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Facebook is not a silver bullet for teachers' professional development: Anatomy of an eight-year-old social-media community

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ABSTRACT

Online communities and social-network sites are used to deliver professional-development services for teachers. Professional development should help teachers to reflect on their practice and improve in helping them to guide students' growth. Peer and community models, such as coaching and sharing knowledge in network and knowledge communities, have been proposed. Recently these practices have been taken into use in social media services, such as Facebook. Although earlier research has examined teachers' online communities, we move beyond understanding individuals motivations and examine community-level dynamics. Understanding these dynamics is important to understand the interaction between teachers, resources and the platform in use and resulting professional development. To understand the evolution of an informal and self-organised Facebook teachers' group, containing nearly 20,000 teachers, its eight years of activity was analysed by employing a mixed-methods research design; data science and participatory observation. Analysis gives account of both the evolution of participants' engagement and activity, and the evolution of content and its relevance for teachers' professional development. The results suggest that managers of professional development need to consider how to facilitate participation in order to focus on pedagogically motivated use of information technology, for system developers to consider how to assist recruitment of members and sustain their activity, and for all stakeholders to acknowledge that a peer-organised online professional development community requires significant effort. Furthermore, we suggest that instead of addressing large groups like these as communities, scholars and practitioners should instead see them as personal learning networks and think about how to establish smaller and more manageable groups as communities.

1. Introduction

There are increasing demands to improve teachers' capabilities to use ICT in education. Shortcomings in teachers' ICT skills have been reported across Europe (Hämäläinen, De Wever, Nissinen, & Cincinnato, 2019). Such skills have both technical and pedagogical components (Ananiadou & Claro, 2009); however, often the attention in schools focuses on the former, technology and technical skills, without consideration of the pedagogical opportunities and challenges new technology may bring. However, various investments in

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digital infrastructure and technology have not improved ICT use in education (Wastiau et al., 2013). In order to improve the use of ICT in education there is a need to support teachers' professional development, in the domains of both technology and pedagogy.

Online communities and social media groups have been proposed as tools to assist in teachers' professional development.¹ There are many motivations for school systems to use this method. It appears to represent a cost-efficient model for professional development (U.S. Department of Education, 2009). In an online community, teachers are expected to develop their professional skills without the costs of external tutors or instructors. Neither are there time use related costs for the system: the teachers are off-duty when participating in online communities, in a sharp contrast with traditional professional-development programmes. Furthermore, learning from one's peers may be viewed as authentic and easy to introduce in local settings. Such learning tends to be rooted in real-world cases, which renders it easier to integrate into personal, professional practice (Dede, Ketelhut, Whitehouse, Breit, & McCloskey, 2009; Trust, Krutka, & Carpenter, 2016). Furthermore, the emergence of self-organised groups to support professional development is afforded by social media services, making it easy to establish online communities (Lantz-Andersson, Lundin, & Selwyn, 2018; Macià & García, 2016).

In response to these changes, research on teachers' professional development has increasingly shifted its focus onto informal professional development taking place outside specific organizational contexts (Lantz-Andersson et al., 2018; Luo, Freeman, & Stefaniak, 2020). However, research is focused on participants' perceptions and experiences, especially questions about information sharing and filtering and emotional support (Lantz-Andersson et al., 2018; Luo et al., 2020; Macià & García, 2016). However, research on informal groups has not examined the evolution of these groups and their focus (identified as a research opportunity in Macià & García, 2016; Lantz-Andersson et al., 2018). To understand these difficulties we studied the evolution of participation level (RQ1), a challenge commonly facing online communities (e.g., a classical problem initially observed by Ortega, Gonzalez-Barahona, & Robles, 2008). Additionally we studied themes of content (RQ2), which should inform us whether the online community focuses on examining the pedagogical use of ICT in school environments. Previous research has already identified how social media platforms are used to share information and to seek for emotional support (e.g., Luo et al., 2020; Macià & García, 2016), but to what degree, and when, remains unknown. The combined research focus on both people and content captures what is seen as essential in professional development through social media (Prestridge, 2019).

To understand the evolution of people and content, we examined an informal and self-organised Facebook group set up by teachers and other education professionals aiming to enhance teachers' ICT use in school contexts. We were able to analyse a full eight years' activity of the group's approx. 20,000 members, facilitated by a research approach employing a mixed-methods design. We used advanced data science methods to extract information about participants and the content they have produced. We supplement these insights with participatory observations we have gained as community members.

The article is structured as follows. First, we review previous research into teachers' professional development and identify previous results from online communities which have been established for this purpose. Based on these, we identify research questions, motivated through previous work and gaps in the knowledge. In Section 4, we describe the settings and Facebook group in detail, explain our research design and describe the data and methods used. In Section 5, we provide empirical results for the research questions. Finally, we summarise and contextualise our results in related literature and discuss key issues our work heightens for academics, professional development managers, system developers and other stakeholders.

2. Background

2.1. Teachers' professional development

It is well known that teachers' professional expertise affects students' learning (e.g., Darling-Hammond, 2000; Rhoton & Stiles, 2002). Due to this, teachers' professional development has been recognized as an important policy action for improving the quality of education (e.g., Li & Dervin, 2018). However, Hofman and Dijkstra (2010) argue that there is no one-size-fits-all solution for cultivating further professional expertise. In particular, many traditional programmes provide teachers with new knowledge and skills while neglecting reflection on how to apply these in their own practice (Darling-Hammond & McLaughlin, 1995).

Research on professional development has concluded that focus should be on helping teachers examine their practice and improve in helping them to guide students' growth (Avalos, 2011). Many consider such goals as not within the reach of traditional professional-development interventions, such as workshops or lectures. In their view, development efforts should instead centre on reform activities and open-ended models that support professional learning. These have demonstrated a slightly larger impact on teaching effectiveness (Garet, Porter, Desimone, Birman, & Yoon, 2001).

Reformist open-ended models include support for **reflection**: helping teachers in self-assessment (per Ross & Bruce, 2007), in engagement in self-directed learning (see James & McCormick, 2009; Mushayikwa & Lubben, 2009), and supporting teacher autonomy via pedagogical research (Castle, 2006), etc. In parallel, **external** support helps in professional learning – such as observation by external agents and feedback on teaching strategies (Kraft, Blazar, & Hogan, 2018; Ross & Bruce, 2007). The challenges of external efforts are related to scaling such activities without reducing their educational impact (Kraft et al., 2018).

To address challenges of scalability, researchers have proposed **peer** and **community models** for professional development. Such

¹ For reviews and focused on this topic, see Lock (2006), Dede et al. (2009), Lomos et al. (2011), Macià and García (2016), Lantz-Andersson et al. (2018) and Luo et al. (2020). Landmark projects include eTwinning (Crawley, Gilleran, Scimeca, Vuorikari, & Wastiau, 2009; Gilleran, 2006), TappedIn (Farooq, Schank, Harris, Fusco, & Schlager, 2007; Schlager & Schank, 1997, pp. 234–243).

interventions include coaching, sharing knowledge through networks, and knowledge communities (Kraft et al., 2018; Olson & Craig, 2001; Ross & Bruce, 2007; Trust et al., 2016; Vangrieken, Meredith, Packer, & Kyndt, 2017). According to Westheimer (2008), the strength of teachers' professional communities lies in professional development that builds on their experiences and needs: teachers, rather than external consultants, are the ones who provide learning content. This approach is considered to support sustainable improvement in education by fostering teachers' engagement in continuous professional development (Dede et al., 2009; Trust et al., 2016; Vangrieken et al., 2017).

In addition to professional development, community-based models increase collegial support and social cohesion in the school (van Meeuwen, Huijboom, Rusman, Vermeulen, & Imants, 2020) and may also yield ideas for the entire school's development (Kraft et al., 2018). Therefore, it may be argued that peer- and community-based models can scale well; their focus and integration into work practices may have a high impact on organizational development. Indeed, studies attest that well-developed teacher communities have a positive effect on teachers' effectiveness, teaching practice and students' achievement (Lomos, Hofman, & Bosker, 2011; Moolenaar, Slegers, & Daly, 2012; Vescio, Ross, & Adams, 2008; Voelkel & Chrispeels, 2017).

