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Merikko, Joonas

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EDITED BY
Fien Depaepe,
KU Leuven, Belgium

REVIEWED BY
Stefanie Vanbecelaere,
KU Leuven Kulak, Belgium
Johanna Pöysä-Tarhonen,
University of Jyväskylä, Finland

*CORRESPONDENCE
Joonas Merikko
joonas.merikko@gmail.com

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"Replacing teachers? Doubt it." Practitioners' views on adaptive learning technologies' impact on the teaching profession

Joonas Merikko* and Ville Kivimäki

Faculty of Educational Sciences, University of Helsinki, Helsinki, Finland

Novel learning technologies have potential in reshaping the teaching profession by automating some parts of the work. However, teachers' perspectives toward automation have generally been critical. In the present study, we examine Finnish education practitioners' thoughts on adaptive learning technologies and their impact on the teaching profession. Using thematic and epistemic network analysis (ENA), we analyzed 114 social media posts. Supportive posts connected technological capabilities and self-directed or self-regulated learning, emphasizing that technology can also guide and support students. Critical posts connected human presence, educational arrangements, and pupil diversity and equality, emphasizing the importance of teachers' presence in addressing pupils' varying needs. Overall, the role of a human teacher was seen as necessary even with adaptive learning technologies available. Our findings reveal themes relevant when discussing the development of adaptive learning technologies and their potential impact on the teaching profession. Moreover, our findings increase the understanding of how supportive and critical argumentation on technology differ.

KEYWORDS

adaptive learning technologies, self-regulated learning, teaching augmentation, teaching profession, epistemic network analysis, teacher workload

1. Introduction

Novel technologies such as machine learning and artificial intelligence are changing labor markets and disrupting industries. Computerization of work is moving fast from routine tasks involving explicit rule-based activities to non-routine cognitive tasks (Frey and Osborne, 2017). There are two prominent scenarios when applying artificial intelligence at work: automation and augmentation. Whereas automation implies that machines take over a human task, augmentation means that humans collaborate closely with machines to perform a task (Langer and Landers, 2021). Despite the predictions by many business people and academics, employees do not in general see these novel technologies as a threat to their career (Brougham and Haar, 2018).

Especially "human touch" and "soft skills" are perceived as irreplaceable by technology (Bhargava et al., 2021), which may partly explain why the education industry has largely been an exception to the trend of disruption by automation and digitalization.

As Selwyn puts it, "most people intuitively feel that education is an essentially human undertaking" and "the belief persists that learning is something best guided by expert human teachers in socially rich setting" (Selwyn, 2019, p. 1). However, when the COVID-19 pandemic interrupted classroom learning for at least 9 out of 10 students worldwide (UNESCO, 2020), schools and teachers worldwide were forced to find ways to maintain continuity of learning without physical proximity. While the exceptional methods used during the school closures were mainly *ad hoc*, these experiences with digital technologies will likely affect education in the post-COVID world (Sánchez-Cruzado et al., 2021). In particular, the new technologies may have an impact on how teacher's role and the teaching profession are seen.

In the present study, we examine Finnish education practitioners' thoughts on adaptive learning technologies and their impact on the teaching profession. First, we present relevant literature related to adaptive learning technologies and teachers' beliefs about them, followed by our research questions. Then we introduce our methods, continuing with our findings. Finally, we discuss our findings and contrast them with previous literature. The current paper extends the preliminary results presented at Nordic Learning Analytics Summer Institute 2021 (Pesonen and Kivimäki, 2021).

1.1. Teaching augmentation

While teachers are considered to have a low risk of being automated (Frey and Osborne, 2017), *augmenting* teachers' pedagogical abilities (An et al., 2020) seems like a more likely scenario than complete automation of teaching. These technologies, potentially shaping the future of the teaching profession, are evolving rapidly and include, e.g., learning analytics applications (Viberg et al., 2020), intelligent tutoring systems (Mousavinasab et al., 2021), adaptive learning technologies (Molenaar et al., 2019), and educational chatbots (Winkler et al., 2020).

The division of control between the teacher and technology varies between different technologies. Molenaar (2021) has presented the *six levels of automation of personalized learning* to demonstrate the fluctuating nature of control between the teacher and technology: the control may be entirely on the teacher (level one) or technology (level six) or flexibly shared between the teacher and technology (levels from two to five). For example, on level four, the teacher is not expected to monitor the learning activities continuously, since technology is expected to signal when teacher control is needed (Molenaar, 2021).

