would have made it possible for us to trace them.

We have conducted a qualitative thematic analysis of messages concerning companion meanings about the relations between the petrochemical industry, society and the environment that were communicated to students during their encounters with industry representatives in the webinars on careers and education in the petrochemical industry. Some of the messages were recurrent and integral to promoting careers in the petrochemical industry (e.g. messages about the innovative nature of the petrochemical industry), while other messages seemed incidental and improvised in response to unexpected questions (e.g. response to a question about how to deal with micro plastic pollution). Both the intended key-messages and the incidental messages carry companion meanings that are important to unravel as part of a scrutiny of how the private interests of petro-pedagogy might come into play in education arenas. Through the analysis we intend to identify and analyse patterns within the data set as a whole. Our analytical procedure roughly followed that suggested by Braun and Clarke (2006; cf. Nowell et al. 2017):

1. We familiarised ourselves with the data set and its complexity with regard to the combination of video, chat and visual presentations. We read through all the data and started developing ideas about coding and possible patterns.

2. We then began generating initial codes, working systematically through the entire data set, developing codes through inductive coding and recoding (cf. Braun and Clarke 2006). For example, during one of the webinars, one of the experts stated:

'We are facing the global warming and the global climate change. We will have to reduce the greenhouse emission by about 40 percent. Those are the challenges, and this is where we can make an impact, and you can make, or you will make, an impact in the future.'

During the second phase of the analysis, this statement was categorised as: 'Negotiating environmental issues and responsibilities'. Examples of other categories were: 'Emphasising the role of chemistry in society', and 'Risks associated with the chemical industry'.

3. After all data had been coded, we searched for themes across the data set. Themes were created inductively while drawing on the ideas emerging from the prior phases of analysis and our experiences as researchers. During the creation of themes we also noted how the interaction between the experts and the students was enacted, and, as in the above quote, how responsibility for tackling environmental issues was also displaced to the students as potential future employees in the petrochemistry ('you can make, or you will make, an impact in the future').
4. The themes were revisited and revised. During this phase, some themes collapsed into one another, resulting in two themes. The themes were constructed to reflect the relations established between the petrochemical industry, science, and society in the data set as a whole. The questions asked by the school classes which were related to the themes were revisited during this part of the analysis.
5. The themes were named and defined. The statement quoted above was eventually interpreted as an instance of the theme 'The petrochemical industry as essential for the solving of environmental problems'.

The phases of creating, revising and naming/defining the themes were interwoven with writing for publication.

## Results

Through our analysis two main themes regarding companion meanings on the relations between industry–society–environment were identified: a) *the petrochemical industry as safeguarding modern life*, and b) *the petrochemical industry as essential for the solving of environmental problems*. During the webinars, as part of both themes, the petro-chemical industry was repeatedly positioned as innovative and as an actor showing exemplary responsibility towards societal and environmental challenges. Both themes were identified in all six webinars. The classes asked some questions which followed the themes, some which disrupted the themes. In four of the webinars, the school classes posed one or more questions related to one or both themes. In the two remaining webinars, however, questions related to the themes were not asked publicly. Below, we account for the themes and the ways in which they were reinforced and disrupted during the webinars.

### ***The petrochemical industry as safeguarding modern life***

During the webinars, industrial representatives communicated that the petrochemical industry was key to improving our lifestyle and *safeguarding modern life*. They spoke about petrochemical products as being all around you: 'Anything made of plastic, rubber, nylon or medicine, paint, cosmetics, from your phone to your sneakers and your shower gel. If you look around you, you will see that petrochemical products, they're all over'. This quote contributes to communicating the ubiquitous presence of the products of the petrochemical industry in modern, everyday

life. In other instances, the importance of the petrochemical industry for upholding and improving life was expressed more explicitly. For example, in one webinar, the industrial representatives described the importance of their business for people's everyday life: 'our products [...] improve people's qualities of life, wellbeing, and safety'. Some of the webinars were held during the Covid-19 pandemic. One of the experts then pointed out that the pandemic had contributed to underscoring the critical role of the petrochemical industry:

In today's situation where we have this, this pandemia, [it] is absolutely critical. All those solutions here are based on materials, whether it's membranes, whether it's the deformers, whether it's plastic things, whether it's formulation [*inaudible*], whether it's lubricants. All those are based on chemicals, on materials that are coming from the petrochemical industry.

