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# Industrial actors and their rationales for engaging in STEM education

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## ABSTRACT

In science education, critical discussions on the engagement of industrial actors in STEM education are scarce. In this study, we take the perspective that industrial STEM education initiatives are an arena for governing STEM education. The aim is to contribute to a critical discussion on the involvement of industrial actors in STEM education by scrutinizing how they describe their engagement. More specifically, we look at the discursive repertoires industrial actors put forward as rationales for engaging in STEM education initiatives. The data consist of web materials wherein industrial actors describe and justify their engagements. We identify the following interpretative repertoires used by industrial actors when justifying their engagement in said initiatives: a) Securing competent labour, b) Securing economic growth, c) Improving the public image—marketing, d) Contributing to a bright future, e) Increasing interest in STEM, f) Increasing knowledge in and of STEM and g) Empowering young people. The repertoires are discussed in light of potential tensions between public and private good. The notion of ‘boundary repertoires’ is introduced to discuss repertoires which can be adapted across discursive practices and which afford industrial actors possibilities for speaking to a varied audience—shareholders as well as teachers.

## KEYWORDS

Industry; science education; STEM; governing; commercialization; science education policy

## Introduction

In Sweden and across the globe, many initiatives to improve, as well as to increase interest in STEM<sup>1</sup> (Science, Technology, Engineering and Mathematics) education are introduced by various actors outside of schools. The initiatives range from explicit recruitment campaigns to educational materials and out-of-school activities and involve different kinds of actors such as various levels of government (Andrée & Hansson, 2013), the scientific community (Andrée & Hansson, 2014), non-governmental organizations (Andrée, Hansson, & Ideland, 2018; Ideland & Tröhler, 2015) and industrial actors (cf. Teknikdelegationen [in English The Swedish Technology Delegation] 2010). Whereas previous research in science education has pointed to the benefits of cooperation between schools and external actors, there is research on educational policy that points to potential tensions between the aims and messages communicated by external actors and curricular goals such as objectivity, democracy and sustainability (cf. Robertson, Mundy, Verger, & Menashy, 2012a).

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<sup>1</sup>The reason for using the concept of STEM education is mainly empirical. When analysing initiatives involving industrial actors it has not been possible to separate science initiatives from, e.g. technological or mathematics initiatives. In a Swedish context, these kinds of initiatives are often mixed both in the initiatives themselves and in the way the actors talk about their engagement.

The overall objective of this article is to contribute to a critical discussion on the problems and possibilities associated with industrial engagement in STEM education. We do this by scrutinizing how businesses and industrial actors account for their engagement in STEM education initiatives. The focus is on the messages industrial actors communicate, on public websites, about their rationales for engaging in STEM education. The websites are part of the mediatization of educational policy where print, as well as digital media landscapes, shape education and how society understands the 'common good' of education (Rawolle, 2010).

### ***Education in the 'STEM crisis'***

The external engagement in STEM education initiatives may be seen in light of the discourse of 'STEM crisis' (cf. Mansfield, Welton, & Grogan, 2014; Panizzon, Corrigan, Forgasz, & Hopkins, 2014). This crisis is depicted in different ways. Sometimes a picture of the 'STEM crisis' is painted in terms of a decrease in STEM knowledge and lack of competences in the young population. The STEM crisis is also depicted as being about young people's low interest in STEM education/careers, i.e. as a recruitment problem (European Commission, 2004; Osborne & Dillon, 2008). One current example is the EC program Horizon 2020, which includes a coordination and support action that aims to 'improve the attractiveness of science education and scientific careers to young people' (European Commission, 2013). Another example is the EC report 'Europe needs more scientists' (EC, 2004) which highlights the lack of scientists and the need to educate more scientists. The report was produced by a group of well-recognized science education researchers to address the concern of the EU that 'Europe should become the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion' (EC, 2004, p. i). In the report, a STEM crisis is depicted in terms of a 'crisis in the production of human resources' for science, engineering and technology (p. iii). Outside Europe, the 'STEM crisis' discourse also prevails, for example, in Australia and the US. The often unproblematized discourse of a STEM crisis has led some scholars to start discussing whether the discourse represents a real problem. For example, Panizzon et al. (2014) discuss the 'rhetoric about impending shortages in the STEM workforce' in an Australian context. Panizzon et al. (2014) argue that the rhetoric about falling participation rates and shortages of the workforce across STEM is not consistent with available data on student enrolment in higher education. Mansfield et al. (2014) problematize the discourse of the STEM crisis in a US context. They reveal how the crisis discourse draws attention away from other problems such as how opportunities for women and minoritized others remain either unchanged or even further restricted. The STEM crisis discourse is accompanied by a tendency to talk about school as failing, for example, to foster an interest in STEM and to educate citizens that are scientifically literate, employable and internationally competitive. Mansfield et al. (2014) highlight how issues of so-called 'leaky' talent pipelines, 'incompetent teachers', 'inferior students', 'deficit curricula' and international rivalry, in fact, fuel the STEM crisis discourse.

In the context of science education research, the STEM crisis has primarily been conceptualized in terms of selection/de-selection, interest/non-interest and increase/decrease of knowledge related to STEM. The research has, for example, focused on rationales behind individual student choices not to pursue the line of STEM education. The processes of educational choice have in turn been conceptualized in terms of interest, identity and values (cf. Anderhag, Emanuelsson, Wickman, & Hamza, 2013). For example, Bøe, Henriksen, Lyons, and Schreiner (2011) have studied young people's relationships to and participation in STEM subjects and careers through the lens of an expectancy-value model of achievement-related choices (cf. Eccles, 2009). A range of studies has been conducted on attitudes towards STEM education that have pointed to a lack of positive attitudes (Lindah, 2003; Osborne & Dillon, 2008; Schreiner, 2006). A recent line of research has conceptualized the problem of young people's choice or lack of choice of STEM education (drawing on the theory of Pierre Bourdieu) as a lack of habitus (Archer et al., 2012), or science capital (Archer, Dawson, DeWitt, Seakins, & Wong, 2015). In doing so Archer et al. (2015) use the notion of science capital to explain

differential patterns of aspiration and educational participation among young people. A similar research interest permeated the EC-funded IRIS project (Interest & Recruitment in Science) which focused on factors influencing recruitment and retention in STEM higher education (Henriksen, Dillon, & Ryder, 2015). The IRIS project focused on how people make educational choices and how STEM is evaluated in this context with a particular focus on female participation. One of the key findings of the project was that educational choice is a process that develops over time (Ryder, Ulriksen, & Bøe, 2015). Whereas most science education research has been related to the educational choices of students, only a few studies have analysed the effects of specific STEM initiatives (e.g. Jensen & Bøe, 2013; Jensen & Sjaastad, 2013), or the messages communicated to students in different initiatives (Andrée & Hansson, 2013, 2014). In sum, most studies in the field of science education primarily address the STEM crisis by focusing on educational choice as a matter of individual factors.

### ***Industrial engagement in STEM education initiatives***

Rather than taking the STEM crisis as a taken-for-granted starting point, this article focuses on industrial engagement in STEM education and more specifically on the rationales for the involvement of industrial actors in STEM education initiatives.

In the Swedish context, where we are working, we find a large range of industrial STEM education initiatives including school programmes, competitions, festivals and other event-based initiatives (cf. Teknikdelegationen, 2010). It has been estimated that about 40% of the STEM initiatives in Sweden are in some way financed by industry and the private sector (op cit).

Despite the many initiatives of various actors, with possibly different agendas for engaging in STEM initiatives, there is little research on these agendas. Instead, initiatives have been embraced rather uncritically. Whereas partnerships between schools and actors such as museums, science centres, zoos and botanical gardens have been widely researched (Braund & Reiss, 2004), partnerships between schools and industry are less commonly studied. Some exceptions are: Loukemies' (2013) study on the use of industrial sites to enhance students' motivation in school science; Cannon and Sandler's (2000) evaluation of a model for academic-industrial partnership for elementary science education; Kousa, Aksela and Ferck Savek's (2018) study on school-industry collaboration as a way to implement STSE issues in the teaching, and Parvin and Stephenson's (2004) study on how industrial sites may be used to challenge stereotypical perceptions of industry as a workplace. Davidsson and Sørensen (2010) have also shown that science and technology centres and museums tend to rely increasingly on external economic support to create new exhibitions, and that sponsors commonly interfere, directly or indirectly, with the design of exhibitions. This latter study underlines the importance of looking further into the tensions between public and private good that might arise as part of industrial engagement in STEM initiatives.

### ***Commercialization of education: public and private good in STEM education***

On a general level, industrial engagement in education may be understood as part of the commercialization of education, where partnerships between different actors are frequent (Simons, Lundahl & Serpieri, 2013a). In education, commercialization is often used in a broad sense to refer to processes where 'private, for-profit agencies and commercial transactions have an impact on or become part of the scene of education' (Simons, Lundahl & Serpieri, 2013a, p. 420). The general trend of commercialization of education opens up science education as an arena for various external actors to engage in. Ball and Junemann (2012) trace networks consisting of a large variety of actors and argue that, in the British educational context, 'there is plenty of evidence of network governance at work' (p. 132). They have shown how networks of different actors, including business actors, have entered the scene of educational governance and changed governance mechanisms in the UK. The situation appears similar in many other countries, including Sweden. In line with this, a special issue of the European Educational Research Journal (Simons, Lundahl & Serpieri, 2013b) illustrates how

commercial actors have increasingly entered European policy space and taken up a variety of roles in different kinds of activities. The special issue points to the various ways in which an arena for governing education emerges through partnerships between schools and commercial actors. Other examples of case studies mapping networks of actors within the current educational landscape are found in the book 'Mapping Corporate Education Reform', including global edu-business, educational entrepreneurial networks and charter schools (Au & Ferrare, eds., 2015).

Previous research on education and educational policy has problematized the influence of economics and capitalism on education as part of a critical discussion on the role of education in a democratic society. For example, Giroux (2019) argues that democracy in a society begins to fail when economic and commercial interests, and not pedagogy, is at the centre of educational politics. This failure risks a loss of 'civic engagement, critical thinking, civic literacy, and the capacity for democratic agency' (p. 149). Boyles (2005) gathers a collection of essays that scrutinize how commercial interests intersect with educational institutions. The topics include privatization of services such as school food services, and marketing to high school students, but also oil company adverts acting as educational policy statements and links between educational policy and the military industry.

