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MEDIATING IMAGINARIES:

Educational robots and collective visions of the future

by Oliver Tafdrup

The aim of this article is to illustrate how visions of the future—sociotechnical imaginaries—mediate and thus shape sociotechnical practices involving educational robots in a Danish school context. In the analysis I show how imaginaries are manifested both in technological artefacts, teachers' discourse and in policy documents from political bodies such as the OECD and the Danish Agency for Digitisation (DIGST). To show this manifestation, I apply two concepts: The Science and Technology Studies (STS) concept of 'sociotechnical imaginaries' as formulated by Sheila Jasanoff (2015) and the concept of 'mediation' known from postphenomenological tradition. I develop an analytical framework based on these two concepts and coin a third — 'symbolic mediation' — to present and analyse a case study based on an ethnographic field study that included semi-structured interviews conducted in a Danish school setting. The case study shows how the use of the robot NAO—an educational technology—is driven by two related imaginaries that both serve as arguments for implementing and using the robot—the imaginary of the digital future and the imaginary of educational optimization.

Keywords: Sociotechnical Imaginaries, Postphenomenology, Mediation Theory, Educational Technology, STS, Human-robot interaction

Author: Oliver Tafdrup, PhD.
Department of Teacher Education, Copenhagen University College

Introduction

In 1920 Karel Čapek introduced the Slavic term 'roboti' in his famous science-fiction play *R.U.R.* (2004) to designate artificial humanoid creations. Ever since, we humans have associated it with both our hopes and fears for the future of human existence and the society we live in. As an early precursor to *The Matrix* (Wachowski, L., & Wachowski, L., 1999), the play tells the now classic tale of how artificial humanoids rebel against their creators—a rebellion that leads to the extinction of humanity. It also illustrates how technologies are often closely associated with dystopic visions and imaginative representations of possible worlds. Such visions are present, however, in the world beyond sci-fi literature and films.

The history of educational technology offers another, less dramatic example of the entanglement between technologies and envisioned futures, as new technologies have historically been used experimentally in classrooms. Educational historian Larry Cuban points out that technologies like film media, the radio, and later the computer are all examples of technologies sold to institutions and implemented in educational practices under the promises of 'bringing the outside world into the classroom' and 'creating new revolutionizing ways of teaching and learning' (Cuban, 1986, p. 9). Like robots, educational technologies have thus been historically tied to technological fantasies and imagined futures about how technological developments will affect education, teaching and learning. This is no less true today, for educational technologies are being developed and used on the premise that digitalization will lead to profound changes in our society, especially in tomorrow's labour market (Tafdrup, 2019; Frey & Osbourne, 2017). However, one problem with this premise is that technologies often fail to realize the potentials such fantasies and visions often ascribe to them.

In this article I use a case study of the educational robot NAO to explore the entanglements of technological artefacts and constructed imaginaries about future society. Based on my fieldwork at a Danish school in 2017, the study illustrates how school principals and teachers associate NAO with certain kinds of imaginaries, and how these associations have led to NAO's implementation and use at the school. For this purpose, I develop a hybrid theory that enables one to conceptualize how NAO becomes associated and entangled with future visions.

More specifically, I argue that Sheila Jasanoff's concept of 'sociotechnical imaginaries' can be combined with the mediation theory found in postphenomenology (Ihde, 1990, p. 73, Verbeek, 2005, p. 123). By combining the two theoretical frameworks, one can show how technological artefacts are embedded into socially constructed imaginaries, and how these imaginaries in turn shape human–technology–world relations. In other words, I contend that one needs both postphenomenology and the concept of sociotechnical imaginaries to describe how the semantics of concrete artefacts like educational robots become associated with socially and politically constructed visions of the future. This article thus makes both a theoretical and an empirical contribution to ongoing debates in the related fields of science and technology studies (STS) and the philosophy of technology (e.g. Jasanoff, S., & Kim, S.-H., 2015; McNeil et al., 2017; REELER, 2019, p. 153; Blond & Schiølin, 2018, p. 151).

The question of why robots are implemented and utilized in an educational context links the theoretical discussion to a very timely topic—educational technology. As in many other OECD countries, in the past 20 years Denmark's public sector has developed a strong focus on digitization (Danish Agency for Digitisation, 2016, p. 13). Every five years, the Danish Agency for Digitisation (DIGST), a department under the Danish Ministry of Finance, publishes *The Digital Strategy*—a policy document outlining the Danish government's new digital initiatives as well as discussing the status of previous efforts. Since 2011, the political focus on educational technology has been intensified. In the 2011–2017 period, public funding of DKK 500 million, or about EUR 67 million, was utilized to equip Danish primary schools with digital technologies ranging from iPads to digital learning resources and robot technologies (Danish Agency for Digitisation, 2011, p. 22). Furthermore, in 2014 the National Agency of IT and Learning (STIL),[1] a department under the Danish Ministry of Children and Education, was established to manage new initiatives related to educational technology in schools and to ensure the success of the related public investments. As a result, digital artefacts have proliferated in Danish classrooms, and much attention has been given to whether and why digital technologies should be used to improve the ways that Danish pupils learn and how public schools prepare them for a labour market that demands a workforce that is able to use and create digital technologies (Tafdrup, 2019).

The arguments presented in DIGST and STIL policy documents emphasize how tomorrow's workforce will need digital competencies like coding, technical know-how, and networking through technology, and that pupils must familiarize themselves with a range of digital technologies to be ready for the future labour market. Critical education studies have described the connection between educational policy and economic rationalities at length. Educational sociologist Stephen Ball, for example, highlights how neoliberal policy agendas have integrated the logic of 'market', 'management' and 'competition' in education systems globally (Ball, 2016). Other scholars have emphasized how technological know-how and the ability to navigate a complex landscape

1 STIL is an abbreviation of the Danish name for the agency – 'Styrelsen for IT og Læring'.

of digital technologies are closely connected to a neoliberal discourse, where the use of data management and governance becomes related to ideas of accountability, quality, and efficiency (Williamson, 2017, p. 66).