In the quote, the expert underscores the dependence on petrochemical products. That the petrochemical industry is innovative and pivotal to safeguarding and improving modern life and lifestyles was emphasised by the experts across the webinars. According to this narrative, the petrochemical industry provides the products necessary for modern ways of life and takes on the most pressing challenges of everyday life and society including medicine/health. In three of the webinars there were questions from the classes about the importance of the petrochemical industry for modern life. This included questions from classes that supported this narrative. For example, one question was about what the represented companies' most important product was: 'What are the most significant product[s]/things [the two companies] have made?'

There were also questions in which the narrative was challenged by the school classes. One example was when a class asked a question about whether the petrochemical industry would lose its importance in the future. The class wrote: 'Since there is an increased awareness of how humans depend less on renewable sources and adapt to a new lifestyle (ex. buying electric cars) would the petrochemical industry lose it[s] importance in 10–20 years? [*sic*<sup>2</sup>]' Another question that challenged the central role of the petrochemical industry and its uses of raw material was: 'How long we will [*sic*] be able to use petrochemical resources?' Both these questions disturbed the narrative that emphasised the petrochemical industry's vital role in modern life, questioning whether the petrochemical industry's role would remain as central in the future. These questions targeted the uses of oil as a source of energy and transportation fuel. In the second question, the use of oil as a resource was emphasised more generally. However, in responding to these questions the experts did not seem worried, responding that they 'think we are very far from running out of petrol' albeit adding that the oil should be used 'wisely'. This notion of a wise use of oil couched in terms of using oil to produce petroleum-derivatives such as plastics and other synthetic products.

There were many examples of the experts communicating companion meanings about the petrochemical industry as innovative and striving 'to stay innovative'. For example, by developing lighter-weight materials with lower ecological footprints or making oil from algae. The role assigned to science and the industry can be viewed as part of a modernistic and technologically optimistic discourse where science is conflated with technology and permeated with a belief in 'never ending progress' (Wolfmeyer 2013). This narrative of how the fossil fuel industry has tied modern post-war life to petroleum products has been documented from the 1950s and onward (Huber 2012). The theme *safeguarding modern life* is consistent with previous descriptions of the ways in which the fossil fuel industry has highlighted how central its products are to modern life (Eaton and Day 2020). However, the experts explicitly distanced themselves from the problems of the fossil fuel industry associated with using oil as a fuel. Thus, they emphasised what Hanieh (2021) has called the 'syntheticisation' of daily life, which refers to the large-scale replacement of naturally derived products (e.g. glass, paper, wood) by synthetic products since the 1950s. By emphasising syntheticisation, the industry experts escape the critical scholarship criticism of oil and its role in politics and democracy, which, according to Hanieh, has mainly focused on oil as a source of energy and transportation fuel and disregarded the use of oil for plastics.

### ***The petrochemical industry as essential for solving environmental problems***

Throughout the webinars, experts and moderators positioned the petrochemical industry as essential for developing solutions to the environmental problems the world is facing. This theme was permeated with notions of *reliability* and *responsibility*. The experts argued that their companies' production of petrochemical products is done 'in a responsible way [...] not impacting in a negative way the planet'. The experts described how companies in the petrochemical industry sector take actions to reduce their use of energy and their emissions, and that they are very engaged in various sustainability projects.

In one of the webinars, one expert talked about the positive influences of the industry on the environment, and how these positive influences are not reflected accurately in the public image:

The impression we have about the chemical industry sometimes is not corresponding [to] how [it] really it is. We always think that plastics are negative and [that the] chemical industry are [sic] just producing emissions of, what else, but they're really... with the whole research and new product, new technologies, they are really trying to protect the environment, to save carbon dioxides. That we do not produce in order to save water, et cetera. So, I think the effort we are doing already is huge. And, uh, sometimes we do not see it.

In the above quote, the expert underscores that the chemical industry's efforts to protect the environment are 'huge'. This stance, that the petrochemical industry's efforts are significantly important, was a recurrent topic during the webinars and contributed to positioning the industry as a responsible actor in relation to environmental issues. In another example, one of the experts talked about the petrochemical industry's contribution in relation to lowering the amount of energy consumed:

[The] company, uh, has reduced very significantly, by fifteen percent, its consumption of energy in the last year and is now a large consumer of renewable resources of energy. [...] We are working, as well as everyone in the petrochemical industry, in having products or designs that are lighter, that are recyclable and that are easier to use. [...] The same thing for the waste, the plastic waste that cannot be directly recycled shall be chemically recycled and transformed again into raw materials. [...] When you are thinking from the, the birth of the product to its end. And you're thinking about recycling, you're thinking about making it biodegradable eventually. This is the kind of project that has an impact on our current life.