In the fields of political science, economy and/or management studies, there is a body of research specifically targeting tensions between private and public good, the functioning of lobbying and corporate social responsibility and the roles that different institutional structures and political legacies play in how governments, NGOs, industry and others determine and implement preferences regarding corporate social responsibility (Doh & Guay, 2006). The question of tension between public and private good is not only a matter for education but for government generally, and corporate involvement (for example, under the label of corporate social responsibility) may need to be managed differently in different institutional environments. Doh and Guay (2006) conducted an analysis of how differences in the institutional environments of Europe and the United States affect expectations about corporate social responsibility by looking at three different case studies (global warming, trade in genetically modified organisms and pricing of anti-viral pharmaceuticals in developing countries). Their analysis suggests that different institutional structures and political legacies are important for explaining how governments understand corporate social responsibility.

The economization of education, including commercial involvement in education, could be understood as a consequence of neoliberal policies of decentralization, new public management strategies and related reforms of administrative and governmental agencies. This economization of education with a rise of new networks of governance in public education has been labelled the corporate education reform (Au & Ferrare, 2015). This movement, which is part of public sector reforms initiated in the 1980s, 'have brought about a shift from the welfare state government to neoliberal modes of governance' (Avelar, Nikita, & Ball, 2018 p. 56). Negative consequences of neoliberal agendas, for science and/or mathematics education, have been discussed, for example, by Carter (2017) in relation to Australian STEM policy discourse, by Bencze, Reiss, Sharma, and Weinstein (2018) in relation to the potential of realizing critical and activist STEM education and by Martin (2013) in relation to prevailing racial agendas. These studies point to the potential dangers of enabling competitive national and neoliberal agendas for human capital production to impact on the aims of science education.

In an increasingly globalized economy most political and economic actors, striving to raise their economic competitiveness and performance, perceive education and knowledge as 'key competitive assets for this purpose' (Verger, Novelli, & Altinyelken, 2018, p 12). Viewed from an economic perspective, knowledge and skills learned in school are regarded as 'capital to be utilized in economic activity' (Spring, 2015, p. 5) and schools as appendages to the global economic system.

To date, not much attention has been given to how these processes actually play out in education (Simons, Lundahl & Serpieri, 2013a). One exception is the study by Molnar (2006, pp. 621–622) that provides a distinction between different forms of the commercialization of education, viz: 'selling to

schools', 'selling in schools', and 'selling of schools'. This includes commercial activities with schools, as well as commercial actors that regard the school as a site for advertisement and contact with buyers. Molnar, Garcia, Boninger, and Merrill (2008) show that American primary schools participate to an extensive degree in corporate-sponsored marketing for foods which, when consumed in quantity, may lead to obesity and its attendant health risks; i.e. primary schools allow marketing programmes that may contribute to an obesity problem, contrary to official school policies.

In the research literature, there is an ongoing debate on the forms and consequences of public–private partnerships in education (Robertson et al., 2012a). Robertson et al (2012a) argue that public–private partnerships represent a new mode of governance that ranges from covert support of the private sector to overt collaboration. Examples of public–private partnerships in education include cooperation with global corporations as well as corporate philanthropy (op cit). In the field of sociology of education, there are studies on networks of actors and the governing of education involving private actors (Ball & Junemann, 2012). Drawing on analyses of networks in contemporary educational reform in England, Ball and Junemann (2012) argues that the public sector, and education in particular, is going through a period of fundamental change making it 'increasingly complex, differentiated and opaque' (p. 141). The moves to 'modernize' educational policy have included setting up partnerships offering businesses entry as school partners, branding of schools, and a wide range of new sponsors (entrepreneurs, businesses, faith groups and charities, for a full overview of the moves see Ball & Junemann, 2012 pp. 26–30). In light of educational policy shifts, scholars have highlighted the risk of the 'erosion of citizens' voice as a contributor to change' (Robertson, Mundy, Verger, & Menashy, 2012b, p. 14; cf. Spring, 2015) as well as contradictions between corporate educational reform and democracy, power and equality (Au & Ferrare, 2015; cf. Giroux, 2019).

The question of commercialization in education is also related to the question of educational aims. Giroux (2019) urges us to recognize 'that education is not just about job training and product manufacturing, but also about matters of civic engagement, critical thinking, civic literacy and the capacity for democratic agency, action, and change' (p. 149). In relation to STEM education, the aims discussed in research literature traditionally include a focus on the preparation of students for the next educational level and for future STEM careers, as well as a focus on learning science concepts and models for their own sake. More recently expressed aims of science education have also come to include aims of social and ecological justice and citizenship. Two examples are Bencze et al. (2018) arguing for a science education for ecojustice and activism, and Gutstein (2012) arguing for a mathematics education for social justice.

The point of departure in this article is that industrial and other commercial actors are increasingly entering the educational policy space to assume various roles in different governing activities and processes. Simons, Lundahl and Serpieri (2013a, p. 421) conclude that it is of 'utmost importance to take into account actors, interactions and interests that are often not associated with the field of governing and policy'. They also stress the importance of studying processes of commercialization in education in local contexts to understand the 'local assemblages of policy' (p. 421).

When industrial actors engage in STEM initiatives, an arena for governing STEM education emerges where industrial actors are able to influence, for example, the knowledge, attitudes and choices of young people. The involvement of industry actors—with their various interests—in STEM initiatives, may be considered part of the processes of both the commercialization and the governance of STEM education. Thus, there is a good reason for industrial involvement in STEM initiatives to be subjected to curriculum research. One relevant question concerns the aims that industrial actors seek to achieve by engaging in STEM education.

### ***Public communication of rationales for engaging in STEM education***

Scrutinizing public communications about industrial engagement in STEM education on webpages, we draw on the framework of discursive psychology (Potter, 1998). Discursive psychology focuses on how attitudes and rationales emerge as part of social interaction and offers a framework for analysing how industrial actors describe the importance of engaging in STEM education initiatives

in general and in relation to specific resources they make use of—such as various STEM education initiatives (teaching materials, industrial visits, exhibitions and so on). Industrial actors engage in communicating on the Internet with the public, with shareholders, competitors and governments, as well as schools, teachers and, sometimes, with students. Such public communication on webpages is one particular form of social interaction of the aims of and rationales for engaging in STEM education.

The different ways in which industrial actors justify why they engage in STEM education are cultural and constitute *interpretative repertoires*, that is, shared collective ways of justifying STEM engagement from an industrial point of view (cf. Hsu, Roth, Marshall, & Guenette, 2009). Interpretative repertoires represent forms of social interaction used by industrial actors to communicate rationales for their engagement in STEM education that participants in discursive practices are expected to accept as taken for granted. Thus, the interpretative repertoires constitute ways of talking that others are presumed to share (Hsu et al., 2009; Potter, 1998). According to Wetherell and Potter (1988, p.172), the interpretative repertoires can be seen as 'building blocks speakers use for constructing versions of actions, cognitive processes, and other phenomena'.

On webpages, a company will seek to present its STEM education activities in ways that presumably justify their engagement in STEM education to shareholders, potential customers, potential employees and society at large (including schools). In this article, we suggest the notion of *boundary repertoire* to account for repertoires that may work across discursive practices. For example, in communicating with shareholders as well as teachers or students. The notion of boundary repertoires builds on the notion of boundary object which was introduced by Leigh Star and Griesemer (1989, p. 393) to characterize objects of activity that are '... both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites'. A boundary repertoire would function as a particular kind of building block that is possible to adapt across discursive practices in order to construct recognizable justifications of actions.

## Methodology

In light of the overall aim to contribute to a critical discussion on the involvement of industrial actors in STEM education, we analyse the discursive repertoires drawn upon by industrial actors as rationales for engaging in STEM education initiatives. The data consist of web materials wherein industrial actors describe and justify their engagements. The web materials are analysed with respect to the interpretative repertoires that are used by industrial actors when justifying their engagement in STEM education initiatives. These interpretative repertoires are then scrutinized with a focus both on the potential tensions related to conflicts of interest and values between private and public good, and the potential of the different repertoires to function as boundary repertoires.

First, we describe the context in which repertoires are used by industrial actors. This includes a description of the Swedish education system and a description of the industrial actors involved, their resources, and their collaborations in the Swedish context. Lastly, we explain our data collection and analysis methods.

### *The Swedish education system*

In Swedish compulsory school, there is a common curriculum for students and all schools follow the same syllabuses in science, technology and mathematics. Children in Sweden go to compulsory school for 9 years (from ages 7 to 15). After compulsory school, most students continue to upper-secondary school for 3 years. In upper-secondary school, they choose from both vocational and academic programmes. The majority of compulsory as well as upper-secondary schools in Sweden are municipally run. There are also charter schools that may be organized and owned by a company, a foundation or an association. About 14% of the compulsory schools

and 27% of the upper-secondary schools are charter schools (Swedish Association of Independent Schools, 2018).

Sweden has a goal steered system with a high degree of local autonomy. The national curricula, decided by the government, provides overall goals and guidelines as well as aims, core content and knowledge requirements for the different school subjects. This national goal steered system thus devolves significant responsibility for the organization of education to the school and its teachers. For example, teachers are responsible for designing classroom practices, developing teaching materials, choosing textbooks (there are no sanctioned or authorized textbooks), as well as assessing and grading student performance. In short, teachers make decisions on how to attain the goals stated in the national curriculum and syllabuses. Schools and teachers may, therefore, plan the teaching of science, mathematics and technology in very different ways. According to Carlgren (2009), decentralization and transfer of responsibility to the municipalities, individual schools and teachers have created incalculable local variation in teaching practices.