I propose that the vision of an increasingly digitalized society can be understood as a sociotechnical imaginary that constructs the greater use of educational technologies as a rational trajectory towards equipping pupils with the competencies needed to succeed in tomorrow's labour market.

Fuelled, perhaps, by technological fantasies from science fiction, the public and political debate on the impacts of new technologies and automatization on human existence, society, and work life (e.g. Frey & Osbourne, 2017) have rendered the robot an artefact and a symbol strongly associated with popular and political visions of the future and the future labour market. As such, phrases like 'the robots are coming' can be found in newspapers as well as in official policy documents (e.g. STIL, 2016, p. 6). In this regard, the robot is a metaphor for autonomous technologies, but actual social and humanoid robots have found their way into primary school classrooms. As I argue in this article, this educational technology trend is driven by the same visions of the future––that is, sociotechnical imaginaries––manifested in Danish government policy documents.

I suggest that sociotechnical imaginaries of robots are not only present in general political discourses but are also part of the cultural lifeworlds and educational practices of the teachers and pupils that use them. The case study covered here emphasizes how sociotechnical imaginaries *mediate* the way teachers and school principals perceive and interact with the robot NAO. In other words, the study aims to illustrate how the use of educational robots is embedded into and entangled with specific imaginaries related to science and technology, and how these imaginaries mediate the relation between the educational robot NAO and its users. This aim can be summarized in the following research question: How can the combined use of mediation theory and the concept of sociotechnical imaginaries be used to analyse how future visions shape the phenomenological experience of the educational robot NAO?

Theoretical approach: Combining sociotechnical imaginaries and mediation theory

A first step to answering the research question is to explain the concepts I use to this end. In the following section I therefore present mediation theory and the concept of sociotechnical imaginaries and argue for why they can and should be combined.

Sociotechnical imaginaries

Within the STS field, the concept of imaginaries is used in ways often inspired by both philosophical and anthropological traditions. (McNeil et al., 2017, p. 425). In philosophy, the term 'imagination' has been used in epistemological discussions of the human ability to generate ideas or forms based on associations stemming from sense data (e.g. Aristotle, 350B.C./2001, p. 580; Hume, 2010, p. 97; Kant, 1980, p. 190ff), with Kantian philosophy being among the most important examples. In his *Kritik der Reinen Vernunft* [Critique of the Pure Reason], as well as in later works, Immanuel Kant dedicates several discussions to the concept 'Die Einbildungskraft' [Imagination] (1980, p. 147ff). One of the functions he arguably ascribes to the imagination is that of synthesizing experienced content so that it appears to the subject as a unity.[2] Without the imagination, for example, a cat would appear not as a cat, but as a flux of unrelated colours, shapes, and sounds. However, because the imagination is able to synthesize the cat, it appears as a single gestalt—a unity of sense data with an identity that persists over time (Ibid., p. 191). For example, I experience the cat I have fed today as the same cat I will feed tomorrow. Kant uses the term in this profoundly epistemological manner to describe a function related to human reasoning. When anthropologists and cultural theoreticians speak of imaginaries, however, their aim is often not epistemological in a narrow philosophical sense but is rather to understand how and why collective identities arise within cultures. Benedict Anderson (2006), for instance, has used the concept to analyse how people come to identify themselves as being part of a nation, and how the idea of a nation is constructed through the synthesis of different types of semantic content like symbols, narratives, and so on.

Although the philosophical and anthropological traditions have different focal points, they both ascribe a synthesizing function to the imagination. Sheila Jasanoff (2015) and her use of sociotechnical imaginaries to analyse future visions is more indebted to the latter. As I will show, though, she focuses on how these future visions are constructed—or synthesized—through sociotechnical practices associated with politics, science, and technology. In the introduction to the anthology *Dreamscapes of Modernity*, she defines the concept in the following way:

> [Sociotechnical imaginaries are] collectively held and performed visions of desirable futures (or of resistance against the undesirable), and they are also animated by shared understandings of forms of social life and social order attainable

2 The role of imagination in Kant's critical philosophy is a debated topic. See e.g. (Thompson, 2013).

> through, and supportive of, advances in science and technology. (Jasanoff, 2015a, p. 19)

This definition indicates that future visions are performed and materialized in sociotechnical practices. Imaginaries shape how policy agendas are formulated and funding is distributed, and they generate ideas about which technological artefacts people should develop and learn to use. In this sense, the concept of imaginaries addresses how shared visions of the future are important in the process of cultural world building—that is, how humans construct a shared understanding of their lifeworld. These shared visions do not come arbitrarily into existence but are co-constructed (Jasanoff, 2004) by various actors, including political organizations, academic disciplines and the local culture where sociotechnical practices are performed. Jasanoff also focuses on the relation between technology and visions of the future, an aspect that makes the concept of sociotechnical imaginaries interesting in relation to the use of educational robots in schools, as it enables one to address how visions of the future affect the way certain technologies are used in educational practices and why—'how the merely imagined is converted into the solidity of identities, and the durability of routines and things' (Jasanoff, 2015b, p. 323). Jasanoff argues that sociotechnical imaginaries are articulated in a variety of different sources, such as policy literature, spoken discourse and—as I will argue—in specific technological artefacts like educational robots.

To gain a more profound understanding of how sociotechnical imaginaries are 'converted into daily routines', one can fruitfully combine the concept with postphenomenological insights into how technological artefacts are always part of a cultural lifeworld in which they mediate human–world relations.