In the above quote, in addition to describing a reduction in the company's own energy consumption, the expert emphasises the importance of product development for tackling issues of energy use and plastic waste. In another webinar, one expert pointed to the fact that the industry, through product development of fridges, has reduced the use of energy in homes by 40% over the last 30 to 40 years.

Several experts underscored the demand for petrochemical products in relation to goals for sustainable development. One example mentioned is the need for gear lubricants and blade coatings for windmill production. One of the experts argued:

So, the product here is bringing a solution that has an impact. [The] chemical industry or other chemical producer[s], uh, has developed coatings for those blades of windmills ... I mean, those blades are huge, they can be up to sixty or even eighty meter long. Uh, and when they're turned, at the tip of the blade you can have the speed at about four hundred to five hundred kilometers an hour. So, developing the coatings that are resistant, light enough, that are eventually sustainable as well, that's where the challenge is. And people are working on it.

In this quote, the expert argues that, in relation to the challenges of energy, the innovations of the petro-chemical industry are crucial. Later, during the same webinar, both experts also pointed to the significance of the petrochemical industry for tackling other complex issues such as the challenges of the Covid-19 pandemic. Thus, the industry was positioned as reliably managing and contributing to the solving of sustainability problems.

In all, there were seven publicly posed questions from the participating classes during the six webinars where the petrochemical industry's positive impact on environmental issues was questioned. Out of the seven, only three questions were acknowledged and passed on to the experts by the moderator. One of those questions asked by a class in the chat concerned problems with microplastics:

Our lives are wrapped with plastic – literally! Problems associated with microplastics are large scale. In [a city in] Ireland we wonder what is the petrochemical industry doing to develop plastic alternatives that are more biodegradable.

When responding to this question the expert reframed the problem of microplastics into a problem of recycling:

Well, we know that plastic can be recycled for many times, [un]til it forms, that it can't be recycled anymore. I think it can be recycled six or seven times. And then if it can't be recycled anymore, uh there is a... it's, it's, it's *burnt*, and it creates energy. And, uh, so the problem of plastic is a problem [of] plastics in the sea for example [which] the school from Ireland was highlighting. [A] problem on the beach, this like finding micro plastics is the way... So, it's not the plastic itself that is the issue. It's what we *do* with it and how we *decide* to dispose [of] it. So, it boils down to *our* relationship with the waste in general.

The individual and not the petrochemical industry, is thus held responsible. The problem of plastic is positioned as a matter of 'our relationship with the waste'. Thus, overall responsibility for environmental problems is displaced in two directions. First, the public must improve its efforts at recycling. Second, oil resources must be used more wisely by other actors (e.g. those using oil as fuels). Later, during the same webinar, when the experts were talking about what skills were needed in the petrochemical industry, the other expert returned to the issue of plastic recycling:

I would also maybe encourage, maybe from today's chat, I mean, why don't your class maybe come up with a project. I think everybody ... It's a responsibility of everybody. [Since] teamwork is very important, so why not combining teamwork with a project, uh, for recycling plastics or something of that. So, I think that could be a great project for a class.

In response to the student question of microplastics, the expert contributes to insulating the petrochemical industry from criticism by positioning 'everybody' as responsible, thus displacing responsibility for the problem from the industry to individuals. This message is similar to the messages discerned by Eaton and Day (2020) in their study of resources for teaching and professional development produced by fossil fuel companies, where they found that it was a common strategy for the companies to present themselves as supporting environmental responsibility while their core business harmed the environment. Eaton and Day also noted, as the above quote also suggests, that companies tended to promote individuals, as consumers of resources, as being responsible for making the right personal choices to protect the environment. In parallel, the message to the students participating in this webinar was clear: reducing plastic pollution is the responsibility of individuals.

In two of the webinars, school classes asked questions about limited oil reserves. One class asked: 'What will happen to [the] petrochemical industry when the oil reserves run out?'. In response, one of the experts emphasised that only seven percent of the oil is used by the petrochemical industry:

I mean, to put yourself into the future, you have to do your kind of homework first. So, check the data and the figures there are around. And what is really important to know is that [...] for the time being, we burn ninety three percent of our oil reserves and that's amazing. That's a lot. And only seven percent going to the petrochemical industry. And we use these seven percent to make ... that reverse more or less. Because it's ... Sorry, it's crazy to burn ninety three percent of our reserves in oil. You know, just by cars, by airplanes or by cooking. That's amazing. You know, cooking as well. So, we should, we should definitely, do something to make that a... that amount of ninety three percent lesser.