In summary, while many approaches are available for teachers' professional development, scholars and practitioners have recently turned their attention to studying professional development that takes place in social contexts, such as communities of professionals or a school environment. This shift is afforded by increased technological abilities. Online spaces have long been considered a promising or suitable context for supporting professional communities engaged in peer learning (e.g., Luo et al., 2020; Macià & García, 2016; more extensively in Section 2.2).

2.2. Professional online communities for teachers

Teachers have many reasons to participate in online communities designed for professional development. Just as in traditional (offline) learning communities, they receive help and support, demonstrate their expertise, and discuss new ideas related to their work (Trust, 2012; Trust et al., 2016). They share interests, experiences, and materials; request assistance; pose questions and offer answers; participate in discussion; and provide and receive emotional support (Bret Staudt Willet, 2019; Macià & García, 2016).

Historically significant effort has been put into officially implemented and specially constructed communities for teachers' professional development. For example, from 1997 to 2013, Tapped In served as a community for professional development in the United States. A study looking at the practices in the Tapped In -community recognized collaboration, sharing, social support and collegiality (Schlager & Schank, 1997, pp. 234–243), mirroring findings from offline professional learning communities. Similar efforts have been introduced also in Europe, including eTwinning, Scientix, the European Schoolnet Academy and Edmodo.² These custom-build services for professional development provide diverse tools to encourage teachers to participate, share resources, ask questions, and take part in group discussions (Trust, 2012).

However, as the technology landscape has changed, professional development has increasingly moved to informal professional communities and bottom-up platforms such as Twitter and Facebook (Luo et al., 2020). An extensive body of research has examined how teachers use these platforms (Bledsoe & Pilgrim, 2016; Bret Staudt Willet, 2019; Forte, Humphreys, & Park, 2012; Gunawardena et al., 2009; Johnson, Bledsoe, Pilgrim, & Lowery-Moore, 2019; Manca & Ranieri, 2016; Ranieri, Manca, & Fini, 2012; Wesely, 2013).

The key result from this rapidly increasing literature on informal professional communities is that many positive effects identified in offline and officially implemented professional development efforts are present here as well. Reviews of the literature show that, as with other professional development mechanisms, teachers can share new ideas, obtain emotional and professional support, strengthen their professional identity, and increase their social capital (Lantz-Andersson et al., 2018; Luo et al., 2020; Prestridge, 2019). These do have drawbacks, though. Social-media communities are limited in their support for critically oriented discussion (Tsiotakis & Jimoyiannis, 2016), with further challenges evident in uneven participation (Rehm & Notten, 2016) and in blurring of the distinction between professional and personal time, which can leave some teachers feeling overwhelmed (Davis, 2015; Wesely, 2013). Prestridge (2019) has suggested that teachers' professional development via online learning could encourage consumerism as opposed to a contribution culture. Notwithstanding these negative aspects, scholars have been optimistic about its opportunities for professional learning.

Beyond understanding opportunities and challenges for professional learning, scholars have extensively examined what motivates someone to use bottom-up online communities for professional development and what people do within them. Prestridge (2019) has highlighted that teachers' use a range of approaches from more socially oriented to individualistic ones, and that some focus on contributing content and others on receiving it. Another study by Prestridge, Tondeur, and Ottenbreit-Leftwich (2019) suggested an additional difference between the orientations to online communities for professional development: resource-seeking vs. a more collaborative, 'sharing' orientation. Analysing Facebook posts by five U.S.-based professional organisations for teachers, Bledsoe and Pilgrim (2016) found that the posts shared and 'Liked' most were those containing teaching tips and teaching resources. Also, a study by Johnson et al. (2019) revealed that the mutually engaging relations in a Twitter discussion aimed at teachers' professional development motivated the participants to contribute while also creating a space that served to promote collaborative practices and knowledge co-construction.

Another line of investigation has focussed on the content produced. Researchers have developed typologies of content in social media communities for teachers' social media presence. Beyond thematic classifications of content (e.g., Bret Staudt Willet, 2019),

² See <https://tappedin.org/>, <https://www.etwinning.net/>, <http://www.scientix.eu/>, <http://www.europeanschoolnetacademy.eu/>, <https://www.edmodo.com/>.

only a few scholars have focused on the potential this content has for professional development. A rare exception is van Bommel (2020), who showed that while 86% of content offers opportunities for professional learning, only 11% of threads demonstrated that learning took place.

These studies demonstrate that teachers are willing to use informal and bottom-up communities for professional development and find value in them, even when the individuals vary greatly in their behaviour and motives for use. However, scholars have not looked closely at the sustainability and success of these communities. Given their bottom-up nature, one must understand both the individuals and the community-level dynamics as, after all, these are peer-organised communities.

3. Objectives and research questions

Our objective is to study the community dynamics within a self-organised group of teachers engaged in professional development. While research has examined professional communities and their use, the question of community-level dynamics is still open (this gap has been documented by Lantz-Andersson et al., 2018; Lomos et al., 2011; Macià & García, 2016; Parsons et al., 2019). Understanding these dynamics are of utmost importance as the professional development outcomes in these groups emerge from the dynamics between people, resources and the platform environment (Trust et al., 2016). Thus, understanding the dynamics can help to improve the professional learning goals. Our study uncovered these dynamics from two distinct perspectives.

The first approach was to view the dynamic from the perspective of participants and their activity. While it is easy to establish communities in online domains (hence, many are in place to support professional development for teachers; see Prestridge, 2019), sustaining the community is often more challenging. For example, online communities often demonstrate unequal participation, which limits knowledge-sharing and renewal of the community (Huang, Dasgupta, Ghosh, Manning, & Sanders, 2014, pp. 117–126; Nelimarkka & Vihavainen, 2015; Ortega et al., 2008; Rehm & Notten, 2016). In our this study we explored via the question:

(RQ1) How does the participants' activity level evolve in the community?

Secondly, an approach to the dynamic was undertaken from the perspective of content within the community. Sharing and co-creating knowledge are seen as important mechanisms of peer-learning (Prestridge, 2019; Prestridge et al., 2019), and in the context of ICT use in education, the specific problem relates to developing pedagogically well-grounded use of ICT in schools (Anderson & Dron, 2012; Mishra & Koehler, 2006). However, increasing concerns have been raised about the ability of online discussions to provide benefits for professional development (van Bommel, Randahl, Liljekvist, & Ruthven, 2020). To understand how well the Facebook group is able to address the challenges identified, we ask:

(RQ2a) What themes are discussed within the case group?

(RQ2b) How have these evolved over time?

Our quest for answers to these two questions led to fuller understanding of the dynamics of self-organised professional development. We will draw attention to how this research and its approaches could be used, not to analyse community dynamics so much as to facilitate community management and facilitation.

4. Data and methods

4.1. Research context

We studied a self-organised Facebook group for teachers, that focused on pedagogical ICT use in Finland. The Facebook group was founded to address the above-mentioned challenge: helping teachers to improve ICT use for educational purposes. The pressing challenge and need for professional development in this area has been suggested in various recent national studies, as the use of ICT in education is low, even though investments for ICT infrastructures have been made (Hämäläinen et al., 2019). Historically, there have been various efforts to improve this situation: Several policy-level efforts to improve ICT utilisation in schools during the early 1990s were followed by various initiatives to improve ICT-related confidence and technology use in schools. These ranged from non-formal, in-service training days to development projects and conferences in various scales, stretching from local schools and school districts up to national events.

Following these efforts, there has been a shift toward peer- and community-based approaches for professional development. Many school organizers, the Educational Trade Union of Finland and other organisations working with teachers professional development, organise events to promote sharing best practices. Community and peer-based models are well suited to the Finnish context, as teachers in Finland are highly educated; formal requirements for teachers include a master's degree qualification. Furthermore, teachers employ, and, in fact, prefer, modes of self-guided professional development (Toikkanen & Leinonen, 2017, pp. 239–248).

The Facebook group was established in this social context in 2010 to support teachers' dialogue and peer learning concerning ICT use in education within Finnish language education and for a Finnish-speaking audience. This group was set up by a well-known figure among Finnish educators and grew organically, with no government offices, companies, or researchers involved. The group's founder also remained as the sole moderator of the group during the study period. In marked contrast to many online communities, the bottom-up organised community aimed to support teachers' professional development. The group has grown significantly and, when we began our study, it had a membership of 19,298. However, the group was, nevertheless, rather lean in its organisation and no systems to organise information, such as tagging, were in use.