Postphenomenology and mediation theory

Founded by Don Ihde (E.g. Ihde, 1979, 1990, 2009), postphenomenology is a contemporary branch of philosophy dedicated to the phenomenological analysis of technological artefacts. Rooted in the empirical turn (Achterhuis, 2001) of American (pragmatist) philosophy of technology, postphenomenology rejects metaphysical and speculative approaches to the study of technology, such as the position Heidegger asserts in *Die Frage nach Der Technik* [The Question Concerning Technology] (1977). In postphenomenology, the metaphysical approach is replaced with a focus on the actual situated use of different technological artefacts—say, educational robots.

This is one reason postphenomenology insists on the prefix 'post',[3] although it is still a branch of phenomenology that shares some key insights with the classical phenomenological tradition of Husserl, the early Heidegger and Merleau-Ponty. Two such insights are the ontological claims that 1) the subject is always enmeshed and situated in the world as a living body, and 2) that consciousness is intentional; it is always directed towards an object—real or imaginary (Aagaard et al., 2018). The commitment to these ontological claims shapes the way materiality and technological artefacts are understood as mediating objects within the postphenomenological framework. The concept of *mediation* designates that artefacts actively shape human–world relations and thus also the various ways subjects are intentionally related to the world via objects (Ihde, 1990, p. 72, Verbeek, 2005, p. 122.). This is apparent when one looks not only at how devices like smartphones are used to connect with contacts or browse the internet for information, but also at how different types of affordances makes these types of artefacts attention magnets (Aagaard, 2018). They mediate human–world relations at both an existential and a hermeneutic level. Existentially, they shape the way we humans interact with and relate to other people by means of social media and text messages, for example. Hermeneutically, they mediate the way we interpret the world, providing us with tools like maps and GPS services that make it easier to navigate an unknown city, as well as with access to information on the internet that enables people to qualify (or confuse) their decision making.

As such, the idea that technological artefacts are neither neutral tools nor simple means to an end is central to postphenomenology. Technological artefacts are non-neutral precisely because they mediate—that is, actively shape—the human–world relation. In the seminal work *Technology and the Lifeworld,* Don Ihde develops four modalities of human–technology–world relations (Ihde, 1990, p. 72ff): 1) embodiment relations where technologies become entangled with the body in a way that shapes a subject's perception and embodied being-in-the-world, for example, when she uses a pair of glasses to improve her eyesight; 2) hermeneutical relations where a subject interprets the world through a technological artefact, such as when she uses a watch to interpret the time; 3) alterity relations where a subject relates to a technological artefact as if it were 'quasi-other', such as when a subject experiences robots as entities that appear to be animated; and 4) background relations where technological artefacts, such as internet cables, refrigerators, and electricity, recede into the background of a subject's surroundings. In 1990 Ihde saw these four relations as four types of mediation, but since then postphenomenologists have elaborated this framework of human–technology–world relations and thus expanded the postphenomenological vocabulary for analysing different kinds of mediation (e.g. Verbeek 2008, Lindsø Andersen 2018, Tafdrup, 2019).

Multistable artefacts, imaginaries and symbolic mediation

A commitment to an ontological anti-essentialism is another key postphenomenological feature that distinguishes the theory from the classical phenomenology of Husserl. Husserl famously developed the methods of 'eiditic reduction' and 'variational

3 For a discussion on the differences between between postphenomenology and 'classical' phenomenology, see (Aagaard, et al. 2018) and (Ihde, 2009).

analysis' as means of perceiving the essence of an object (Husserl, 2002). Contrary to Husserl, Ihde argues that there are no essences, only stabilities—stating that technological artefacts are thus 'multistable' (Ihde, 1990, p. 144). A knife, for example, can be used as both a kitchen utensil and a weapon. The use—and stability—of a technological artefact depends on the practice in which it is integrated, and every practice involving technological artefacts takes place in a culturally shaped lifeworld. For Ihde the term 'lifeworld' designates that technological artefacts are always used in an everyday context shaped by cultural references, semantics, discourses, and historicity. Thus, how a person interprets and uses technological artefacts depends on the cultural lifeworld in which that person as a body is situated (Ihde, 1990, p. 29).

I argue that the concept of sociotechnical imaginaries reveals an important aspect of how humans interpret and make sense of technological artefacts in their lifeworlds. As I show in the analysis sections, some artefacts—such as educational robots—are interpreted through a culturally shaped hermeneutic framework through which they come to be associated with certain shared visions of the future. I also argue that this insight can be utilized to give the postphenomenological toolbox a new perspective on mediation: 'symbolic mediation'. In this type of mediation, the focus lies not only on the concrete materiality of the artefact, but also on how the artefact is embedded in a hermeneutic and semantic framework that associates it with shared—and in the case of educational robots politically shaped—visions of the future. One can thus use the concept of symbolic mediation to analyse how future visions are converted into daily routines via technological artefacts, a use achieved by addressing the different ways artefacts come to be associated with imagined futures, for example, through the cultural hermeneutic frameworks of the users interacting with the given artefact.

Related ongoing debates in postphenomenology

Before commencing the analysis, I would like to highlight some relevant perspectives from contemporary debates in post-phenomenology. Imagination, robots, and politics are all topics that have come up in older as well as more recent postphenomenological debates.

As regards imagination, Gallit Wellner has contributed a philosophical discussion on how different technologies have historically shaped the way humans use their imagination to produce ideas and images (Wellner, 2018). With reference to Don Ihde and Kathryne Hayles, Wellner argues that what she calls 'the posthuman imagination' is distributed across humans and nonhumans. For example, augmented reality can technologically layer imaginative content onto reality. Wellner's conception of imagination thus corresponds with my point that technological artefacts materialize sociotechnical imaginaries. Her idea of posthuman imagination is also close to what I call symbolic mediation—that the symbolic value of an artefact affects how it is used. Wellner's concept of imagination differs from Jasanoff's conception of imaginaries in that Jasanoff focuses on the political implications of imaginaries. In my own use of sociotechnical imaginaries to analyse the educational robot NAO, I too focus on the relation between imaginaries as distributed future visions and as political discourse.

