A Systematic Literature Review of Participatory Design Studies Involving Teachers*

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Abstract

Participatory design is a well-known approach that involves stakeholders in designing technologies and other innovations. In education, participatory design is especially advocated for involving students with special needs. However, less attention has been paid to how participatory design can help in collaborations with teachers. This paper presents a systematic literature review of participatory design studies conducted between 2007 and 2017 that involved teachers. A comprehensive compilation of studies was collected from 14 search engines and databases and then analysed, categorised, and synthesised to produce an overview of the current research knowledge on this topic. Three main categories emerged from the review process: environments, practices, and technologies. The environments category of studies considered teachers who were involved in designing physical buildings and technologies that were integrated into the environment. The practices category considered professional communities, instructional planning, and professional development programmes. The technologies category considered assessment and monitoring tools, educational games, learning and teaching applications, security and safety technologies, and technology for special needs. This systematic literature review provides a solid starting point for future participatory design research involving teachers.

Keywords: **education, participatory design, systematic literature review, teachers**

1. Introduction

Participatory design (PD) is an approach that involves stakeholders as decision-makers through collaboration, mutual learning, and stakeholder empowerment (Frauenberger et al., 2015; Halskov & Hansen, 2015; Kensing & Blomberg, 1998; Simonsen & Robertson, 2013). PD is an established approach in the field of Human-Computer Interaction, but it has only recently drawn attention in the educational field. In the book, *Participatory Design for Learning*, PD was proposed as an untapped resource for improving the development, implementation, and sustainability of learning innovations through direct input from educational stakeholders (DiSalvo et al., 2017). Furthermore, some notable studies have been published in special issues of *Instructional Science* (Könings et al., 2014), *Cognition and Instruction* (Bang & Vossoughi, 2016), and *European Journal of Education* (Könings & McKenney, 2017). Despite this, no comprehensive literature reviews exists that systematically examines the possibilities and challenges of PD with students, teachers, and other educational stakeholders.

For this paper, a decision was made to focus on the involvement of teachers. Teachers are often, unfortunately, seen as mere users of new innovations such as educational games or learning management systems (see Cviko et al., 2014, p. 69 and Kyza & Nicolaidou, 2017, p. 263). When these innovations are being developed, typically, teachers are not involved in the design process. For example, a systematic review of

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studies in *Computers and Education*, the highest ranked journal about the pedagogical use of technology, found that of 352 studies, only 30% involved teachers as study participants and only 24% involved stakeholders, whether teachers or not, in co-designing the technology (Pérez-Sanagustín et al., 2017, p. A11). In a large-scale survey in Cyprus, almost half (43%) of the 531 teachers involved said that they had no influence on how technology is introduced into their schools (Vrasidas, 2015). Likewise, the focus in PD studies tends to be on involving the students (e.g. Benton & Johnson, 2015; Druin, 2002; Iversen et al., 2017). Although students' learning is the ultimate goal of education, the teachers' perspectives should not be ignored, especially when introducing new technologies or learning environments.

The method used in this paper is a systematic literature review (SLR) (Brereton et al., 2007; Kitchenham & Charters, 2007; Kitchenham et al., 2010). A SLR involves identifying, evaluating, and interpreting all available research relevant to a particular question or topic area (Kitchenham & Charters, 2007). According to Kitchenham et al. (2010), SLRs can serve two purposes: to answer a specific research question (e.g. 'which is the best option') or to identify and categorise the primary studies in a specific topic area. Both of these objectives are pursued by extracting relevant literature using rigorous inclusion and exclusion criteria. SLRs that aim to categorise are also referred to as 'scoping reviews' (e.g. Major et al., 2018; O'Flaherty & Phillips, 2015) or 'mapping reviews' (Kitchenham & Charters, 2007; Kitchenham et al., 2010). This type of review is valuable as it provides researchers with an overall understanding of a topic where the existing research knowledge is scattered and where even to identify relevant studies is an arduous task.

The objective of this SLR was to identify all PD studies that have involved teachers as the main stakeholders and to categorise these studies based on their research topics. For this purpose, all studies that were published between 2007 and 2017 and included the search terms 'participatory design' and 'teacher' were identified and examined. These studies were collected from 14 different academic search engines and databases. The reason for such a wide search process was that PD is used across many research fields and disciplines, and so relevant research findings are published in a wide range of publications. After the relevant studies were identified, the categorisation was conducted by analysing the research topics included. Three high level categories emerged from the analysis: environments, practices and technologies. Further examination lead to more detailed sub-categories. Although this categorisation was the main purpose of this SLR, it also revealed topics that need further attention: there is a need for longitudinal research and there is a contradiction between teacher and student involvement that requires further investigation. In addition, it revealed a variety of analytical tools that can be used for examining PD initiatives involving teachers.