Historically, the group does extend previous efforts for bottom-up organised support for teachers' professional development. The first large-scale, national level online community for teaching professionals in Finland was created in 2007; Sometu, on the Ning platform (Hintikka, 2008). In addition to Ning, the community actively used the Jaiku social-networking service, which is similar to

Twitter. Until 2010, Sometu was highly active, with nearly 5000 members, but the community started to disintegrate when Ning's free service was suspended and Jaiku's future under Google became unclear. The continuity of this history of online communities for professional development suggests that teachers are able to use such tools and develop sustainable practices for online communities.

4.2. The research design

There are many approaches scholars could take to study online communities, such as the Facebook group in question. The traditional approach would utilize participant-observations and other ethnography-inspired research (Kendall, 1999; Schroeder & Bailenson, 2008). Nowadays, the research is increasingly conducted with data science methods, such as network analysis or automated content analysis. Both approaches have limitations. Participant-observations are limited in scale and extent, but data science approaches do not always acknowledge the context critical for interpretation (e.g., Boyd & Crawford, 2012) and require extensive validation (e.g., Grimmer & Stewart, 2013). Therefore, we opted to conduct a mixed method research which combine qualitative and computational approaches (e.g., Laaksonen et al., 2017; Muller, Guha, Baumer, Mimno, & Shami, 2016).

4.3. Data and methods

We collected all posts, comments, and reactions presented in the Facebook group between its establishment and the end of 2017. The data was gathered via the Facebook application programming interface (API), which at the time of data-collection allowed access to the content of public groups. The dataset consists of 95,061 contributions, made by 5107 unique users, over the seven-year span. If we also encompass the 'Likes' and other reactions for messages posted in the Facebook community, the total number of engaged users totals 13,477. Due to restrictions in the API, we are not able to extract people who did not interact with the content, such as those users merely lurking in the community.

We study the participants' activity level (RQ1) through the evolution of the active user-base and the distribution of activity within it. In this case, an active user is any user who has posted at least once, commented on, or reacted to content in the Facebook group. Since exact timestamps were available for posts and comments but not for reactions, we estimated the reactions' timing on the basis of the post or comment responded to. Our analysis is based on identifying each user and the user-specific number of contributions for every month covering 2010–2017. To capture the potential unequal levels of participation, we calculate the Gini coefficient for each year. This coefficient indicates the balance of contributions within the group: If all members provide the same amount of content, the Gini coefficient would be 0, and a value of 1 would denote a single user creating all the content. These two approaches, combined, allow us to speak about the community's life cycle with the knowledge of the level of members' contributions.

We study the thematic focus (RQ2) using automated content clustering. While there are many approaches to this, we opted to use topic models³ which extract 'topics' from the data. This approach has been demonstrated to work well in order to extract meaningful thematic groups from unstructured text documents (e.g., Blei, 20,212; Baumer, Mimno, Guha, Quan, & Gay, 2017). Specifically, we used the Structural Topic Model with its default settings (Roberts, Stewart, & Tingley, 2019). Topic models compute a prevalence score for each document and for each topic. This value indicates how much of the document (from 0% to 100%) is covered by a particular topic. The higher the prevalence, the more relevant the document is to a particular topic. Topic models also provide a second output. Alongside the relationships between documents and topics (prevalence), for each topic, there is a keyword list that can be used to interpret the meaning of the topic (Blei, 2012).

Automated content clustering methods require pre-processing the text for analysis. Firstly, the words were transformed into their base form (the lemma), and punctuation and numbers were removed, as were rare, common, and stop words, in accordance with best practices (Denny & Spirling, 2018). This included making sure that words with the same stem but various suffixes (common in the Finnish language) were correctly identified as a single word. Furthermore, topic modelling is sensitive to the various parameter choices, such as the number of topics (k). To avoid our subjective biases to impact this stage (Nelimarkka, 2019), we conducted statistical optimisation which resulted in 42 topics.

The final step in the thematic analysis was to carry out reflexive grouping of topics by theme, applying established qualitative research practices (Guest, MacQueen, & Namey, 2011; Silverman, 2016). Since topic models lead to more abstraction than classifications that emerge from human labelling – e.g., through a grounded-theory process (Baumer et al., 2017) – we regarded the topics as 'open codes', which we analysed in light of the keyword list for each topic, reading high prevalence sample posts for each topic. This step loosely corresponds to what is referred to as the axial coding stage. We collegially discussed interpretations of the topics and allowed meanings to emerge from these conversations. Based on this collective discussion and reflections from participant-observations, we merged topics into thematic categories with meanings relevant to the research question. It must be stressed that this stage always requires subjective interpretation, as per the more traditional qualitative research approaches. In Section 5, we cite examples that support and clarify these interpretations. Thereby, the reader need not blindly trust our subjective conclusions but can see illustrative vignettes that back up our arguments.

In online community research, the question of ethics is always present. The ongoing ethical debates ponder whether scholars can use data from semi-public sources for research purposes (e.g., Markham & Buchanan, 2012). Given the case community's size and

³ In education research, topic modelling has been applied in the development of interactive systems. For example, novel text-summarisation systems have been proposed that employ this method extensively (e.g., Atapattu, Falkner, & Falkner, 2017; Yang, Chen, Sutinen, Anderson, & Wen, 2013). In contrast, we utilised it as a community-analysis method, following social-science-oriented approaches.

prominence in Finland, as well as its relaxed attitude to even non-professional people joining it, we consider the Facebook group to be a public space. Therefore, we find it justified to analyse the material from this group just as we would analyse any public discussion. To respect individual users' privacy, we anonymised the contributions and conducted analysis at the community level only. Aggregate statistics are reported here. With regard to another critical aspect of research ethics, in avoidance of harming members of vulnerable groups during the research, we believe that the ensuing discussion and debate in the Facebook group studied could be of potential harm to the community (Markham & Buchanan, 2012), but, at the same time, we consider that reflection and reflexivity are critical for evolving communities of practice. Accordingly, we consider our work a necessary contribution to the community and a positive force for its further development. We will monitor the group and, for healthy dialogue and development, respond to reactions to this paper there.

5. Results

5.1. Evolution of activity among members

As Fig. 1 shows, the total number of active participants increased rapidly from late 2013 and reached its peak in late 2015. After that, 2017 witnessed a steady decrease in the number of active members. Clear seasonal effects are also visible in Fig. 1: The count of active members increases during the fall semester, dips during the winter holiday period, increases during the spring semester and dips again during the summer holiday period. Due to the limitations of Facebook APIs, we cannot ascertain the number of people who consume content but do not produce it themselves. Therefore, we have been inclusive in our definition of 'active user' to also include 'lighter' forms of engagement i.e. 'Likes' and other such reactions. We observed that about 10% of all members were active in some way at the end of the time span considered. This is roughly in line with the 1–9–90 rule that characterises many such online environments: 1% produce original content, 9% comment on it, and 90% merely view it (e.g., Ortega et al., 2008).

However, while the number of active participants increases, the level of participation across active participants is highly unequal (see Table 1). Among those who contributed content, some members were extremely active while others were relatively passive. Temporal analysis showed that the inequality in active participation rose from 2010 to 2014, then decreased from 2015 to 2017. This suggests that the community may have grown more balanced in the final three years, with either several 'super-participants' becoming less active, or some other users becoming more engaged.

To examine possible reasons for the changes in the distribution of members' activity, we conducted *post hoc* analysis that considered users in terms of activity bands; those with an activity level of 1–5 actions (the median for all users was about 5), 6–10 actions (roughly corresponding to the second most active quartile of users), and more than 10 posts (corresponding to the most active quartile of users). As Table 2 shows, the increase in equality as indicated by the Gini coefficient seems to stem from super-participants being less involved from 2014 onwards. There appears to have been greater balance between those and other active members since then. The most active members might have lost some interest in the community.

