Empowerment through computational thinking: A literature survey

Abstract
There is a global consensus that computational thinking (CT) should be integrated into education, and empowerment is often used as an argument for why future generations need to be able to think computationally. In this paper we report on a systematic literature survey that categorises various strands of empowerment as they unfold in CT education research. We apply an existing categorisation tool that defines the use of empowerment in relation to five interpretations: *management*, *critical*, *democratic*, *functional* and *educational empowerment*. Our analysis identifies several important limitations in the current literature. First, ‘empowerment’ is frequently used, but seldom defined, in current CT education literature. Second, the understanding of empowerment varies substantially depending on geographic region, which means that empowerment as an end-goal in CT education may differ significantly from region to region. Our study also found that critical and managerial empowerment are under-represented in the international CT education literature, but are more prevalent in research carried out in the Nordic countries. We conclude this paper by suggesting a research agenda to secure a more palpable research literature related to empowerment and to CT in education, to support future research, and to support ongoing policy-making.

Keywords: computational thinking, empowerment, computing education

Empowerment gennem computationel tænkning: En undersøgelse af den eksisterende litteratur

Sammendrag
Integrationen af computationel tænkning (CT) i uddannelse bliver diskuteret på internationalt nivå, og ‘empowerment’ (på dansk: myndiggørelse) bliver ofte brugt som argument for hvorfor fremtidige generationer har brug for at kunne tænke computacionelt. I denne artikel rapporterer vi fra en litteraturundersøgelse om begrebet empowerment som det udfolder sig i forskningen omkring CT i uddannelse. Vi
anvender et eksisterende kategoriseringsværktøj til at definere brugen af empowerment i relation til fem kategorier: ledelse, kritisk, demokratis, funktionel og uddannelsesmæssig empowerment. Vores analyse påpeger flere begrænsninger i den nuværende forskningslitteratur. For det første bruges empowerment ofte i CT uddannelselitteratur, men begrebet bliver sjældent defineret. Desuden fant analysen også at forståelsen af empowerment varierer betydeligt afhængig af hvilken geografisk region forskningen stammer fra. Dette kan betyde at empowerment som mål for CT i uddannelse kan være forskelligt fra region til region. Endelig fandt vores studie også at empowermentkategorierne ‘kritisk’ og ‘ledelse’ er underrepræsenteret i den internationale CT uddannelses-litteratur, men er dog mere fremtrædende i forskning der stammer fra de nordiske lande. Vi afslutter denne undersøgelse med at foreslå en forskningsagenda der kan sikre en mere transparent forskningslitteratur i relation til empowerment og til CT i uddannelse for at støtte fremtidig forskning og igangværende politisk arbejde.

Nøgleord: computationel tænkning, empowerment, computeruddannelse

Introduction

There is a general consensus that computational thinking (CT) should be integrated into primary and secondary education to empower students and/or educators (Blikstein & Krannich, 2013). The Oxford English Dictionary defines ‘empowerment’ as (1) “authority or power given to someone to do something”, and (2) “the process of becoming stronger and more confident, especially in controlling one’s life and claiming one’s rights”. However, as our study reveals, several understandings of ‘empowerment’ coexist in the current literature on CT in education. Therefore, it is both timely and highly appropriate for the CT education community to investigate which kinds of empowerment would be strengthened by including CT in education. Our aim is not to call for a standardisation of the term ‘empowerment’, but to establish an awareness and understanding of the various interpretations that co-exist in CT education research.