This paper presents a comprehensive knowledge base regarding PD involving teachers. Although there are some high-quality literature reviews about PD (e.g. Halskov & Hansen, 2015), none have examined PD in the formal educational context, let alone followed the SLR methodology. This SLR can serve researchers in two ways. First, the proposed categorisation provides an overview of previous research on PD involving teachers. Second, it provides a shortcut to relevant studies, as authors, publication years, research purposes, methods and main findings have been extracted from every study and are supplied in the appendix. The rest of the paper elaborates on the PD literature, describes the SLR process in greater detail, and synthesises the categorisation developed.

2. Participatory design

The roots of PD lie in the workplace democracy movement that emerged in the late 1960s and 1970s in Scandinavia. The movement addressed concerns regarding employees' opportunities to influence how, and with what implications, computer systems were introduced into the workplace (Beck, 2002). The foundations of the movement were established through projects that demanded more democratic working conditions, which were to be achieved by increasing workers' influence on the use of technology, on developing new technologies and work practices, and on developing new design methods (Bødker & Kyng, 2018; Gregory, 2003; Iversen et al., 2012). Some of these projects are presented in the book *Computers and Democracy: a Scandinavian challenge* (Bjerknes et al., 1987), which further inspired the expanding PD community (Suchman, 1988). These ideas were disseminated by pioneer researchers such as Susanne Bødker (1987), with *Through the Interface: a Human Activity Approach to User Interface Design*; Pelle Ehn (1988), with *Work-Oriented Design of Computer Artifacts*; Joan Greenbaum and Morten Kyng (1991), with their *Design*

at Work: Cooperative Design of Computer Systems; and Tone Bratteteig (2003), with *Making change: Dealing with relations between design and use.*

Today, PD researchers and practitioners form an established and multidisciplinary community, which is committed, to varying extents, to the original PD ideals (see Vines et al., 2015). Topics such as democratic decision-making and empowering marginalised people are still in the current debate, especially at the community's main venue: the biannual Participatory Design Conference. At the same time, involving stakeholders has become mainstream practice and the pragmatic side of PD, that is developing techniques for involving stakeholders, has pervaded other design approaches as well (Bødker et al., 2000; Bødker & Kyng, 2018; Spinuzzi, 2002). This has led to intensive discussions around what are, or should be, the contemporary characteristics of PD (see Bødker & Kyng, 2018; Halskov & Hansen, 2015; Pilemalm, 2018; Smith et al., 2017).

The essence of PD is the concept of genuine participation (Bødker et al., 2004). It resonates with the idea that people who are affected by a design should be involved in making decisions about it (Greenbaum, 1993; Simonsen & Robertson, 2013). In the *Routledge International Handbook of Participatory Design*, genuine participation is defined as a 'fundamental transcendence of the users' role from being merely informants to being legitimate and acknowledged participants in the design process' (Simonsen & Robertson, 2013, p. 5). Genuine participation is actualised when participants are not just answering questions but are drawing, sketching, and using other ways to explicate their perspectives. This illustrates the extent to which PD is about enabling participants to realise that there are alternative choices, that they can negotiate what they care about in those choices, and that they can influence how the choices are pursued (Bødker, 2003; Bødker & Kyng, 2018; Iversen et al., 2012). Establishing genuine participation requires that participants are provided with access to relevant information, hold an independent position, and have the right to take part in decision-making, and that there are appropriate design methods and sufficient organisational flexibility to make this possible (Clement & Van den Besselaar, 1993; Kensing & Blomberg, 1998).

Establishing genuine participation is challenging because there is no single right way to do it (Schuler & Namioka, 1993). Even when the participants are constantly involved in the design, they can still be held back from influencing any actual decisions (Bratteteig & Wagner, 2012; Frauenberger et al., 2015). For example, this may be the case when participants are present in design meetings but lack the proper concepts and language needed to state their opinions (Bødker, 2003; Simonsen & Robertson, 2013). Thus, genuine participation requires critical reflection rather than simply being satisfied with the fact that stakeholders are involved: it requires questioning who initiates and directs the participation, why certain participants are involved, who these participants are, and who benefits from the outcomes of their participation (Frauenberger et al., 2015; Halskov & Hansen, 2015; Saad-Sulonen et al., 2018; Smith et al., 2017; Vines et al., 2013).

The idea of genuine participation has led PD researchers to identify and define the roles that participants may play in design. Druin (2002) analysed the ways in which children take part in design and defined a framework with four roles: users, testers, informants, and design partners. Users are the main audience for an existing technology, whose practices are investigated to improve the technology. Testers use technology that is not yet released for commercial use, with the aim of developing that technology for a larger audience. Informants play an active part throughout the design process and provide input before, during, and after the technology is developed. Partners are acknowledged as legitimate decision-makers and promoted to a role that equals that of the designers and researchers. Later, this framework was expanded to include two other roles, those of co-researcher and protagonist (Iversen et al., 2017). Co-researchers take part in gathering and analysing data to investigate the context of use side by side with researchers (Duarte et al., 2018), whereas protagonists establish ownership of the design project and carry the responsibility for pursuing it further (Bødker & Kyng, 2018).