While those users may have concluded that the community no longer needed a strong push, our results clarify that most members were still passive and only a few were active producers of new content. We stress that, while activity levels showed greater balance in the most recent years, this appears to be due to a decline in highly prolific members' activity rather than an increase in that of previously less active members. As Table 2 shows, roughly 70% of members made only a few content contributions per year. This suggests that the community has not drawn most of its members into active creation.

Considering the downswing after the initial strong growth in engagement, rapid decline began after approximately six years. From the data, the engagement level appears to be falling rapidly. Our observations are in line with prior research on large online communities and their development (Huang et al., 2014, pp. 117–126; Nelimarkka & Vihavainen, 2015; Ortega, Gonzalez-Barahona, & Robles, 2008) with regard to the participation-related challenges that all online communities face: Increasing members' activity level may be difficult, but if this is not achieved, a reduction in activity on the part of the most active users affects the whole community.

5.2. Discussion themes

To answer RQ2, we carried out structural topic modelling of the data and interpreted the topics in light of the authors' experiences with the Facebook group. The modelling process arrived at 43 distinct topics, from which we identified five thematic groups by merging the topics: 1) **tools, apps, and infrastructure**; 2) **teaching and learning**; 3) **professional development**; 4) **social functions**; and 5) **society and technology**. These five clusters account for 71% of the discussion, while those without interpretations relevant to our research question⁴ accounted for the remaining 29%. Our thematic groups were identified from the words used frequently in connection with each topic, the example context and our personal experience. Table 3 characterises the common words and example material for each of the five thematic groups.

Thematic group 1 focuses on hardware in school environments, discussion of services such as Google and YouTube and conversation about teaching materials. The common words suggest a focus on hardware and services, and not on content or on the execution

⁴ Such topics are common in application of topic models (e.g., Jacobi, van Atteveldt, & Welbers, 2016). For example, our modelling identified a topic connected with generic school-related vocabulary and one for Finnish words referring to emotions and beliefs. While these constitute clear groupings in a linguistic sense, they do not provide insights into the orientation of the discussion. Given the focus of RQ2, we did not analyse these topics further.

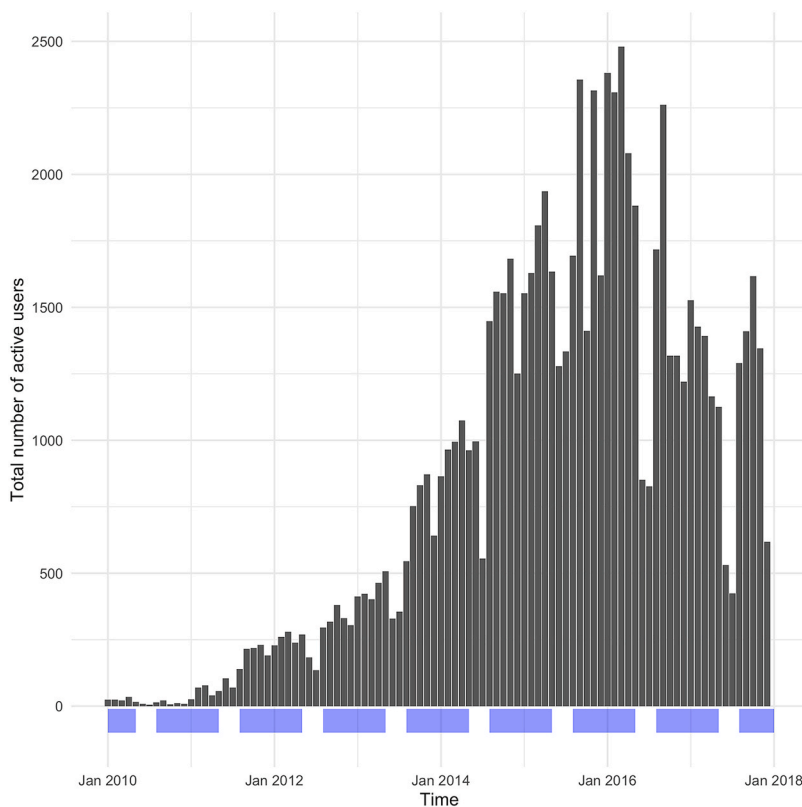


Fig. 1. The total number of active users over time. Blue boxes indicate school years. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

Table 1
Group participation evaluated through Gini coefficients per year (0 = highly equal participation, 1 = highly unequal participation).

Year	Participation Gini
2010	0.738
2011	0.747
2012	0.754
2013	0.761
2014	0.751
2015	0.707
2016	0.671
2017	0.646

Table 2
Breakdown of users by activity band (%).

Year	Number of actions		
	5 or fewer	6–10	Above 10
2010	88.6	6.3	5.1
2011	66.7	14.0	19.4
2012	62.6	10.9	26.5
2013	56.9	18.4	24.7
2014	69.9	12.9	17.3
2015	71.7	11.8	16.5
2016	75.3	11.6	13.1
2017	76.5	12.0	11.5

Table 3
Common words under each theme.

Theme	Example keywords (in translation)	Example content (translated by the authors and edited for length and clarity)
1) Tools, apps, and infrastructure	computer, tablet, to log in, account, material, book, content, problem, system, to require	‘We use TrueTouch displays. They are HID devices, so there is no touch delay. The picture is bright enough, and the colours are good.’ ‘The opportunities are Windows-based (like laptops), Android-based (Google’s OS – for example, used by Samsung and 10 others), or Apple’s OS (iPads).’ ‘At the same time, we can fix the IT architecture in other of the city’s schools also. So if you have money reserved for this, you can fix things for all schools at the same time.’ ‘Material from [service] costs only a fraction of paper books’ price. Online materials include many interactive materials, exercises, exams, and so on.’ ‘Control – in its traditional meaning – takes away ownership [of learning]. Ownership is critical for learning. Without some degree of ownership, it is difficult to deep-learn the subject matter.’ ‘What students do is what they learn. But you cannot measure everything. This type of learning during free time is voluntary.’
2) Teaching and learning	student, teacher, to learn, motivation, work life, skill	‘It’s unfair that we make comments on pupils’ behaviour only in Wilma and Helmi [online services where teachers report on students’ classroom behaviour]. Teachers are entitled to comments and feedback also [...]. Use this printout to ask your pupils to evaluate your behaviour.’ ‘In Fall 2014 and Winter/Spring 2015 there are courses for updating Ope.fi social-media skills.’ ‘The DigiKilta project, funded by the Finnish National Agency for Education, is holding an open webinar about StudentAgent activities on 30.8.14.’ ‘It should not go like this, but long-term improvement of learning outcomes has not been demonstrated’ and ‘Saari and Sääntti [Finnish researchers] have not shown strong evidence of increasing take-up of ICT in education.’
3) Professional development	training, to organise, to participate, knowledge, research report, curriculum	‘Thank you for the detailed descriptions. I will use the advice from [anonymised name].’ ‘The starter of this thread has no real contribution. If someone posts content here that’s already been shared without any comment other than that the group is fussing, the person and this thread should be removed.’
4) Social functions	group, join, follow, share, link	‘I think it would be better if students were to use their breaks for sports, play, movement, and face-to-face interaction with their friends, rather than surfing the Internet.’ ‘Does Finnish law allow us to use online communities with students under the age of 13 if the parents give permission? Do the age restrictions in the terms of service apply only within the USA?’
5) Society and technology	children, Internet, programming, solution, copyright law, personal-data law, terms of service	

of teaching. This tone is visible also in the example posts gleaned from the data. The first and the second author recalled several hardware, software, or service-recommendation discussions of this nature, typically presented without articulation of pedagogical goals for the systems’ use. Our observations suggest that the community was frequently approached as a ‘help desk’ that could help solve problems related to basic use of these technologies and services.

Approaches to teaching and learning form the core of thematic group 2. The common words refer to many roles in a school setting (such as ‘teacher’ and ‘pupil’) and to meta-skills related to learning (‘motivations’, ‘to learn’, ‘to understand’, etc.). The example posts illustrate the ways in which the participants engaged in pedagogical thinking and in their consideration of new models for teaching with the aid of ICT tools. Our experiences also highlight how these concepts have been used in discussions that reflect pedagogical thinking and in-depth exchanges of fleshed-out, grounded ideas concerning these topics.