We develop the foregoing understanding by hypothesising that a definition and understanding of empowerment is lacking in the current literature on CT in education. We conducted a literature survey of 210 papers on CT in education that include ‘empowerment’. Thus, this study addresses the research question: How does current literature on CT in education address empowerment related to CT? This study is important, as it differentiates between how empowerment is used in relation to CT in education to K–12 teachers, teacher educators, and students, and in particular, whether the Nordic countries have a special focus on specific aspects of empowerment through CT in education. Our study is also highly relevant to education policy-makers world-wide, who may be confused by the uncertainty surrounding the term ‘empowerment’ as they attempt to contextualise and integrate CT education in K–12 education.
Since Papert (1980) first coined the term CT and Wing (2006) reintroduced it, many researchers introduced CT to both primary and secondary educational settings. Much research has gone into trying to define, conduct and assess CT, and various positions that attempt to characterise CT have been published. In contrast to Wing’s description of CT as “[…] thinking like a computer scientist” (Wing, 2006), diSessa (2018) argues that as a trend in education, CT has some counterproductive elements, the most important one being that CT is excessively focused on computer science, and is not broad enough. Denning (2017) lists a number of attempts to define CT, but concludes that owing to attempts to appeal to fields other than computer science, these offer vague and confusing definitions. Like diSessa, Tedre and Denning (2016) warn against turning CT into “an extended object-oriented curriculum”, but to aim to define it as something “greater than programming”, in order to empower students and give them equity (diSessa, 2018). In their recent book, Denning and Tedre (2019), state that “Computational thinking is not only something programmers must know, but it is also a thinking tool for understanding our technology-infused social world. It increases our awareness of how everyday digital tools work, grounds our cyber ethics, and improves our resilience against various threats such as algorithm-driven attempts to guide our behaviour, personally tailored fake news, viral powers of social media, and massive, data-intensive analysis of our movements. What is more, computational thinking has irrevocably changed the tools, methods, and epistemology of science. Learning CT has many benefits beyond programming.” In his blog, Guzdial (2019) recently took up the challenge of establishing a definition of CT; he recommends the approach taken by Weintrop et al. (2016), who focus on computational scientists’ practices and the subsets of computing skills and thinking they use in their work, and the way in which CT empowers them to apply their thinking and problem-solving skills in their professional life. Also, Angeli and Giannakos (2020) describe how CT education may help engage students in meaningful learning, to develop useful thinking skills for their future education, work and life, and Schaper et al. (2022) discuss emerging technologies related to CT in K–12 education.

CT may provide an element of empowerment to all learners; however, by analysing existing CT education literature on empowerment, we identify and address a knowledge deficit related to CT’s potential for empowerment. With this study we hope to provide an initial understanding of empowerment in CT education, not only for computing-education researchers and educators, but also for policy-makers who are making an effort to make CT part of the curricula. As CT is implemented in educational settings, a shared understanding of ‘empowerment’ is essential to understanding how CT education policy is considered. For instance, the OECD report on “Educating 21st-century children” (Tracey & Francesca, 2019) states that new technologies may “empower children’s self-expression, information seeking and socialization”, but also that “Empowering an active and ethical (digital) generation is a key policy goal for education ministries across the
OECD.” A diverse understanding of ‘empowerment’ may distort the objectives of these important political goals.

This paper is structured as follows. First, we provide a more nuanced understanding of the term ‘empowerment’ by examining its origins, and we propose a tool for categorising mentions of empowerment in CT education literature. Second, we describe the methods used to conduct the literature survey, including the selection of research papers, the coding process and the limitations of our study. We present the results of our analysis in terms of a growing interest in the term ‘empowerment’ in relation to CT education, and of the five different understandings of empowerment and how they are anchored in various geographic regions.

Background and related work

The concept of empowerment was introduced in the 1960s and 1970s by social service providers and researchers, notably in the fields of development and community psychology (Calvès, 2009). The aim of these early practitioners was to give marginalised groups a voice, and involve them in decision-making processes that affected them, to ensure their well-being (Wise, 2005). Among the many origins of the concept of empowerment – including Marxism, Freudian psychology, Gandhism and the Black Power Movement (Cornwall & Brock, 2005) – Freire’s seminal work, Pedagogy of the Oppressed (1968), is often cited, in which he argues that in every society a small number of people have power over the masses, which results in a “dominated consciousness”. To counterbalance this and attain critical consciousness, Freire proposes an active teaching approach, whereby educators do not merely transmit knowledge, but actively help the oppressed to move from understanding to acting, enabling them to transform the world around them (Freire, 1968).