Postphenomenologists also debate the topic of human–robot relations. As shown above, Ihde was aware of how humans tend to relate to certain kinds of technologies as quasi-others, of which robots are, of course, an obvious example (Jørgensen & Tafdrup, 2017). Postphenomenological studies of human–robot relations have tended to elaborate on Ihde's concept of alterity relations by investigating the various problems and aspects of relating to robots in this way (e.g. Irwin, 2006; Liberati, 2017; Funk, 2018). The topic of otherness and the types of sentimental relations that humans can have with robots is a key topic in the field of human–robot interaction (HRI). In this article, however, I do not focus on how the teachers studied attribute a certain otherness to the robot NAO—although they tend to use sentimental concepts like 'cute', 'friendly', and 'baby-like' when describing it. As such, the topic of otherness is not irrelevant to the theme of this article, but I wish instead to explore the political dimension of educational technology, here exemplified by robots and future visions, and how this dimension drives the use of such artefacts in the classroom.

This focus inevitably introduces politics into the core of post-phenomenology. Researchers within the postphenomenological tradition have typically focused on the bodily and hermeneutical aspects of mediation, thus leaving the political dimension of the cultural lifeworld relatively untouched. As Ihde writes:

> My choice inevitably leaves other dimensions of the technological lifeworld underdeveloped. There are gaps, the largest and most important of which is the social-political dimension. … The sociology and politics of technological science itself are underplayed. (Ihde, 1990, p. xii)

Postphenomenology has, as stated, undergone some theoretical development since 1990. For instance, Robert Rosenberger (2018) discusses the potential of using concepts from Actor-Network Theory (ANT), Social Construction of Technology (SCOT), and postphenomenology in an article on the political dimensions of urban planning. In this connection, he applies a theoretical hybrid construct to analyse how architecture is used to keep skateboarders and homeless people away from Love Park in Philadelphia. Still, the theoretical potential for analysing the political dimensions of the technological lifeworld has arguably yet to be realized. Ihde's notion of the lifeworld has been criticized for not taking politics and power relations into account. Philosopher David Kaplan argues that one must address the lifeworld's political dimensions, such as authority and power, to

reach a more profound understanding of how materiality shapes our relations to the world (Kaplan, 2009, p. 237). Likewise, Rao et al. (2014) have argued that the concept of mediation can and should be understood through the lens of Marxism and the critical theories of Foucault, Hardt, and Negri. Rao et al. argue that such an approach can show how mediation processes are often tied to capitalist relations of production. Interpreting the concept of mediation through a Marxist lens enables a better understanding of how different types of mediation can function as a resistance to capitalist modes of commercial and profit-oriented production types. The use of open source software is an example of such resistance.

I agree with Rao et al. that the power relations and political dimensions of mediation are an important theme to elaborate on, and I suggest that the concept of sociotechnical imaginaries can be utilized to venture into this area. An enquiry into how sociotechnical imaginaries mediate the implementation and use of robots in schools can elucidate an aspect of the sociopolitical dimension of mediation. Sociotechnical imaginaries, understood as politically shaped visions of the future, mediate the relation between user and robot in at least two ways. First, on an institutional level they serve as a catalyst for organizational change. For example, school principals and teachers tap into sociotechnical imaginaries when they argue that robot technologies should be implemented and utilized in the classroom, thus providing teachers with a narrative that emphasizes why students should engage with robot technology. Second, the narratives related to sociotechnical imaginaries shape local practices with robots and characterize which practices are to be considered successes or failures.

Methods, data, and context

In the introduction I asked how one might combine mediation theory and sociotechnical imaginaries to analyse how future visions shape the phenomenological experience of educational robots. In the following, I discuss the methods I have used to answer this question. I also describe the case, the school where I conducted fieldwork and the educational robot NAO in greater detail.

To explore how sociotechnical imaginaries mediate the use of educational robots, I have utilized a case study research design based on interviews with five informants. I have also read policy papers for the purpose of doing desktop research into political agendas. This approach is firmly rooted in the traditions of both postphenomenology and STS. As Rosenberger and Verbeek emphasize, case study methodology has been essential to postphenomenological research because the tradition is committed to the empirical analysis of human–technology relations. The case study enables one to develop philosophical concepts closely related to everyday practices (Rosenberger & Verbeek, 2015, p. 32). A case study of robots in education is therefore an obvious springboard for a study intended to make a theoretical contribution to STS and philosophy of technology by theorizing sociotechnical imaginaries as a form of mediation. The case concept utilized in the study is inspired by what Bent Flyvbjerg refers to as a 'paradigmatic case' (Flyvbjerg, 2006, p. 232.), a concept implying that a case should be designed to reflect some general problems and phenomena related to a given field, in this case educational technology. To make the case reflect a paradigmatic attitude to educational technology, I selected a school that emphasized the use of technological artefacts—especially educational robots—as the site of my fieldwork. Since technology was a big part of the school's organizational identity, I saw an opportunity to study how sociotechnical imaginaries are converted into local practices and identities, to paraphrase Jasanoff's words above.

The case thus reflects a paradigm in contemporary education and politics—a human capital paradigm stressing the link between the use of educational technology, the competencies to use various digital technologies and the future labour market. As such, using the lifeworld of practitioners, I was able through this case to study the complex relations between these sociotechnical imaginaries and the everyday practices with robots at the school (Ibid. p. 223). The following table provides an overview of the informants[4] that participated in the case study.

TABLE 1.