At the heart of the third group was sharing information on opportunities for professional learning, with the material including invitations to webinars and in-person events, alongside sharing and discussion of recent scholarly work and reports related to ICT use in classrooms. Also, discussion and debate connected with the national curriculum appeared in this cluster. In Finland, each municipality and school adapts and expands on that curriculum. In the course of that work, in which teachers are required to participate, they grow more familiar with the curriculum’s goals and content and they gain further understanding of these. These activities entail professional development. Hence, the curriculum-related content in this cluster further demonstrates how the participants shared resources for professional development with the community and invited other members to engage in such activities.

We found a clear cluster of content focused on social functions within the online community. Forming thematic group 4, this included both thanking and criticising other participants for their contributions. Announcements of new, more narrowly focused Facebook groups suggest the social importance of this particular group. We interpret such activities as maintaining the social cohesion of the community.

Finally, the fifth group comprises conversation about use of the Internet, copyright laws and the teaching of programming in schools. This discussion is relevant in that it highlights that the teachers were considering ICT’s social implications. However, notwithstanding the members’ active focus on topics that are ‘on-topic’ for the Facebook group, often the aim was not to develop pedagogical practices or pedagogical knowledge, so much as to engage, even in political terms, about the purposes and impacts of ICT use, as the sample posts attest. Another example is drawn from the first and second authors’ recollections of several discussions focused on the overall value of teaching programming in comprehensive school. The debate often centred, not on skills that pupils should or

might learn but, on whether future workplaces are going to require such skills and to what extent artificial intelligence may render programming skills obsolete. While valuable and relevant in terms of personal learning, these discussions lack a clear dimension of pedagogical thinking and development.

Evaluating the mutual balance of the five groups (see Fig. 2), we observed that discussion about tools, apps, and infrastructure dominated the online learning community. This was followed in popularity by material on professional-development opportunities, such as formal courses, and only then by discussion focusing on pedagogical approaches that benefit from online teaching and learning.

With regard to temporal development (see Fig. 3), we detected an increase in the salience of the first thematic group. In 2010, approximately 24% of the discussion focused on tools, apps and infrastructure, with the figure reaching 27% by the end of 2017. While thematic group 3 was similar in prominence to the first one at the outset, the salience of the professional-development theme clearly waned over the eight years in question. Initially, the difference amounted to less than 5% but it grew as time passed, coming to about 10% by the end. All other themes (social functions, teaching and learning, and society and technology) were quite stable over time, with only small fluctuations in prominence.

Completing our answer to RQ2, we found that discussion of **tools, apps, and infrastructure** (thematic group 1) came to dominate the online community's content (see Figs. 2 and 3). A small and decreasing amount of the content was related to **teaching and learning** (thematic group 2) i.e., consideration of the pedagogical use of ICT in the school environment. This observation, emerging from the computational analysis, mirrored our participant-observations findings, which suggest that the group is frequently used for peer help on the use of applications or in seeking solutions to mechanically described problems (such as 'I want the tool to do X').

6. Discussion and conclusions

Various online communities, whether self-organised or professionally operated, have been established with the aim to change pedagogical practices in schools in order that they would better support the use of educational technologies. Proceeding from previous research, we identified the main issues to centre on both the maintenance of the community and a focus on discussion concerning pedagogical approaches that might support alignment between technology use and teaching goals. It was in this light that we examined the content and participation visible in a teachers' professional-development community organised via a social-media platform.

With regard to community maintenance, we found that only a small fraction of the membership participated actively in the community studied. While there were nearly 20,000 members, only 10% of them made visible contributions to it. Furthermore, we detected a general decline in the level of activity within the community, a troubling trend that follows patterns commonly observed in various mature online communities, such as Wikipedia (e.g., Ortega et al., 2008).

In respect to content, our thematic analysis showed the discussion to be focused on tools, apps and infrastructure, and both this analysis and the authors' experiences within the community suggest that the Facebook group was indeed, often used as a help resource or a place to seek recommendations for applications with a specific pedagogically justified goal. We believe that such emphasis on tools and infrastructure limits the extent of vital pedagogically aligned use of technology (Anderson & Dron, 2012; Glover, Hepplestone, Parkin, Rodger, & Irwin, 2016; Graham, 2011; Mishra & Koehler, 2006; Prensky, 2008). We see a striking contrast between, on one hand, scholars' and practitioners' emphasis on the latter and, on the other hand, the focus on instrumental themes and their increased

Topics discussed in the group

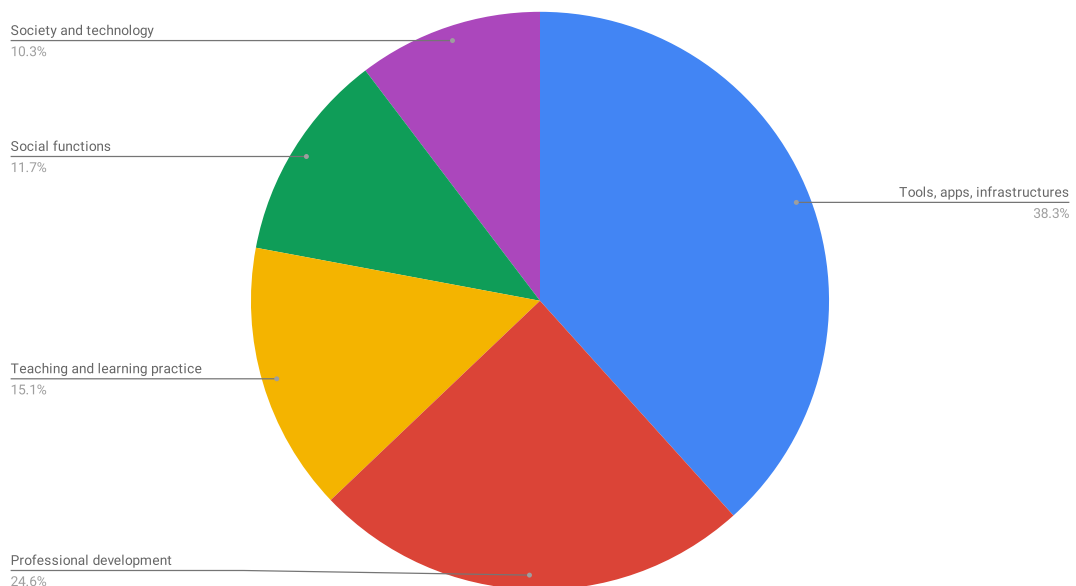


Fig. 2. Distribution of the themes discussed in the group.

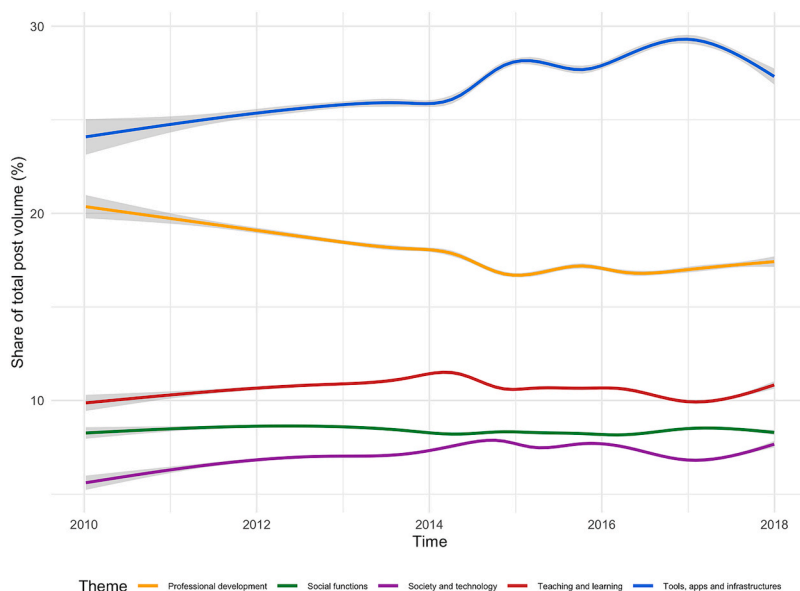


Fig. 3. Evolution of the themes from 2010 to 2018.

salience in the group.