According to the Swedish national curriculum, schools and teachers in Sweden are supposed to cooperate with external actors. The curriculum for compulsory school states that teachers should 'assist in establishing contacts with schools that will be receiving the pupils, as well as with organisations, companies and others who can help enrich the school's activities and establish it in the surrounding society' (Swedish National Agency of Education, 2011, p. 19). Along with the national curriculum, there are laws dealing with advertising in general, and advertising aimed at children specifically. The Swedish Consumer Agency provides specific guidelines about marketing aimed at children and young people. In cooperation with The National Agency of Education, and the Association of Local Authorities, the Swedish Consumer Agency provides a short document dealing with sponsorship in schools (The Swedish Consumer Agency, 2004). This document is intended as a guide for writing local policy documents concerning this, and potential conflicts are highlighted in the text:

The sponsorship must not conflict with the values of school legislation, and requirements of factuality and comprehensiveness. It must also not conflict with the principle of objectivity and the principle of equality. One must also, especially when it comes to compulsory school, remember that there is an obligation to attend school which means that children and adolescents cannot choose to avoid the impact that a sponsored message may imply (p. 2, our translation).

Thus, on a policy level, there is an expressed awareness of the need to evaluate both the educational value and the potential impact that a sponsored message may carry.

The Swedish context provides an example of how a decentralized national educational context—where teachers and local school governors have significant freedom and responsibility—may function as an arena for governing education through partnerships between schools and external actors. In other national contexts, the arena for governing education open to external actors may be more restricted (for example, with regard to providing teaching materials). However, as described below, several of the industrial actors active in the Swedish national context are also active transnationally and globally.

### ***Industrial actors and STEM resources in the Swedish context***

In Sweden, STEM initiatives are launched through a variety of industrial actors and networks of industrial and other actors. Sometimes initiatives are initiated by a single company but in many cases, industrial actors engage in complex networks where other industrial actors as well as academia and different levels of government are involved in joint initiatives. One example of a partnership between different industrial actors is a science centre called *Molekylverkstan* (in English, The Molecule Workshop) which is owned by five large chemistry companies. Another example of an industrial initiative relying mainly on public funding, is a group of three companies jointly operating an upper-secondary technical charter school. This phenomenon of interweaving



private and public funding underscores the importance of scrutinizing what interests the industrial initiatives serve. Thus, situations where external actors are involved in education in Sweden appear similar to what Ball and Junemann (2012) identified in England with respect to the emergence of network governance at work in education.

Sometimes collaborations are local, as is the case in the collaboration around the charter school above, while in other cases collaboration is enacted on a national, European or global level. There are also examples of industrial actors in the form of business and employers' organizations which engage in STEM initiatives. For example, the business organizations for both the chemical industries and engineering companies in Sweden provide different STEM resources for students and teachers. In many cases, the industrial actors work together with public actors. Sometimes these kinds of collaborations are direct collaborations with public schools. For example, a metals company collaborates with an upper secondary school by providing a set of local courses constituting a local company profile at the local public school. Another example of a complex network where industrial actors, university and/or diverse government bodies (European Commission, EC and local municipalities) engage in joint partnerships is the Ingenious project—a collaboration platform provided by the EC where multinational companies work with smaller-scale companies to produce STEM education resources ranging from teaching activities (lesson plans, teaching activities, games, etc.) to teacher professional development. Yet another example is the First Lego League. This project was founded by a US-based foundation (FIRST) with the Lego Group. In addition, there are several global sponsors of the First Lego League. Locally, the First Lego League involves collaboration with local industries, universities and provincial government. These are but some examples of how private, industrial actors work with different levels of government, as well as with publicly funded universities. The actor networks at play in industrial STEM initiatives in Sweden point, in a similar vein to the findings of Ball and Junemann (2012), to the emergence of new types of hybrid actors in educational governance where public and private spending (and potentially also ideas) are blurred and interwoven.

**Table 1.** Categorization of resources

	Inside formal STEM-education	Outside formal STEM-education
<b>Directly targeting students</b>	- Upper-secondary school/ programmes with industrial profiles	-Summer school and extracurricular course
	- Workplace practicum programme	-Competition
	- Home-work assistance	-Information material about industrial sectors/industrial careers
	-Teaching resource	-Exhibitions at science centers and other public spaces
	-Field/theme day	<b>DIRECTLY and OUTSIDE</b>
	-Competition	
	-Information material about industrial sectors/industrial careers	
	-Engineers as role-models	
	- Exhibition	
	-Science center	
<b>DIRECTLY and INSIDE</b>		
<b>Indirectly targeting students, e.g. through targeting teachers and other professionals</b>	-Teacher professional development	-Sponsoring of science centers, organizations and specific activities
	-Quality labeling of public upper-secondary schools	-Lobbying/network for industrial actors' exchange of experience of STEM-initiatives
	<b>INDIRECTLY and INSIDE</b>	<b>INDIRECTLY and OUTSIDE</b>

The industrial actors use a range of resources (e.g. teaching materials, competitions, exhibitions) when they engage in STEM education. Table 1 provides an overview of the different types of resources. The resources used by industrial actors target diverse groups, such as students, teachers, and other professionals, and are used in different educational practices inside and outside formal STEM education. The resources targeting students directly inside formal STEM education settings include, for example, industry-run charter schools. Charter schools are common in Sweden and the industry-run schools claim to prepare young people for both engineering careers and vocational careers relating to a specific sector or even a specific company. Other resources targeting students in formal STEM education are homework assistance programmes, field days, hands-on activities for schools, student competitions, and so on. The resources targeting students indirectly via teachers and other educational professionals include teacher professional development programmes and quality-labelling of public upper-secondary schools (ensuring that the students graduating from a school will meet future demands of specific competency). Likewise, some resources outside formal STEM education target young people, directly or indirectly, such as summer schools, extracurricular courses and competitions. A more indirect approach includes the resources used for industrial sponsoring of science centres and particular activities (e.g. competitions) and lobbying of school policymakers. Some resources such as competitions and exhibitions are potential resources inside as well as outside formal STEM education and may target students both directly and indirectly (via professionals).

### **Data collection and analysis**

We analysed web materials wherein industrial actors describe their STEM initiatives. These webpages evolve over time as various resources, as well as the actors themselves, change and evolve, so we needed to limit data collection to a specific time period. For this study our material consisted of webpages describing industrial initiatives targeting young people in Sweden between 2013 and 2014. The materials were downloaded during this time. Web materials were selected in three steps. The first step involved Internet searches for industrial initiatives by different industrial actors and collaborations. The second step was to use a governmental investigation of STEM initiatives in Sweden (*Teknikdelegationen*, 2010)<sup>2</sup>, as a cross-reference. This survey enabled us to identify additional actors and initiatives that did not surface in the initial Internet searches. The third step, which was conducted parallel to the first and second steps, was to use snowball sampling (cf. Bryman, 2008). As many industrial STEM initiatives turned out to be set-up in networks of industrial actors we could use information about the actors involved in one initiative and then, through continuing investigations, find other initiatives that the actor was involved in. For example, we found that the initiative X was supported by actors A, B and C. C was new to us and by searching the web pages of actor C we found that actor C was also involved in initiative Y, which also involved actor D, and so on. Our data eventually consisted of 25 actors describing and providing reasons for their engagement in STEM initiatives. The actors included single companies<sup>3</sup>, business and employer organizations, and networks of corporate actors.

The primary object of analysis is interpretative repertoires (Potter, 1998). In the data, we looked for patterns in the descriptions of and rationales for the industrial STEM initiatives. We focus on the variations within the accounts of a single STEM initiative by a single industrial actor, as well as across accounts of different initiatives by different actors. The authors collaborated closely during the analysis. It began with a repeated reading and re-reading of the webpages in order to develop in-depth familiarity with the material as a whole. After this, the coding process began, which involved

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<sup>2</sup>*Teknikdelegationen* [in English the Technology Delegation] was appointed by the Swedish Government in the fall of 2008 to promote greater interest amongst children and young people in mathematics, science, engineering and ICT. Along a governmental investigation, there are several reports from the work of *Teknikdelegationen* including a report giving an overview of STEM initiatives in Sweden.

<sup>3</sup>The names of single companies have been removed and replaced with generic labels.

identifying specific descriptions of and reasons for their engagement in STEM initiatives. On one webpage, an actor could provide a range of different reasons for their engagement, that is, draw on several different repertoires. These utterances were coded into tentative categories and then revised. The coding included identifying, naming, categorizing and describing repertoires found on the webpages, within and across different cases. The naming of the discursive repertoires is primarily descriptive in character with the aim of making the data intelligible. Through constant comparison, properties for the categories were developed, integrated and reorganized until they became stable (cf. Glaser & Strauss, 1967). During this process the names of categories evolved, so that the final names reflect the properties of the categories.

The analysed data included webpage material and due to this only the public justifications that the actors made available on these pages were part of the analysis. Thus, more private or opaque rationales concerning why the actors engage in STEM initiatives are not the subject of analysis. For example, when an energy company launches an initiative in the form of a teaching resource on energy and sustainability, they write that they want to 'raise the level of knowledge about energy issues in interaction with sustainable development'. This public justification of the initiative constitutes a means for the energy company to express itself in ways implicitly shared by others (Hsu et al., 2009). However, the initiative as such may also function as a means to improve the public image of the energy company, as the company positions itself as a company that takes sustainability challenges seriously. Thus, there may well be additional, private rationales concerning why an actor decides to launch an initiative that are not communicated in the public sphere, but these are not scrutinized in this study. Making such private rationales available for analysis would require other forms of data collection.

## Results

In the results section, the interpretative repertoires are presented in the form of seven categories, illustrated by excerpts from the webpage materials. In most cases, the web materials were not written in English and the excerpts have been translated during the study. Industrial actors make use of a range of repertoires when justifying their engagement in a specific STEM initiative or resource. In this section, we provide an account of different interpretative repertoires and give examples from the analysed web material. The repertoires were:

- (A) Securing competent labour
- (B) Securing economic growth
- (C) Improving the public image—marketing
- (D) Contributing to a bright future
- (E) Increasing interest in STEM
- (F) Increasing knowledge in and of STEM
- (G) Empowering young people

For an overview of the repertoires drawn upon by the various actors see [Table 2](#). [Table 2](#) illustrates that actors draw on a combination of repertoires and that the most frequently drawn upon are Securing competent labour and Increasing interest in STEM.

### ***A. Securing competent labour***

The *Securing competent labour* repertoire refers to STEM initiatives as a means of recruiting competent young people—now or in the future. Thus, when using this repertoire, the industrial actor describes the engagement in a STEM initiative as a means to find or train a new workforce. The rationale for this repertoire is that industrial actors need to secure a future STEM workforce and, to some degree, that this workforce should have certain qualities in terms of skills and competencies.