A recent emphasis in the PD literature involves a shift in the focus from designing objects towards establishing communities (Bødker et al., 2017; Bødker & Kyng, 2018; Iversen & Dindler, 2014; Saad-Sulonen et al., 2018; Smith & Iversen, 2018; Vines et al., 2015). Coming from this perspective, 'infrastructuring' has become a popular concept (see Bjögvinsson et al., 2012; Dantec & DiSalvo, 2013; Karasti, 2014). This means that the community is understood as an infrastructure that connects technical, social, and organisational aspects and includes people, technology, standards, procedures, and practices (Karasti, 2014). Hence, infrastructuring is the action of building these socio-material assemblies (Bjögvinsson et al., 2012). Bødker

et al. (2017, p. 269) brought this concept into the PD context and defined 'participatory infrastructuring' as being where participants are involved in creating the structures, networks, and agreements necessary for sustainable outcomes. The shift from designing objects to building communities has placed emphasis on both configuring and sustaining PD initiatives. The configuring PD initiative involves exploring the project context, anticipating potential participants, and defining the project's agenda in a way that enables people, practices, and networks to co-evolve (Smith & Iversen, 2018; Vines et al., 2015). When the PD project is over, it is critical that it has developed the necessary resources for its stakeholders so that they may take ownership and responsibility for continuing the project, and sustaining the initiative (Bødker & Kyng, 2018; Iversen & Dindler, 2014).

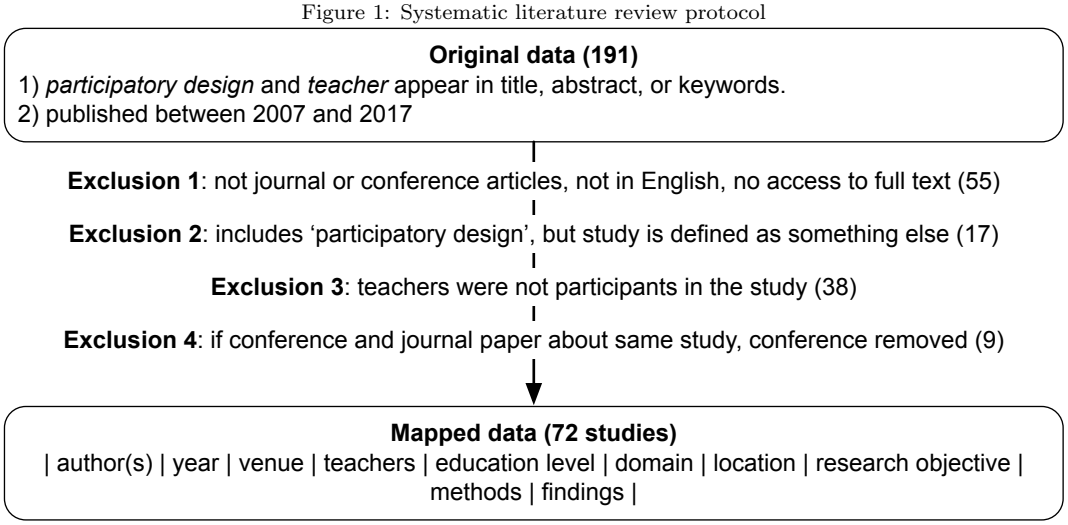
3. Systematic literature review process

Data collection took place across 14 search engines and databases to gather a wide sample of PD literature: ACM Digital library, Bielefeld Academic Search Engine, EBSCOhost Research Databases, ERIC Institute of Education Sciences search, IEEE Xplore Digital library, JSTOR, ProQuest, SAGE Journals, ScienceDirect, Scopus, SpringerLink, Taylor and Francis Online, Wiley Online Library, and Thomson Reuters Web of Science. Criteria for database selection were the possibility of 1) exporting multiple references and 2) exporting references in a Mendeley supported format (RIS, Bibtex, Endnote XML, or Zotero). Thus, Google Scholar, Semantic Scholar, and CiteSeerX were excluded.

References where 'participatory design' appeared in the title, abstract, or keywords, and which were published between 2007 and 2017 were collected. The references from different search engines were imported into the Mendeley reference management tool to build a single reference database (2943 studies). Because two references could have different meta-information and still point to the same source, the duplicates were removed by using a duplicate identification tool. From the reference database, the references that included the word 'teacher' in either title, abstract, or keywords were extracted. In total, 191 references included both 'teacher' and 'participatory design'.

The data refinement process is illustrated in Figure 1. In the first exclusion stage, the references were screened and those not published in a journal or for a conference, or where there was no access to the full text in any of the 14 databases were removed (55 studies). Furthermore, only studies written in English were included, although three studies in Spanish were found. The excluded references consisted of workshop descriptions, research proposals, posters, extended abstracts, introductions to special issues, and editorial notes.