These two key findings illustrate the challenges for peer-organised social-media communities intended for teachers' professional learning. Firstly, community engagement issues that are relevant for peer-production based communities in general, arise in the fora intended for teachers' professional development. Furthermore, attention seemed to be centred on themes that might not represent the greatest gains in teachers' professional development (Anderson & Dron, 2012; Glover et al., 2016; Graham, 2011; Mishra & Koehler, 2006; Prensky, 2008). It might be that the community's rapid growth hampered the successful passing on of the group's norms and the expertise already accumulated, similar to how this occurs in traditional communities of practice (Wenger, 2011), where experts convey not only content, but also social practices to newcomers. Next we will identify the implications this study has for academics and practitioners.

For academics, we call to question whether social media groups should be understood as communities in the traditional sense. Firstly, we showed that the maintenance of such groups is challenging as the membership grows. Alternatively, scholars can articulate these activities as personal learning networks (Tobin, 1998) and personal learning environments (Attwell, 2007). Such models have been shown to play an important role in teachers' professional development, aiding in filtering/targeting important information and identifying learning resources and opportunities for the other teachers (Grosbeck & Holotescu, 2011; Tobin, 1998; Trust et al., 2016).

For those responsible for teachers' professional development, our results suggest that "just setting up" an online community may not lead to the best professional development gains. Most significantly, it seemed that the Facebook group became more focused on tools and infrastructures, due to the absence of other avenues of support for tackling ICT-related problems and for addressing teachers' worries about their ICT skills. While such uses point to an area of professional development and to efforts to deal with it, this kind of interaction might not advance participants' pedagogical thinking and practices. While exposing participants to versatile technical tools available for education, it does not support the extensive efforts required for translation into educational activities or for putting the tools to their full use. This mismatch may limit professional-development gains for the members of the group. To challenge such development, we suggest that a clear onboarding process to help participants to engage with these deeper challenges may be needed. Furthermore, professional community management and facilitation can help to align the discussion and topics raised there to match with the goals set for professional development. For such work, visualisations similar to Figs. 2 and 3 could assist with community maintenance. Even with the growing demands of remote working and distance learning, due to the COVID-19 pandemic, we suggest that organisations working with teachers' professional development should consider blended practices, combining offline and online activities. During the offline sessions the participants can be motivated and facilitated to move in their discussions to consider pedagogical challenges more than technology. These interventions may help to maintain the quality of discussions in the online community.

Secondly, our results suggest that those developing professional development platforms should seriously consider the challenges of joining new groups. Newcomers may find it difficult to ascertain what has already been addressed, let alone the culture and tacit rules of the community. In the absence of active facilitation it is natural also for long-term members' enthusiasm within the group to decline as time passes. While any online community encounters this challenge to some degree, its importance should not be underestimated. During the study period and after it, Facebook has made several changes to the user interface and functionality of the Groups system in order to help newcomers to better engage, including specific sections for rules and FAQs (pinned posts).

Finally, our results highlight to all stakeholders - policymakers, designers, administration and even to teachers themselves - that setting up a (peer-organised) online community requires careful focus to ensure transition of 'likers' to contributing members, keeping

members active and ensuring that the thematic focus is kept within topics that lead to the best professional development gains. We invite groups to consider how smaller and easier-to-maintain communities, such as school or subject-based communities can serve as professional development models (Attwell, 2007; Lantz-Andersson et al., 2018; Macià & García, 2016). That said, a place may remain for services such as Facebook and Twitter in filtering information with peers' help and enriching day-to-day work by providing a platform for discussion related to professional development, but also for socialising, sharing jokes and memes, etc. Furthermore, since these services are integrated into users' other practices, their use may prove easier than adopting bespoke learning platforms (Nelimarkka & Vihavainen, 2015).

As always, there are several limitations to our work. Firstly, it involved a single-case study on an evolving and constantly changing social media platform and socio-technical system facilitated through that platform. While our findings are consistent with previous research into online peer-production communities, they may not generalise to all communities intended for teachers' professional development, even on Facebook. Secondly, while our content-analysis approach utilised advanced computational techniques, qualitative thematic analysis and participant observation, in a mixed-methods set-up that mitigates some concerns related to the lack of context in big data-based research (Boyd & Crawford, 2012; Laaksonen et al., 2017), the findings still represent interpretive conclusions. We brought our own experiences of being members of the community to the table. These informed the thematic analysis of the content, and other observers of the Facebook group may have labelled these themes differently, or chosen a different number of themes, or alternative association of topics with these themes, as is usual in qualitative research. Finally, the scope of our study was motivated by gaps observed in teachers' professional competencies, especially in terms of pedagogical thinking. There are many other perspectives we could have taken when studying the community. For example, the Facebook group serves a social function, connecting professionals in numerous organizational settings. In the course of our study, we identified the theme of social functions and observed that meme photos and jokes received many responses in the community. The social element may support the emotional work that is so important in teachers' professional development (Avalos, 2011). Likewise, all social interaction takes place in mediated space, not least in that algorithmic systems perform extensive filtering. The social interaction observed is set within a highly complex socio-technical system, additional facets of which could always be explored.

In conclusion, our study shows that Facebook groups are a double-edged sword in work toward teachers' professional development. They may have extensive reach and count multitudes of teachers among their users, but making them into a truly active community is subject to the challenges facing nearly all peer-production communities: Most members do not contribute new content very actively and the weight is seen to be laid on a few keen participants. We also draw attention to the mismatch that our content analysis revealed between the community's discussion of educational technologies (connected with apps, tools, and infrastructure) and the core professional-development need identified (i.e., aligning the pedagogical goals with the technological opportunities). While acknowledging that the Facebook group provides clear value to its users, and given the number of active users remaining, we must emphasise that advanced professional development may demand more elaborate interventions than the creation of peer communities. We propose that facilitation techniques and community management could aid in augmenting the professional-development gains. Alternatively, social-media groups could be approached as personal learning networks or personal learning environments that, in turn, may be supported by smaller groups more directly angled toward integration of the relevant tools into pedagogical practices.

Our results would be a cause for concern for any learning community designed to focus on developing participants' pedagogy skills, which are primarily linked not to tools but, rather, to broader methods of utilising ICT in order to transform education. Previous work has prompted strong calls to align educational technology with pedagogical goals/approaches and to attend to the tools only after that. Pinpointing the same need, we uncovered a mismatch between the intended purpose of the group and the community's actual behaviour: It might not advance the participants' pedagogical thinking. While exposing participants to versatile technical tools available for education, it does not support the extensive efforts required for translation into practice or for putting the tools into full use. This mismatch may limit professional-development gains for the members of the group.

Author contribution

M.N. and T.L. worked together to formulate the research idea. M.N. collected data for the research. M. N, T.L and E. D. analysed the data together. M. N, T.L, E. D. and P. D. wrote the paper manuscript together.

References

- Ananiadou, K., & Claro, M. (2009). 21st century skills and competences for new millennium learners in OECD countries. In *OECD education working papers* (Vol. 41). OECD Publishing. <https://doi.org/10.1787/218525261154>
- Anderson, T., & Dron, J. (2012). Learning technology through three generations of technology enhanced distance education pedagogy. *European Journal of Open, Distance and E-Learning*, 15(2).
- Atapattu, T., Falkner, K., & Falkner, N. (2017). A comprehensive text analysis of lecture slides to generate concept maps. *Computers & Education*, 115, 96–113. <https://doi.org/10.1016/j.compedu.2017.08.001>
- Attwell, G. (2007). Personal learning environments – the future of eLearning? *eLearning Papers*, 2(1), 1–8.
- Avalos, B. (2011). Teacher professional development in *Teaching and Teacher Education* over ten years. *Teaching and Teacher Education*, 27(1), 10–20. <https://doi.org/10.1016/j.tate.2010.08.007>
- Baumer, E. P. S., Mimno, D., Guha, S., Quan, E., & Gay, G. K. (2017). Comparing grounded theory and topic modeling: Extreme divergence or unlikely convergence? *Journal of the Association for Information Science and Technology*, 68(6), 1397–1410. <https://doi.org/10.1002/asi.23786>
- Bledsoe, C., & Pilgrim, J. (2016). Creating 'spaces' for professional development: Education organizations' use of Facebook. *The Journal of Social Media in Society*, 5(1), 89–110.
- Blei, D. M. (2012). Probabilistic topic models. *Communications of the ACM*, 55(4), 77. <https://doi.org/10.1145/2133806.2133826>