By the mid-1990s, ‘empowerment’ had entered institutional discourse, and was increasingly adopted by NGOs and policy-makers. Empowerment also found its way into the field of education, and although one could argue that empowerment is intrinsically linked to education because many empowerment programmes include education, education is also empowering in itself (Lincoln et al., 2002). At the individual level, education may result in profound change, because people acquire a sense of their own power as learners and meaning-makers, as was shown by Courts (1991) in his study of how language gives the illiterate a sense of self-worth and empowerment. Education also has a social dimension and can have different empowerment potential for different people, especially when there is a dominant group and a disadvantaged one. A disadvantaged group may see education as a means of improving their status in their society but, at the same time, education may be designed to enforce the ruling ideology and prevent the...
disadvantaged from determining the material presented in a society’s educational programmes, reinforcing the status quo (Al-Haj, 1995).

By the early 2000s, the term ‘empowerment’ had become ‘domesticated’. Empowerment was increasingly used to legitimise existing top-down policies and programmes, thereby limiting the concept of power to individual and economic decision-making, and softening the radical idea of power sharing (Calvès, 2009). The co-opting of empowerment by management discourse serves as a good example of this broader trend. Flattening organisational structures empowers employees by giving them more responsibility with less supervision, and increased opportunities to participate in decision-making. Whereas this may result in higher quality and more responsible jobs, organisational goals are rarely questioned, and are regarded as shared by all employees unproblematically (Clement, 1994).

The lack of clarity regarding the underlying motives for empowering people remains a pressing concern. To address this in the context of digital technology design, Kinnula et al. (2017) developed a framework for identifying various types of empowerment. They build on the work of Lukes (1974), and Hardy and Leiba-O’Sullivan (1998) among others, and argue that empowerment is a multi-dimensional concept that may be achieved in a myriad of ways. The authors distinguish between five forms of empowerment (management, critical, democratic, functional and educational empowerment), and use this categorisation to critically reflect on projects in which children were involved in designing games to promote digital literacy (Kinnula et al., 2017).

The first form of empowerment, management empowerment, is empowerment used as a tool for motivating people to strive for organisational goals by giving them some power over how they achieve the goals that are assumed to be shared by all (Clement, 1994). Management empowerment does not liberate people from those in power, nor does it allow people to set goals themselves (Kinnula et al., 2017). A recurring example of this form of empowerment in CT education research is providing support for teachers, allowing them to build their confidence and develop a better understanding of how to teach. Having their [principal’s and deans’] explicit support would greatly empower the teachers to get more done at their schools and feel that they have a clear mandate and resources needed to inspire to change (Heintz & Mannila, 2018).

The second form of empowerment, critical empowerment, enables those without power (i.e., the oppressed) to combat those in power (i.e., the oppressors) and to acquire power in this way. This rather idealistic view of empowerment does not encourage collaborative development among all stakeholders (those with and without power), and usually ignores organisational goals and the practicalities of organisations (Kinnula et al., 2017). In CT education literature, statements about empowering children and students to question design decisions and utilise technology to fight social injustice fits into this category: “This will empower them...
[students] and provides them with the tools to examine and question design decisions they encounter” (Kafai, 2016).

The third form of empowerment, **democratic empowerment**, is empowerment as people’s right and ability to participate in all decisions that affect their lives. Whereas management empowerment may result in a false consensus, democratic empowerment distributes power equally among stakeholders. As is critical empowerment, this form is idealistic, in that it tends to ignore organisational goals and practicalities (Kinnula et al., 2017). In CT education literature, this form manifests when students are invited into the decision-making arena, and when they are encouraged to put their computational thinking skills into action in authentic and meaningful ways.

By connecting with students’ real lives, we can help them develop a critical consciousness of the role they can play in affecting their communities through computing and empower them to move beyond simply learning to code. Instead, we can ask them what they want to code and why they want to code it. (Tissenbaum et al., 2019, pp. 34–35)

The fourth form of empowerment, **functional empowerment**, aims to improve people’s life-conditions to serve organisational goals, for instance, by enabling them to do their tasks more effectively and efficiently by using better technological tools. Similar to management empowerment, functional empowerment does not liberate people from those in power, nor does it allow people to set goals themselves, which are assumed to be shared by all unproblematically (Kinnula et al., 2017). In CT education literature, examples of this form may be found in descriptions of digital tools, including learning dashboards and block-based programming software.