[...]

And we should definitely use that because this is a raw material. And we should really use it wisely in the future, not just burning it, you know. Let's do something with it, you know and make our lives and our world a better place.

In answering the question, the expert frames the need to decrease the use of oil as the responsibility of those burning oil (e.g. gas companies and the automotive industry). According to the expert, the part of the oil used by the petrochemical industry should continue to be used in the future. Here, the expert engages in a different kind of displacement of responsibility. Whereas their own company is positioned as acting responsibly in the use of oil as a raw material, the expert identifies other sectors of the petrochemical industry involved in the burning of oil which is labelled as 'crazy'. Instead, the expert argues, the oil should be used 'wisely'.

In relation to this theme, the classes asked nine public questions. Among these were five questions with the potential to disrupt the overall narrative which were not passed on to the experts: 'How does the petrochemical industry care about the environment?'; 'With the environmental awareness being raised among the young generation, what steps are large companies in this industry taking?'; 'How will you replace petroleum in the future, if it disappears?'; 'What is the way to get rid of nuclear waste? If you also deal with such chemical?'; and 'What raw materials are used by enterprises of the petrochemical industry?'. In relation to the first question, the chat moderator wrote: 'I think we already answered a couple of questions that were repeated to some extent' and, in relation to the two last questions, a chat moderator responded that the chat of the day had mostly been about careers and continued, 'if you have such questions, you can address them here and now!'. In some cases, the experts answered potentially disruptive chat questions. The questions, in addition to the question on microplastics cited above, were: 'Has the world us running out of petrol, what is the future of the petrochemical industry?'; 'Is there a possibility that electro cars will replace all car production of petrol cars? And what is the prognosis or time horizon?'; and 'How long we will be able to use petrochemical resources?'

When the experts did respond to such potentially disruptive questions, these questions were used to reinforce the overall theme and emphasise the positive impact of the industry. For example, in response to the question, 'How does the chemical industry influences [sic] the environment?', which was a question not visible in the chat but read aloud by the moderator, one of the experts answered:

I think the industry is always trying to find new ways of production, of new products, to really protect the environment. And also, we... You know that the environment... I mean, it's a political question. Nobody can be against the environment. All of us, we know that we have to protect the environment and that the environment is important.

Here, the expert avoids potential disruption. First, by emphasising the *innovative* character of the petrochemical industry. Second, by framing the question as *political* ('it's a political question'), the expert frames environmental protection as being beyond the scope of the *apolitical industry*. However, while also stating that '[n]obody can be against the environment', care for the environment is framed as apolitical, and as an uncontroversial issue. Both the political and the apolitical framing serve as means of protecting the overall narrative.

In summary, the companion meanings positioned the petrochemical industry as responsible and caring in relation to environmental issues. The questions the school classes asked about the consequences of our lives being wrapped in plastic, or what will happen to the petrochemical industry when the oil reserves run out, may be seen as attempts to disrupt the overall narrative. The questions from the classes pointed to problems related to the positioning of the petrochemical industry as reliable and salvatory through the innovations it develops. When the students raised such issues there was a tendency for environmental issues, such as plastic pollution and global warming, to be downplayed and treated as unproblematic, or as the responsibility of other stakeholders such as the public and other actors that use petrochemical

products. This is in line with the petro-pedagogical practice of emphasising students' individual actions and thereby guarding the industry from criticism (cf. Eaton and Day 2020). One difference to Eaton and Day (2020) findings, is that in the webinar series the representatives from the petrochemical industry distanced themselves from companies involved in the burning of oil, such as oil- and gas companies and the automotive industry. In this way, the focus on problems with the use of oil were limited to the use of oil as *fuel* in transport or as an *energy source* (cf. Hanieh 2021), while potential problems with the use of petrochemicals in everyday products remained hidden. In contrast to those involved in the burning of oil, the participating experts positioned the companies they represented as contributing to solving complex environmental problems through innovative solutions. This theme resonates with tendencies towards depoliticisation which have been described previously in science education research, particularly in the teaching practices of public high school science education (Dunlop, Atkinson, and Turkenburg-van Diepen 2021).