- van Bommel, J., Randahl, A. C., Liljekvist, Y., & Ruthven, K. (2020). Tracing teachers' transformation of knowledge in social media. *Teaching and Teacher Education*, 87.
- Boyd, d., & Crawford, K. (2012). Critical questions for big data. *Information, Communication & Society*, 15(5), 662–679. <https://doi.org/10.1080/1369118X.2012.678878>
- Bret Staudt Willet, K. (2019). Revisiting how and why educators use Twitter: Tweet types and purposes in# Edchat. *Journal of Research on Technology in Education*, 51(3), 273–289.
- Castle, K. (2006). Autonomy through pedagogical research. *Teaching and Teacher Education*, 22(8), 1094–1103. <https://doi.org/10.1016/j.tate.2006.07.001>
- Crawley, C., Gilleran, A., Scimeca, S., Vuorikari, R., & Wastiau, P. (2009). *Beyond School Projects, a report on eTwinning 2008–2009*. Brussels: Central Support Service of European Schoolnet.
- Darling-Hammond, L. (2000). Teacher quality and student achievement. *Education Policy Analysis Archives*, 8(1). <https://doi.org/10.14507/epaa.v8n1.2000>
- Darling-Hammond, L., & McLaughlin, M. W. (1995). Policies that support professional development in an era of reform. *Phi Delta Kappan*, 76(8), 597–604. <https://doi.org/10.1177/003172171109200622>
- Davis, K. (2015). Teachers' perceptions of Twitter for professional development. *Disability & Rehabilitation*, 37(17), 1551e1558. <https://doi.org/10.3109/09638288.2015.1052576>
- Dede, C., Ketelhut, D. J., Whitehouse, P., Breit, L., & McCloskey, E. M. (2009). A research agenda for online teacher professional development. *Journal of Teacher Education*, 60(1), 8–19. <https://doi.org/10.1177/0022487108327554>
- Denny, M. J., & Spirling, A. (2018). Text preprocessing for unsupervised learning: Why it matters, when it misleads, and what to do about it, 0 *Political Analysis*, 26(2), 168–189. <https://doi.org/10.1017/pan.2017.44>
- Farooq, U., Schank, P., Harris, A., Fusco, J., & Schlager, M. (2007). Sustaining a community computing infrastructure for online teacher professional development: A case study of designing tapped in. *Computer Supported Cooperative Work*, 16(4–5), 397–429. <https://doi.org/10.1007/s10606-007-9049-0>
- Forste, A., Humphreys, M., & Park, T. (2012, May). *Grassroots professional development: How teachers use twitter*. Presentation at the Sixth International AAAI Conference on Weblogs and Social Media.
- Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal*, 38(4), 915–945.
- Gilleran, A. (2006). *Learning with eTwinning*. Brussels: Central support service of European Schoolnet.
- Glover, I., Hepplestone, S., Parkin, H. J., Rodger, H., & Irwin, B. (2016). Pedagogy first: Realising technology enhanced learning by focusing on teaching practice. *British Journal of Educational Technology*, 47(5), 993–1002. <https://doi.org/10.1111/bjet.12425>
- Graham, C. R. (2011). Theoretical considerations for understanding technological pedagogical content knowledge (TPACK). *Computers & Education*, 57(3), 1953–1960. <https://doi.org/10.1016/j.compedu.2011.04.010>
- Grimmer, J., & Stewart, B. M. (2013). Text as data: The promise and pitfalls of automatic content analysis methods for political texts. *Political Analysis*, 21(3), 267–297. <https://doi.org/10.1093/pan/mps028>
- Grosbeck, G., & Holotescu, C. (2011). Teacher education in 140 characters – microblogging implications for continuous education, training, learning and personal development. *Procedia – Social and Behavioral Sciences*, 11, 160–164. <https://doi.org/10.1016/j.sbspro.2011.01.053>
- Guest, G., MacQueen, K. M., & Namey, E. E. (2011). *Applied thematic analysis*. SAGE Publications.
- Gunawardena, C. N., Hermans, M. B., Sanchez, D., Richmond, C., Bohley, M., & Tuttle, R. (2009). A theoretical framework for building online communities of practice with social networking tools. *Educational Media International*, 46(1), 3–16.
- Hämäläinen, R., De Wever, B., Nissinen, K., & Cincinato, S. (2019). What makes the difference – PIAAC as a resource for understanding the problem-solving skills of Europe's higher-education adults. *Computers & Education*, 129, 27–36. <https://doi.org/10.1016/j.compedu.2018.10.013>
- Hintikka, K. (2008). Sosiaalinen media aktiivovan oppimisen välineenä. Available online: http://kans.jyu.fi/tutkimuksia/copy_of_aineistot/esitysaineistoja/JY-Sosiaalinen-media-2008-loppuraportti.pdf/view
- Hofman, R. H., & Dijkstra, B. J. (2010). Effective teacher professionalization in networks? *Teaching and Teacher Education*, 26(4), 1031–1040. <https://doi.org/10.1016/j.tate.2009.10.046>
- Huang, J., Dasgupta, A., Ghosh, A., Manning, J., & Sanders, M. (2014). Superposter behavior in MOOC forums. *L@S '14: Proceedings of the first ACM conference on learning @ scale*. <https://doi.org/10.1145/2556325.2566249>
- Jacobi, C., van Atteveldt, W., & Welbers, K. (2016). Quantitative analysis of large amounts of journalistic texts using topic modelling. *Digital Journalism*, 4(1), 89–106. <https://doi.org/10.1080/21670811.2015.1093271>
- James, M., & McCormick, R. (2009). Teachers learning how to learn. *Teaching and Teacher Education*, 25(7), 973–982. <https://doi.org/10.1016/j.tate.2009.02.023>
- Johnson, M., Bledsoe, C., Pilgrim, J., & Lowery-Moore, H. (2019). Twitter: A tool for communities of practice. *SRA Journal*, 28(1), 61–75.
- Kendall, L. (1999). Recontextualizing 'cyberspace': Methodological considerations for on-line research. In S. Jones (Ed.), *Doing Internet research: Critical issues and methods for examining the net* (pp. 57–74). London: SAGE Publications. <https://doi.org/10.4135/9781452231471.n3>
- Kraft, M. A., Blazar, D., & Hogan, D. (2018). The effect of teacher coaching on instruction and achievement: A meta-analysis of the causal evidence. *Review of Educational Research*, 88(4), 547–588.
- Laaksonen, S.-M. M., Nelimarkka, M., Tuokko, M., Marttila, M., Kekkonen, A., & Villi, M. (2017). Working the fields of big data: Using big-data-augmented online ethnography to study candidate–candidate interaction at election time. *Journal of Information Technology & Politics*, 14(1), 110–131. <https://doi.org/10.1080/19331681.2016.1266981>
- Lantz-Andersson, A., Lundin, M., & Selwyn, N. (2018). Twenty years of online teacher communities: A systematic review of formally-organized and informally-developed professional learning groups. *Teaching and Teacher Education*, 75, 302–315.
- Li, Y. D., & Dervin, F. (2018). *Continuing professional development of teachers in Finland*. Cham, Switzerland: Palgrave Macmillan. <https://doi.org/10.1007/978-3-319-95795-1>
- Lock, J. V. (2006). A new image: Online communities to facilitate teacher professional development. *Journal of Technology and Teacher Education*, 14(4), 663–678.
- Lomos, C., Hofman, R. H., & Bosker, R. J. (2011). Professional communities and student achievement – a meta-analysis. *School Effectiveness and School Improvement*, 22(2), 121–148.
- Luo, T., Freeman, C., & Stefaniak, J. (2020). “Like, comment, and share”—professional development through social media in higher education: A systematic review. *Educational Technology Research & Development*, 68(4), 1659–1683.
- Macià, M., & García, I. (2016). Informal online communities and networks as a source of teacher professional development: A review. *Teaching and Teacher Education*, 55, 291–307.
- Manca, S., & Ranieri, M. (2016). Is Facebook still a suitable technology-enhanced learning environment? An updated critical review of the literature from 2012 to 2015. *Journal of Computer Assisted Learning*, 32(6), 503–528.
- Markham, A., & Buchanan, E. (2012). *Ethical decision-making and Internet research: Recommendations from the AoIR ethics working committee* (version 2.0) <https://aoir.org/reports/ethics2.pdf>. (Accessed 14 July 2020).
- van Meeuwen, P., Huijboom, F., Rusman, E., Vermeulen, M., & Imants, J. (2020). Towards a comprehensive and dynamic conceptual framework to research and enact professional learning communities in the context of secondary education. *European Journal of Teacher Education*, 43(3), 405–427.
- Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108(6), 1017. <https://doi.org/10.1111/j.1467-9620.2006.00684.x>
- Moolenaar, N. M., Slegers, P. J., & Daly, A. J. (2012). Teaming up: Linking collaboration networks, collective efficacy, and student achievement. *Teaching and Teacher Education*, 28(2), 251–262.
- Muller, M., Guha, S., Baumer, E. P. S., Mimmo, D., & Shami, N. S. (2016). Machine learning and grounded theory method. In *Proceedings of the 19th international conference on supporting group work – group*, '16 pp. 3–8. New York: ACM. <https://doi.org/10.1145/2957276.2957280>