There are many tools that try to achieve an appropriate level of support for empowering novice programmers. In particular, educational programming languages and environments are engaging to students when they enable them to build their own interactive media—that is, mobile applications, games, experiences, and art. (Berns et al., 2019, p. 78)

The fifth form of empowerment, **educational empowerment**, is about empowering people by teaching them important skills, and aims to increase people’s ability to shape their lives and the society in which they live (Kinnula et al., 2017). As is the case with management and functional empowerment, educational empowerment does not give people full autonomy (Kinnula et al., 2017). In CT education literature, examples of this form include teaching students how to code and, more broadly, how to communicate their needs and envision meaningful alternatives:

Given the very fragile nature of third world village socio-economics, we feel it is essential that children are empowered to understand, make and create with technology. (Unnikrishnan et al., 2016, p. 140)

The five forms of empowerment are not necessarily mutually exclusive, and one could argue for other forms of empowerment. Nonetheless, there are strong
arguments for using the five-dimensional framework, primarily because it was
developed to categorise various forms of empowerment at schools and with regard
to digital technology, but also because the framework combines various theo-
retical lenses, and offers a condensed understanding of empowerment that makes
it suitable for analysing a large body of CT education literature.

Method

Research paper selection

This survey includes research papers on qualitative, quantitative and mixed-
methods educational intervention studies published in peer-reviewed journals,
and proceedings included in the Association for Computing Machinery (ACM)
Digital Library between 2012 and 2020. We focused on this time interval to
capture the most recent trends in CT, education and empowerment, and to build
on existing reviews of CT reported in the literature (Grover & Pea, 2013; Shute
et al., 2017; Lye & Koh, 2014; Grover & Pea, 2018; Wing, 2011; García-Peñalvo
et al., 2016; Weintrop et al., 2016; Tedre & Denning, 2016; Van Mechelen et al.,
2021). The databases were searched for English-language studies because these
include a broad array of papers on CT in education. Within the databases the
representation of empowerment in papers was examined.

We designed search strategies in two steps: 1. CT as the main focus in an
educational setting, and 2. the use of the term ‘empowerment’, and how it relates
to specific research. The concept of CT in education was chosen over computing
education in an attempt to widen the search and obtain a broader corpus of
literature. Hence, the studies had to meet the following criteria:

1. ‘Computational Thinking’ is a concept mentioned in the abstract.
2. ‘empower%’1 mentioned somewhere in the text.

Peer-reviewed full papers were the approved form of report, which excluded short
papers, theses, keynote abstracts, etc. An interprofessional team of three re-
searchers applied and discussed these steps. The team consisted of representatives
from Computing Education, Cultural Studies and Interaction Design.

As shown in Table 1, 244 papers were found by applying the first and second
criteria, of which 210 were included in the final survey.

<table>
<thead>
<tr>
<th>Search criteria (2012–2020)</th>
<th>Number of papers found</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT used in abstract and empower% in full text</td>
<td>244</td>
</tr>
<tr>
<td>Full papers (i.e., not short papers etc.)</td>
<td>210</td>
</tr>
</tbody>
</table>

1 The % symbol was used to truncate the search.
For completeness, we included both papers that use empowerment as a central concept, and those that use the term more sparingly or rhetorically. We are aware of the limitations of analysing papers that may use the concept of empowerment rhetorically; however, as our research question focuses on the landscape of current literature on CT education (corpus analysis), we found it important to include all these papers in our analysis.

Coding
The research team developed a data extraction tool for documenting all sentences (n=605) that contained the word stem ‘empower’ in the 210 papers.

The entire paragraph in which each such sentence occurred was extracted using a Python script. If the sentence was part of the title, it was excluded. The sentences, and the paragraphs in which they occurred, were examined by the following process. First, the research team discussed and familiarised themselves with the categories of empowerment introduced by Kinnula et al. (2017) and described in “Background and related work” in this paper. The categories of empowerment were 1. Management, 2. Critical, 3. Democratic, 4. Functional and 5. Educational. A joint understanding was reached by first categorising 10 randomly selected sentences from various papers and agreeing on how to interpret the categories. Second, coding guidelines were developed through an iterative process that used another ten different papers, which were coded and classified by all members of the research team. The guidelines proved very useful as pointers for categorisation. Third, all sentences were classified according to the above-mentioned five categories. Two researchers coded each sentence individually. For each instance of the term ‘empowerment’, the researchers read the sentence and the paragraph in which it occurred before assigning codes, with one or several hits in the five categories. This eventually led to the characterisation of the whole paper. If a sentence was difficult to assign to a code, the two researchers presented an explanation of why the sentence was difficult to code and discussed this until a consensus was reached.