## Discussion

During the webinars, the role and contributions of the petrochemical industry in relation to the environment and society were primarily communicated in a positive way, while omitting more critically oriented perspectives and questions. This, in itself, is not entirely surprising since it lies in the interests of the petrochemical industry to present itself in a positive light. However, a key question in this study concerns what these narratives entail. What are the companion meanings (Östman 1998) on industry–society–environment that constitute hidden curricula (Jackson 1968) about industry–science–environment in these STEM education webinars on careers?

Our analysis resulted in two overall themes. The petrochemical industry is positioned as a reliable and pivotal actor for (I) maintaining modern life, and (II) saving the world in times of global environmental crises. The two themes contribute to a hidden curriculum of petro-pedagogy (cf. Jackson 1968) enacted, through these career webinars, in classrooms across Europe. The first theme concerns the key role of the petrochemical industry for maintaining modern life. For example, through providing us with products and materials used in everyday life. The need to make the widespread use of petrochemicals in everyday products visible is highlighted by Hanieh (2021). However, instead of confronting this widespread use of oil, to be able 'to move beyond oil' (Hanieh 2021, 51), the webinars contribute to the normalisation of petroleum-based products, while potential problems remain hidden. This normalisation – which contributes to positioning the petrochemical industry as a safeguard for modern life – forms the basis of the webinars' hidden curriculum. The second theme adds to the hidden curriculum on the relationships between industry–society–environment through communicating that the petrochemical industry is not only 'compatible with environmental sustainability' (cf. Eaton and Day 2020, 470), but *necessary* for solving environmental and societal problems. Overall, the capacity for innovation is presented as key for improving our lifestyle and, at the same time, solving societal and environmental problems. This way of positioning science and the industry can be seen as part of a modernistic and technologically optimistic discourse where science is conflated with technology and permeated with the myth and metaphor of continuous progress (Wolfmeyer 2013; cf. Huber 2012).

The petro-pedagogy narratives of the two themes as part of public STEM education become problematic in that the webinars provide an arena for greenwashing the petrochemical industry (cf. Delmas and Burbano 2011). The greenwashing acts both through what is said and what is not said. The webinars provide space for the petrochemical industry representatives to talk about the engagement of the industry in local environmental issues, but also to displace responsibility onto other individuals and other parts of the industry. These results are in line with those of Eaton and Day (2020) who reported that oil industry greenwashing strategies

included focusing on local environmental projects not connected to the industry's core business, as well as displacing responsibility for environmental problems onto individuals. Eaton and Day argued that these strategies functioned as a way to 'insulate fossil fuel industries from criticism and dissuade young people from questioning or understanding the role of corporate power in the climate crisis' (p. 458). The results of our study differ in some respects regarding how the petrochemical industry approached greenwashing. A main difference is that the experts participating in the Scientix webinars repeatedly distanced themselves from the uses of fossil fuels, arguing that their businesses represented wiser ways of using the oil through developing and producing materials and products. Through this manoeuvre, the petrochemical industry is positioned as reliable, responsible and necessary for solving environmental problems (e.g. through the development of more environmentally friendly materials). Because of the shortage of counter-narratives on the roles of STEM in ecological crises (cf. Wolfmeyer 2013), and any recognition of problems related to the widespread use of petroleum-based products (Hanieh 2021), the webinars function as an arena for greenwashing the petrochemical industry. That industrial actors use STEM education to revise and improve public images of a company or a branch of industry is by no means specific to the petrochemical industry. In another study, we showed how industrial actors justify their engagement in education as a means to improve their public image (Andrée and Hansson 2020). Another main rationale, described in our same study, was the need to secure a competent workforce which is related to the explicit focus of the webinars on careers in the petrochemical industry.

### ***Smokescreens for communicating petro-pedagogy narratives in schools***

The results of this study provide grounds for concerns raised in the educational policy literature (e.g. Robertson et al. 2012; Spring 2015; Giroux 2019) regarding the participation of commercial, private interests in education, and the associated risk of communicating unproblematised, overly positive messages regarding the role of the industry in society. Based on their interviews with teachers and oil industry representatives, Eaton and Day (2020) caution against the risks of communicating industrial narratives as common sense in the classroom. Their findings showed how teaching resources produced in collaboration with the fossil fuel industry worked to legitimise beliefs relating to climate change, energy, and the environment and align these beliefs with the interests of the industry. Skarstein (2020) has suggested that such risks might be more salient in oil-dependent economies. However, our analysis of the webinars in this study illustrate that the petrochemical industry representatives communicated petro-pedagogy interests, beliefs and narratives directly to students participating in classrooms across Europe. In addition, few critical questions with the potential to disrupt the industry narratives were posed publicly by the teachers and students. As researchers in education, we may ask how this is possible. We suggest, based on our previous research on teachers' uses of corporate and industry-produced teaching resources (Andrée and Hansson 2021, 2022), that it might be difficult for teachers as well as policy makers to see through the 'smokescreens' of the webinars.

