The situated power of computational empowerment

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Abstract

Processes of computational empowerment necessarily involve changing the relationships of power between children, digital technologies, and social contexts. However, research into computational empowerment rarely explicates a theory of power nor reflects on the dynamics of power implicated in attempts at empowerment. The purpose of this article is thus to investigate the problem of power in computational empowerment. The method applied is one of empirical philosophy. The article utilizes three paradigmatic cases describing how the power of computational empowerment is a matter of situated knowledge and agency, an outcome of invisible work, and a question of ontological politics.

Keywords: Power, Computational empowerment, Situated agency, Infrastructure, Ontological politics, HCI

Introduction

The concept of 'computational empowerment' is central to many contemporary initiatives to educate and prepare children for a life pervaded by digital technologies on all levels [1–4]. As indicated by the literal meaning of the word 'em-power-ment,' the normative ambition is to create a process that will bring someone into a state of power. Moreover, in relation to the concept of computational empowerment, the crux of empowerment is that children may be brought into a state of power with, through, and in relation to digital technologies [5–7].

However, the current focus on computational empowerment does not explicate what constitutes the 'power' of empowerment [1,2]. This is a problem not only in relation to a research agenda that seeks to develop a rich and nuanced theory of computational empowerment. It is also an ethical problem since research projects involving ambitions of empowerment are often premised and configured in relation to both implicit and explicit normative agendas of funding agencies and governments who, so to speak, exercise their power to define empowerment through these projects.

The main motivation for this article is thus to investigate the problem of power in computational empowerment. Following the empirical turn in the philosophy of technology, the article takes a socio-technical and empirically situated approach to power and computational empowerment, which entails that these phenomena are investigated through concrete relations between human and technological actors in different circumstances [8,9]. As such, the overall research question for the article is how power and empowerment are negotiated in situated educational practices aimed at computational empowerment. This overall question is divided into three sub-questions:

1. How do different empirical actors practice and promote different forms of empowerment?

2. Which forms of power are implicated and negotiated in processes of empowerment?

3. How can the identified forms of power and empowerment be explicated, conceptualized, and theorized?

The research questions are investigated through three empirical cases developed from projects with which the authors have been involved and which were aimed at empowering children with, through, and in relation to digital technologies. As such, the cases should be understood as the authors' reflections and an attempt to develop 'paradigmatic' cases for others to discuss the power of computational empowerment [20].

The first case shows the agency of children to create new and somewhat disruptive arenas for learning. For instance, the children include their everyday practice of taking

smartphone selfies for social media in a school project aimed at more formal education in a 21st-century education context. The second case describes how laptops from the One Laptop per Child project were intended to empower students at a school in Nigeria but suffered from conflicting translations and negotiations of their nature and empowering potential. The third case illustrates the amount of social, pedagogical, and technical 'invisible work' necessary to make tablets empower children with special needs with new forms of expression.

The article concludes with a discussion of the empirical cases in relation to the concepts of 'situated knowledge,' 'ontological politics,' and 'invisible work.' The purpose is to use these concepts to explicate and develop our findings further in ways that will help others analyze the different forms of power involved in computational empowerment. In line with our empirical approach, the overall ambition is not to explain the theoretical nature of power in all cases but to start building a vocabulary to make the differences between forms of power and computational empowerment stand out more clearly.

The problem of power in computational empowerment

In this section, we first sketch out the origin of empowerment in relation to computers and digital technologies. Then we outline recent research on computational empowerment based on already published literature reviews. And, finally, we discuss how researchers may engage the problem of power in computational empowerment.

The relationship between power, children, and digital technology has been a topic of ongoing discussion since the 1980s. For instance, the 1990s were marked by debates over the 'digital divide' as a driver of structural and social inequality [11]. Sugata Mitras' [12] 'hole in the wall' experiment, where impoverished children proved remarkably skilled in using computers without any formal guidance, is a famous example of how computational empowerment for children was understood during this period as a question of creating access and 'bridging the divide.'