Inter-rater reliability
Inter-rater reliability (IRR) between two coders was established through the use of unweighted Cohen’s Kappa analysis (Fleiss et al., 1969). If agreement was reached on one or more categories of a sentence, this was noted and the category recorded. For the 605 sentences we obtained an IRR of 0.89 (Standard Error: 0.01, Range: 0.86–0.91, in a 0.95 confidence interval). This range value was interpreted as almost perfect agreement (McHugh, 2012).

Limitations
The overarching goal of this study is to determine how concepts of learner empowerment related to CT are presented in the research literature, but our methods introduced a number of limitations. First, the decision to conduct an
electronic search in only one database – the ACM digital library – may have excluded some relevant papers, especially since we did not complement this search strategy with citation screening. It is obvious to investigate the incidence of the term ‘empowerment’ in other research forums, and therefore we welcome other studies that include searches on Elsevier and Google Scholar, for instance. Second, there were concerns about the objectivity of the interpretations of the sentences, because of the variety of sentences in each category. However, the interdisciplinarity of the research team and the use of two or more researchers to code each sentence ensured a high objectiveness of the coding and the categorisation. A third concern was the scope of the categories, that is, whether five categories were sufficient. In the data yielded by coding the sentences, only 3 of 605 sentences used the term ‘empowerment’ in a way that the researchers could not categorise. The researchers debated whether the categories in the exiting framework were sufficient, or whether there was a need for new categories, but the researchers were unable to identify a common denominator in the three uncategorised sentences, and hence unable to suggest a new category. Moreover, it should be noted that the research team, although interdisciplinary, is Western European: its researchers come from either Denmark or Belgium. However, we do not believe that this created any bias in the work. Finally, we focused on the term ‘empowerment’ when we selected papers for this study, in order to establish a manageable corpus. However, it is probable that there is research on aspects of empowerment that does not explicitly use this term. Indeed, other terms are related to ‘empowerment’, for example, ‘enable’, ‘emancipatory’, and ‘participatory’. Because of this, papers that reference elements of empowerment, but do not explicitly use the term ‘empowerment’, are absent from our study.

Results

Definition of empowerment
The data from the survey were analysed according to the above-mentioned categories of empowerment, year of publication and country of the contributors’ institutions.

From our data set we determined that, in relation to CT, ‘empowerment’ is most frequently presented as a desired outcome. Nevertheless, only one of the papers included in the survey explicitly defined ‘empowerment’ accordingly. This paper is by Andersen and Pitkänen (2019), who relied on Freire’s seminal work, *Pedagogy of the Opppressed*, and its definition of empowerment as “making people stronger, increasing their self-confidence, ability, and power to control their own lives” (Freire, 1968).
Categorisation of empowerment by sentence
To present an overview of how the five categories described in “Background and related work” are represented by the sentences from the papers included in this study, we developed Figure 1, which visualises the percentages of all sentences (n=605) that include the word stem ‘empower’ in each category. Figure 1 shows a bias towards discussions of empowerment related to its educational, democratic and functional aspects.

Figure 1. Percentage of sentences containing ‘empower’, by category.

In our survey, two examples of discussions of the educational aspect of empowerment, which focuses on teaching students skills, and also on supporting competence which leads to a sense of agency, are:

Moreover, the focus is from teaching how to use computers – digital literacy, to how to program – informatics, empowering children. (Chiprianov & Gallon, 2016, p. 112)

Computational empowerment emphasises the need to build children’s capacities in at least three respects, which we separate as skills, competence and ‘Bildung’ (Iversen et al., 2018). These differ from the following example, also included in the survey, which illustrates the discussion of the functional aspect of empowerment in CT education, and focuses on enabling students to execute their tasks more effectively and efficiently by using better technological tools:

[…] offers practice exercises, instructional videos, and a personalized learning dashboard that empower learners to study at their own pace in and outside of the classroom, in diverse subject. (Figueiredo & García-Peñalvo, 2017, p. 2)

The democratic aspect of empowerment is concerned with children’s involvement in designing digital technologies in a way that supports their right to participate in decision-making that affects their lives. Two significant statements about democratic empowerment are included in the survey. Pragmatic viewpoints note
that children gain democratic empowerment by having a say in the design of
technology for them, as stated in this example:

Cooperative Design is often revered as a powerful tool to empower users to be part of
the design process and, thereby, having an equitable say in the design of things for them.
(Walsh, 2018, p. 434)

Politically-oriented viewpoints state that children’s participation in design pro-
cesses may itself raise awareness of their presence in the world, and lead to
broader civic involvement, as this example states:

Our primary goals were to leverage computational thinking to empower communities
to communicate about their needs and problems, as well as provide a life-changing
service learning experience for student participants. (Burns et al., 2014, p. 44)

Another important finding concerns the critical and management aspects of em-
powerment, which are underrepresented in terms of the percentage of sentences
concerned with these two aspects of empowerment, compared to the percentages
that address the aspects of educational, democratic and functional empowerment
(Figure 1). The management aspect of empowerment is concerned with moti-
vating people to strive for organisational goals by giving them some power over
how they achieve these goals, as the following sentence, included in the survey, illustrates:

It will be important for future work that we investigate what type of support would most
assist these teachers, and how we can empower them to begin teaching the material.
(Duncan et al., 2017, p. 5)

Although the critical aspect of empowerment is underrepresented in the sentences
in the texts that were included in this study, discussions of critical empowerment
related to CT in education focus on empowering children and students to question
and utilise technology to fight injustice, as described the following sentence,
which was included in this survey:

[...] mission is to empower children by seeing them as active individuals with their own
strengths and possibilities that can shape and give meaning to society, instead of prob-
lem youths. (Schepers et al., 2018, p. 398).

To summarise, the educational, democratic and functional aspects of empower-
ment are the most frequently represented in all 605 sentences, indicating that we
already have good tools and the means to apply them in a CT education.

Empowerment over time
If we go from analysing sentences and qualitative examples to analysing papers,
in Figure 2 we see that in general, papers that discuss empowerment related to CT
in education have increased in number since 2012, with 6 papers in 2012, and
peeking in 2018 with 39 papers that use the term ‘empower’. The increase in the
number of papers that use the term indicates a growing interest in the concept of
empowerment related to CT education. What may also be seen in Figure 2 is that the term ‘empowerment’ has been part of the research communities’ discourse for some years.

**Figure 2.** Number of papers published per year.

![Number of papers published per year](image)

Empowerment in various geographic regions
The geographic distribution of the authors’ institutions of the papers that include ‘empower’ may be seen in Figure 3. This figure illustrates the prevalent characterisation of each paper in relation to the geographic locations of the institutions that contributed papers. The most frequent category of empowerment was recorded for each paper, together with the first author’s institution, to produce Figure 3.

**Figure 3.** Number of papers representing each category of empowerment, by geographic region.

![Number of papers representing each category of empowerment, by geographic region](image)
In the papers whose authors’ are from North America, the discussion of empowerment related to CT education falls mainly into two categories, that is, educational and functional empowerment. Each of these two categories represents one third or more of the papers from this region. In North America, the predominant understanding of the functional category of empowerment is characterised by a focus on the development of specific technologies and tools. The category of democratic empowerment is represented by approximately 10% of the papers, and critical and management empowerment by less than 5% each of the papers from North America.

In Europe, we see a different distribution of the categories of empowerment. As in North America, educational empowerment is the most frequently represented category; it appears in approximately 50% of the papers, whereas functional empowerment is represented by less than 15% of the papers. The democratic empowerment category is represented by 15% of the papers, slightly more than functional empowerment. The management category appears in less than 5% of the papers from North America, and in nearly 20% of the European papers.

In the papers whose authors are from Asia and Oceania, we found roughly the same distribution of categories, as is found in North America.

Figure 3 also reveals a lack of geographic diversity in our research into empowerment in CT in education. The authors of approximately 85% of the papers included in this study were from North America or Europe.