Informant name	Occupation	Gender
Jim	Teacher	Male
Michael	Teacher	Male
Rikke	Teacher	Female
Jacob	School principal	Male
Lisa	Teacher	Female

The case study consists of interviews with four teachers and one school principal. The use of semi-structured interviews was a vital means for determining how sociotechnical imaginaries among the informants mediate their relation to the robot NAO. The five interviews gave me valuable insight into how the informants link their everyday sociotechnical practices to a (more or less) specific vision of a future digital society and labour market—an

4 In order to anonymize the interviews, the names of the informants have been changed.

insight I achieved by analysing their discourse and comparing their statements with those found in the policy literature.

Jasanoff emphasizes the methodologies of interpretive research in her methodological considerations, stating that examining how the past and present are linked to a possible future world is one way of looking into sociotechnical imaginaries (Jasanoff, 2015a, p. 24). This was my perspective throughout the data production and analysis process.

The interviews were based on an interview guide with questions grouped into three main categories: 1) associative questions, 2) questions related to interpretations of the future, and 3) questions related to the actual use of robots. In the first category, which consisted of *introductory questions* (Kvale, 2007, p. 60), informants were shown a picture of a robot the school had implemented and then asked to describe their associations. The second category consisted of *follow-up* and *probing questions*, with informants being asked to reflect on the future impact of robot technologies on society in general and education specifically. The third category consisted of direct questions about the informants' concrete experience with educational robots.

This range of categories and questions provided insight into how informants' future visions affected their attitudes to robot technology and use practices. After the interviews were conducted, the data was transcribed and analysed with the use of NVivo software. Here, theme codes based on the three aforementioned categories were applied to identify relevant topics, patterns and similar arguments across the interviews. Next, desktop research was carried out so that the interview data could be compared to the policy discourse on the contemporary political agenda of educational technology.

Policy documents from the OECD, The Danish Agency for Digitisation (DIGST), and the National Agency of IT and Learning (STIL) served as the basis for the document analysis. STIL's policy agenda (STIL, 2016) offered an up-to-date presentation of politically formulated arguments for why educational technologies, including robots, should be implemented as tools in Danish primary schools. In its policy agenda, STIL also refers to transnational policy literature, which provided an opportunity to follow the arguments through references to documents like the OECD policy agenda. This analytical strategy enabled an insight into how distributed sociotechnical imaginaries mediate local practices. The following table provides an overview of the policy literature.

TABLE 2.

Organization	Title	Year
The Danish Agency for Digitisation	Den Digitale Vej til Fremtidens Velfærd––Den Fællesoffentlige Digitaliseringsstrategi 2011-2015 [Digital Strategy 2011 – 2015]	2010
The Danish Agency for Digitisation	A Stronger and More Secure Denmark––Digital Strategy 2016-2020.	2016
STIL	STIL på vej mod 2020: Undervisningsministeriet [STIL––On the Way to 2020]	2016
OECD	OECD Digital Economy Outlook	2017

The document analysis was intended to provide an insight into how future visions were articulated and emphasized in the literature. The documents were therefore coded in NVivo, with a focus on how the future was conceptualized across the documents and on how the political and educational sector should respond to the challenges posed by society's ongoing digital transformation.

Context and case: The educational robot NAO

In this section I explain why I selected the robot NAO as an analytical object and the school as the site of my fieldwork.

NAO is a humanoid robot designed for classroom use. It is approximately 60 cm tall and can be programmed to perform various simple tasks. The figure below illustrates its visual appearance.

Fig. 1 - NAO

At the school, NAO is a tool primarily used to teach 7th–9th graders to code. The teacher would bring two to three NAOs to the classroom and divide the pupils into work groups. The pupils would then connect a computer to a NAO and use Choreograph software to code small sequences that the NAO could then execute. The actual programming consisted of combining pre-coded blocks of code into sequences. No actual programming language was used, although advanced users could program the NAO by using Python codes. The teacher would often give pupils some exercises that allowed them to explore NAO's various functions. For example, they could make NAO do Tai Chi, perform simple interactions with the surroundings, such as avoiding gaps, and recognize faces as well as greet people.

NAO was also used in 3rd- to 6th-grade language education, in which the teacher used pre-coded 'apps' that enabled pupils to have rudimentary conversations with NAO. For instance, NAO could ask pupils simple questions like 'What is your name?' and 'How old are you?' in English. When the pupils answered, NAO would respond 'Nice to meet you!' These were the most common uses of NAO that I encountered during my fieldwork.

I chose to conduct fieldwork at this particular school because the school has made technological innovation and the integration of educational technology in the classroom a major part of its brand, strategy and pedagogy. It was also among the first Danish schools to use robots in class. The school encourages pupils to engage with different technologies—during and after school—and has facilitated various workshops in the area of science, technology, engineering, and mathematics (STEM). The workshops have included how to build robots in Lego, to use 3D printers or to become better at programming NAO. In an interview I conducted with the school principal, he stressed that the school wanted to be frontrunners in this area, for which reason they have partnered with institutions such as the Technical University of Denmark (DTU) on developing educational technologies and STEM-related didactics.