Figure 1: Systematic literature review protocol



Before the second exclusion stage, the full text version for each remaining reference was downloaded. Studies that included the words 'participatory design' but defined the study as action research, user-centred design, or another research approach were eliminated for being beyond the scope of the present study (17 studies). In the third exclusion stage, the studies that did not involve teachers as participants were removed (38 studies). For example, Hussain (2010) stated that 'valuable user perspectives are lost if only information from adult carers, such as teachers and parents are included in the design process' but did not consider teachers any further. Studies that did not define the participants in detail, but obviously considered teachers, were included. The final exclusion stage (9 studies) removed conference papers where the same research was reported in a journal paper.

The following basic information was then extracted to an Excel sheet after reading all studies: author(s), year, venue, participants, number of teachers as participants, other stakeholders, education level, and geographic location. The studies were then scrutinised in greater detail to include three additional information fields to the sheet: research objectives, methods and main findings. Comparing the studies by using these three additional fields revealed that the research objective was the most suitable piece of information around which to organise the studies. Three higher level categories emerged from an analysis of the research objectives of each study: environments, practices and technologies. Further analysis of these categories led to the defining of more precise sub-categories, for example, in some cases, the environment related research objective concerned physical buildings and in others, an online environment. As an outcome of this SLR, these categories and sub-categories are synthesised in the next section.

4. Teachers in the participatory design of environments, practices, and technologies

The 72 studies included are summarised in Table 1. Most of the studies were published in journals (51). The studies considered several educational levels: pre-primary, primary, secondary, and higher education. Seven studies were about PD in teacher education, while six investigated PD in more than one educational level. Most of the studies were small-scale investigations, such as case studies, with no more than five teacher participants. Seven large-scale studies consulted 20 or more teachers. However, some studies did not specify the exact number of teacher participants. Over half the studies were conducted in the United Kingdom, Netherlands, United States, Australia, and Finland, and five studies covered more than one geographic location.

Table 1: Summary of participatory design studies involving teachers ($n = 72$).

Venue	**Education level**	**Number of teachers**	**Location**
Journal: 51	Pre-primary: 2	Not defined: 22	United Kingdom: 16
Conference: 21	Primary: 22	1 – 5: 25	Netherlands: 10
	Secondary: 19	6 – 10: 9	United States: 7
	Higher: 16	11 – 20: 9	Australia: 5
	Teacher education: 7	Over 20: 7	Finland: 4
	Several levels: 6		Rest of Europe: 16
			Asia: 6
			Rest of the world: 3
			Multiple locations: 5

4.1. Environments

The studies related to *Environments* are presented in Table 2. In the largest category, *School buildings*, teachers were involved in envisioning a new school concept or re-design of an existing concept (Burke & Könings, 2016; Könings et al., 2017; Koutamanis et al., 2017; van Merriënboer et al., 2017; Woolner et al., 2007, 2010). These studies generally considered the school building as a whole, including furniture, (technological) equipment, materials, and structures, whereas two of the studies focused on specific facilities:

the university cafeteria (Lundström et al., 2016), and library learning commons (Somerville & Collins, 2008). In the second category, *Technology-enhanced learning spaces*, the studies focused not only on the physical space but also on how technology is integrated into the learning environment.

Table 2: Teachers in participatory design of environments ($n = 15$).

Category	Studies
School buildings	Burke & Könings (2016), Koutamanis et al. (2017), Könings et al. (2017), Lundström et al. (2016), van Merriënboer et al. (2017), Somerville & Collins (2008), Woolner et al. (2007), Woolner et al. (2010)
Technology-enhanced learning spaces	Bossen et al. (2010), Casanova & Mitchell (2017), Cober et al. (2015), Joyce et al. (2014), Kreitmayer et al. (2013), Otero et al. (2013), Stephen et al. (2014)

Regarding the studies in the *School buildings* category, Burke & Könings (2016) examined how a school's history inspires the participants' design imagination. They present an example from the Netherlands, De Werkplaats, a school that was re-designed according to the educational thinking of Kees Boeke. They point out how a historical narrative can be utilised as a positive agent for change, but also that previous traditions from more conservative schools can limit and hinder the potential for design innovations.

Two other studies took place at De Werkplaats. As reported by Koutamanis et al. (2017), visual information technology (Building Information Model) was utilised as a collaborative tool during the building's life-cycle. The tool served as a knowledge repository and a communication service, which enabled the participants to engage in decision-making. van Merriënboer et al. (2017), in turn, addressed the relationship between pedagogy and physical spaces. They framed a three-stage design process: specifying the pedagogy, aligning the chosen pedagogy with seating arrangements and physical learning spaces, and realising the school building. They found PD especially beneficial when teachers' pedagogical needs and architects' non-pedagogical needs (resources, cost-effectiveness) were in contradiction (Woolner et al., 2007). van Merriënboer et al. (2017) conclude that the PD of school buildings is not about the building per se but about negotiating a shared pedagogical vision and establishing a commitment to this vision.