Figure 3 illustrates the considerable differences in the focus of research on empowerment related to CT in education, depending on geographic region, of which we, as researchers, should be aware when designing, reporting and reading about studies in this field.

**Empowerment in the Nordic countries**
With regard to CT education research in the Nordic countries (extracted from the European region), Figure 4 reveals interesting results when we compare with the distribution of papers per category from North America, and from Europe in its broader sense.

In the Nordic countries, mentions of empowerment are mostly related to the democratic and management categories. These categories are most frequently represented, each by approximately one third of the papers from institutions in the Nordic countries, although represented by less than one fifth of the papers from institutions in North America and Europe.
Notably, the democratic and management categories of empowerment are particularly strong in the Nordic countries, and the use of critical empowerment is overrepresented, when compared to North American and European output (including the Nordic countries). In fact, critical empowerment seems to be most frequently represented in literature rooted in the Nordic countries. The educational and functional aspects of empowerment through CT in education seem to be underrepresented in the papers from the Nordic countries, in particular when compared to the papers from North America.

Discussion

We began this study with the hypothesis that empowerment was poorly defined in the current research on CT in education. Moreover, we foresaw an urgent need for a better understanding of empowerment in CT education, with regard to the ongoing and increasing adoption of CT education in primary and secondary schools world-wide. A recent report by Vegas and Fowler (2016) indicated that 44 of the world’s countries (of 219 countries) now offer some kind of CT education as an elective or mandatory course. The report also concluded that there is no one-size-fits-all computer science curriculum for educational systems, schools or classrooms. Instead, countries are adapting their curricula to contextual factors such as regional context and school infrastructure; the objectives of the current school systems are embedded in these (Vegas & Fowler, 2016). Our
literature review provides some important findings related to this global trend, which we discuss below.

**A framework for understanding empowerment in current research**

If research on CT in education is to provide a research-based foundation for integrating CT into national curricula, we need a better understanding of empowerment. Our survey provides an overview of the current use of the term ‘empowerment’ related to CT in education. By applying the categorisation tool developed by Kinnula et al. (2017), we have provided a preliminary understanding of the term ‘empowerment’ in current research. We categorised the 210 papers we selected for this study according to five categories: management, critical, democratic, functional and educational, with an IRR for the 605 sentences of 0.89 (Standard Error: 0.01, Range: 0.86–0.91, with a 0.95 confidence interval). In that respect, Kinnula et al.’s work provides a useful categorisation tool for establishing a better understanding of empowerment in CT education. It is worth mentioning that instances of the term ‘empowerment’ could be easily categorised both in papers that use it as a central concept or objective, and in papers that use it less frequently and more rhetorically. We are aware of the limitations of a categorisation tool that builds on just five forms of empowerment. As we reported in our literature survey, various understandings of empowerment have been developed in a range of disciplines, which could nuance our study. It is also important to note that the categorising framework was developed in an educational setting in the Nordic countries. Therefore, we invite our colleagues in other regions to replicate and further develop our study, as needed. Nevertheless, our analysis provides a point of departure for addressing various understandings of empowerment, and thus for assisting educational policy-making, when adopting CT in national curricula.

**Empowerment is poorly defined in CT education**

All 210 papers in our study use the term ‘empowerment’ as a desirable and positive expression of learners’ involvement with digital technology. Some use the term rhetorically, others more concretely. However, of all the papers included in our study, only one, from 2019, mentions a definition of the term ‘empowerment’. ‘Empowerment’ is a poorly defined term in current educational research, which makes it very difficult to compare and reproduce CT education research related to stated outcomes and goals. Our survey reveals that in a quarter of the papers, especially those from North America, the use of the term ‘empowerment’ is tightly connected to the aim of providing better technologies and tools for introducing CT to education, that is, functional empowerment. In other papers, empowerment is a concern related to people’s awareness of democracy through CT education. CT education research would be significantly strengthened if future research contributions more explicitly present their meaning of empowerment. This would eventually improve our ability to compare and discuss research
results. Perhaps even more importantly, the currently insufficient definition of empowerment in CT education research puts a significant burden on policy-makers who translate research studies into national policy. In the worst-case scenario, the poorly defined term ‘empowerment’ in research on CT education may confuse or mislead policy-makers in their current efforts to introduce CT to many different educational systems worldwide. This field of research will not only improve our ability, as a community, to better understand ‘empowerment’ as described in various publications, but also to achieve the goal of empowering teachers and students through CT education.