Selwyn (2019) envisions two different scenarios regarding teaching augmentation. In the first scenario, technology frees up teachers to engage in meaningful acts of leading, arranging, explaining, and inspiring while technology takes care of routines and duties (Selwyn, 2019). In the second, more pessimistic scenario, teachers end up losing their autonomy while fulfilling the expectations of the technology (e.g., encouraging students to write in ways favored by automatic grading systems) (Selwyn, 2019). There is already some evidence of development toward this scenario: In a UK survey carried out during the COVID-19 pandemic, it was found that higher education teachers thought that their pedagogical practice had been "reduced to the fulfilment of rudimentary technical functions" (Watermeyer et al., 2021).

In both scenarios, teachers will increasingly be involved in designing digital environments and making meaning of the data students produce (Lodge et al., 2018). Pedagogical knowledge is required to define what type of data is needed and what is valuable to analyze to support learning (Viberg et al., 2018). Moreover, while some aspects of the learning process are more straightforward to quantify and analyze than others, using specific learning technologies may enforce particular pedagogies (Williamson et al., 2020). It is crucial that teachers are engaged in the development of teaching augmentation technologies and that these systems are studied in real-world contexts (Holstein and Aleven, 2022). Arantes and Buchanan (2022) suggest that the teachers who are active in the co-development of learning technologies should be recognized as *educational data advocates*, experts who understand the implications of using data-driven educational technologies.

1.2. Technologies supporting the development of learning skills

Development of learning skills such as self-regulated learning (SRL) and self-directed learning (SDL) have globally become important aims of education (European Commission and Directorate-General for Education, Youth, Sport and Culture, 2019; OECD, 2019; ILO, 2021). Both concepts describe the learner's active role in setting goals, choosing learning strategies, and evaluating learning outcomes and are sometimes used interchangeably—however, SDL describes the more general approach to learning, whereas SRL focuses on the learning processes in a certain context (Gandomkar and Sandars, 2018).

In a traditional classroom setting, the teacher can support learners' self-regulation and then gradually decrease the amount of support, promoting the learning of self-regulation skills. One of the long-term goals for learning technologies is to take up the role of supporting and promoting students' SRL. However, in the current state-of-art learning technologies, the primary focus is on cognitive aspects of learning (i.e., student's knowledge) instead of a broader view of the student, including emotion, motivation, and self-regulation (Molenaar, 2021).

It has been suggested that learning technologies can support students' SRL indirectly (i.e., nudges, prompts) and directly (i.e., targeted suggestions specific to the student and the lesson)

(Lodge et al., 2018) and adjust external regulation based on insights gained from data (Molenaar et al., 2019). Developing such a technology requires collecting and analyzing data about a learner's self-regulated learning behavior (Lim et al., 2021; Fan et al., 2022a,b) and using the generated insights to provide personalized feedback for the learner (Pardo et al., 2019, 2022). Currently, such systems are at their preliminary stages, and most solutions rely on a human teacher who is in control (Molenaar, 2021).

As the sophistication of such systems grows over time, they may affect how we see the role of a teacher. However, it is important to note that the effects on the teaching profession are not predetermined. As Selwyn (2019) points out, integration of any technology into society should be approached as a choice: "it is crucial that we consider the possibility of alternative technological pathways and different digital futures for education". Therefore discussing these topics within the community of education practitioners is extremely important.

1.3. Teachers' beliefs and learning technologies

Understanding teachers' beliefs is important, as beliefs are related to their teaching practices and student outcomes (Fives and Buehl, 2012). Generally, teachers' perspectives toward automation of teaching have been critical (Tondeur et al., 2013). One reason might be, that novel technologies may challenge teachers' intuitive epistemic theories, and they need to rethink what learning is and how it should be promoted (Lammassaari et al., 2022).

Optimally, technology use should evolve simultaneously with novel learning and teaching practices (Hakkarainen, 2009). However, the rapid uptake of learning technologies during COVID-19 pandemic seems to have caused a situation where educational technologies are partly redefining and reducing the concepts of teaching and learning (Teräs et al., 2020). Teachers may be ill-prepared to face this situation, resulting in (perhaps healthy) distrust with learning technologies. Nazaretsky et al. (2022) argue that the key to gaining a teacher's trust is teacher agency: technologies should not restrict teachers to follow specific pedagogical scenarios and should allow teachers modify or override recommendations given by the technology. Moreover, Luckin et al. (2022) suggest AI readiness training for educators to be better equipped in leveraging AI to the benefit of learners. Finally, Lammassaari et al. (2022) found that if teachers' epistemic theory was in harmony with the digital reforms, there is a positive association with work engagement and negative association with burnout.