Two methodological contributions deserve to be highlighted: Woolner et al. (2010) described using visual tools, such as photo elicitation, diamond mapping, and map-based activities, to gather the perceptions of various participants and to improve the learning environment. They concluded that the visual methods produce rich understandings of the current school environment and enable the triangulation of participants' different perceptions. The second study developed an interdisciplinary model of practice for participatory building design (Könings et al., 2017). The model integrates an action research cycle, a stakeholder analysis model, a ladder of participation tool, and a participation matrix to address the complexity of involving several different stakeholder roles.

In the *Technology-enhanced learning spaces* category, three studies developed technologies to be integrated into classrooms: an Internet of Things ecosystem (Joyce et al., 2014), a UniPad application (Kreitmayer et al., 2013), and digital displays (Otero et al., 2013). Two studies involved teachers in designing new learning environments where technology plays a major part: Casanova & Mitchell (2017) provided participants with two provocative design space concepts, which were then re-designed. This process resulted in rich data about how the participants conceptualised the learning spaces and the value of technology. Similarly, Stephen et al. (2014) involved teachers and students in designing technology-rich classrooms as 'community spaces' that are owned and maintained together.

Two studies are described in detail because they pay specific attention to teachers' participation. Bossen et al. (2010) reported on a large PD project, iSchool, which was about envisioning new learning spaces and opportunities for pervasive technology. They interviewed the teachers three years after the project ended and examined what they had gained from the project. According to the teachers, the most satisfying experiences were reflecting with professionals from other backgrounds, the enthusiasm of the students in relation to the technology, and gaining experience of using modern technology. Moreover, the teachers expressed four types of gain: the opportunity to reflect on teaching methods, to develop skills and understandings about

technology, to have leverage to influence technology-related decisions, and to advance their own interest in technology.

Cober et al. (2015) analysed teacher engagement in two case studies and investigated what supports teacher participation. They found that the teachers engaged in: theory-driven discussions with researchers and developers to ground design work and to understand each other's perspectives; design partnerships where they provided input, guidance, and ideas; reflecting on the innovations from a pedagogical perspective and evaluating the potential impact for students; adjusting implementation enactments. Regarding the conditions supporting the teachers, the authors highlighted a combination of highly facilitated conditions with flexibility, an atmosphere of trust and partnership, and designing with contextual knowledge about the physical environment, the students, and the potential technologies.

4.2. Practices

The studies in the *Practices* category were about instructional design, professional communities and professional development programmes (Table 3).

Table 3: Teachers in participatory design of practices ($n = 29$).

Category	Studies
Instructional design	Anderson & Östlund (2017), Barbera et al. (2017), Gros & López (2016), Harrison et al. (2017), Janssen et al. (2017), Kuure et al. (2016), Könings et al. (2011), Könings et al. (2010), Könings et al. (2007b, A), Könings et al. (2007a, B), Prins et al. (2016)
Professional communities	Booker & Goldman (2016), Duell et al. (2014), Farooq et al. (2007), Ishimaru & Takahashi (2017), Karimi et al. (2017), Pollock & Amaechi (2013), Selwyn et al. (2017), Tammets et al. (2011), Vakil et al. (2016)
Professional development programmes	Al-Eraky et al. (2015), Goeze et al. (2014), Janssen et al. (2014), Kyza & Georgiou (2014), Kyza & Nicolaidou (2017), Põldoja et al. (2014), Rodrigo & Ramírez (2017), So et al. (2009), Tulinius et al. (2012)

The *Instructional design* category consists of studies about designing learning practices and curricula. Most of the studies were conducted by the same researchers from the Netherlands. Könings et al. (2007b, A) aimed to reduce discrepancies between students' and teachers' perceptions on appropriate learning environments and to design these environments collaboratively. Könings et al. (in 2007a, B) expanded this work by focusing on teachers. In two other studies (Könings et al., 2010, 2011), the authors invited students to collaborate with teachers. Both the teachers and students found PD appealing in this context, but with several challenges: PD takes too much time, students underestimate their capability to decide on educational issues, teachers doubt students' willingness to take part in PD, and PD outcomes were perceived positively by the students involved but not by the rest of the class.

Janssen et al. (2017) defined 'participatory educational design' and conducted a study with three aims: to view classroom teaching as a bounded rational design, to develop a tool that supports participants in mapping and sharing their goals, and to develop another tool that helps participants to explore practical and effective possibilities for designing learning environments. This study demonstrated the use of tools in improving the quality and usability of learning environments and stated that even participants with similar backgrounds benefited from learning about each others' practices and goals.

The remaining studies in this sub-category considered a variety of topics. Barbera et al. (2017) developed learning scenarios to identify 'moments of change', and they describe causes and agents that motivate these changes. Gros & López (2016) examined the Learning Centric Ecology of Resources model to facilitate co-design processes. Two studies considered assessment in teaching: Harrison et al. (2017) explored how to redesign a summative assessment culture that takes into account students' post-assessment feedback, and Anderson & Östlund (2017) considered assessment practices for students who attend special schools. Janssen et al. (2014) developed a PD-based teacher training trajectory for guided discovery learning (GDL) lessons in biology. The teachers were found to be willing and capable of implementing GDL, utilising the heuristics that were developed by experienced teachers, and valuing the GDL at a higher level than regular lessons.