The current focus on computational empowerment often references Paulo Freire's or Seymour Papert's works [1,13]. Both Freire [14] and Papert [15] operated on relatively explicit theories of power relating technology with individuals and social structures, which can be summarized like this: The disempowerment and oppression of children are structurally built into industrial and colonial school systems operating through a 'banking approach' to learning, where children are quite literately forced to memorize the ignorance and prejudices of former generations rather than to learn how to learn for themselves. In this system, empowerment is achieved by children learning 'how to learn' —to explore and construct knowledge about the world in which they are situated and in which they must realize their own agency. To this end, computers and computational

technologies were seen by both Papert and Freire as potent agents of children's learning and, in consequence, of structural change in and of society [16,17].

While many researchers of computational empowerment are inspired by the similarities between Freire and Papert in their use of computers to empower children, there are also significant differences in their theories of power which seem less appreciated [16–18].

In Papert's thinking, empowerment is a product of children's innate ability to learn through concrete 'mathetic' reasoning coupled with the ability of computational technologies to support and magnify this learning potential [15]. Papert's approach is thus a micro-approach focused on the empowerment of individual children with and through computers, a process which eventually will undermine and revolutionize industrial school systems [16]. In line with this thinking, Papert later inspired and promoted the MIT Media Lab initiative 'One Laptop per Child'—which we return to below—aimed at empowering every child in the world with their own laptop meant for learning [19–21].

Freire, on the other hand, operated through a Marxist dialectics of history where the disempowered are bound to reproduce their oppression through false consciousness unless they undergo a facilitated process of 'conscientization'—that is, an education which enables them to know their own situation through critical thinking [14,18]. This form of empowerment against a system of oppression requires not only the 'tools of participation' and expression (e.g. computers and computational thinking) but also the 'pedagogical facilitation' of educators who can help children explore their social, political, and historical context. Contemporary examples of this approach include using the 'Theatre of the Oppressed' as a method for critical codesign of technologies with children to promote social responsibility and human agency [13].

The description of Freire and Papert illustrates why it is important to tease out the differences in assumptions about who and what holds the power to create which forms of social change. The purpose is not to prove one theory right and the other wrong but to recognize that research on computational empowerment builds on *different assumptions* about power, technology, and social change, which need to be made clear, discussed, and developed.

Power and empowerment in contemporary research

As Iivari et al. [2] argue, it should be possible to develop and distinguish between several 'critical agendas' concerning computational empowerment. However, literature reviews clearly show that while empowerment has increasingly become central in child-computer interaction research, it is rarely defined explicitly as a normative and/or theoretical concept [1–3]. Also, in relation to our current focus, the research makes very limited use of theories of power [2].

In a review focused on computational empowerment by Van Mechelen et al. [1], the authors analyzed 582 sentences related to empowerment from 188 publications. Of the 188 publications, however, only five explicitly defined empowerment. An analysis of the sentences nonetheless shows that empowerment is mostly approached as either a functional, educational, or democratic concept and, as such, there is a need for more research on mainstream and critical approaches [1].

A similar review by Iivari et al. [2] analyzed 96 publications on child-computer interaction. This review found that while empowerment and emancipation are emerging as prominent concepts, they are often used in a commonsense way, mentioned in passing or used synonymously with children's learning. When empowerment is defined in relation to an explicit understanding of power, it is often in relation to the Scandinavian tradition of participatory design, discourse studies, feminism, and gender studies. The authors thus conclude that future work on computational empowerment needs to include more critical theories of power and be more explicit on different types and concepts of empowerment [2].

This situation is not unique to child-computer interaction and the concept of computational empowerment but relates to a more general problem across research areas. For instance, yet another literature review of empowerment as a concept within international development shows a similar situation of empowerment being taken for granted and, as such, rarely being defined or theocratized [4]. Furthermore, as the author argues, this commonsense use of empowerment may result in negative and disempowering effects for the poor being 'empowered.'

Situating empowerment in children's life

Iivari et al. [2] argues that more critical theory is needed. However, it is also important to approach power and empowerment as phenomena situated empirically in the life and contexts of children and the projects aimed at empowering these children. And in relation to *computational* empowerment, it is similarly important to consider the technologies within an empirical context rather than 'in themselves.'