1.4. Aims of the current study

With the massive increase in the use of digital tools in teaching and learning during the pandemic, it is essential to investigate the implications to educational arrangements in general and the teaching profession in particular. Based on the literature (see, e.g., González-Calatayud et al., 2021; Molenaar, 2021), machines can handle routine teacher tasks such as grading. However, supporting learners' self-regulation has been an exclusively human endeavor and central to the teaching profession. As digital systems get more sophisticated, it is essential to broadly discuss a machine's possibilities and limitations to guide, encourage and support students and promote their self-regulated learning skills. This kind of technology potentially has far-reaching effects on teacher's role, workload, and profession in general. So far, there has been little discussion about the topic among practitioners, and little is known about practitioners' views on the topic.

In April 2021, an opinion piece by a Finnish elementary school teacher was published in the largest daily newspaper in Finland (Luoto, 2021). In the opinion piece, the author describes how learning new content is increasingly guided by adaptive learning technologies instead of a human teacher and how this kind of shift would free teachers' time to focus on tasks where humans are best. The piece sparked a lively discussion among Finnish education practitioners in several social media platforms. While such discussion spontaneously occurred, we decided to collect the material and analyze the discussion in depth.

In the present study, we analyze social media posts commenting on the scenario where some teacher tasks are controlled by technology instead of the teacher. Our research questions are the following:

RQ1: What kind of argumentation do Finnish education practitioners use in social media discussions to support or criticize a scenario of teacher tasks being controlled by technology instead of the teacher?
RQ2: How do the practitioners see a teacher's role in contrast to technology's role in supporting pupils' self-regulated learning?
RQ3: How do the practitioners see the effects of adaptive learning technologies on teacher workload?

2. Methodology

2.1. Context

In Finland, all schools shifted to remote learning because of the COVID-19 pandemic for 8 weeks during spring 2020. Afterward, schools have altered between contact teaching and remote learning depending on the development of the epidemic in each region.

During the pandemic, there have been active discussions in Finnish media about learning with digital technologies. One contribution to this discussion is an opinion piece (Luoto, 2021) written by a Helsinki-based elementary school teacher and published on April 19th, 2021 by Helsingin Sanomat, the largest daily newspaper in Finland. The author suggested introducing weekly remote learning, where elementary school pupils would study remotely 1 day a week, leveraging adaptive learning technologies. He describes how this shift would free teachers' time to focus on things where humans are best, such as contextual interaction.

The piece generated lots of comments on social media, especially in two Facebook groups: a general forum for discussion among Finnish education professionals (ca. 17,500 members) and a group specializing in the teaching profession (ca. 13,000 members). Comments were posted during April 2021.

2.2. Material

We gathered social media posts related to the opinion piece from a Finnish education professionals group ($N = 48$) and a teaching profession group ($N = 81$) on Facebook, Twitter ($N = 12$), and a newspaper comment board ($N = 10$). Typically one person started the discussion by posting a link to the opinion piece, and others commented on the discussion thread. We collected all comments posted by the end of April 2021. We removed posts that did not include any argumentation (e.g., posts with only one word or emoticon) from the dataset, ending up with 114 posts. In addition to the post content, we collected the amount of social media reactions (i.e., likes) for each post. The original language of the opinion piece, as well as all the comments, is Finnish. We translated and paraphrased the excerpts presented here.

Townsend and Wallace (2016) suggest that when using data from social media, the researcher should consider the terms and conditions of the platforms, social media users' possible vulnerability, their expectation to be observed by strangers, subject matter sensitivity, and anonymization of research outputs. In the ethical considerations of the current study, we addressed these themes. First, we checked that the platforms used allowed their data to be used for research and obtained necessary approvals (e.g., Twitter Academic Account). Second, we considered the users in question (education practitioners) not particularly vulnerable. Third, since the forums of the discussion were either really large or completely open, we considered that users should reasonably expect to be observed by strangers. Fourth, we did not consider educational practitioners views and opinions about adaptive learning technologies as sensitive data. Finally, we anonymized all the data and paraphrased all the excerpts used in this research output.

2.3. Analyses

2.3.1. Preliminary analyses

The posts were rated by both authors as *supportive*, *critical*, or *ambivalent*, based on the perspective on the presented scenario. Ratings were attributed to the whole post—if the post was neutral or contained both supportive and critical arguments, it was rated as ambivalent. The inter-rater reliability was moderate (Cohen's kappa 0.77) (McHugh, 2012). Out of the 17 posts with diverging rating, 11 were rated critical/ambivalent and five supportive/ambivalent. The only post with ratings supportive/critical was related to context: while the content of the post sounded critical, as a comment to another post it could be interpreted as supportive. Ratings by the second author were used in the further analyses.