The school purchased NAOs both because of its focus on using educational technology and because of the political focus on developing the STEM competencies of the future workforce. The school principal emphasized how he annually visited the BETT[5] show in London to gain inspiration, and how he often browsed the web for new interesting educational technologies. This was also how he became aware of NAO. In an interview he explained how a colleague and a YouTube video inspired him to implement NAO at the school:

> I made the decision to invest in NAO. A colleague from the school's IT-support team came by my office and showed me a video of NAO on YouTube. The video showed how NAO was used to teach children English. I was completely sold, and I knew we had to get one, because I knew that a couple of our pupils were struggling with traditional English classes. (Jacob, school principal)

This quote indicates how sociotechnical imaginaries are distributed and shared across various platforms ranging from the BETT Show in London to YouTube and local primary schools in rural Denmark. Danish media has also shown great interest in the use of NAO in schools. NAO was featured on Danish prime time television several times (e.g., TV2, 2015; Politiken.dk, 2010). In the media NAO has often been portrayed as a harbinger of schools' and society's impending digital transformation. As such, I can make the empirical observation that NAO—as an example of robotic technology—was closely related to distributed sociotechnical imaginaries at the time I conducted my fieldwork in 2017. As Ben Williamson argues: 'The imagining of a digital future projects a kind of mythology (a set of ideas and ideals) that animates, motivates and drives forward technical development' (Williamson, 2017, p. 17).

In my data set, NAO emerged as the Zeus of this mythology, which made the robot an obvious entry into a discussion on how sociotechnical imaginaries mediate the use of technological artefacts. In my interviews I also asked the teachers about various other kinds of educational technology, but they kept returning to NAO as an example of technological development and the robot itself as a somewhat mythological figure at the heart of shared future visions.

Analysis

In the following sections, I highlight two related imaginaries encountered in my fieldwork and my exploration of policy documents: the imaginary of the digital future and the imaginary of educational optimization.

The imaginary of the digital future

The following quote stems from an interview I conducted with a science teacher who had experience with using the NAO robotic technology.

> It's the direction in which society seems to be developing—more and more digitalized and more oriented to ICT. If you're not able to utilize these technologies, you're excluded from society. So, for us it's all about preparing them [the pupils] to be part of the labour market and making sure that they've got the competencies that are needed—and maybe we can achieve that through the technology we've acquired. Maybe we can make them frontrunners. (Jim, teacher)

5 BETT is an annual show and networking event for the educational technology industry.

Drawing on my theoretical framework, I would argue that the informant's response to my question indicates how the imaginary of the digital future mediates the use of technologies like NAO in the educational setting. The teacher emphasized how using technological artefacts served to prepare pupils for a future labour market. He adopted the arguments from the contemporary political discourse that stresses the importance of acquiring technological competencies and a familiarity with artefacts like robots. The informant also emphasized how the future in this imaginary is ambiguous. On the one hand, it is determined in the sense that the technological development producing technological artefacts like robots will lead to a society where digital solutions and the use of technological artefacts are at the core of the labour market and integrated into the everyday practices of more and more professions. On the other hand, the future is also seen as open-ended because the actual consequences of the digital transformation are fundamentally uncertain. A strategy for coping with this uncertainty is for the school to expose pupils to as many technologies as possible to prepare them for a wide range of future contexts that might confront them with problems requiring technologically mediated solutions. As one of the school's science teachers put it:

> We must give them [the pupils] skills and competencies, but we also need to familiarize them with tools. The more technologies we can expose them to, the more ready to engage with new technologies they become, I think. Because the chance that the new technologies remind them of something they have tried before is bigger. If our pupils can be ahead of the others when they reach high school in relation to knowledge and familiarity with technology, then I think this is good. Because then they quickly reach a state where they can start to use the technologies. (Michael, teacher)

This argument points to how the imaginary of the digital future contains an explicit emphasis on competition. The pupils' technological competencies and experience need to surpass those of pupils at other schools, a competition premised on a general technologically driven transformation of society and the labour market. Another teacher emphasized that, as she saw it, the school where she works and the education system at large mirror a greater transition in society. Thus, when robots like NAO find their way into more functions in the labour market, they will ultimately also become part of the teaching that takes place in the classrooms:

> I think that [the use of robots and other digital technologies] reflects the development of society. When the kids are done with school, robots will be everywhere. There are already lots of robots at factories, and they [the pupils] also see robots out there in society. So, in that way [the use of robots in the classroom] reflects the society. (Rikke, teacher)

All the above-quoted teachers stressed how digital technologies like robots serve as classroom tools to prepare pupils for the future labour market by familiarizing them with technological innovations and teaching them skills like coding. The school justifies the presence of technologies in the classroom by the fact that they mirror a general digital transition of the society that the school is a part of. In this respect, the imaginary of the digital future is congruent with other analyses of the present-day neoliberal education system and its relation to the labour market. Educational sociologist Stephen Ball highlights how neoliberal policy agendas have integrated the logic of 'market', 'management', and 'competition' in education systems worldwide (Ball 2016). I argue that the imaginary of the digital future and the idea of a transition to a digital society are among the ideological ways of legitimizing the integration of neoliberal and human-capital-related ideas into educational practices. The imaginary expressed by the teachers above resonates with the type of discourse found in both transnational and national policy literature. In OECD literature, a common interpretation of the future states that:

> The development of the digital economy and society fundamentally depends on the use of digital technologies by individuals, firms and governments … Such use can only be ensured if all actors improve the skills required for effective use of digital technologies. (OECD, 2017, p. 160)

This type of argument and future vision is also found in the Danish agenda for implementing educational technology. As mentioned above, The Danish Agency of IT and Learning (STIL) is a prominent actor in relation to the Danish policy agenda of educational technology. The following two citations from STIL show the discursive similarity between the above OECD argument and STIL's political agenda.

> In an increasingly digital world, STIL is given an important function in relation to improving the learning of children, young people, and adults and to qualifying the workforce for the future labour market. (STIL, 2016, p. 5)

Like the OECD, STIL emphasizes how an ongoing societal transformation into a digital future means that new skillsets will have to be taught at all levels of education, as acquiring these skillsets will be vital to the future workforce. Below, STIL elaborates on the consequences of transition for the education system.