Katterfeldt et al. [6], for instance, describe how children's 'Bildung' (the moral pedagogical project of learning-to-be in life and society) is dependent on children being able to materialize ideas with and through digital technologies that are personally meaningful to them and which they bring into the situation from their life world. Making those ideas 'graspable' by children gives them an experience of agency and power to change their world. Similarly, Blikstein [7] has argued that students born and raised in working-class environments may be empowered through maker activities that build on their familiar practices—in contrast to more academic approaches to technology education which these children may experience as alienating. Also, the abovementioned Theatre of the Oppressed method enables children to re-enact a problematic situation from their own life to identify both the means of oppression and possible solution [13].

Expanding on this argument, Iversen et al. [5] have argued that it is not enough that children engage in design and maker activities concerning ideas and problems already known to them. Children must also learn to see the impacts of technologies not known to them in their life and society.

In continuation of this line of research, our intention in this article is to investigate our own prior research for how computational empowerment is situated in the contexts and socio-technical relations of the involved children.

Method—empirical cases for theoretical development

Our methodological approach is related to the so-called 'empirical turn' within the philosophy of technology and science and technology studies (STS) [8,9,22]. One of the main points of the empirical turn is that human-technology relations are always complex entanglements shaped by situated techno-practices and the cultural lifeworld in which they unfold. The implication is that *a priori* propositions of human-technology relations, or the power of computational technologies to empower, will fail to capture the variety of ways that human-technology relations unfold in different contexts by theoretically making them all the same.

The case study has gained a central significance within the empirical turn and is also the method used in this article [23]. More specifically, we have revisited our own prior research projects on computational empowerment (through purposeful sampling) to build 'paradigmatic' cases for further theoretical development as well as the authors' self-reflection [23,24]. A paradigmatic case is an example of a particular phenomenon that may be used to understand and explore other examples of the same phenomenon [23]. Michel Foucault's use of Jeremy Bentham's Panopticon is a famous example of a paradigmatic case of disciplinary power—used to understand a wide range of other examples of disciplinary power. Importantly, however, paradigmatic cases such as the Panopticon are not intended to draw out the same points in all cases. As Foucault argued, concepts such as the Panopticon are meant to make us attentive to the details of how different forms of power become visible in empirical circumstances by the forms of resistance they evoke—rather than make us assume that all forms of power are panoptic and able to exercise their influence without resistance or transformations.

> I would like to suggest another way to go further toward a new economy of power relations, a way which is more empirical, more directly related to our current situation, and which implies more relations between theory and practice. It consists of taking the forms of resistance against different forms of power as a starting point. [10]

In the following sections, we will thus utilize the cases to enquire into the power of empowerment which may then, together with cases from other researchers, serve as a basis for further theoretical development of the concept of computational empowerment.

Case 1: The power to negotiate forms of empowerment

This case demonstrates how the legitimacy of different forms of empowerment is negotiated in situated practices that are carried out in specific cultural settings characterized by both explicit and implicit norms and values. More specifically, the case shows the agency of students in a Danish primary school to transform the telos of a learning process aimed at collaboration with and through digital technologies in ways natural to the lifeworld of children yet deemed inappropriate by teachers in a more formal educational context. The student's behavior nonetheless carries enough agency to make the teachers reconsider both the learning objective and pedagogical framework for their classes.

The case is based on interviews, participant observation, and video recordings of teachers during an in-service training program [25,26]. The training program was part of a municipality-wide strategy called 'Future Schooling' focused on empowering students to use and construct digital technologies in democratic, innovative, and creative ways. The strategy was, in turn, informed by the global Partnership for 21st Century Skills which, among others, emphasizes that students must learn to collaborate on problem-solving as part of their core competences and use digital technologies efficiently in all aspects of their professional and personal life [27].

The in-service training program was organized around a 'learning laboratory' (a type of maker space) where teachers gather to develop lesson plans which are then carried out at their school. The case follows a particular lesson plan for students in second grade (aged around 7-8 years) called 'technology comprehension and well-being,' carried out during a special project week outside the normal lesson structure.

At the start of the project week, the teachers present the students with an initial task on 'collaboration.' They divide the students into groups of four, where each student is given five Lego bricks. The teachers then ask the students in each group first to build a figure individually and then to build a figure for their group out of the individual ones. Finally, the students are to post a picture (a selfie) of their group with their collective Lego figure on an online platform for collaboration—a Padlet that their teachers had learned to use as part of their in-service training.