**Table 2.** Overview of actors and the repertoires drawn upon.

Actors	Repertoires						
	(A) Securing competent labour	(B) Securing economic growth	(C) Improving the public image— marketing	(D) Contributing to a bright future	(E) Increasing interest in STEM	(F) Increasing knowledge in STEM	(G) Empowering young people
<i>Single companies</i>							
Automotive industry	X	X			X		
Chemical manufacturer			X		X	X	
Chemical manufacturer					X	X	
Chemical manufacturer			X		X		
Energy company	X		X	X	X	X	
Energy company				X		X	
Energy company	X				X	X	
Global computer company	X			X			
Global Internet company				X			
Mining company	X						
Mining company	X	X	X		X	X	
Nuclear Fuel and Waste Management Company					X		
Pharmaceutical company	X	X		X	X		
Telecommunications company	X				X		X
<i>Business and employers' organizations</i>							
The Innovation and Chemical Industries in Sweden	X	X	X		X		
The Forest Industry	X	X	X		X	X	
The Engineering Companies	X	X			X		
A trade and employers' association	X					X	
The Confederation of Swedish Enterprise						X	
Regional chamber of commerce	X					X	
<i>Network of corporate actors</i>							
European Roundtable of Industrialists	X	X			X	X	X
the First Lego League	X			X	X	X	
<i>InGenious</i>	X	X			X		X
Academy of Engineering Sciences	X	X					
The International Telecommunication Union	X						X

One example of how this repertoire is used is when a mining company describes its engagement in an upper-secondary school (a school with what is called a company profile): ‘The reason for our involvement in this upper secondary school programme is that we want to secure our long-term talent pool’. In this quote, the company frames its engagement in the upper-secondary school in terms of a need to secure access to skilled employees in the future. In the example, the repertoire is related to the specific needs of the single industrial actor—the single company in need of skills supply.

The repertoire is sometimes used more generally, not coupled with the needs of a specific company, organization or sector, but related to securing the future STEM workforce in general. For example, an energy company justifies its sponsoring of and engagement in a regional competition in mathematics and logic for secondary school students by stating that they want to ‘contribute to regeneration in the areas of science and technology, as interest in these subjects has declined’. Thus, engagement in STEM is justified in terms of enabling a broad recruitment base in the future.

One aspect of the repertoire *Securing competent labour* concerns the notion of access to the ‘right competence’. On the webpage of an upper-secondary school run by an automotive industry one of the school’s ambassadors (who is a site manager at the automotive company) describes his expectations of the upper-secondary school:

... students are well prepared to meet a desired requirement profile, for example when it comes to competence to run machines and maintain our equipment. [...] We expect that the [company] upper-secondary school will continue to be an important supplier of competent workforce to the company.

The rationale is that STEM initiatives provide the means to ensure that young people develop specific skills or competences that are important for the future STEM workforce, in both a narrow and broad sense. The narrow sense is related to the need of a specific company or a specific business organization, as in the example above. Another example is from a pharmaceutical company that describes its engagement in an upper-secondary charter school, run in collaboration with a group of local industrial actors:

The primary purpose of the initiative is to, through education, find skilled employees that we as a company need for our future development.

In this example the need for competence and employees is stated in direct relation to the company’s need for skilled employees in the future.

The broader sense of securing competent labour may be exemplified in how the organization FIRST writes about the aims of the Lego League project (a tournament for teams of kids aged 10–16 involving problem-solving via programming of Lego-robots) as ‘[to] teach them [young people] valuable employment and life skills’.

Securing access to the right competences is, in some cases, coupled with a deficit perspective on school and teaching; presuming that the industry needs to compensate for teaching not being good enough. One example is when an industrial business organization explains their engagement in STEM initiatives:

To companies who want to invest and produce in Sweden, access to the right competences is an important factor. Without a functioning school with good teaching in Science and Chemistry, Sweden will lose out. Therefore, [the business organization] invests in school.

Coupled with a deficit perspective on schools is an expressed need for industrial actors to influence and control education. Another example is how a business organization, representing Swedish engineering companies, describes their engagement in the quality label ‘*Teknikcollege*’ [Technical College], which is a certification for upper-secondary education:

The goal is that future corporate employees have the competencies needed in a global market. For the students, *Teknikcollege* means attractive technical programmes leading to employability in our member companies and preparation for further studies [...] *Teknikcollege* provides technical/technological companies with the

opportunity to participate in the control of educational programmes so that they will meet the companies' future demand for competency.

In this quote, the need for future employees is underscored together with an expression of employability. They also reinforce the notion that engagement with *Teknikcollege* will allow member companies to influence the curriculum to secure the right competencies in relation to their specific future needs. Similarly, a regional chamber of commerce states, in relation to their engagement in a regional competition on mathematics and logic for secondary school students, (the same competition as the one referred to by the energy company above) that:

[s]chool is probably the most important supplier to companies. We work to assure that quality in schools corresponds to the needs of trade and industry, from compulsory school to universities.

Here, the actor justifies the engagement in a specific STEM initiative by referring to the school as a supplier and the initiative as part of their work to assure quality in relation to their needs.

In summary, the *Securing competent labour* repertoire frames STEM initiatives as a means to secure competent labour with relevant skills for the industry in the future (for a specific company/sector or for STEM in general). The repertoire includes explicit references to engagement in STEM initiatives as a quality assurance mechanism and as a desire to influence education to better suit the actor's needs. The repertoire is also an example of how market principles are being applied to education—industrial engagements in STEM education initiatives are justified by references to so-called human capital arguments (cf. Spring 2015) where the educated workforce is referred to as an asset and schools as suppliers (or subcontractors) to the industry. This line of reasoning emphasizes the teaching of skills needed in the workplace and becomes particularly explicit in the Swedish context of industry-owned charter schools, upper-secondary school programmes tailored to the needs of a specific company or sector, and the quality label aimed at ensuring that education 'meet[s] the companies' future demand for competency'.

### **B. Securing economic growth**

The second repertoire, *Securing economic growth*, also draws on human capital arguments with the difference being that it frames industrial STEM initiatives as a means to secure economic growth and prosperity of the country or region.

The European Round Table of Industrialists (ERT) is a forum of leaders of major companies in Europe that has as its core mission to 'promote the competitiveness of European industry'. In a report on Mathematics, Science and Technology (MST) Education, ERT writes:

Education has long been acknowledged as the cornerstone of Europe's success and will continue to be a determining factor in the prosperity of Europe's citizens and economy for the foreseeable future. [...] ERT decided to explore ways of increasing young Europeans' interest in MST education and careers with the ultimate aim of advancing Europe's competitive position.

Here, it is not the needs of a single company nor an industrial sector that are used to account for engagement in STEM education, but rather the wider perspective of economic growth for the sake of Europe with the 'ultimate aim of advancing Europe's competitive position'.

Another example, also from a European context, comes from the *inGenious* project. The *inGenious* project was a strategic partnership in the form of a consortium between major industrial companies, industry associations, public bodies and universities within the European Union. It focuses on youth unemployment and the need for growth as a background for the engagement in STEM initiatives. On one of the project websites engagement in STEM education is seen in relation to a wish to 'drive growth' (in this case in the larger EMEA region):

The EMEA region (Europe, Middle East and Africa) shares common challenges as youth unemployment, and need for new skills to reinvigorate the job market and drive growth in the region. Investing in STEM education is of the outmost importance to address them.

Both the report from ERT and the *inGenious* project represent examples of how industrial actors participate in educational policymaking on a European policy level and justify their engagement by drawing on arguments about global competition.

The repertoire of *Securing economic growth* for the country or region is also mobilized nationally and locally in relation to specific STEM initiatives. For example, when a pharmaceutical company provides a rationale for their engagement in running a charter technical upper-secondary school they write:

The school also has a mission from a broader perspective—Sweden has been able to build a series of companies with good technology and has signed up thousands of high-quality skilled and dedicated technicians and engineers. Several of the companies became world famous and still provide Sweden with a strong economy, which is the very foundation of our prosperity.

In this quote, the company draws on a combination of the repertoires *Securing competent labour* and *Securing economic growth* by claiming that access to a skilled workforce, as provided by the technical charter school, constitutes a foundation for national prosperity. Here, the industrially owned technical charter school is justified, not just in relation to the needs of a specific sector of industry or a specific company, but in relation to higher purposes of national prosperity.

Another example, from a mining company situated in the northern part of Sweden, illustrates how the repertoire *Securing economic growth* may be drawn upon in local contexts. They write that their ‘ambition is to be a catalyst for development in the region and contribute to the entrepreneurial abilities of children and young people’. This ambition is to be achieved by ‘giving exposure to technology and enterprises in the regional industry, projects that provide professional development, networks and materials for teachers in [the region’s] schools, and a lot more’.

In summary, this repertoire is used when actors conceptualize their initiatives as a means to secure economic growth and prosperity on a local, national or transnational level in comparison to and in competition with others. Here, STEM education is framed as a ‘key competitive asset’ (cf. Verger et al., 2018). The repertoire builds on assertions of relationships between education and economic growth within a rhetoric of STEM education investments and global economic growth; a rhetoric that has also permeated engagement in education by non-industrial actors such as the OECD, the World Bank and the World Economic Forum (Spring 2015).

### **C. Improving the public image—marketing**

The marketing repertoire refers to actors justifying the engagement in STEM initiatives as a means to increase awareness of and/or improve the image of a single company, or a group or branch of companies working in a specific STEM sector. In line with the definition of marketing by the American Marketing Association (2013), marketing commonly refers to ‘the activity, set of institutions and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners, and society at large’. In relation to STEM initiatives, this means that actors motivate engagement in STEM initiatives in terms of raising the profile of the company/sector in the public mind and thus increasing the value of a specific company, a specific sector, or products produced by them.