Inductive thematic analysis was used to analyze the themes included in the social media posts. Both authors took part in the process. First, the first author coded all the posts and created the initial coding scheme. Typically two to five codes were assigned to each post. Next, the second author used the coding scheme with 20 first posts. Then, we discussed inter-rater differences and readjusted the coding scheme (e.g., removed two of the initial codes). Finally, both authors used the agreed flat coding scheme with all the posts. The codes with their descriptions and inter-rater reliability are presented in Table 1. Inter-rater reliability ranged from moderate (Cohen's kappa 0.62) to strong (Cohen's kappa 0.85) (McHugh, 2012). Ratings by the second author were used in the further analyses.

2.3.2. RQ1: Epistemic network analysis

To answer the first research question, we applied Epistemic Network Analysis (Shaffer et al., 2016; Shaffer, 2017; Shaffer and Ruis, 2017) to our data using the ENA 1.7.0 Web Tool (Marquart et al., 2018). Our ENA model included the codes presented in Table 1. We defined conversations as all posts associated with a single social media forum. The ENA model normalized the networks for all units of analysis before they were subjected to a dimensional reduction, which accounts for the fact that different units of analysis may have different amounts of coded lines in the data. For the dimensional reduction, we used a singular value decomposition, which produces orthogonal dimensions that maximize the variance explained by each dimension (see Shaffer et al., 2016 for details).

In this study, ENA was used to compare mean networks of posts with *a supportive*, *critical* or *ambivalent* perspective on the presented scenario. Networks were visualized using network graphs where nodes correspond to the codes, and edges reflect the relative frequency of co-occurrence between two codes. The positions of the network graph nodes are determined by an optimization routine that minimizes the difference between the plotted points and their corresponding network centroids. Because of this co-registration of network graphs and projected

TABLE 1 Codes with their descriptions and inter-rater reliability.

Code	Title	Example	Cohen's kappa
ARR	Educational arrangements	*"That works best live, worse remotely"*	0.67
PRE	Human presence and interaction	*"Most of them need interaction and discussion about other things among teaching"*	0.69
TEC	Technological capability	*"Now the machine does the same in a matter of seconds"*	0.67
WOR	Teacher workload and efficiency	*"The workload of checking student assignments on a screen is staggering"*	0.85
DIV	Pupil diversity and equality	*"Technology [–] will never be a substitute for teacher's help to those with challenges in studying"*	0.62
SKI	Learning skills	*"The pupils aren't self-directed except for a few cases."*	0.71

TABLE 2 Number of posts and sum of likes by code and perspective toward the scenario.

Code	Supportive		Ambivalent		Critical		Total	
	Posts	Likes	Posts	Likes	Posts	Likes	Posts	Likes
Educational arrangements (ARR)	22	84	18	157	37	699	77	940
Human presence and interaction (PRE)	13	44	7	20	24	563	44	627
Technological capability (TEC)	21	57	7	9	15	402	43	468
Teacher workload and efficiency (WOR)	12	47	13	42	17	309	42	398
Pupil diversity and equality (DIV)	8	40	4	28	16	377	28	445
Learning skills (SKI)	10	36	3	123	14	390	27	549
Total	32	103	30	192	52	956	114	1251

A single post has a single perspective but may contain multiple codes. For example, *"Technology will never be a substitute for teacher's help to those with challenges in studying"* is a critical post concerning both technological capability (TEC) and pupil diversity and equality (DIV).

space, the positions of the network graph nodes and the connections they define can be used to interpret the dimensions of the projected space and explain the positions of plotted points in the space. Our model had co-registration correlations of 0.93 (Pearson) and 0.93 (Spearman) for the first dimension and co-registration correlations of 0.91 (Pearson) and 0.91 (Spearman) for the second. These measures indicate that there is a strong goodness of fit between the visualization and the original model.

2.3.3. RQ2 and RQ3: Qualitative content analysis

To answer the second and the third research question, two themes (learning skills and teacher workload and efficiency) were analyzed in more depth. Excerpts are presented to elucidate education practitioners' thinking regarding these themes.

3. Findings

3.1. Discussion themes and connections between them

To answer our first research question, we conducted thematic and epistemic network analyses on social media posts by Finnish education professionals. In thematic analysis, we found six themes: Educational arrangements (found in 77 posts), human presence and interaction (44 posts), technological capability (43 posts), teacher workload and efficiency (42 posts), pupil diversity and equality (28 posts) and learning skills (27 posts). The number of posts, including each code, and the sum of those posts' likes are presented in Table 2. Out of 114 posts analyzed, 32 (28%) were supportive of the proposed scenario, whereas 30 (26%) were ambivalent and 52 (46%) critical. While this presents the perspectives of professionals taking part in the discussion, the sum of social media likes shows the perspectives of the larger community. Out of 1251 likes, 103 (8%) were connected with posts showing a supportive perspective, whereas 192 (15%) were connected with posts showing ambivalent and 956 (76%) with posts showing a critical perspective.