However, contrary to intentions, the students spend minimal time on the collaborative brick-building process but become engulfed in taking selfies instead. The municipality

has given each student an iPad; therefore, they can bypass the Lego exercise and instead post selfies of themselves and others to the Padlet. The selfie production becomes increasingly intense, and students also engage in writing texts about each other on the Padlet. Some posts turn into bullying, and some students start deliberately distorting and teasing the teachers' intentions and their classmates' work.

In their use of iPads and the Padlet, the students display their agency to reconfigure how the teachers intended them to use Lego bricks, iPads, and Padlet to learn about collaboration with and through digital technologies. Instead, they translate the process into one of experimenting with selfies, emojis, and various other forms of expressions normal in contemporary Danish children's culture [25].

The teachers do not initially perceive these activities as legitimate in a school context. During a subsequent group interview, they discuss their experience and how to distinguish between 'serious' and 'unserious' students. As one teacher begins to explain:

> And then we could see that there are some [students], who mess up. It is awful that we must look at that when others produce serious posts and takes it seriously [...]

The teacher continues to read aloud what her colleague, who was also present, wrote to the students on the Padlet: "It is so wonderful to see serious posts, and we will not accept messy posts anymore," and the teacher explains to us that "it is really bad when some [students] just ruin it, right?" After a short break, the teacher exclaims: "But they test the limits." The other teacher smilingly responds, "It is a new medium to test the limits of."

In retrospect, the teachers start to see the iPad+Padlet combination as a medium for students to explore limits. After the interview, the teachers return to class to shift the lesson's focus from collaboration to children's digital communication (including selfies and emojis). The teachers, in other words, integrate and normalize the students' culture and techno-practices as children in a digitized society into the teaching activities and make them the subject of education and 'Bildung.'

The case demonstrates how using iPads and Padlet in the second grade changes how learning activities are negotiated between teachers and students. The students take power over the technologies in ways difficult for teachers to control. They integrate the technologies into the children's culture of playing, messing around, and even bullying, which contains some inherent conflicts with the norms and values of the school setting. Initially, the teachers react not so much to the process of children taking control, which they partly intended, but more to the products of this process: the large number of silly, bullying, or 'childish' selfie posts on the Padlet. However, later the teachers came to focus on the process of taking control as a good subject for education.

This case may appear familiar to many teachers who recognize how children draw into class their everyday out-of-school use of technologies for selfies, playing around,

maintaining friendships and even bullying [28]. However, what is easy to miss from a pedagogical perspective is that the case, in fact, also describes a normative negotiation between three forms of empowerment that inform, transform, and even distort each other. First, a political ambition of a municipality to build on a global agenda of empowerment through 21st Century Skills. A second form of empowerment is the ambition of children to use digital technologies for 'childish' purposes. Third is the pedagogical translations between the political and pedagogical levels and the children's agency to negotiate and transform both these levels. As such, it is not only the power of empowerment that is at stake but also a play of power to decide which forms of computational empowerment are appropriate to whom in the given context.

Case 2: The political nature of laptops for empowerment

In 2005, key persons from the MIT Media Lab launched the highly ambitious One Laptop per Child (OLPC) initiative, which aimed at empowering every child in the world with a cheap and rugged laptop meant for learning—also known as the $100 laptop. This case demonstrates that the nature of the OLPC laptop—what it *is* and how it may empower children was not decided by MIT nor was it inherent in the 'essence' of the technology, but rather it is the product of processes of relational negotiation. The case is based on prolonged and multi-sited ethnographic fieldwork during an OLPC project in Nigeria [20,29] alongside relevant research literature on OLPC in other contexts [21,30,31].