One example is when an energy supply company writes about a competition for lower-secondary school students on future energy supply solutions. The competition involved making two-minute films about the needs and supply of energy in the future. A Corporate Sustainability manager makes the following statement on the website:

This competition has been a way to create interest in the energy sector among young people, and how we create a sustainable society together. That [the company] is a natural part of young people’s consciousness when we talk about energy and sustainable solutions, creates a value for us, both now and in the long term

Here, the marketing is directly related to the profile and standing of the company as a company associated with ‘sustainable solutions’ and the creation of student interests. A similar example is

a paint and chemicals company drawing on the marketing repertoire when describing its engagement in the initiative 'Kemins år' (in English International Year of Chemistry). The International Year of Chemistry was part of the United Nations' decade for sustainable development and an initiative of the United Nations (see [www.chemistry2011.org](http://www.chemistry2011.org), an international website intended as an 'informational resource for students, educators and the self-taught in the field of chemistry'). The paint and chemicals company writes on their webpage that their engagement was motivated by a striving to contribute to solving the Earth's problems (a statement that is categorized as the repertoire *Contributing to a bright future*), but they also state: 'Finally, we want to increase awareness of [the company] in Sweden and the Nordic region'. Thus, the industrial actor draws on the repertoire of marketing to justify their engagement in the STEM initiative. The initiative becomes a means of associating the company with values of sustainability and responsible action.

Marketing is also used as a repertoire in relation to STEM sectors. One example is when a manufacturer of petrochemicals describes their engagement as one of five owners in a science centre that aims to:

Demonstrate the role of the plastics and chemical companies in society by presenting production, products, applications, research and development, the development of society and historical recapitulations.

In the above quote, the role of 'plastics and chemical companies' and their products for society are emphasized, thereby marketing an industrial sector rather than a single company. In a similar example, the business organization for the forestry industry states in a yearly report on their initiative 'The Forest in School' that one of their goals with the initiative is that: '[t]he target groups are to view the forest as a renewable resource, forestry as sustainable and the forestry industry as an important and valuable industry for Sweden'. In this example, the actor positions itself as a promoter of Sweden, representing a valuable sector (the forestry industry), and expresses aims of communicating/transferring such views of the forestry industry to target groups.

In summary, industrial actors drawing on this repertoire frame STEM initiatives as an arena for marketing; as an arena for launching initiatives that will create value for specific companies (e.g. the positioning of an energy company as an actor providing sustainable solutions) or whole sectors (e.g. the important role of 'plastics and chemical companies' or of the forestry industry). Thus, this repertoire is yet another example of how industrial actors use an economically grounded repertoire (in addition to the repertoires *Securing competent labour* and *Securing economic growth*).

#### **D. Contributing to a bright future**

The repertoire *Contributing to a bright future* expresses a rationale for industrial STEM initiatives and engagement in terms of contributing to a better world—a 'bright future'. In our analysis we find that actors drawing on the Contributing to a bright future repertoire conceptualize 'a bright future' in different ways, focusing on different aspects of life. One example is how a global Internet company describes a science competition they host:

Just curious: why is [the company] hosting an online science competition? We believe that universal access to technology and information can truly make the world a better place. We also believe that the need for access to useful information transcends all borders. That's why we created it [the science competition]: to champion young scientific talent and give students across the world an opportunity to showcase ambitious ideas.

Here, the company justifies the initiative as an act of altruism and as a way of 'truly mak[ing] the world a better place'.

'The bright future' is often conceptualized in relation to sustainability and environmental issues. One example of the use of this repertoire is when a global computer company describes its engagement in an Internet tutoring project for secondary school mathematics students:



Our community commitment is based on the philosophy that people can accomplish amazing things if they have access to the resources they need. In cooperation with several organizations and associations, we provide resources that help people and improve the environment. By using technology as a positive force, we want to facilitate learning and make our society a little better.

In the example, positive markers such as ‘amazing’ and ‘positive force’ are used and the company positions itself as one which provides resources to improve the environment and make society better. A similar example is when an energy company justifies its engagement with a competition for ninth grade students:

We [the company], together with partners and future generations, want to lead the development of a sustainable society. If resources are to be sufficient for everyone in the future, we need to find new energy solutions and consume smarter. We believe in today’s young people and therefore want to let them join in creating the energy solutions of the future.

In summary, the repertoire *Contributing to a bright future* builds on altruistic justifications for engagement in STEM initiatives. However, this ‘altruistic’ rationale is sometimes associated with the business area of the company, such as in the example of the global computer company above. In line with this, it is not uncommon for actors to use the bright future repertoire in combination with economically oriented repertoires A–C (see Table 2). Thus, the repertoire *Contributing to a bright future* appears plastic enough to accommodate different levels of ‘altruism’, including agendas that couple a bright future with the economic growth of the company. Thus, the repertoire might function as a boundary repertoire which can be used across discursive practices in which different types of actors are involved.

### **E: Increasing interest in STEM**

Using this repertoire, the actors justify their engagement in STEM initiatives as a way to increase interest in STEM; either in terms of a general, unspecified interest in STEM, or directly related to a specific domain of STEM. There are many examples where initiatives are framed within this repertoire by industrial actors. One example is a pharmaceutical company describing their engagement in a summer school using the *Increasing interest in STEM* repertoire:

[The company]’s Summer Research School is organized this year by the Federation of Young Scientists as one of the initiatives [the company] is launching in order to encourage interest in science and technology among young people.

Also, a nuclear fuel and waste management company—engaged in a range of school projects such as digital text book resources on technology and ethics, films, a study-visit programme and a theatre project—writes about their aim to increase a general interest in science and STEM education: ‘The goal is to increase interest in technology and energy, and inspire people to continue studying’. Another example is an industrial business organization—engaged in producing teaching resources and arranging theme or field days (school days dedicated to a specific theme or field visits)—that writes about its engagement in STEM as a ‘broad range of investments in increasing interest in chemistry and studying science’. In the above examples, the repertoire is used in a general way in relation to whole science areas. However, in other cases, the increased interest in STEM is focused on a specific domain of STEM. For example, the forestry industry writes that they seek to achieve an increased interest in forests, an energy company writes that it seeks to increase interest in energy and sustainability and an industry-owned science centre writes about arousing interest in ‘... chemical reactions, products and materials used in everyday life which originate from plastics and chemical companies’. In these cases, the repertoire *Increasing interest in STEM* is tightly coupled with the specific domain of the actor’s industrial activity.

Sometimes, the Increasing interest repertoire is also used as a rationale for achieving other aims. For example, an industry-owned science centre draws on the *Increasing interest in STEM* repertoire as a means of creating better conditions for a sustainable future: ‘Our challenge is to awaken interest

and thereby create better conditions for a sustainable future by stimulating increased knowledge in science, mathematics and technology'. Here the repertoire *Increasing interest in STEM* is used together with the *Contributing to a bright future* repertoire. There are also a few examples where the repertoire is used in combination with the *Securing Competent labour* repertoire. For example, an automotive company describes its engagement in projects aimed at 'raising young peoples' interest in technology and science subjects and getting more young people to see the opportunities in the industry'. The background to the projects is this:

Swedish industry is facing an important challenge. We will have a great need to recruit competent staff who meet the high knowledge requirements of modern industrial production. At the same time, we find it increasingly difficult to attract young people. Too few young people see a future in the industry.

Here the *Increasing interest in STEM* repertoire is used in relation to careers in STEM and in combination with the *Securing competent labour* repertoire.

In summary, using the *Increasing interest in STEM* repertoire, industrial actors justify their engagement in STEM initiatives in relation to a need to increase young people's general interest in STEM or increasing interest in areas more directly coupled with a specific domain or career. The possibility of using the repertoire in a general way (in relation to STEM at large) or in relation to specific domains (directly coupled with the operations of a company) contributes to making the repertoire plastic. The repertoire is easily combined with the *Securing competent labour* repertoire and other economically permeated repertoires such as *Marketing* (e.g. to arouse interest in products originating from chemical companies), but also with, for example, the *Bright future* repertoire. Thus, reasons as to why the industrial actors state that they want to increase interest in STEM could well be coupled with different agendas. This indicates that the *Increasing interest* repertoire is plastic enough to be able to include potentially contradictory agendas. Thus, the repertoire could function as a boundary repertoire.

#### **F. Increasing knowledge in and of STEM**

This repertoire refers to when actors argue for their engagement in STEM initiatives as a way to increase knowledge in and of STEM. The repertoire typically focuses on a specific domain related to that of the industrial actor. One example is when an energy company developed an e-game called [the company] Energy Game, which is a teaching resource developed for secondary schools. The company writes: '[The company] Energy Game is intended as a teaching tool for the nation's secondary schools in order to raise the level of knowledge about energy issues in interaction with sustainable development'. The energy company also states that they want to increase knowledge of the complex reality that we live in and that 'increasing knowledge about energy is incredibly important to us'. The energy game is but one of many resources developed by energy companies that is motivated with references to the need for increasing public knowledge of energy specifically (cf. Andrée et al., 2018). An example from a different domain of STEM comes from a chemical manufacturer. The chemical manufacturer is engaged in an initiative called the water school and describes the aim of the resource as providing an opportunity for '... children and young people who can learn more about how we use water in everyday life'.

In some cases, the aim to increase knowledge is justified with respect to the public view of an issue as somehow distorted or false. For example, the Confederation of Swedish Enterprise writes about an aim of one of their teaching materials (a booklet on environmental issues) as '... to provide a good orientation about the environment and environmental debate and hopefully dispel some myths and misunderstandings'. In other words, the initiative is motivated as a means of correcting the public view on environmental issues (from the industrial actor's point of view) by means of school science. Another example of this is a booklet about plastics produced by Innovation and Chemical Industries in collaboration with *PlasticsEurope* (a European trade association for plastics manufacturers) that formulates one of its aims as '[c]reating educational resources to provide fact-

based information and to correct misconceptions'. Correcting misconceptions could appeal to the common good of education, but such statements might simultaneously carry specific agendas in relation to the private good, aligned with the interests of the industrial actors (such as marketing the plastics industry).

Within the repertoire *Increasing knowledge in and of STEM*, there are also examples where the repertoire is used in relation to knowledge that is not directly connected to the domain of the actor. For example, a regional chamber of commerce and industry organizes a mathematics competition, which aims at '... promoting the development of mathematical skills and logical thinking among Swedish youth'.