The epistemic network analysis graphs are presented in Figure 1. The most central code was *Educational arrangements (ARR)*, having strong connections with all other codes. When comparing the networks of supportive and critical posts, it is clear that different themes are highlighted. In the supportive network, the focus is on connections with *Technological capability (TEC)*, and in the critical network on connections with *Human presence and interaction (PRE)*.

Moreover, comparing what connections are missing in each graph is interesting. In the supportive network, the connection between *Pupil diversity and equality*

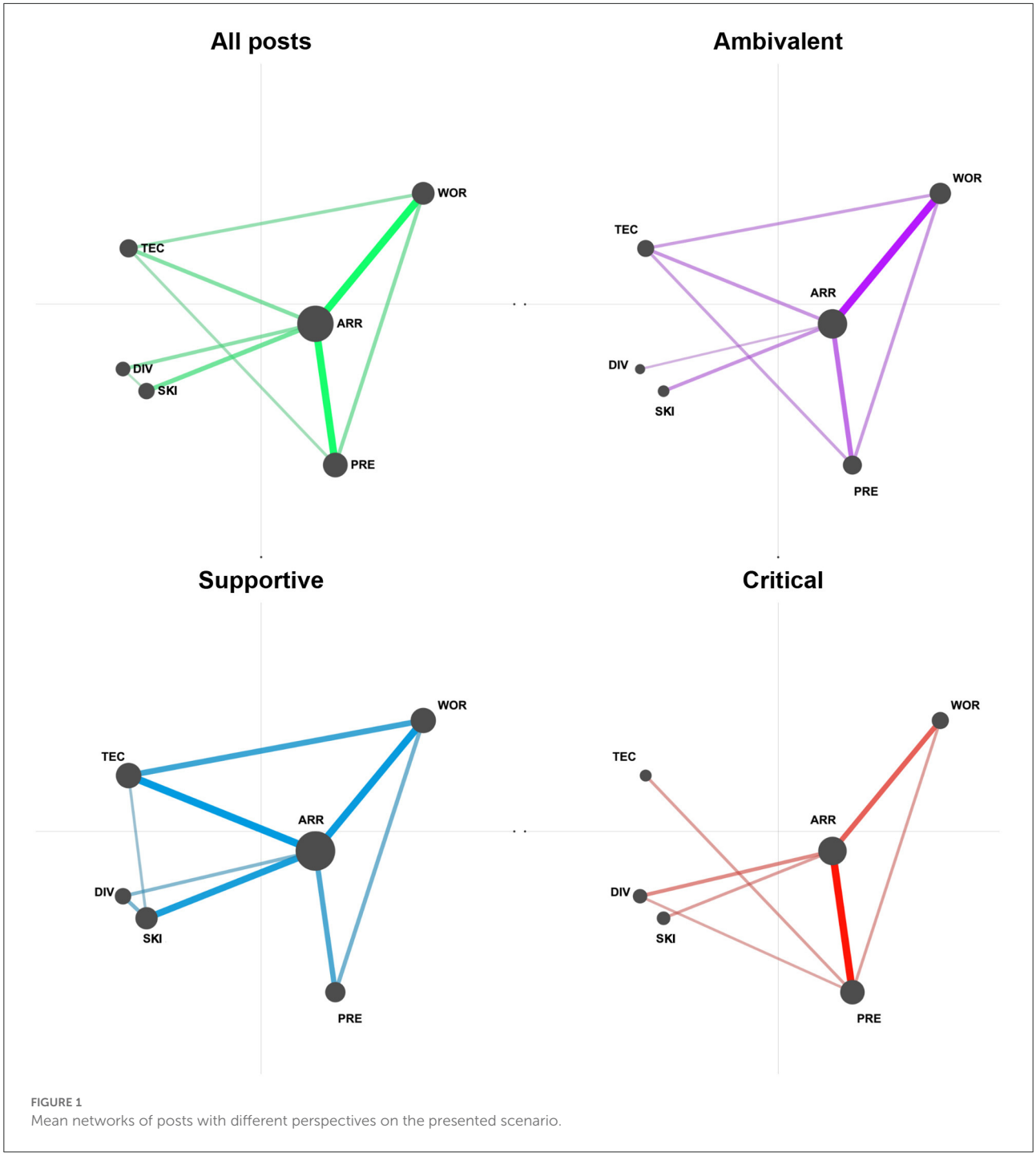

FIGURE 1
Mean networks of posts with different perspectives on the presented scenario.