Firstly, the participation of, and funding from, governmental bodies may function as a smoke-screen that legitimises and conceals corporate agendas. The Scientix webinars are part of an EU-funded project for advancing STEM teaching which aims to promote and support a Europe-wide collaboration and inspire students to pursue careers in STEM. In this case, corporate and governmental actors form a complex configuration that includes the EU-funded Scientix-programme, STEM Alliance, EPCA and specific companies. Thus, the webinars can be seen as part of a corporate education reform network, in line with Tannock's (2020) description of how the corporation BP has actively become involved in UK STEM education policy and practice. These career webinars can be regarded as having been launched by the kind of complex policy network that operates not only on a transnational European level, but also on national and international levels of educational governing (Ball and Junemann 2012; André

and Hansson 2020). For teachers, it might be difficult to discern what actors are actually involved in the webinars.

Secondly, the events were announced as webinars about *careers and skills* in the petrochemical industry. The explicit aim of the webinars is to provide opportunities for students to meet with experts from the industry and to listen to their life stories and work experiences. This framing may contribute to lowering teachers' sensitivity to noticing potentially contentious companion meanings regarding relationships between the petrochemical industry, society and the environment, such as imbalances between the narratives of innovation and reduced consumption.

Thirdly, current societal discourses permeating STEM education in general might also make it difficult for teachers and students to identify bias in the narratives communicated by the industry representatives. Such STEM education discourses include the dominant modernist public discourse on science as a saviour, in which science is associated with hope for the wellbeing and general progress of society (technologically and economically), and the Earth (solving environmental problems) (Wolfmeyer 2013). This modernist discourse is supported by overall discourses of consumerism, neoliberalism and neoconservatism (Bencze and Carter 2011). In addition, there is a 'STEM-crisis discourse' at play that focuses on an alleged shortage of scientists and engineers in society (Carter 2017; Camilli and Hira 2019). In this study we have also found that science was conflated with technology in a myth of progress based on assumptions that change is improvement and that it 'moves society forward and makes human society better off' (Wolfmeyer 2013, 39). In addition, because educational policy discourse emphasises the benefits of collaboration with external actors, this might also contribute to teachers' lowering their guard against the potentially biased perspectives that accompany this teaching resource. Ultimately, there are discourses at play in society that contribute to the clouding of concerns about the webinars and the potentially biased messages they may contain.

### **Concluding words**

The webinars analysed in this study were set in the intersection of career education and STEM education, although this initiative targets STEM teachers and their students. When students, as part of career education, meet with, for example, industry representatives, it is perhaps not surprising that the industry tries to give a positive impression. However, both career education and core science curricula need to support students in asking questions about the interests of different business organisations, companies and other actors. The inclusion of ethically and critically oriented questions when working with careers and the role of industry in society might be one way to avoid contributing to unbalanced teaching and to support students' capacity for critical reasoning. We argue – in light of the global ecological crisis – that petro-pedagogy narratives need to be contested and troubled with counter narratives that problematise the roles of STEM in this crisis, be it as part of STEM or career education. This contestation and troubling is an indispensable dimension of environmental education cutting across all areas of education.

To conclude, critical pedagogy has a responsibility to 'unsettle power, trouble consensus, and challenge common sense' (Giroux 2019, 149). This urges us as researchers, policy actors and teachers to ask questions about what narratives are communicated in initiatives like the Scientix webinars, whose interests the narratives represent and the potential consequences of recirculating the narratives. This includes unveiling smokescreens and critically engaging with the issue of what narratives do (and do not) become part of the teaching – and what would be desirable.

### **Acknowledgement**

This study was supported by the Swedish Research Council (Grant no. 2017-03657).

## Notes on contributors

**Maria Andrée** is an Associate Professor in Science Education at the Department of Teaching and Learning, Stockholm University, Sweden. Her research mainly focuses on conditions for student participation and learning in science education. This study is part of a line of research about external actors' engagement in STEM education.

**Lena Hansson** is a Professor in Science Education at Kristianstad University, Sweden. Her main research interest lies in the intersection between nature of science perspectives and cultural perspectives on science teaching. Lena has an interest in research which is close to school practice, but also in theoretical and policy issues. One research line is concerned with external actors in science education.