In sum, the industrial actors drawing on the repertoire *Increasing knowledge in and of STEM* justify their engagement in STEM initiatives by pointing to a lack of knowledge or ability (for example, logical reasoning) in young people. Mostly, the knowledge in focus is closely related to the respective enterprises. In some examples concerning environmental issues, initiatives are justified in relation to a perceived need for correcting public misunderstandings. On other occasions, the repertoire is used more generally—increasing knowledge in science generally. Thus, similarly to the *Increasing interest in science* repertoire, this repertoire could function as a boundary repertoire. Different actors would easily agree on the importance of increasing knowledge as something good. However, the increase in knowledge could mean different things and be coupled with different agendas for different actors. For example, correcting misconceptions and contributing with knowledge might mean two very different things to an industrial actor (such as the plastics industry) and an environmental organization.

### **G. Empowering young people**

Using this repertoire industrial actors justify their engagement in STEM initiatives in terms of a need to empower young people. For example, the *InGenious* project aims to 'improve the image of STEM careers among young people and encourage them to think about the wide range of interesting opportunities that STEM can bring to their lives in the future'. Here, the initiative is framed as a means to expand how young people think about career opportunities in STEM. In a similar vein, the European Roundtable Industrialists write in a report that businesses can help young people overcome limits and barriers:

As a result too many young Europeans opt out of MST [Mathematics, Science, Technology] subjects at an early age. Not only is this exacerbating the shortfall in MST graduates, but it limits their options, creating barriers for them [young people] in the future. It is here that business can play a critical role, specifically explaining how business operates.

When using the repertoire of empowerment, industrial actors most often draw on the fact that STEM is, and has been, a gender-biased area. The backdrop of the report from the European Roundtable Industrialist is that '[t]here is a significant gender issue in the MST area, with an insufficient number of girls taking up or being encouraged to take up these subjects'. Another example is when the International Telecommunication Union<sup>4</sup> (ITU) writes about the initiative *Girls in ICT*, which is a -theme day aiming at providing young girls with first-hand insights into the ICT-sector. The ITU states that they seek to 'raise awareness on empowering and encouraging girls and young women to consider studies and careers in ICT' as well as 'raise awareness about the opportunities of the ICT sector and empower girls and young women with the knowledge that careers in ICT can be for them'.

The repertoire of empowerment is often used in combination with the repertoire *Securing competent labour*. One example of this is the initiative *Girls in ICT*, mentioned above, which curates a wide range of events organized by industrial partners across the world. ITU motivates *Girls in ICT* in relation to potential corporate partners with the following:

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<sup>4</sup>ITU is the United Nations agency for information and communication technologies.

You will be contributing to the expansion of the female labour market . . . a measure to avoid future challenges in employing women for ICT-related positions. Being part of this initiative will give you the chance to play an active role in enabling future workforce diversity.

The initiative is presented as ‘a measure to avoid future challenges’ of employment for the industry. When a telecom company writes about their engagement in Girls in ICT they focus on the initiative as a means for the company to expand the workforce to include more women:

[The company] believes in diversity in all aspects of our business, and our ambition for 2020 is to have one third of our organization made up of women. We also have more long-term initiatives such as participating in Girls in ICT to try to change the mindset among young people. . . . The Girls in ICT initiative at ITU is a global effort to raise awareness on empowering and encouraging girls and young women to consider studies and careers in ICTs.

Here the empowerment is coupled, not only with young people’s desires, but also directly with the company’s expressed need to expand their workforce to include more women.

In summary, using the *Empowering young people* repertoire, industrial actors justify their engagement in STEM initiatives in relation to a perceived need to empower young people to engage in STEM. The industrial actors especially emphasize the need to empower girls. This repertoire is frequently used by industrial actors, in combination with the *Securing Competent labour* repertoire (e.g. empowering girls to take on education and careers in the actor’s sector as a means to secure a diverse labour force in the future). However, the repertoire is also used in combination with the *Increase Interest in science* repertoire. The plasticity of the *Empowering young people* repertoire allows it to function as a boundary repertoire. For example, it might function in discursive practices where actors use the *Increase interest in science* repertoire (perhaps in combination with potentially citizen-oriented building blocks not used by the industrial actors in the web materials analysed in this study), but also in discursive practices that are permeated with economically oriented repertoires that justify STEM initiatives.

## Discussion

This article adds to the literature by highlighting the rationales used by industrial actors for engaging in STEM education initiatives targeting young people. We analysed web materials and described seven different repertoires that industrial actors typically draw upon. The repertoires should not be regarded as ‘truths’ in relation to why industrial actors engage in STEM education; rather, the repertoires must be situated in a discursive practice, as they function potentially both as means to legitimize engagement in STEM education and as a means to establish particular images of the actors. At the same time, the interpretative repertoires represent what industrial actors take for granted as shared interests/agendas and valid rationales. A specific repertoire could appeal to societal notions of (common) good in education, while simultaneously playing a role in the marketization of companies or industrial sectors in relation to the private good.

### *Repertoires permeated with economic language*

The industrial actors’ justifications for their engagement in STEM initiatives are permeated with economic expressions—‘school as supplier’, ‘demand of competencies’, ‘global markets’—mirroring the economization of education and application of market principles to education (cf. Spring, 2015). The economic language is most obvious in the repertoires *Securing competent labour*, *Securing economic growth* and *Improving the public image—marketing*. These three repertoires reflect market-based as well as modernistic and technology-optimistic agendas.

The repertoires *Securing competent labour* and *Securing economic growth* are based on an economic conceptualization of education. The uses of these repertoires align with the discursive shift that took place in the 1960s when education started to be referred to as an economic enterprise, framing education as an investment that would result in economic growth and increased

productivity (Spring, 2015). The concepts of human capital and expressions such as ‘shortage of manpower’ have contributed to the development of thinking about education as an economic activity. According to Spring (2015), the ideas about the economization of education regard knowledge and skills learned in school as ‘capital to be utilized in economic activity’ (p. 5). From this point of view, education should provide more efficient workers with the level of skills and knowledge needed to produce more than others (op cit).

The economic discourse of education is not only reproduced by corporate actors but also by governmental and policymaking bodies such as the OECD and other political actors who have come to talk about education and knowledge as ‘key competitive assets’ to raise economic competitiveness (Verger et al., 2018, p. 12). The economically formulated justifications provided for industrial actors’ engagement in STEM education thus echo a widespread educational policy discourse. In order to understand the enabling and legitimizing of industrial STEM initiatives, it is also important to take into account the discursive practices of non-commercial actors (including governmental and non-governmental organizations) as well as policy choices that might play a role in enabling and legitimizing initiatives (Simons, Lundahl & Serpieri, 2013a).

### ***Tensions between public and private good***

Several of the repertoires used by the industrial actors imply potential conflicts of interests and values. The most obvious example is the repertoire *Improving the public image—marketing*, where industrial actors justify their engagement in STEM initiatives with the explicit aim of influencing young people in a direction that would be advantageous for the industrial actor. However, also, examining the *Securing competent labour* repertoire we saw explicit examples of industrial actors justifying their STEM initiatives as a means to influence or control education in schools in line with the actor’s specific needs.

A broader overview of the repertoires demonstrates that perspectives relating to citizenship and democracy are only indirectly present as part of the repertoires *Contributing to a bright future* and *Empowering young people*. The repertoire *Contributing to a bright future* takes an optimistic approach to the possibilities of science in line with a discourse associating science with hope for the wellbeing and progress of society (technologically and economically), and the Earth (solving environmental problems) (cf. Hira, 2010; Wolfmeyer, 2013). However, critical perspectives, including the potentially negative consequences of science and technology to society and/or the environment are missing in the industrial actors’ discursive repertoires. Instead, the general public is addressed in relation to an expressed need to raise public awareness of the importance of STEM, as in the repertoire *Improving the public image—marketing*.

Similarly, the *Empowering young people* repertoire is most often used by industrial actors in relation to STEM careers and the expanding of students’ visions of future career opportunities. Attempts to integrate seemingly conflicting perspectives on growth (securing competent labour) and social responsibilities (empowerment of young people) align with research on how business negotiates conflicting perspectives in other social areas. For example, a study on sustainable fishing pointed to how international business actors seek to integrate conflicting perspectives on growth and corporate social responsibility relating to sustainability to create shared meaning on sustainability across different organizations (Cerne, 2011). By means of such integration, social issues of sustainability can be placed in a context of international trade.

The lack of a critical stance in relation to the field of STEM and the STEM industry validates the concerns raised by some scholars about the risk of a decreased emphasis on citizen perspectives in education with the increase of private sector participation (e.g. Robertson et al., 2012a). Thus, tensions between different aims of education, highlighted by Giroux (2019), Boyles (2005), and others, come to the fore when scrutinizing the repertoires used by industrial actors. These repertoires indicate that their school initiatives might be more aligned with some aims (e.g. preparing for future

STEM careers, and positive and uncritical attitudes towards science and technology) than other aims (e.g. preparing students for critical citizenship and/or activism).

The repertoire *Securing competent labour* builds on the rhetoric of ensuring that young people develop specific skills that are important to the industry. The repertoire aligns with the notion of 'skills gap' portrayed by major global institutions and businesses (Spring, 2015). Among the more extreme examples in this study, we found an industrial company publicly justifying its engagement as the owner of a for-profit charter school with reference to them needing to '... find skilled employees that we as a company need for our future development'. This example points to a predominance of private interests (finding employees) over public interests (e.g. general education for participation in a democratic society). The repertoire builds on an assumption that there is a need to expand the STEM workforce. This assumption has been critiqued, for example, in the US context by Hira (2010) who suggests that the need for an expanded STEM workforce is not as significant as has been anticipated (cf. Panizzon et al., 2014). The emphasis on skills amenable to the industrial actor is of great significance for educational governance since it threatens democratic—public—values. The importance of citizenship, social justice and critical perspectives on the role of STEM in society has been discussed in science and mathematics education literature (e.g. Bencze et al., 2018; Gutstein, 2012), but also in general educational literature where, for example, Girouz (2019, p. 149) argues that education should not be 'just about job training and product manufacturing' and that matters of civic engagement and democracy need to be emphasized as an ultimate objective.