(DIV) and *Human presence and interaction (PRE)* is missing, as well as the connection between *Technological capability (TEC)* and *Human presence and interaction (PRE)*. Respectively in the critical network, the connection between *Technological capability (TEC)* and *Teacher workload and efficiency (WOR)* is missing, as well as the connection between *Technological capability (TEC)* and *Learning skills (SKI)*.

3.2. The roles of the teacher and technology in supporting pupils

To answer our second research question, we conducted qualitative content analysis on posts about learning skills. Learning skills were recognized as a theme in 27 social media posts, of which 14 were critical (390 likes), 10 supportive (36 likes), and 3 ambivalent (123 likes). The theme of learning

skills was connected with both educational arrangements and technological capability in the supportive posts, but only with the theme of educational arrangements in the critical and the ambivalent posts.

In many comments, it was emphasized that pupils had limited learning skills and that supporting self-regulation remotely is challenging:

> *"Uppermost the delusion that you could just 'leave' the children to study the vocabulary etc. Not at all. Online the teacher presence is highlighted more intensively so that high-quality learning and continuous assessment can happen. It requires a lot: both from teachers and pupils. The most self-directed learners can surely do something as described, but I would not in any case - and fortunately it's not legally possible - categorically increase remote learning in basic education."*

> *"[–] The pupils aren't self-directed except for a few cases. Most of them need interaction and discussion about other things among teaching. That works best live, worse remotely."*

Some of the critical comments directly addressed the shortcomings of technology in guiding and supporting pupils:

> *"This digital-environment-self-directed-learning mantra has been tooted as forthcoming for thirty years now. Nevertheless, give any 'self-directing' learning material or digital platform to a group of 24 pupils and follow the situation for 45 minutes. I'll eat my hat if even half of the group is doing what they're supposed to with the program or if they're even in the program. In small bits, yeah, but replacing teachers, doubt it."*

Other comments did not mention the technology but emphasized that guiding and supporting should be carried out by the teacher:

> *"Oh my god! The teacher's role is to follow how learning proceeds and help when necessary. For example, there are a lot of tools and collaborative learning plans for multiplication tables."*

On the other hand, there were many comments which described how technology would be able to support pupils :

> *"The technology should distribute exercises, grade them, correct errors, praise success, and guide otherwise, too. The teacher would get some kind of overview."*

> *"Using digital materials does not necessarily lead to an increase in distance education but also creates possibilities for individual work by providing direct feedback and differentiation possibilities. At school, or home."*

As described in the Introduction, a skilled teacher gradually decreases the amount of support for learners to learn to regulate themselves. It is interesting whether this kind of fine-grained adaptive regulation support is expected from a machine. One comment discussed developing students' learning skills. Still, it was left a bit unclear whether this development is seen as a side effect of individual studying with technology or as a consequence of scaffolding by either teacher or technology:

> *"I think that while provocatively formulated, the idea is rather good. Many digital tools fit really well to differentiation and, e.g., vocabulary drilling. Pupils could and should be guided to plan, test, and differentiate their learning themselves and, for example, proceed to more advanced exercises or broader vocabulary when the basics work out. [–]"*

In another comment, it was suggested that pupils could practice self-regulatory skills with technology, but there should be a human backup:

> *"[–] it's worthwhile to let those with [self-regulatory] problems have a chance to practice at school. In short snippets and so that someone is there to return drifters back to the track."*

A recurring theme in the posts was pupil diversity. Some pupils were seen as capable of studying with learning technologies while others were not:

> *"Technology can help a lot in teaching, but will never be a substitute for teacher's help to those with challenges in studying - and it is an increasing crowd!"*

In some comments, the professionals suggested that technology could help by allowing teachers to focus on the pupils who need support:

> *"This can also be seen in a way that if those competent in the independent study are in remote learning, those who are unable may get tailored contact teaching."*

> *"Let's teach just those who need teaching. Others might find learning even easier alone on their own."*

> *"Yes. We have already done this. Those capable of independent study may study partly remotely, and those needing more support come to school. Thereby those needing more support are under the teacher's efficient guidance."*

In summary, in the supportive posts, technology was seen as capable of guiding and supporting students' self-regulation. On the other hand, the critical posts mostly, rather than criticizing the technology, emphasized the role of the teacher in

supporting self-regulation. Overall, the role of the teacher is seen as necessary even with adaptive learning technologies available.