The OLPC laptop featured high-quality learning applications such as Scratch and innovative hardware such as mesh networking and a screen that could be used in direct sunlight. Papert helped promote the OLPC initiative, which was also based on his theories of learning alongside the thinking of Nicholas Negroponte [32], who co-founded both the OLPC initiative and the MIT Media Lab. As such, OLPC intended to empower millions of children around the world by allowing them to develop computational ideas, thinking, and cultures which would leapfrog them into a global digital society. OLPC operated on an implicit theory of power where traditional educational systems and oppressive structures and cultures could be circumvented by distributing laptops to the children on a 1:1 basis. As explained by Negroponte:

> How do you eliminate poverty? The answer is simple: education. How do you provide education? [...] OLPC leverages the children themselves, bringing the learning medium into their lives 24x7, at a total cost of a dollar per week (that includes buying, maintaining, and connecting the laptop). [33]

The case begins with the arrival of 100 laptops from OLPC at a private school in Nigeria. The school was part of a Christian community, and the school management was very concerned about how to give the community children better opportunities in the local

job market. With unemployment numbers reaching upwards of 40%, the school management hoped that knowledge of computers and software such as Microsoft Windows and Office could give students a decisive advantage for the few good jobs available.

Motivated by the prospect of becoming 'IT-literate,' many new students enrolled at the school to become part of the OLPC project. For the many new students, like the primary five student Akila, the future looked better than it had before:

> I like school because I am supposed to be someone in the future. And it is good for a child to be in school. All these people are hungry and waiting for food. Imagine all of them; they have nobody to help them! [...] And this school is very important because they brought laptops for us to learn. If you are 20-25, you can go to an office.

The laptops were the talk of town, and students were eager to experiment with the computers. However, contrary to OLPC's theory of computational empowerment, the laptops could not circumvent the educational system and children were rarely allowed to use the laptops outside of structured classes. Also, their use of laptops within classes was part of the national Nigerian learning framework, which relies heavily on rote learning. As illustrated by this observation of students presenting their own research on Wikipedia:

> The students read out loud the article text from the XO (including lines such as "This article redirects here"). If they do well, the teacher encourages them and gives them credit. He tells them, "good work" and "well done." If they don't do well or can't answer any questions related to their topic, he sends them back to their seat without further comment.

As such, the OLPC laptops went from being a medium for mathematic learning and computational thinking to being a prospect of a future job and achieving the objectives of the Nigerian curriculum.

Meanwhile, the Nigerian school partnered with a Danish NGO to help finance the project and facilitate the in-service training of the teachers. The theory of the Danes was that laptops alone would not empower students without a more fundamental change of pedagogy at the school. This approach is also reflected in the formal project description, which describes the main purpose and objective as creating:

> A successful transformation [...] from a classic instruction-based blackboard learning environment to a constructionist learning environment backed by computer-supported activities.

In line with this thinking, the Danish NGO was training teachers and worked to facilitate a cultural and pedagogical transformation at the school. To the Danes, the laptops played the role of 'backers' or 'facilitators' of this change. If the transformation succeeded, it

would, in turn, also clear the ground for the OLPC laptop to (finally) become technologies for learning and computational thinking, as intended by OLPC.

However, creating a fundamental change of culture and pedagogy to make laptops work is difficult. One aspect of the pedagogical transformation that kept creating controversy between Nigerians and Danes was the use of physical discipline and punishments to maintain classroom control. When witnessing the school from a Scandinavian context, the frequency and variety of physical corrections inflicted on students by teachers gets a lot of attention. Volunteers, tourists, and journalists visiting from Denmark came to see the laptops at work, but their focus soon changed to the physical punishments, which they had to 'culturally translate' if the project were to continue, as one journalist writing about the school explained:

> In reality, we could have made a history titled "Danish project supports school violence," but we did not do that because it would be unfair. The things they are collaborating on would fall apart if we wrote like that.

The computers, of course, became part of this controversy. Initially, many teachers used the laptops to practice a form of soft disciplinary power, and, for a period, the laptops quite literately replaced rattan canes (tellingly, computers and canes were stored in the same room). Students who behaved well could be awarded extra time with laptops. Students who were behind in paying their tuition fees (a regular occurrence) would get no time with laptops, and so forth. The school management used the laptops in much the same way. In a move to strengthen the relative position of their community, they, for instance, expelled all the Muslim students and made teachers sign a five-year contract not to leave their job for a better job once the Danes had trained them on using computers for learning.

In summary, the OLPC laptops had to replace rattan canes as disciplinary technologies to keep Danes and Nigerians aligned in facilitating a pedagogical transformation at the school, which, in turn, could enable the laptops to become technologies for children's learning. In all cases, the laptops had to become workplace relevant to provide better job opportunities for students and a strengthened position for the local community.