The distinction between private and public good is not always clear-cut. Most classifications of public-private good in education are informed by economics and divisions between state and market, non-profit and profit (Robertson et al., 2012b). However, many public-private partnerships are cooperative institutional arrangements between public and private actors—developing joint products or services and sharing risks, costs and resources (*op cit*). In addition, education will always serve the public as well as private interests. Public interests include democracy, economy and society. Private interests include those of the individual student and family as well as for-profit business. Thus, there are no grounds to conclude that public and private interests are necessarily antithetical (Robertson et al., 2012b). However, this study, corroborates previous research (e.g. Cuban & Shipp, 2000; Robertson et al., 2012a), which shows that contributions to the governing of STEM education from industrial actors (and others) imply tensions between different interests and values. One example in the broader field of education is the study by Molnar et al. (2008), which illustrates how the mission of the school and curricular aims may conflict with the interests of external actors. Molnar and his colleagues showed how American primary schools allowed marketing programmes that could contribute to the obesity problem, in contrast to official school policies that focused on fighting obesity. Our results point, in a similar vein, to tensions that may emerge between private and public good when education opens up to external actors. This may be regarded as problematic in light of the overall purposes of education in a democratic society.

### **Boundary repertoires**

It is perhaps not surprising that market-based, modernistic and technology-optimistic agendas are put forward by industrial actors to justify the engagement in STEM initiatives. More surprising, perhaps, is that these kinds of repertoires may become successful in communicating with governmental actors, individual schools and STEM teachers. However, when looking at the repertoires, we find, perhaps not surprisingly, that the industrial actors also draw on the repertoires of *Increasing interest in STEM* and *Increasing knowledge in and of STEM*. These repertoires are, in general terms, in line with repertoires used by governmental actors in curricula and other policy documents (cf. Andrée & Hansson, 2013).

We have suggested the notion of boundary repertoire, building on Leigh Star and Griesimer's (1989) notion of boundary object. In this study, the plastic properties of the *Increasing Interest in STEM* repertoire have been particularly pertinent, but the repertoires *Increasing Knowledge in and of*

*STEM, Contributing to a bright future* and *Empowering young people* may also be conceptualized as boundary repertoires. Boundary repertoires, across discursive practices and intersecting social worlds such as industry, local government and schools, afford industrial actors the opportunity to speak to a varied audience including shareholders, policymakers and teachers. Thus, the notion of boundary repertoires helps to make visible how repertoires may integrate conflicting perspectives and function to achieve agreement across different organizations and actors on a STEM initiative.

The use of these boundary repertoires across discursive practices may be understood in light of overarching discourses of a 'STEM crisis' (Mansfield et al., 2014; Panizzon et al., 2014) and 'science as saviour' where science is positioned as the solution to many of today's problems (Hira, 2010; Wolfmeyer, 2013). These discourses function to legitimize the involvement of industrial actors in STEM education and enable the repertoires *Increasing interest in STEM*, *Increasing knowledge in and of STEM*, *Contributing to a bright future* and *Empowering young people* to function as boundary repertoires. These repertoires might thus accommodate both neoliberal and citizen-oriented, critical agendas, thus contributing to the plasticity of the boundary repertoires. The plastic properties of the boundary repertoires enable them to open up education governance arenas for industrial actors.

### ***A decentralized school system open to outside influences***

The restructuring of the Swedish education system—where much of what had historically been decided on at a central level was left to local schools and teachers to decide—has implied increased local variations on matters such as school economy, teacher working conditions and segregation of the student body (Carlgren, 2009). Carlgren (p. 647) writes that the school system as a consequence has been '... destabilised and more open to outside influences'. In this educational landscape, the materials and out-of-school activities provided by external actors may function as a way for teachers to deal with shortages of funding in the local school and constraints to buying teaching materials and/or taking their students on costly excursions outside school.

In the Swedish education system, the primary responsibility to deal with the tensions between private and public good in industrial STEM initiatives rests with the local municipality or owner/organizer of a charter school, the school and the teacher. In Sweden today, the National Agency of Education provides a short document dealing with sponsorship in schools, intended as a guide for writing local policy documents in municipalities. The policy states: 'Education shall be objective and balanced. All parents should feel confident to send their children to school assured that they will not be prejudiced in favour of any particular view or another' (p. 3). At the same time, the national curriculum emphasizes cooperation with society as an inherently positive and necessary condition for providing good education. Thus, curriculum policy on a national level contributes to the enabling and legitimizing of industrial STEM initiatives. The national curriculum for compulsory school states:

Pupils should receive an education of high-quality in the school. They should also obtain a foundation for making choices in their further education. This presupposes that the compulsory school works closely with the upper secondary school pupils. It also presupposes close co-operation between working life and the local community in general. (The Swedish National Agency of Education, 2011 p. 18, official translation)

From a teacher's perspective, this policy is not generally easy to manage. Our results suggest that many of the industrial actors have clear private agendas. In light of this, we may question the capacity of individual teachers to engage in symmetric co-operation around STEM initiatives and we would like to emphasize the need of further research scrutinizing teacher-industry co-operation.

The highly decentralized Swedish education system provides an arena for educational governance that is easily accessible to industrial and other external actors. In other national contexts where curricula may be more detailed and the professional freedom of teachers more restricted (for example, in the selection of teaching materials), the arena for educational governance may be more restricted and work on different systemic levels. However, as we showed in the overview of resources (Table 1), industrial actors engaging in STEM education not only produce teaching

materials for schools, but also offer various forms of teacher professional development and resources that may be used outside formal STEM education in science centres, after-school science clubs, etc. In addition, several of the industrial actors are also active transnationally, in European and even global contexts. Thus, even though tensions between private and public good in the industrial STEM initiatives we examined may play out differently in different national educational systems, there is a reason to believe that such tensions are also present in other national education systems.

However, there might be differences in the repertoires that actors draw upon in different national contexts. The repertoires reported in this study reflect the educational policy discourse in present-day Sweden. Even though similarities exist between many countries, there are also differences. For example, against the backdrop of national educational policy in the US, where questions of national security have been an issue in educational reform (e.g. Klein, Rice & Levy, 2012), one might imagine a discursive repertoire justifying STEM initiative engagements with reference to the importance of addressing national security concerns.

### **Concluding remarks**

It is of outmost importance that schools and different levels of government become aware of the governance elements at play in the commercialization of education (e.g. when industrial actors engage in various STEM education initiatives), and that commercialization almost necessarily involves tensions between public and private good. Manteaw (2008) has called for a change regarding business contributions to school under the label of corporate social responsibility for sustainability. He suggests that issues of sustainability, social justice and so on are commonly perceived as noneconomic but that schools should 'maintain an informed balance between the push for economic and technical rationalities and social and ecological imperatives' (p. 125). Spring (2015), also cautions against global businesses and organizations emphasizing human capital goals for education, since such goals tend to 'trump other educational goals, such as education for social justice, environmental improvement, political participation, and citizenship training' (Spring, 2015, p. 5).

In light of the results of this study and the large number of industrial STEM education initiatives in Sweden and globally, it is urgent that researchers continue scrutinizing public–private partnerships in STEM education. It is also important to provide empirical foundations and tools to support the reflection of STEM teachers upon the values at stake, as well as when and how it may be appropriate to engage in collaborations with external actors, and, not least, when not to. However, we need more research that examines how teachers and schools negotiate tensions between public and private good when making decisions about what initiatives to take part in, and, perhaps most urgently, how initiatives are enacted in practice with students and what values and norms are communicated to students through different STEM initiatives. Indeed, research focusing on the realities of industrial STEM initiatives on the ground is ongoing and will be published in forthcoming articles by the authors.

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## References

- American Marketing Association. (2013). definition of marketing. Retrieved from <https://www.ama.org/AboutAMA/Pages/Definition-of-Marketing.aspx>
- Anderhag, P., Emanuelsson, P., Wickman, P.-O., & Hamza, K. M. (2013). Students' choice of postcompulsory science: In search of schools that compensate for the socio-economic background of their students. *International Journal of Science Education*, 35(18), 3141–3160.
- Andrée, M., Hansson, L., & Ideland, M. (2018). Political rationalities in science education: A case study of teaching materials provided by external actors. In A. Arvola-Orlander, K. Otrrel-Cass, & M. K. Sillasen (Eds.), *Cultural, social, and political perspectives in science education – A nordic view* (pp. 75–92). Dordrecht: Springer.
- Andrée, M., & Hansson, L. (2013). Marketing the 'broad line': Invitations to STEM education in a Swedish recruitment campaign. *International Journal of Science Education*, 35(1), 147–166.
- Andrée, M., & Hansson, L. (2014). Recruitment campaigns as a tool for social and cultural reproduction of scientific communities: A case study on how scientists invite young people to science. *International Journal of Science Education*, 36(12), 1985–2008.
- Archer, L., Dawson, E., DeWitt, J., Seakins, A., & Wong, B. (2015). 'Science capital': A conceptual, methodological, and empirical argument for extending bourdieusian notions of capital beyond the arts. *Journal Research in Science Teaching*, 52, 922–948.
- Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2012). Science Aspirations and family habitus: How families shape children's engagement and identification with science. *American Educational Research Journal*, 49(5), 881–908.
- Au, W., & Ferrare, J. J. (Eds.). (2015). *Mapping corporate education reform: Power and policy networks in the neoliberal state*. New York: Routledge.
- Avelar, M., Nikita, D. P., & Ball, S. J. (2018). Education policy networks and spaces of 'meetingness': A network ethnography of a Brazilian seminar. In A. Verger, M. Novelli, & H. K. Altinyelken (Eds.), *Global education policy and international development: New agendas, issues and policies* (pp. 55–74). London: Bloomsbury Publishing.
- Ball, S., & Junemann, C. (2012). *Networks new governance and education*. Bristol: Policy Press.
- Bencze, L., Reiss, M., Sharma, A., & Weinstein, M. (2018). STEM education as 'Trojan horse': Deconstructed and reinvented for all. In L.A. Bryan & K. Tobin (Eds.), *Thirteen Questions in Science Education*, (pp. 69–87). New York: Peter Lang.
- Bøe, M. V., Henriksen, E. K., Lyons, T., & Schreiner, C. (2011). Participation in science and technology: Young people's achievement-related choices in late-modern societies. *Studies in Science Education*, 47(1), 37–72.
- Boyles, D. (Ed.). (2005). *Schools or markets? Commercialism, privatization, and school-business partnerships*. New Jersey: Lawrence Erlbaum Associates.
- Braund, M., & Reiss, M. (Eds.). (2004). *Learning science outside the classroom*. London: Routledge.
- Bryman, A. (2008). *Social research methods* (3rd ed.). Oxford: Oxford University Press.
- Cannon, K. C., & Sandler, S. R. (2000). A successful model for an academic-industrial partnership for elementary science education. *Journal of Chemical Education*, 77(10), 1291–1294.
- Carlgrén, I. (2009). The Swedish comprehensive school—Lost in transition? *Zeitschrift Für Erziehungswissenschaft*, 12(4), 633–649.
- Carter, L. (2017). Neoliberalism and STEM education: Some Australian policy discourse. *Canadian Journal of Science, Mathematics and Technology Education*, 17(4), 247–257.
- Cerne, A. (2011). Like a bridge over troubled water: Discourses integrating corporate social responsibility and growth in international business. *The Journal of Interdisciplinary Economics*, 23, 177–199.
- Cuban, L., & Shippis, D. (Eds.). (2000). *Reconstructing the common good in education: Coping with intractable American dilemmas*. Stanford, CA: Stanford University Press.
- Davidsson, E., & Sørensen, H. (2010). Sponsorship and exhibitions at Nordic science centres and museums. *Museum Management and Curatorship*, 25(4), 345–360.
- Doh, J. P., & Guay, T. R. (2006). Corporate social responsibility, public policy, and NGO Activism in Europe and the United States: An institutional-stakeholder perspective. *Journal of Management Studies*, 43, 47–73.