Kuure et al. (2016) supported English teachers in a Finnish university to become designers of language learning with new technologies, and Prins et al. (2016) developed an instructional framework that provides educational designers with a set of prescriptive guidelines for transforming authentic modelling practices.

In the *Professional communities* category, two studies examined online communities: Duell et al. (2014) established a yearly ambassador programme for introducing design thinking as a general competency in K-12 education in Australia. In this study, PD was undertaken to create an online design education platform and to increase teachers' capacity to teach creativity and design. Farooq et al. (2007) developed an online environment for a diverse community of distributed education professionals. The project drew on PD and included four design interventions. The study proposed that the interventions were successful because the community members developed ownership over the online environment and kept using it for long-term professional development and social networking. Karimi et al. (2017) organised a 'hackathon' workshop for teachers, where the teachers experimented with technology and designed learning activities. Because the teachers faced challenges when implementing the digital technology projects, it provided an honest experience of exploring novel technologies and demystifying some aspects of the technical practices.

The other studies in this sub-category were about empowering local communities. Booker & Goldman (2016) examined PD as an approach for tackling maths fears in families by restoring epistemic authority. Pollock & Amaechi (2013) explored how texting can support rapid and individualised communication with vulnerable youth. Selwyn et al. (2017) explored the possibilities of making existing school data available in digital form for teachers, students, and administrators. This study revealed technical, informational, organisational, and social issues in democratising data engagement within school settings. Tammets et al. (2011) examined a teacher accreditation programme that requires the teachers to be involved in a community of practice, collaborative learning, and knowledge building. Finally, Vakil et al. (2016) used the notion of politicised trust to analyse how political and racial solidarity was established, contested, and negotiated through two PD projects.

Two studies in the *Professional development programmes* category were about improving professional development through PD. Kyza & Georgiou (2014) examined PD for promoting teachers' sense of ownership of inquiry-based learning modules. They found that the teachers perceived PD as a collaborative and supportive framework that enables the exchange of different perspectives, encourages critical constructivism, and facilitates new teaching methods and technologies. Conversely, the time-consuming nature of PD, communication problems, and participants' unequal contributions were identified as its main disadvantages. Despite these, all teachers preferred designing the teaching module rather than using pre-made modules. Kyza & Nicolaidou (2017) conclude that an iterative design facilitates teachers' professional development because it enables teachers to reflect on inquiry learning and teaching.

The remaining studies in this category were about training programmes. Al-Eraky et al. (2015) involved teachers in designing a faculty development programme for teaching professionalism in medical education, Rodrigo & Ramírez (2017) developed a master course for online teaching, and Tulinius et al. (2012) designed a programme for teachers to obtain critical appraisal skills and higher academic capacity. Four studies were about developing digital platforms for professional development: Goeze et al. (2014) examined how video case-based learning can promote teachers' analytical competence to become immersed, to adopt multiple perspectives, to apply conceptual knowledge, and to describe pedagogical situations. Similarly, Põldoja et al. (2014) addressed the design challenges of a software solution for self- and peer-assessment of teachers' digital competencies. Finally, So et al. (2009) designed an online platform where teachers can share vivid images of their practices with peers.

4.3. Technologies

The studies related to technologies were assigned to the following categories: *Assessment and monitoring tools*, *Educational games*, *Learning and teaching applications*, *safety and security technology*, and *Technology for special needs* (Table 4).

In the *Assessment and monitoring tools* category, Gillies et al. (2015) developed an application for giving feedback about students' playing posture in music education. They created a prototype, then asked teachers for feedback before developing the next version for evaluation. Rodrigo & Ramírez (2017) developed computer-supported collaborative learning scenarios for monitoring students' interactions. Siozos

Table 4: Teachers in participatory design of technologies ($n = 28$).

Category	Studies
Assessment and monitoring tools	Gillies et al. (2015), Rodríguez-Triana et al. (2012), Siozos et al. (2009)
Educational games	Hoda et al. (2014), Klonari & Gousiou (2014)
Learning and teaching applications	Carmichael (2015), Cramer & Hayes (2013), Girard & Johnson (2010), Hannon et al. (2012), Kalra et al. (2007), Pedersen et al. (2012), Rahamat et al. (2011), Song & Oh (2016), Su et al. (2010), Triantafyllou & Timcenko (2013)
Safety and security technology	Ervasti et al. (2016), Jutila et al. (2015), Pantsar-Syväniemi et al. (2015)
Technology for special needs	Abdullah & Brereton (2015), Bossavit & Parsons (2016), Brereton et al. (2015), Medeiros-Braz et al. (2017), Fage et al. (2016), Herstad & Holone (2012), Lingnau & Lenschow (2010), Parsons et al. (2011), Parsons & Cobb (2014), Mohd Zainuddin et al. (2010)

et al. (2009) reported positive outcomes after involving teachers and students in designing computer-based assessment tools: both teachers and students perceived PD as an opportunity to re-conceptualise existing pedagogies and felt that PD supported locality, diversity, participation, and attitudes that counter impassivity and homogenisation.