## Notes

1. There were also a few questions read out loud by the moderator that referred to questions that were not visible in the chats or Q/A windows. These questions might have been asked privately to the moderator and were not counted among the questions from the classes. However, to the extent they were mentioned by the moderator they are analysed as part of the communication during the webinar sessions.
2. This question is likely posed by someone for whom English is a second language. We assume the question is intended to refer to the increased awareness of how humans currently are overdependent on fossil fuels and so are moving towards renewables.

## ORCID

Maria Andrée  <http://orcid.org/0000-0002-5574-8636>

Lena Hansson  <http://orcid.org/0000-0003-3175-5185>

## References

- Andrée, M., and L. Hansson. 2020. "Industrial Actors and Their Rationales for Engaging in STEM Education." *Journal of Curriculum Studies* 52 (4): 551–576. doi:10.1080/00220272.2019.1682055.
- Andrée, M., and L. Hansson. 2021. "Industry, Science Education and Teacher Agency: A Discourse Analysis of Teachers' Evaluations of Industry-Produced Teaching Resources." *Science Education* 105 (2): 353–383. <https://onlinelibrary.wiley.com/doi/10.1002/sce.21607>.
- Andrée, M., and L. Hansson. 2022. "Teachers' Negotiations of Bias in Relation to Teaching Resources Offered to Schools by Industrial Actors." *Nordic Journal of Studies in Educational Policy* 8 (1): 52–64. doi:10.1080/20020317.2022.2031831.
- Ball, S., and C. Junemann. 2012. *Networks New Governance and Education*. Bristol: Policy Press.
- Bencze, Larry, and Lyn Carter. 2011. "Globalizing Students Acting for the Common Good." *Journal of Research in Science Teaching* 48 (6): 648–669. doi:10.1002/tea.20419.
- Braun, V., and V. Clarke. 2006. "Using Thematic Analysis in Psychology." *Qualitative Research in Psychology* 3 (2): 77–101. doi:10.1191/1478088706qp063oa.
- Camilli, G., and R. Hira. 2019. "Introduction to Special Issue—STEM Workforce: STEM Education and the Post-Scientific Society." *Journal of Science Education and Technology* 28 (1): 1–8. doi:10.1007/s10956-018-9759-8.
- Carter, L. 2017. "Neoliberalism and STEM Education: Some Australian Policy Discourse." *Canadian Journal of Science, Mathematics and Technology Education* 17 (4): 247–257. doi:10.1080/14926156.2017.1380868.
- Chambers, J. M. 2011. "Right Time, Wrong Place? Teaching About Climate Change in Alberta Schools." *Alberta Science Education Journal*, 42(1), 4–12. <https://sc.teachers.ab.ca/SiteCollectionDocuments/ASEJ%20Vol%2042%20No%201.pdf>
- Delmas, M. A., and V. C. Burbano. 2011. "The Drivers of Greenwashing." *California Management Review* 54 (1): 64–87. doi:10.1525/cmr.2011.54.1.64.
- Dunlop, L., L. Atkinson, and M. Turkenburg-van Diepen. 2021. "The Environment and Politics in Science Education: The Case of Teaching Fracking." *Cultural Studies of Science Education* 16 (2): 557–579. doi:10.1007/s11422-021-10017-z.
- Eaton, E., and N. Day. 2020. "Petro-Pedagogy: Fossil Fuel Interests and the Obstruction of Climate Justice in Public Education." *Environmental Education Research* 26 (4): 457–473. doi:10.1080/13504622.2019.1650164.
- Giroux, H. 2019. "Toward a Pedagogy of Educated Hope Under Casino Capitalism." *Pedagogía Y Saberes*, 50, 147–151. [http://www.scielo.org.co/scielo.php?script=sci\\_abstract&pid=S0121-24942019000100147](http://www.scielo.org.co/scielo.php?script=sci_abstract&pid=S0121-24942019000100147)
- Hanieh, A. 2021. "Petrochemical Empire. The Geo-Politics of Fossil-Fuelled Production." *New Left Review*, 130(July–August), 25–51. <http://hdl.handle.net/10871/127582>