3.3. Adaptive learning technologies and teacher's workload

To answer our third research question, we conducted qualitative content analysis specifically on the posts about considering teachers' workload. Teacher's workload was recognized as a theme in 42 social media posts, of which 17 were critical (309 likes), 13 ambivalent (42 likes), and 12 supportive (47 likes). The workload theme was connected with educational arrangements, technological capability, and human presence in the supportive and ambivalent posts. In the critical posts, the workload theme connected with educational arrangements and human presence themes.

Especially the word *efficient* in the original opinion piece ("Teacher's working hours could be used more efficiently") sparked many comments. There was some confusion about how the presented scenario would increase efficiency and whether that is even a meaningful goal:

> *"Efficiency? What would it mean in this context?"*
>
> *"The idea of increasing teacher 'efficiency' remained unclear. Did you mean that while students are working remotely, the teacher would have other work to do? Should remote teaching be carried out with high quality, I think it may even increase workload"*
>
> *"I wonder, why would efficiency be the aim that directs the development of working methods? And how would this kind of method increase teacher efficiency in practice?"*
>
> *"Why would the use of teacher's time need to be more efficient? Does someone feel like the use of teacher's time is not efficient enough in a full classroom?"*

In many posts it was highlighted that teachers are currently overloaded, and working with learning technologies was seen as additional work that would require additional resources:

> *"All of these new additional things would require additional permanent funding. Currently, teachers and also students are overloaded. Something should be taken away if AGAIN something new is added."*

Some of the comments about technology increasing workload were related to negative experiences with current systems rather than future possibilities of learning technologies:

> *"The workload of checking student assignments on a screen is staggering. During lessons, erroneous notation etc. can be corrected on-the-fly. It's annoying when the pupil submits answers in a batch, and the same mistake must be corrected multiple times."*

On the other hand, in many posts, technology was seen as increasing efficiency:

> *"[–] A few years ago, I spent a couple of hours checking reading proficiency tests. Now the machine does the same in a matter of seconds. [–]"*
>
> *"Machines can execute many traditional teacher tasks more efficiently than humans. E.g., checking assignments and providing differentiated tasks. This should be utilized."*
>
> *"[–] While I do not completely share the original author's views, this discussion largely ignores e.g., learning analytics included in many environments. Maybe that would be the aspect of efficiency, which undeniably remains a bit unclear in the original piece."*

In some posts, technology was seen as an enabler for more meaningful interactions in the classroom:

> *"[–] So if the teacher could streamline her use of time by externalizing some routine work with high-quality technology and pupils who have become self-directed, the teacher could concentrate on teacher-led action with those needing more support and, with the whole group, on the interaction where a machine cannot replace humans. [–]"*
>
> *"More and more learning is carried out in digital environments. Routine exercises are guided by artificial intelligence. This enables distance education but also more time for human interaction and coaching in contact teaching."*

In summary, the views on adaptive learning technologies' effects on workload are polarized. Some professionals are already overloaded and fear that the new technologies will increase workload rather than decrease it. On the other hand, some professionals see that the latest technologies could enable more meaningful classroom interaction by automating routine work.

4. Discussion

4.1. Critical and supportive argumentation focus on different themes

In line with previous work in different industries (Brougham and Haar, 2018), teachers were not concerned about being replaced by novel technologies. The general sentiment toward

adaptive learning technologies was critical: 76% of social media reactions (i.e. "likes") were connected with posts showing a critical attitude. The themes found in the discussion mostly replicated the themes of the original opinion piece. However, the most prevalent themes differed between critical and supportive posts.

In the critical posts, the professionals emphasized the role of the teacher's presence in facing student diversity and varying levels of self-directedness and self-regulation. This emphasis on human presence or "human touch" is in line with previous work on employees' perceptions among different industries (Bhargava et al., 2021). The theme of technological capability was mentioned in only 29% of the critical posts, whereas in the supportive posts, it was one of the main themes (66% of posts). In a sense, the critique on learning with adaptive learning technologies focused more on whether it "should be done" than whether it "could be done". On the other hand, in the supportive posts, the theme of technological capability was connected to the themes of teacher workload and self-directed or self-regulated learning. These connections were absent in the critical argumentation, and we will discuss this further in the following.

4.2. Technology can guide students to some extent, but the teacher is still needed

The views regarding the capability of technology to support students' self-regulated learning varied. In some supportive posts, technology was seen as capable of guiding students, e.g., providing direct feedback. However, in many posts, this vision was recognized, but there was skepticism about the actual capability of technology to guide students. Overall, the professionals admitted the possibilities of technology in guiding and supporting students to some extent, but technological scaffolding alone was not considered sufficient. Compared to six levels of automation of personalized learning (Molenaar, 2021), most comments about technological capability considered automation on levels two or three. Moreover, the possibilities of learning analytics were mentioned only once, and none of the posts mentioned an option that technology could signal the teacher when teacher control is needed.