Two of the studies were about *Educational games*. Hoda et al. (2014) involved teachers as part of a multidisciplinary team that designed a game for supporting reciprocal teaching and collaboration with children. They evaluated and refined the game through functional testing, teacher trials, and children–teacher trials. As an outcome, the game was perceived as engaging and easily understood by young children. Klonari & Gousiou (2014) described a game for helping teachers to become aware of their pedagogical choices. The game itself was described in detail, but it remained unclear how the teachers engaged in the design of the game.

The studies in the *Learning and teaching applications* category designed technology for dance and environmental education (Carmichael, 2015), financial education (Cramer & Hayes, 2013), STEM education (Hannon et al., 2012; Su et al., 2010), mathematics (Pedersen et al., 2012; Triantafyllou & Timcenko, 2013), and literature (Rahamat et al., 2011). Three studies examined the development of tutoring systems (Girard & Johnson, 2010; Kalra et al., 2007; Song & Oh, 2016). The studies in this sub-category focused on the technologies themselves. An exception was the study by Carmichael (2015), which criticised the assumptions behind education technology development. That is, it raised the risks of designing educational technology based on stereotypical views, such as 'digital natives', and losing sight of practice-based knowledge.

All three studies in the *Safety and security technology* category related to designing a situation-aware safety service. Jutila et al. (2015) examined the technological enablers and requirements for building a safety system, Pantsar-Syväniemi et al. (2015) analysed the design process itself, and Ervasti et al. (2016) analysed the feedback from children, parents, and teachers. Even though the design clearly focused on children, these studies were able to bring together various perspectives from teachers and parents as well.

The largest category was *Technology for special needs*. The studies considered various special needs, such as Autism Disorder, language delays, and cognitive and sensory impairments. Some studies focused on identifying requirements for technology design (Lingnau & Lenschow, 2010; Mohd Zainuddin et al., 2010) or on describing how technology can support these needs (Abdullah & Brereton, 2015; Fage et al., 2016; Herstad & Holone, 2012; Parsons et al., 2011). Medeiros-Braz et al. (2017) emphasised that teachers have valuable knowledge about students' special needs and can envision technologies to support the students' abilities and learning possibilities. In contrast, Brereton et al. (2015) noted that teachers (and other adults) have their own needs, and these may be different from the objectives of students who have special needs.

Finally, two methodological contributions stand out in this category: Bossavit & Parsons (2016) utilised a stakeholder analysis framework to reflect the design process of an educational game. The framework was grounded in PD literature and used to map stakeholder roles, levels of engagement, design tools, and decisions. Parsons & Cobb (2014) addressed the complexity of involving multiple stakeholders: in this case,

teachers and children with special needs. They discussed how the key challenge is to prioritise different stakeholders and decisions. They argue that prioritising each stakeholder equally is impossible and question if an outcome-focused agenda, which aims for efficient technology development, is even possible to combine with the empowering approach of PD.

5. Discussion

Rigorously conducted literature reviews can shape a view of the state of a field of research (Murphy et al., 2017). So far, the research about PD in the educational context has been scattered. This paper contributes by conducting a SLR that focuses on a single, but crucial, stakeholder role – the teachers. An examination of the research topics, why teachers are involved in PD, brought three high level categories to light: environments, practices, and technologies. Studies in the environments category were about designing physical buildings, such as classrooms, or about technologies that were intended to enhance the learning space. The second category, practices, included studies about instructional design, professional communities and professional development programmes. The studies in the third category, technologies, involved teachers in designing assessment and monitoring tools, educational games, learning and teaching applications, safety and security technology, and technology for special needs.

The purpose of this SLR was to search and organise existing research rather than formulating and answering a single well-articulated question. Therefore, the categorisation process was strongly data-driven: to examine what exists and to build a frame to contain a wide body of literature. As Kitchenham & Charters (2007) point out, this kind of SLR can identify evidence deserts and clusters – what needs more attention and what is already known. Becoming familiar with the PD literature and going through a large number of studies brought the following insights: First, there is a need for more longitudinal studies. Second, the contradictions between teacher and student involvement needs more attention. Third, several analytical tools already exist for examining the PD process in the education context.

There is a need for more longitudinal research, showing the impact initiated by PD projects and how these changes are sustained (e.g. Bossen et al., 2010). Many of the studies included were exploratory one-time projects that did not examine situations in the long-term, especially when the research objective was to design new technologies. Typically, a technological artefact would be designed, and the findings from the participatory workshops or meetings would be examined and reported, but without considering the positive or negative aspects when the designed artefact would be adopted into use by the teachers and students at the local school. The call for more longitudinal research reflects a recent discussion in PD literature: the aim of PD should not only be to initiate but to sustain change (Bødker & Kyng, 2018; Iversen & Dindler, 2014).