In this latter regard, the OLPC laptops proved lacking. The school was disappointed that they were not "real computers." Instead of Microsoft Windows, they featured a Linux-based system called Sugar, their award-winning design made them look like children's toys (which was a deliberate design choice from OLPC), and in contrast to how they were advertised, they suffered from many technical faults and were slow and troublesome to use.

The OLPC laptops were thus difficult to translate into better job opportunities, and their maintenance was expensive and laborious. Furthermore, since the laptops had limited affordances for upholding strict discipline, the rattan canes were soon back in the

classrooms. All these difficulties and differences in negotiating the nature of laptops and their purpose at a Nigerian school eventually made the project come to a halt. It was not cancelled per se, it just ran out of energy and momentum, and the laptops ended up in a state of limbo where it was unclear what they were, what they could hope to become, or how they could make any positive difference for either part [29].

Case 3: On the pedagogical work of computational empowerment

The third case offers an opposite situation to the OLPC project. Whereas the laptops struggled to attain a strong and clear existence at the Nigerian school, this case describes an iPad app with a clear and well-orchestrated use for computational empowerment at a school for disabled children. The case was produced through interviews, participant observation, and video recording. It illustrates that behind the success of the app lies a lot of pedagogical work and a long process of setting up a socio-technical infrastructure around the app. Furthermore, this work of getting technology 'to work' for empowerment risks being pushed into the background and rendered invisible the moment it succeeds because then the technology may be all that we see [34].

The app in question is called GoTalk NOW and is an augmentative and alternative communications (AAC) app. Moreover, the case describes how three children with speech-related disabilities use the app as a new medium for communication and expressing themselves. In a telling example of this use, one of the students went home to his parents and pushed the "I love you" icon in the app—which was the first time he could 'verbally' express this statement to his parents.

The student's use of GoTalk NOW to express love to his parents traces back to a municipal decision to implement a new mandatory computing subject across all primary and lower secondary schools. The subject consists of competence areas such as computational thinking, computational empowerment, and programming. The political decision became an opportunity for the school for disabled children to enhance their efforts within technologically supported learning and communication. This was especially so because the increased financial and political support following such a decision allowed the school to purchase iPads for all students and proprietary apps such as GoTalk NOW. In the words of a speech therapist working at the school, it was a prolonged process just to get ready to begin:

> It costs a lot of money, and it has been a long, long process through the communication center, and then the municipality had to commit to it, and there is a contract… Um, but now that it's available on iPads at an affordable price, we decided a few years ago at our school to say, 'we're buying it for all the school's iPads'. So now we can try it out and play with it at different levels.

The school is relatively small, with only 120 students, and has a strong tradition for interdisciplinary collaboration between parents, teachers, pedagogues, and other specialists in speech therapy, motor skills, and more. If we fast-forward, we find ourselves in a small room where a speech therapist and a teacher sit together with three students, each of whom has an iPad in front of them. The atmosphere is calm and relaxed. The pupils are accustomed to working in small groups, and it is common at the school to have two professionals teaching three to four students. During the last two years, the speech therapist and a team of teachers have collaborated to configure GoTalk NOW to each individual student's specific needs and train the students in using the app. The result is that each student now has a custom-made interface to accommodate his or her individual need. Words have been selected, recorded, and laid out alongside more generic templates with the alphabet and numbers. It is now time for the students to train using these generic templates.

The speech therapist holds a card in her hand with a drawing of a lit candlelight and asks the students for the first letter. One of the students tells the therapist in sign language that he cannot see the card. The therapist then asks all of them, "Which letter does light start with? Can you say the sound here?" She points at the iPad, but the student is unable to find the letter in GoTalk NOW. "Look at me," the teacher says to the students. She pronounces the sound "L" with her mouth while she shows it in sign language. She points at the iPad. The student now responds by pressing L on GoTalk NOW, and a voice pronounces "L." The students become highly engaged in the exercise. When a lightning drawing is shown, he presses L, so the GoTalk NOW app pronounces the sound 'L' just like it did before, so the game continues.