> The rapid digital development of society affects the educational systems in two ways: First, the education system is responsible for providing students with the best methods and tools in the classroom … Second, the accelerating technological development poses new demands to which competencies are needed in order for us in Denmark to benefit from the possibilities of creating growth and welfare in society that stem from digitalization. (STIL, 2016, p. 9)

As both these citations manifestly show, a strong association exists between a certain interpretation of the future labour market, the

technological development and the learning that takes place in the education system. The imaginary of the digital future is arguably tied to a set of sociotechnical imaginaries that stress the ongoing technological and digital transformation of the economy and the impact this transformation will have on future society. Often cited examples of this argument are found in Brynjolfsson and McAfee's book *The Second Machine Age* (2014) and Frey and Osbourne's analysis titled *The Future of Employment: How Susceptible are Jobs to Computerization?* (2013). Despite the differences between these works' positions, a common theme is the economic and societal transition driven by continual technological development.

The above analysis indicates a close connection between capitalism, technology, and education—and, of course, learning. According to Foucault, this connection can be interpreted as an example of human capital thinking. In his lectures on the birth of biopolitics, he analyses the emergence of neoliberalism, pointing out that human capital theory contains a perspective of the individual 'as an active economic subject' (Foucault, 2009, p. 256). This implies that the labouring individual is regarded as possessing her own means of production in the form of health, intellectual, physical, social and other factors related to the personality and body of the worker, and which further affect the individual's opportunities to trade and generate value in a market. This understanding of human capital is closely tied to the politics of educational technology (Selwyn, 2017, p. 27). One consequence of this imaginary is a push for a transition to a type of learning environment that emphasizes the importance of using digital artefacts to give pupils the competencies needed in an increasingly digital society. As Alexander Means points out, the OECD's reaction to the above-mentioned technological developments is to argue for an emphasis on 21st-century learning—that is, on how to use digital technologies to collaborate and create knowledge, among other things (Means, 2018, p. 327-328). The use of robots in education can thus be seen as an example of teaching pupils 21st-century skills so they can develop their human capital and be prepared for a future where digital technologies are ever more present. Comparing the policy statements with those of the teacher reveals a distributed imaginary that is part of everyday school practice as well as present in the development of political strategies.

From an STS perspective the imaginary of the digital future is interesting because it explicitly associates sociocultural and economic change with technological change. I would argue that these associations between materiality, conceptions of the future and education are present in the local practices illustrated above. As Jasanoff emphasizes, sociotechnical imaginaries are embedded into practices, artefacts, and the discourse of everyday life as visions of the future. From a postphenomenological perspective, this embeddedness can be understood theoretically as a type of mediation. The imaginary of the digital future shapes the relation between the teachers and the (robot) technologies by installing a *technological intentionality* (Ihde, 1990, p. 141; Verbeek, 2010, p. 114) and by assigning a specific symbolic value to the materiality of digital artefacts. In this instance, technological intentionality refers to how sociotechnical imaginaries shape the way the teachers relate to the world through technological artefacts like robots. Robots are primarily used in classes to prepare pupils for the future labour market, a purpose manifested in the way the robots are used and the arguments for doing so. Thus, a specific interpretation of the future shapes how users perceive and interact with the robots as material artefacts. As I have illustrated through the interviews, robots become a sociocultural artefact tied to the idea of a transition to a digital future. Phrased in a classical phenomenological vocabulary, a specific *being-towards-the future* often characterizes the relations between the users and the robot. Moreover, both teachers and politicians seem to interpret this future along the lines of a transition to a digital society and a labour market that demands digital competencies. The imaginary of the digital future thus mediates the use of robots.

The imaginary of educational optimization

During the analysis of my empirical data, a second perspective emerged, namely the idea that educational practices in classrooms are undergoing a transition driven by the technological development of educational technologies. Thus, as I will show below, the use of digital technologies like robots is also tied to a sociotechnical imaginary that emphasizes how education is moving towards a future where technological artefacts will gradually optimize classroom practices and thus learning outcomes and release teachers from time-consuming basic tasks. I refer to this idea as the imaginary of educational optimization—an imaginary the school principal strongly emphasized in his interview, as he expressed a fascination with new technologies and their apparent potential. As he saw it, the robot NAO served as a tool for improving classroom practices by engaging pupils in an interactive learning process involving programming the robot to do specific tasks, and as a tool for motivating pupils to engage in learning processes.

> They [the robots] become more and more interesting and sophisticated. And I say interesting because I can use them in a teaching context. They have a positive impact on the pupils' learning processes and their self-esteem. (Jacob, school principal)

To elaborate on how digital technologies impact pupils' self-esteem, he related an anecdote about a pupil who had experienced failure and therefore lacked the motivation to engage in English class. When the pupil interacted with NAO, he gained the motivation to participate in the class and ultimately received high marks. This point is tied to a more general conception among some informants that digital technologies serve as change agents that fascinate and engage students in learning processes, thus optimizing the learning environment by affording the pupils an opportunity to engage in interactions with a learning outcome. As he also stated in the interview:

> They [the robots] are fascinating in a toy-like way. But at the same time there is much learning associated with them. You can immediately see if the shit works. How much learning do you think is associated with blabbering in German? You seldom get to speak German. With the robot you see the results right away. I think that is a point. (Jacob, school principal)

The school principal was making the point that the pupils are more quickly rewarded in learning processes where NAO is integrated, such as in coding classes, because, unlike in German classes, they can immediately see whether NAO reacts according to their intentions, which serves to speed up the learning process. However, contrasting experiences among the teacher group also counter the notion that NAO improves learning processes. As a Danish language teacher put it:

> I get tired. I have an ambiguous relationship with NAO, I must say. It's a technology that cost DKK 100,000 when we bought it. But it doesn't reach enough pupils. I haven't found any meaningful ways of using NAO. When I see NAO, I think of 100,000 kroner we could have used on something more relevant. (Lisa, teacher)

Several of the informants have had negative experiences with NAO and other digital technologies that failed to function properly or even broke down during class. Interestingly, such experiences did not seem to challenge the imaginary of educational optimization to any great degree. Although several teachers related their negative experiences with digital technologies, they also seemed to believe that the continued development and perfection of educational technology would eventually solve the problems and thus optimize teaching and learning practices in school. The below quote illustrates this point. A teacher who has had trouble with NAO in his classes asserts that the problems might have been averted if a newer version of NAO had been available.