- Eccles, J. (2009). Who am I and what am I going to do with my life? Personal and collective identities as motivators of action. *Educational Psychologist*, 44(2), 78–89.
- European Commission. (2004). Europe needs more scientists (Report by the high level group on increasing human resources on science and technology in Europe). Retrieved from <https://ec.europa.eu/digital-single-market/en/news/europe-needs-more-scientists-eu-blueprint-action>
- European Commission. (2013). Call for making science education and careers attractive for young people. Participant portal. Research and Innovation. Retrieved from <http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/seac-1-2014.html>
- Giroux, H. (2019). Toward a pedagogy of educated hope under Casino capitalism. *Pedagogía Y Saberes*, 50, 147–151.
- Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Chicago: Aldine De Gruyter.
- Gutstein, E. (2012). *Reading and writing the world with mathematics. Toward a pedagogy for social justice*. New York: Routledge.
- Henriksen, E. K., Dillon, J., & Ryder, J. (Eds.). (2015). *Understanding student participation and choice in science and technology education*. The Netherlands: Springer.
- Hira, R. (2010). U.S. Policy and the STEM workforce system. *American Behavioral Scientist*, 53(7), 949–961.
- Hsu, P.-L., Roth, W.-M., Marshall, A., & Guenette, F. (2009). To be or not to be? Discursive resources for (Dis-)identifying with science-related careers. *Journal of Research in Science Teaching*, 46, 1114–1136.
- Ideland, M., & Tröhler, D. (2015). Calling for sustainability: WWF's global Agenda and educating Swedish exceptionalism. In D. Tröhler & T. Lenz (Eds.), *Trajectories in the development of modern school systems: Between the national and the global* (pp. 199–212). New York: Routledge.
- Jensen, F., & Bøe, M. V. (2013). The influence of a two-day recruitment event on female upper secondary students' motivation for science and technology higher education. *International Journal of Gender, Science and Technology*, 5(3), 317–337.
- Klein, R., & Levy. (2012). *US education reform and national security* (Independent Task Force Report Nr. 68). New York: Council on Foreign Relations.
- Konsumentverket [The Swedish Consumer Agency]. (2004). *Sponsring i skolan. Vägledning för utarbetande av lokal policy för sponsring*. [Sponsoring in school. Guidance for developing local policy for sponsoring]. Retrieved from [http://www.konsumentverket.se/Global/Konsumentverket.se/Best%C3%A4lla%20och%20adda%20ner/V%C3%A4gledning/Dokument/kov\\_v%C3%A4gledning\\_sponsring\\_skolan\\_2004.pdf](http://www.konsumentverket.se/Global/Konsumentverket.se/Best%C3%A4lla%20och%20adda%20ner/V%C3%A4gledning/Dokument/kov_v%C3%A4gledning_sponsring_skolan_2004.pdf)
- Kousa, P., Aksela, M., & Ferck Savek, V. (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, 1034–1045.
- Leigh Star, S., & Griesimer, J. (1989). Institutional ecology, 'translations' and boundary objects: Amateurs and professionals in Berkeley's museum of vertebrate zoology, 1907-39. *Social Studies of Science*, 19(3), 387–420.
- Lindahl, B. (2003). *Lust att lära naturvetenskap och teknik? En longitudinell studie om vägen till gymnasie*. [Pupils' responses to school science and technology? A longitudinal study of pathways to upper secondary school] (Doctoral dissertation). University of Gothenburg, Gothenburg.
- Loukomes, A. (2013). *Enhancing students motivation towards school science with an inquiry - based site visit teaching sequence: A design - based research approach* (Doctoral dissertation). University of Helsinki, Helsinki.
- Mansfield, K. C., Welton, A. D., & Grogan, M. (2014). 'Truth or consequences': A feminist critical policy analysis of the STEM crisis. *International Journal of Qualitative Studies in Education*, 27(9), 1155–1182.
- Manteaw, B. O. (2008). When businesses go to school: Neoliberalism and education for sustainable development. *Journal of Education for Sustainable Development*, 2(2), 119–126.
- Martin, D. B. (2013). Race, racial projects, and mathematics education. *Journal of Research in Mathematics Education*, 1, 316–333.
- Molnar, A. (2006). The commercial transformation of public education. *Journal of Education Policy*, 21(5), 621–640.
- Molnar, A., Garcia, D. R., Boninger, F., & Merrill, B. (2008). Marketing of foods of minimal nutritional value to children in schools. *Preventive Medicine*, 47(5), 504–507.
- Osborne, J., & Dillon, J. (2008). Science education in Europe: Critical reflections (A report to the nuffield foundation). Retrieved from [http://www.nuffieldfoundation.org/sites/default/files/Sci\\_Ed\\_in\\_Europe\\_Report\\_Final.pdf](http://www.nuffieldfoundation.org/sites/default/files/Sci_Ed_in_Europe_Report_Final.pdf)
- Panizzon, D., Corrigan, D., Forgasz, H., & Hopkins, S. (2014). Impending STEM Shortages in Australia: Beware the 'Smoke and Mirrors'. *Procedia - Social and Behavioral Sciences*, 167(8), 70–74.
- Parvin, J., & Stephenson, M. (2004). Learning science at industrial sites. In M. Braund & M. Reiss (Eds.), *Learning science outside the classroom* (pp. 111–129). London: Routledge.
- Potter, J. (1998). Discursive social psychology: From attitudes to evaluative practices. *European Review of Social Psychology*, 9(1), 233–266.
- Rawolle, S. (2010). Understanding the mediatization of educational policy as practice. *Critical Studies in Education*, 51(1), 21–39.

- Robertson, S., Mundy, K., Verger, A., & Menashy, F. (2012b). An introduction to public private partnerships and education governance. In S. Robertson, K. Mundy, A. Verger, & F. Menashy (Eds.), *Public private partnerships in education: New actors and modes of governance in a globalizing world* (pp. 1–17). Northampton, MA: Edward Elgar Publishing.
- Robertson, S., Mundy, K., Verger, A., & Menashy, F. (Eds.). (2012a). *Public private partnerships in education: New actors and modes of governance in a globalizing world*. Northampton, MA: Edward Elgar Publishing.
- Ryder, J., Ulriksen, L., & Bøe, M. V. (2015). Understanding student participation and choice in science and technology education: The contribution of IRIS. In E. Henriksen, J. Dillon, & J. Ryder (Eds.), *Understanding student participation and choice in science and technology education* (pp. 351–366). Dordrecht: Springer.
- Schreiner, C. (2006). *Exploring a rose garden. Norwegian youth's orientations towards science: Seen as signs of late modern identities* (Doctoral dissertation). University of Oslo, Oslo.
- Simons, M., Lundahl, L., & Serpieri, R. (2013a). Introduction. The governing of education in Europe: Commercial actors, partnerships and strategies. *European Educational Research Journal*, 12(4), 416–424.
- Simons, M., Lundahl, L., & Serpieri, R. (Eds.). (2013b). Special issue: The governing of education in Europe: Commercial actors, partnerships and strategies. *European Educational Research Journal*, 12(4), 416–424.
- Spring, J. (2015). *Economization of education: human capital, global corporations, skills-based schooling*. New York: Routledge.
- Swedish National Agency for Education. (2011). *Curriculum for the compulsory school system, the pre-school class and the leisure-time centre 2011*. Stockholm: Swedish National Agency for Education (Skolverket).
- Swedish Association of Independent Schools (2018, September 14). Fakta om friskolor [Facts about independent schools]. Retrieved from [http://www.friskola.se/faktaom?expanded\\_accordions=vacc-390b4a8a](http://www.friskola.se/faktaom?expanded_accordions=vacc-390b4a8a)
- Teknikdelegationen [The Technology Delegation]. (2010). *Engagemang för naturvetenskap och teknik – Fördjupad kunskap om svenska initiativ som syftar till att öka barns och ungdomars intresse för ämnena. Rapport 2010:3*. [Engagement for science and technology – In-depth knowledge about Swedish initiatives aiming to increase children's and young people's interest for the subjects. Report 2010:3]. Retrieved from [http://www.skolverket.se/polopoly\\_fs/1.129012!/Menu/article/attachment/Rapport%25202010\\_3.pdf](http://www.skolverket.se/polopoly_fs/1.129012!/Menu/article/attachment/Rapport%25202010_3.pdf)
- Verger, A., Novelli, M., & Altinyelken, H. K. (2018). Global education policy and international development: A revisited introduction. In A. Verger, M. Novelli, & H. K. Altinyelken (Eds.), *Global education policy and international development: New agendas, issues and policies* (pp. 1–34). London: Bloomsbury Publishing.
- Wetherell, M., & Potter, J. (1988). Discourse analysis and the identification of interpretative repertoires. In C. Antaki (Ed.), *Analysing everyday explanation: A casebook of methods* (pp. 168–183). London: Sage.
- Wolfmeyer, M. (2013). STEM, meet ecojustice. *Green Theory and Praxis Journal*, 7(1), 32–46.