Later the three students are back together with their class. The therapist asks the class, "Who is present today and who is sick?" She asks one of the students, "Can you tell me who is present today?" The student hastily types the icons on his iPad, showing both names of pupils and teachers, which GoTalk NOW then reads out loud at a natural pace. Everyone responds positively with small appreciative sounds and gestures as their name is spoken out loud from the iPad. Next, they move on to an alphabet song where the pupils use their iPads to pronounce the letters as the alphabet is sung.

In line with the municipal strategy of computational empowerment, the ambition is to provide students with new forms of expression inside the school and empower them with more communicative opportunities in their life as children and future citizens. To support this ambition, the school has established a close partnership with parents who help support the use of GoTalk NOW and collaborate with the school on adapting the interface for different contextual usages.

Building the infrastructure for GoTalk NOW has demanded commitment from students, teachers, the school principal, the municipality, speech therapists, and parents. As explained by a teacher during an interview, the app and the iPads have become commonplace at the school:

> So now we also use it for everyday conversation [...] at the same time as we use it as an educational tool in class [...] a lot of students don't have much language yet but have a lot on their minds.

Some parents have furthermore learned to use the program, so they are able to use it and communicate with their children at home through the iPad. Returning to the "I love you" example from the introduction, the teacher and speech therapist elaborate on how GoTalk NOW has empowered students to express themselves in new ways—also among their families:

> Often when you give children a vocabulary, you want them to be able to express what they want. The first thing he did when he had played around with the app was that he went into this thing called 'small talk,' picked a category, and chose to make the iPad say 'I love you' to his parents. It was such a huge moment for them [...] wow when he gets the opportunity and the language, he actually says 'I love you.' Therefore, it also gives the pupils other possibilities than what we think they need.

As described by the teacher, the GoTalk NOW app has provided students with new forms of expression beyond what the teachers and the speech therapist had envisioned. The app has indeed become empowering to students, increasing their communicative agency and, by implication, opportunities in life more generally. However, it is not the GoTalk NOW app alone that empowers students no more than it is the faucet that produces water. The GoTalk NOW relays years of work on speech therapy, software configuration, funding, partnership formation, and much more. It would be more precise to say that all these actors in concatenation produced the empowerment with and through the code and user interface.

Discussion

The word 'em-power-ment' implicates a process of bringing someone (children) into a state of power. However, what exactly constitutes 'power' in empowerment is rarely defined or explicated. The main motivation and overall research question for this article was thus to investigate how different forms of power in different processes of empowerment are negotiated in empirically situated educational practices. From this empirical outset, the objective was subsequently to discuss how the identified forms of power and empowerment may be explicated, conceptualized, and theorized within research on computational empowerment. This approach was inspired by the 'empirical turn' in the philosophy of technology as well as Foucault's suggestion to analyze power through its empirical specificities.

In the following, we summarize the empirical findings from the three cases while discussing how the theoretical concepts of 'situated agency,' 'ontological politics,' and

'invisible work' may help to make them useful (or paradigmatic) for others in analyzing computational empowerment. All three concepts are, to some extent, relevant in all cases, but for the sake of clarity, we primarily discuss them in relation to one case each.

Computational empowerment as a matter of situated agency

In the first case, a Danish municipality made a political decision to work with 'future schooling,' which then informed how teachers were trained to educate children for their future life in a digitized society. However, on the ground and inside the classrooms, the teachers translated the political agenda into very concrete lessons with Lego bricks, iPads, and Padlet, to which the children reacted in unruly, playful, and childish ways. This, in turn, prompted the teachers to do classes on 'online behavior' instead.

The point of the case is that at least three forms of empowerment are at play—each being negotiated in relation to the others. These include empowerment in the form of children being prepared for future life, empowerment in the form of children attaining agency to create new and alternative arenas for school activities, and empowerment in the form of children learning about online behavior from their teachers.

Donna Haraway's [35] notion of 'situated knowledge' is a good concept for understanding these situated forms of power and their implications for empowerment processes: how the teachers gained the power to teach with iPads and tablets from a municipal strategy while their students, in relation to this, gained the power to disrupt and transform the teaching to their own playful purposes. Haraway argues that it is unfair and highly political for any one actor to *a priori* define which forms of empowerment are 'true' or 'right' in these circumstances. She calls it a 'God trick'—a view from nowhere which is above the politics on the ground. Instead, she asks us as researchers and practitioners to acknowledge the agency of others by 'situating' our knowledge and agency in relation to these and in the specificities of the situation. In this light, the teachers display good professional judgement by seeking out ways to connect future schooling with the existing technological culture of children.