The use of ‘empowerment’ based on geographic region
Most of the papers included in this study originated in institutions based in North America (89) and Europe (89), followed by institutions based in Asia (14) and Oceania (13), whereas South American and African institutions are underrepresented. The educational aspect of empowerment generally seems to be the most frequently mentioned, followed by the functional aspect, whereas the critical and management aspects of empowerment seem to be underrepresented in CT education research in regions such as North America, Asia and Oceania, when they discuss CT in education. However, the geographic distribution of the use of empowerment is different when we focus on Europe, and the Nordic countries in particular. In the Nordic countries, the management and democratic aspects of empowerment are of greater concern than in other geographic regions. The extent to which these geographic differences are due to cultural differences or other variables is an important area of research, and should be investigated further. The lack of geographic diversity in CT education research may influence our general understanding of empowerment in CT education. Most of the literature addressed in our survey was authored in the West, which imposes a cultural bias that does not represent the global-level complexity of empowerment and empowerment agendas. We need studies on empowerment in CT education that represent various educational systems and empowerment agendas.

Can Nordic research promote a critical empowerment perspective globally?
The Nordic-based research literature included in our survey suffers from the fact that its definition of the term ‘empowerment’ is poorly defined. This literature also seems to place little emphasis on discussing the functional aspect of empowerment. Given the great prominence of this aspect of empowerment in the literature from North America, the results illustrated in Figure 4 may be interpreted as a reaction to the fact that we already have educational tools from North America. Furthermore, the management empowerment aspect is strong in the Nordic countries, which motivates people to strive for organisational goals that emphasise teacher education. A focus on the Nordic countries reveals that their use of critical empowerment seems to exist at a scale not found elsewhere. The numbers do not reveal why Nordic research has a tendency to emphasise this
aspect. However, one may speculate that the critical thinking that is inherent to the Nordic countries’ educational systems may promote critical aspects of empowerment, also with regard to CT. We believe that the cultural landscape of the Nordic countries, with their focus on critical thinking with respect to digital technology, may stimulate more research on critical empowerment, which could influence CT education research world-wide.

The need for a CT education research agenda that addresses empowerment

Ultimately, our study indicates the need for a more explicit research agenda concerning empowerment in current CT education research. That is, to secure a more palpable body of research literature that addresses empowerment, to support future research and ongoing policy-making. Our aim is not to call for the standardisation of the term ‘empowerment’, but to raise awareness and offer an understanding of the various interpretations that co-exist in CT education research. For a heightened awareness of how to discuss and categorise the impact of CT in education, we hope that leading research communities will embrace the findings of our literature study as a point of departure for future research. Especially, we hope the following four questions can help cultivate future paths for research in CT education:

- How can Kinnula et al.’s categorisation tool be developed to further nuance the various, and perhaps even conflicting, understandings of empowerment in the interdisciplinary field of CT education research?
- How can we, as a community, more systematically identify the various understandings and underlying aims of empowerment that are embedded in CT education research?
- How do we fruitfully acknowledge the cultural biases in the current understandings of empowerment in CT education?
- How can we develop and articulate our understandings of ‘empowerment’ without compromising the diversity and interdisciplinarity of CT education research?

Conclusion

An investigation of how empowerment is used in current research as an objective of CT is both timely and highly appropriate. We have provided a survey of the current uses of ‘empowerment’ in the literature on CT education research. The survey indicates that all but one of the papers we included lack a clear definition of empowerment and a thorough account of their understanding of empowerment. We used the work of Kinnula et al. (2017) on empowerment to develop categorisation guidelines that identify how current research on CT in education applies to five categories of empowerment: management, critical, democratic, functional
and educational. We found that functional, democratic and educational empowerment are overrepresented in current research, whereas critical and management empowerment are underrepresented. We discussed why this line of research is important to both the progress of current research into CT in education and to current efforts to introduce CT in education around the globe.

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