Examples of research initiatives with a longitudal perspective were based on three different aspects: the individual researcher, a research location or an online community. Karen Könings has been conducting research on PD and teachers for a long time and has collaborated with several other researchers. She was one of the authors in ten of the included studies, which all examined relevant topics such as teachers' perspectives on innovations (Könings et al., 2007a) or teachers as participatory designers (Cober et al., 2015). Furthermore, her long-term research efforts culminated in the aim of defining 'participatory educational research', as presented (Janssen et al., 2017). The second aspect means that three different studies were located at the 'De Werkplaats', a private school based on the pedagogical ideas of philosopher Kees Boeke (Burke & Könings, 2016; Koutamanis et al., 2017; van Merriënboer et al., 2017). Although these studies were not longitudinal as such, it can be assumed that this research context will inspire more research initiatives in the future. Third, one longitudinal research project included was about 'Tapped in', an online community of practice for teachers (Farooq et al., 2007). The emphasis of this study was on how the design interventions executed had managed to maintain the community over a long period of time.

The second topic involved the question of whether to involve the teachers together with the students. Although some studies especially proposed PD as a means for resolving contradictions between teachers' and other stakeholders' needs (van Merriënboer et al., 2017; Woolner et al., 2007) or for reducing discrepancies between teachers and students (Könings et al., 2007b, 2010, 2011), there was little discussion on the benefits or the problems when involving teachers and students together, versus separately. There are good arguments

for both options. For example, Casanova & Mitchell (2017) claimed that dividing students and teachers into separate groups offers a more pleasant environment for both. Woolner et al. (2007) warned that the unique perspectives of teachers may be pushed into the background if the students and teachers are together. Thus, the point here is to explicate the reasoning for the decision made, as most of the reviewed studies contented themselves with stating their stakeholder roles without ever discussing these decisions.

In general, plenty of analytical tools exist for conducting PD, such as the Actual Role Analysis in Design (Barcellini et al., 2015), the multimodal analysis method for evaluating participants' actions by Malinverni et al. (2016) or the decision-making framework for analysing participation from a political perspective by Bratteteig & Wagner (2016). This SLR revealed analytical tools that are designed specifically for the educational context. For example, the use of visual methods for investigating participants' experiences and for understanding the particular school environment (Woolner et al., 2010), a mapping tool for collecting the specific contributions made by each participant and who made the decisions at the different stages of the design (Bossavit & Parsons, 2016), a framework for an interdisciplinary model of participatory building design (Könings et al., 2017), and the laddering and building blocks tools presented by Janssen et al. (2017). As these tools were identified from the studies about PD with teachers, they are potentially helpful for researchers on this topic. Furthermore, new methodological innovations can be evaluated by reviewing what additional value they offer compared to these existing ones.

Regarding the quality of this study, Kitchenham et al. (2010) note that SLRs are supposed to be as unbiased as possible by being auditable and repeatable. The strength of this SLR is that the studies were collected from 14 academic search engines and databases, which is a very wide scope for a SLR. However, it needs to be noted that some studies may not have been available when the data collection was carried out at the beginning of 2018. The data collection procedure can be repeated by using the reported exclusion criteria, which would allow external validation and increase the study's reliability. The exclusion criteria were designed to be as verifiable as possible, for example that an included study needed to be in a journal or a conference paper. The excluded studies, and the reasons for the exclusion, were recorded and are available on request.

Although SLRs are meant to be unbiased, Alexander (2020) raises the point that the theoretical orientations of those who conduct the SLR necessarily affect the topics, search procedures and outcomes of any SLR. The first stage of this SLR was to include the references with the search terms 'participatory design' and 'teacher'. It is reasonable to question how many potential studies with a high degree of teacher involvement were left out because they did not include the words 'participatory design' in the title, abstract or keywords. In turn, there is an ongoing debate of what constitutes genuine PD, even within the PD community. In this SLR, the decision was made to rely on the authors' own judgement: if the study explicitly defined itself as PD, it was included and otherwise, it was not. Furthermore, the categories developed should not be taken as definitive. Deciding the right category for each paper was challenging, because some of them could belong to many categories. For example, the study by So et al. (2009) was put into the practices category, as it examined teachers' professional development. However, it could also have been put into the environments or technologies categories as well, as it also considered online environments and the outcome of the study was an online video platform.

Finally, a possible future research option could be to review the so called 'grey literature' (Garousi et al., 2019). This SLR included only studies that were published in either conference proceedings or journals. However, novel insights might be found in venues that are not typical research-oriented publication venues, such as blog posts, white papers, workshops or artistic exhibitions. As PD projects are often quite explorative, where the value is to experiment with something completely novel, it may be difficult to publish this kind of work in conventional research articles. Furthermore, this SLR included only studies written in English. The PD community itself has recognised that a requirement for English can limit the possibilities for publishing research done in countries where English is not a mainstream language. Hence, the most recent PD conference had a dedicated paper track for contributions written in Spanish or Portuguese. This is definitely something that future SLRs should take into account.

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