As described in our review of literature on computational empowerment, there is a move in contemporary research toward situating computational empowerment in the lifeworld of children [5–7]. The concept of situated knowledge adds to this literature that we cannot know beforehand what role children and their lifeworld will play in empowerment because they might not share our understanding of what it means to become empowered. Haraway [35] uses the figure of the trickster to remind us that the situated world is full of agencies others than our own and that we should expect to negotiate what computational empowerment might mean and to whom.

Computational empowerment as ontological politics

The second case on the One Laptop per Child initiative illustrates how a given technology's empowering potential is not given in a universal nature or static nature of that technology but that its ontology is negotiated in the arrangements and infrastructures in which it is situated.

The MIT Media Lab produced and promoted laptops to circumvent the deficiencies of traditional school systems and their 'banking approach' to education. The Danish NGO and researchers promoted laptops as a way to facilitate pedagogical transformation through teacher training. The school management, alongside students and parents, needed to empower students against unemployment and poverty by teaching them how to work with 'real' workplace computers. The local technicians had to find ways to keep the laptops powered and connected to the internet. All these practices and perspectives had to be aligned if the laptops in Nigeria were to make any difference to students.

The concept of 'ontological politics' by scholars such as Annemarie Mol and Ivan da Costa Marques [36–38] emphasizes that negotiations between forms of empowerment cannot be closed by appeal to the true nature of technology (i.e. computing technologies are X which makes true empowerment Y—the God trick again). This is because the true nature of technology is what is being negotiated! Inspired by Actor-Network Theory and related positions, the argument is that laptops as technologies are not bounded by their logical circuits nor the design of their software or the plastic of their casing. Instead, their ontology is negotiated in socio-technical infrastructures and arrangements like those described in all three cases. Moreover, when technologies appear stable or universal, it is because alternative ontologies have been rendered invisible and silent (again, a move of power).

The main contribution of ontological politics to research on computational empowerment—aside from being an antidote to technological determinism—is twofold. One is to promote the possibility of more than one ontological nature of any given technology. From this outset, the other is to draw analytical attention to how processes of computational empowerment also entail negotiations of the nature of the technologies themselves—a question of who holds the power to decide what is ontologically 'real' and to whom.

Computational empowerment through invisible work

In all three cases, many people and technologies were at play in creating and maintaining a process of computational empowerment—not just computers and their users. The third case similarly describes how teachers, speech therapists, parents, and students worked with iPads and the GoTalk NOW app to empower the children with new forms of expression. The main point is that it took almost two years of hard work before students

could use the app for the intended purpose and that such prehistories are often overlooked and underestimated.

The school had to align itself with political processes in the municipality. A specialist speech therapist had to work closely with teachers and students to configure the software. Likewise, parents had to help teachers train their children on how to use the software. The empowerment of the special needs children was thus produced in a complex network where each of the 'knots' contributed to the form and content of their new expressiveness.

The concept of 'invisible work' [34,39] helps to highlight the long and toilsome work processes involved in getting technology to work. Derived from an interactionist and micro-sociological tradition, the concept is used by, amongst others, Lucy Suchman and Susan Leigh Star to analyze how the infrastructures that maintain technologies in existence—and mediate their effects—are often built upon work which is difficult to see and appreciate. Furthermore, with relevance to our current focus, Star and Suchman have shown that what type of work is rendered invisible is very much a question related to the power structures of the given situation. The concept of invisible work thus asks us to assume that no matter what appears on the surface as the vehicle of empowerment (the app empowers, the teacher empowers, the research empowers, etc.), someone or something unseen and unacknowledged is toiling behind the scenes to produce and mediate this effect.

Selection and Participation

In the first case, all participants (or the participants' parents) had signed an agreement giving us permission to observe and conduct interviews in the location.

In the second case, the school signed a letter allowing researchers to conduct observations and interviews. The parents received written and oral information about the project and were given the opportunity to opt out during the research period.

In the third case, all participants (or the participants' parents) had signed an agreement giving us permission to observe and conduct interviews in the location.

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