- Mushayikwa, E., & Lubben, F. (2009). Self-directed professional development – hope for teachers working in deprived environments. *Teaching and Teacher Education*, 25(3), 375–382. <https://doi.org/10.1016/j.tate.2008.12.003>
- Nelimarkka, M. (2019). Aihemallinnus sekä muut ohjaamattomat koneoppimismenetelmät yhteiskuntatieteellisessä tutkimuksessa: Muutama kriittinen havainto. *Politiikka*, 61(1), 6–33. <https://journal.fi/politiikka/article/view/79629>.
- Nelimarkka, M., & Vihavainen, A. (2015). Alumni & tenured participants in MOOCs. In *L@S '15: Proceedings of the second (2015) ACM conference on learning @ scale* (pp. 85–93). <https://doi.org/10.1145/2724660.2724671>
- Olson, M. R., & Craig, C. J. (2001). Opportunities and challenges in the development of teachers' knowledge: The development of narrative authority through knowledge communities. *Teaching and Teacher Education*, 17(6), 667–684.
- Ortega, F., Gonzalez-Barahona, J. M., & Robles, G. (2008). On the inequality of contributions to Wikipedia. *Proceedings of the 41st annual Hawaii international conference on system sciences*. IEEE. <https://doi.org/10.1109/HICSS.2008.333>, 304–304.
- Parsons, S. A., Hutchison, A. C., Hall, L. A., Parsons, A. W., Ives, S. T., & Leggett, A. B. (2019). US teachers' perceptions of online professional development. *Teaching and Teacher Education*, 82(1), 33–42.
- Prensky, M. (2008). The role of technology. *Educational Technology*, 48(6), 64.
- Prestridge, S. (2019). Categorising teachers' use of social media for their professional learning: A self-generating professional learning paradigm. *Computers & Education*, 129, 143–158.
- Prestridge, S., Tondeur, J., & Ottenbreit-Leftwich, A. T. (2019). Insights from ICT-expert teachers about the design of educational practice: The learning opportunities of social media. *Technology, Pedagogy and Education*, 28(2), 157–172. <https://doi.org/10.1080/1475939X.2019.1578685>
- Ranieri, M., Manca, S., & Fini, A. (2012). Why (and how) do teachers engage in social networks? An exploratory study of professional use of Facebook and its implications for lifelong learning. *British Journal of Educational Technology*, 43(5), 754–769.
- Rehm, M., & Notten, A. (2016). Twitter as an informal learning space for teachers!? The role of social capital in twitter conversations among teachers. *Teaching and Teacher Education*, 60, 215e223. <https://doi.org/10.1016/j.tate.2016.08.015>
- Rhoton, J., & Stiles, K. E. (2002). Exploring the professional development design process: Bringing an abstract framework into practice. *Science Educator*, 11(1), 1–8.
- Roberts, M., Stewart, B., & Tingley, D. (2019). stm: An R Package for Structural Topic Models. *J. Stat. Software*, 91(2), 140. <https://doi.org/10.18637/jss.v091.i02M>
- Ross, J. A., & Bruce, C. D. (2007). Teacher self-assessment: A mechanism for facilitating professional growth. *Teaching and Teacher Education*, 23(2), 146–159. <https://doi.org/10.1016/j.tate.2006.04.035>
- Schlager, M. S., & Schank, P. K. (1997). Tapped IN: A new on-line teacher community concept for the next generation of Internet technology. *Proceedings of the 2nd international conference on computer support for collaborative learning*. International Society of the Learning Sciences. <https://doi.org/10.3115/1599773.1599802>
- Schroeder, R., & Bailenson, J. (2008). Research uses of multi-user virtual environments. In N. Fielding, R. M. Lee, & G. Blank (Eds.), *The SAGE handbook of online research methods* (pp. 327–343). London: SAGE Publications. <https://doi.org/10.4135/9780857020055.n18>.
- Silverman, D. (Ed.). (2016). *Qualitative research*. SAGE.
- Tobin, D. R. (1998). Building your personal learning network. *Corporate learning strategies*.
- Toikkanen, T., & Leinonen, T. (2017). The code ABC MOOC: Experiences from a coding and computational thinking MOOC for Finnish primary school teachers. *Emerging research, practice, and policy on computational thinking*. Cham: Springer.
- Trust, T. (2012). Professional learning networks designed for teacher learning. *Journal of Digital Learning in Teacher Education*, 28(4), 133–138. <https://doi.org/10.1080/21532974.2012.10784693>
- Trust, T., Krutka, D. G., & Carpenter, J. P. (2016). 'Together we are better': Professional learning networks for teachers. *Computers & Education*, 102, 15–34. <https://doi.org/10.1016/j.compedu.2016.06.007>
- Tsiotakis, P., & Jimoyiannis, A. (2016). Critical factors towards analysing teachers' presence in on-line learning communities. *The Internet and Higher Education*, 28, 45e58. <https://doi.org/10.1016/j.iheduc.2015.09.002>
- U.S. Department of Education – Office of Planning, Evaluation, and Policy Development. (2009). *Evaluation of evidence-based practices in online learning: A meta-analysis and review of online learning studies*. Washington, DC http://repository.alt.ac.uk/629/1/US_DepEdu_Final_report_2009.pdf. (Accessed 14 July 2020).
- Vangrieken, K., Meredith, C., Packer, T., & Kyndt, E. (2017). Teacher communities as a context for professional development: A systematic review. *Teaching and Teacher Education*, 61, 47–59.
- Vescio, V., Ross, D., & Adams, A. (2008). A review of research on the impact of professional learning communities on teaching practice and student learning. *Teaching and Teacher Education*, 24(1), 80–91. <https://doi.org/10.1016/j.tate.2007.01.004>
- Voelkel, R. H., Jr., & Chrispeels, J. H. (2017). Understanding the link between professional learning communities and teacher collective efficacy. *School Effectiveness and School Improvement*, 28(4), 505–526. <https://doi.org/10.1080/09243453.2017.1299015>
- Wastiau, P., Blamire, R., Kearney, C., Quittre, V., Van de Gaer, E., & Monseur, C. (2013). The use of ICT in education: A survey of schools in Europe. *European Journal of Education*, 48(1), 11–27.
- Wenger, E. (2011). *Communities of practice: A brief introduction*. <https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/11736/A%20brief%20introduction%20to%20CoP.pdf>. (Accessed 20 July 2020).
- Wesely, P. M. (2013). Investigating the community of practice of world language educators on Twitter. *Journal of Teacher Education*, 64(4), 305–318.
- Westheimer, J. (2008). Learning among colleagues: Teacher community and the shared enterprise of education. In M. Cochran-Smith, S. Feiman-Nemser, & J. McIntyre (Eds.), *Handbook of research on teacher education* (pp. 756–782). New York: Routledge and the Association of Teacher Educators.
- Yang, G., Chen, N. S., Sutinen, E., Anderson, T., & Wen, D. (2013). The effectiveness of automatic text summarization in mobile learning contexts. *Computers & Education*, 68, 233–243. <https://doi.org/10.1016/j.compedu.2013.05.012>