- Henriksen, E. K., Dillon, J., & Ryder, J. (Eds.). 2015. *Understanding student Participation and Choice in Science and Technology Education*. Dordrecht: Springer.
- Hodgkins, A. 2010. "Manufacturing (Il)lteracy in Alberta's Classrooms: The Case of an Oil-Dependent State." *Journal for Critical Education Policy Studies (JCEPS)*, 8(1). <http://www.jceps.com/wp-content/uploads/PDFs/08-1-10.pdf>
- Huber, M. 2012. "Refined politics: Petroleum Products, Neoliberalism, and the Ecology of Entrepreneurial Life." *Journal of American Studies* 46 (2): 295–312. doi:10.1017/S0021875812000126.
- Jackson, P. 1968. *Life in Classrooms*. New York/London: Teachers College Press.
- Kousa, Päivi, Maija Aksela, and Vesna Ferk Savec. 2018. "Pre!Service Teachers' Beliefs about the Benefits and Challenges of STSE Based School-Industry Collaboration and Practices in Science Education." *Journal of Baltic Science Education* 17 (6): 1034–1045. doi:10.33225/jbse/18.17.1034.
- Kozinets, R. 2002. "The Field behind the Screen: Using Netnography for Marketing Research in Online Communities." *Journal of Marketing Research* 39 (1): 61–72. doi:10.1509/jmkr.39.1.61.18935.
- Loukomies, A. 2013. "Enhancing Students' Motivation Towards School Science with an Inquiry-Based Site Visit Teaching Sequence: A Design-Based Research Approach" Doctoral diss., University of Helsinki. [https://helda.helsinki.fi/bitstream/handle/10138/42269/loukomies\\_dissertation.pdf?sequence=1](https://helda.helsinki.fi/bitstream/handle/10138/42269/loukomies_dissertation.pdf?sequence=1)
- Molnar, A. 2006. "The commercial Transformation of Public Education." *Journal of Education Policy* 21 (5): 621–640. doi:10.1080/02680930600866231.
- Nowell, L. S., J. M. Norris, D. E. White, and N. J. Moules. 2017. "Thematic Analysis: Striving to Meet the Trustworthiness Criteria." *International Journal of Qualitative Methods* 16 (1): 160940691773384–160940691773313. doi:10.1177/1609406917733847.
- Östman, L. 1998. "How companion Meanings are Expressed by Science Education Discourse." In *Problems of Meaning in Science Curriculum*, edited by D. Roberts and L. Östman, 5–12). New York: Teachers College Press.
- Östman, L. 2010. "Education for Sustainable Development and Normativity: A Transactional Analysis of Moral Meaning-Making and Companion Meanings in Classroom Communication." *Environmental Education Research* 16 (1): 75–93. doi:10.1080/13504620903504057.
- Parvin, J., and M. Stephenson. 2004. "Learning Science at Industrial Sites." In *Learning science outside the Classroom*, edited by M. Braund and M. Reiss, 111–129. Routledge.
- Robertson, S., Mundy, K., Verger, A., & Menashy, F. (Eds.). 2012. *Public private Partnerships in Education: New Actors and Modes of Governance in a Globalizing World*. Northampton, MA: Edward Elgar Publishing.
- Simons, M., L. Lundahl, and R. Serpieri. 2013. "Introduction. The Governing of Education in Europe: Commercial Actors, Partnerships and Strategies." *European Educational Research Journal* 12 (4): 416–424. doi:10.2304/eej.2013.12.4.4.
- Skarstein, F. 2020. "Climate beliefs in an Oil-Dependent Economy: Norwegian Pre-Service Science Teachers' Attitudes towards Climate Change." *Environmental Education Research* 26 (4): 491–510. doi:10.1080/13504622.2020.1728233.
- Spring, J. 2015. *Economization of Education: Human Capital, Global Corporations, Skills-Based Schooling*. New York: Routledge.
- SVT. 2021. *Så Ska Ungdomar Tro På Framtida Gruvor – Lockas Med VR-Teknik [How to Make Young People Have Faith in Future Mines - Enticing with VR-Technology]*. <https://www.svt.se/nyheter/lokalt/norrbotten/gruvforetag-avander-vr-for-att-paverka-ungdomars-syn-pa-gruvor>
- Tannock, S. 2020. "The oil Industry in Our Schools: From Petro Pete to Science Capital in the Age of Climate Crisis." *Environmental Education Research* 26 (4): 474–490. doi:10.1080/13504622.2020.1724891.
- Wolfmeyer, M. 2013. "STEM, Meet Ecojustice." *Green Theory & Praxis Journal* 7 (1): 32–46. <https://greentheoryand-praxisjournal.org/volume-7-issue-1-december-2013/>.