> We had a first-generation NAO. There were some difficulties with the software, so we often experienced that it did not work, and we had to move on to something else. The blue one is a second-generation NAO, and the orange one is a first generation. Maybe we wouldn't have had all these problems if we had had the second-generation NAO from the start. (Michael, teacher)

The quote illustrates how (many) negative experiences with technologies seldom lead to a pessimistic view on the potential of educational technologies to improve education. This rationality lies at the core of what I understand as the imaginary of educational optimization—a fundamental belief that the technological development in the long run will optimize teaching and learning processes. I see the imaginary of educational optimization as sociotechnical because the line of thinking resonates with a certain philosophy of history tradition. An Enlightenment conception of history emphasizes how history—qua technology—progresses towards ever higher and better states (Misa, 2003). This imaginary is associated with, but not identical to, what Neil Selwyn critically analyses as 'the discourse of disruption'. This discourse also stresses that new technology paves the way for rethinking teaching and learning throughout the world's education systems, and is often manifested in slogans involving phrases like 'Education 3.0' or '21st-century skills' (Selwyn, 2013). As such, the discourse of disruption is arguably also linked to a metaphysical conception of history as continually progressing and developing towards higher states. For some of the teachers, however, the imaginary of educational optimization was not just a discourse but also a strategy for coping with negative experiences with NAO and digital technologies in general. This strategy is based on the premise that they as teachers must accept initial problems and occasional useless technologies in order to be technological frontrunners and to harvest the benefits of technology-driven educational practices in the future. Another variation of this argument is found in the interview with the school principal:

> If they [the robots] were better. If we had Pepper—the big brother of NAO, which is designed not to look dangerous—the teachers (if they had enough preparation time) could program the robot to do basic tasks. If NAO were better at speaking you could use it to carry out Danish dictation in the class, and then the teacher could do something else meanwhile, if the pupils were used to it. I could actually see a potential for cost reduction in this, to put it polemically. (Jacob, school principal)

The school principal expressed the imaginary of educational optimization through the argument that if they only had had a newer and better technology, Pepper, the problems related to using NAO might not have occurred. Further, he reflected on an improved version of NAO's ability as releasing teachers from such basic tasks as class dictation, and associated such a possibility with savings. This idea is also closely linked to the Enlightenment discourse, which highlights the continuous optimization of practices through a continual development of new technologies and improvement of already established technologies. Using the concept of symbolic mediation developed in this article, one can understand this line of thinking as an example of how sociotechnical imaginaries mediate human–technology relations. The imaginary of technological optimization shapes the human–technology relation by shaping how the technological artefact—in this case NAO—is interpreted and used. In this case, NAO has been interpreted through a specific hermeneutical framework that associates the technology with an ongoing technological development that will gradually improve teaching and learning processes.

Concluding discussion

The aim of this article has been twofold. First, I have argued the benefits of understanding the STS concept of sociotechnical imaginaries as a form of mediation that shapes the user–technology relation, thus bringing together the theoretical work of Sheila Jasanoff and the tradition of postphenomenological philosophy of technology. I have also put this theoretical construction to use by empirically analysing how sociotechnical imaginaries mediate the use of educational robots in a Danish school context. In this analysis, I have identified two related imaginaries that mediate the local practices involving robots (and other digital artefacts) at the school where the fieldwork was conducted: *the imaginary of the digital future and the imaginary of educational optimization.* The first imaginary associated the use of robots and digital technologies with an ongoing economic and societal transition to a future where the ability to use digital technologies is a key competency and a condition for success in the labour market. The other imaginary associated technological development with an ongoing improvement of teaching and learning activities in schools and functioned as a coping strategy when a technological breakdown or limited usability was encountered. At the core of both the identified imaginaries lies a technological determinism that stresses a type of causal relation between the development of technological artefacts and social change—both on a large scale (the society and economy in general) and on a small scale (teaching and learning processes in the classroom). However, this technological determinism was sometimes challenged when the informants encountered a breakdown of NAO or its failure to appeal to the pupils in class.

By tapping into the complex relation between education, technology and politics, I have shown how sociotechnical imaginaries mediate local practices through material artefacts. I have called this 'symbolic mediation' to emphasize how the robot NAO is associated with and materializes visions and images of the future that shape why and how NAO is used. Much more can be done to integrate the concept of sociotechnical imaginaries in the phenomenological and postphenomenological vocabularies. The phenomenological tradition contains several perspectives on the concept of imagination that have not been addressed in this article. Far more can also be done to analyse how future visions are established in education and how interpretations of the future shape pedagogical arguments.

A critique one could level against this article's findings is that arguments formulated in a political context seem to travel relatively undisturbed to the domain of education. However, as the empirical dataset of this study is not large enough to generalize any conclusions, the thesis of the article remains a potential basis for new research. Still, I would like to highlight that the informants quoted above use arguments close or similar to those of the policy actors. As such, one must consider the value of such arguments in relation to profound pedagogical reflections. In the interviews, the techno-political arguments seem to render the pedagogical arguments secondary, and I believe school principals and teachers need to be aware and critical of this pitfall when considering their strategies for implementing and using digital technologies spanning from tablets to robots. The successful use of digital technologies in education takes time and careful professional considerations. If such considerations are not carried through, educational technologies end up being expensive investments with limited use potential.

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