The levels of automation model (Molenaar, 2021) is based on the idea that some teacher tasks are automatized and others controlled by the teacher. However, this kind of thinking was largely absent in the posts by education professionals. Instead, the focus was on differences between students: which students need a human teacher and which students can learn with adaptive learning technologies. In many posts, there was an idea that part of the group could study independently with adaptive learning technologies, and the teacher could focus on the pupils who need individual guidance and support. This kind of teacher-led grouping of students based on their learning skills could be a first step toward the vision of fluctuating SRL support between human teachers and technology.

4.3. Mixed views about teachers' workload

The views on adaptive learning technologies' impact on teachers' workload were mixed. Comparing the epistemic networks, the connection between technological capability and teacher workload is relatively strong in the positive network and non-existing in the critical network. The comments where technology was seen as increasing efficiency and decreasing workload were mostly about automatic assessment and provision of exercises. Additionally, one comment mentioned learning analytics as a way to increase efficiency. The remarks on technology increasing workload were related either to dissatisfaction with current information systems or the effort to design remote teaching.

When compared to Selwyn (2019) two scenarios of how technology may change the teaching profession, many posts, as well as the original opinion piece, resemble Selwyn's first scenario: technology frees up teachers' time for more meaningful activities. Again, these comments emphasized the differences between students. While some students can study with adaptive learning technologies, the teacher can focus on the students who need the human teacher most. The fear about teachers ending up fulfilling expectations of technology, as in Selwyn's second scenario, was not found in any of the comments. This may be related to Finnish teachers' high autonomy (Niemi et al., 2018)—if a teacher does not see the value of a particular technological tool, they will most likely stop using it.

4.4. Limitations and future directions

The present study has some limitations. First, the sample size is small, with only 114 social media posts. This is related to the method of data collection: we collected all the posts in the discussions that spontaneously occurred in the social media after the publication of the opinion piece. Spontaneous discussions considering such a specific topic are scarce, and other data collection methods would be needed to obtain a larger sample size.

Second is the question of representativeness. While we do not have any background data about the social media users, we cannot tell how well the views presented in the analyzed posts represent the views of Finnish education practitioners. For example, we do not objectively know the amount of teaching experience the users had—if any. However, the contents of the posts certainly reflected personal experiences from a school

environment. Moreover, it is possible that the strongest opinions were loudest in the discussion. There is a well-accepted view that social media platforms act as echo chambers that encourage the adoption of more extreme ideological positions, although the empirical evidence is still inconclusive (Kitchens et al., 2020). On the other hand, the forums in question were relatively large and general by nature, instead of groups of only like-minded people.

Third limitation is related to the authors' role in interpreting the qualitative data. The backgrounds of the authors influenced on both the creation of themes as well as the coding of individual posts. To increase the objectivity of our analysis, coding was carried out separately by both authors, and inter-rater reliability metrics for different codes were calculated. The agreement was lowest in the themes of pupil diversity, technological capability and educational arrangements. Some repeated disagreements were whether the use of video conferencing tools was about educational arrangements or technological capability, and whether posts mentioning differences in learning skills should be coded with both SKI and DIV codes.

In future work, alternative data gathering methods such as surveys and interviews should be considered. Furthermore, future work should also target possible differences in views, e.g., between different professional groups, geographical areas, teaching subjects, gender, and age, a few to mention.

4.5. Implications

Based on our findings, the discussion about adaptive learning technologies is polarized and includes many misconceptions. The supportive and critical argumentation are focused on different themes, limiting the opportunities for constructive dialogue. To enhance this dialogue, supporters of adaptive learning technologies could focus more on the effects of technologies regarding pupil diversity and equality. On the other hand, the critique of adaptive learning technologies could be broadened by analyzing the limitations in the technological capabilities of such systems.

Furthermore, when adaptive learning technologies are used, it is essential to collect and analyze the experiences of teachers and pupils. Do the teachers feel that the technology allows them to focus on more meaningful things, or do they feel like being servants of the technology like in Selwyn's second scenario? Do the pupils find the methods of studying meaningful? This is especially important should the technologies be more responsible for supporting and promoting pupils' self-regulation. Technological capability is an important but only one of many aspects to consider when using adaptive learning technologies.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical review and approval were not required for the study in accordance with the local legislation and institutional requirements. Twitter data has been included in accordance with an API licensing agreement.

Author contributions

JM: research idea, data collection, analysis, and writing. VK: analysis and co-writing. Both authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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