Journal of Online Learning Research (2022) **8**(3), 315-342

Social Engagement in Distance, Remote, and Hybrid Learning

NINA BERGDAHL
Halmstad University, Sweden
Stockholm University, Sweden
nina.bergdahl@hh.se

LAURI HIETAJÄRVI
University of Helsinki, Finland
lauri.hietajarvi@helsinki.fi

A growing interest has been directed toward including a fourth dimension in the engagement construct: the social dimension. The aim of this study is twofold: first, to explore how teachers talk about the social dimension of student engagement in online learning, and second, to explore the possibilities of using computational methods for interview data analysis. A longitudinal intervention (interview-diary-interview) was conducted with teachers who actively teach online classes in hybrid, remote, and distance modes of delivery. Natural language processing methods, more specifically topic modelling, were used to extract and analyse topics discussed in the data. Analysis of topic overlap and distinctions were made. Key results reveal that co-creation and shared cognition are core concepts when teachers talk about social engagement. However, results also show that individual engagement is critical for social engagement, and that teacher-student interaction can, potentially, be viewed as a separate component. Interestingly, the teachers' talk also reflected phases in learning such as process and product-based focuses. Following the results, we suggest that computational methods can be combined with traditional (human) analysis to contribute to a richer and more nuanced understanding of abstract topics. Understanding social engagement may inform theory development and is vital for researchers, practitioners, and decision-makers.

Keywords: social engagement; computational methods; online education

INTRODUCTION

The 2000s will probably be seen as a major turning point in digitalisation. What can be done digitally is continuously replaced with new and improved digital communication and interaction. That teachers and students can be co-located and online using video conferencing systems has created opportunities to adapt the teaching to the needs of different students across K-12 and adult education (Bergdahl, 2022a; Buehler et al., 2020; Lu & Churchill, 2014). The shift from co-located to online learning affects how teachers can understand and support student engagement in general and social engagement in particular (Bond et al., 2021). The online conditions for social presence, belonging, and interaction influence the possibility of establishing relationships with peers and teachers (Borup et al., 2020; Jan & Vlachopoulos, 2018) and learning outcomes (Hostetter & Busch, 2013). Working toward a general theory of engagement, Johnston (2018) concluded that "the transfer of engagement attributes from individual to social level is not well understood, as social influences have the potential to transform attributes of engagement through social processes" (p. 19). However, this accounts for a more general approach toward social engagement. It has also been pointed out that research on student engagement online is lacking in general (Martin et al., 2020; Zhang et al., 2020) and in the particular, for example, research exploring the interdependence and overlap between dimensions of engagement and social engagement (Philp & Duchesne, 2016). Such insights are critical as student engagement online is communicated and perceived differently than in the physical classroom (Bergdahl, 2022a, b; Martin et al., 2020), and students who enrol with distance education may have done so due to previously being disengaged with school, or for social reasons (Bergdahl, 2022b).

Student engagement, which we generally refer to as engagement in the present study, is commonly viewed as a multi-dimensional construct. In 2004, the most common conceptualisations of engagement included a behavioural, an emotional, and a cognitive dimension (Fredricks et al. 2004), with the adoption of a four-dimensional conceptualisation gaining interest (e.g., Fredricks et al. 2016; Fredricks et al. 2019; Bowden et al., 2021; Wang et al. 2017; Wang & Kang, 2006). As engagement traditionally has been treated as a three-dimensional construct, with the social dimension of engagement being suggested only in the more recent years (Fredricks et al. 2019), the phenomenon is less explored and less applied than the other engagement dimensions. Studies that examine how teachers conceptualise, understand, and talk about student engagement can inform the field (Zyngier, 2008). Such approach is particularly critical to advancing the understanding of social engagement (Fredricks et al., 2016). Moreover, exploring how teachers talk about engagement online is vital, as this may inform measures that make sense to practitioners (ibid.). Against this background, the following research questions are raised:

RQ 1: How do teachers frame the social dimension of student engagement in online learning in their talk at the beginning and the end of an intervention?

RQ 2: How can computational methods support interview data analysis?

The aim, methodologically, is to explore the possibilities of using such natural language processing methods in analysing textual interview data.

BACKGROUND

The social dimension of engagement

Engagement is closely related to student achievement, school success, and general wellbeing (Fredricks et al., 2004; Wang & Hofkens, 2019; Wang et al., 2017) and is included in national standards for quality online learning (National Standards for Quality, 2019).Engagement in learning can be conceptualised as a multi-dimensional construct with four dimensions: a behavioural, an emotional, a cognitive, and a social (Wang et al. 2017). The behavioural dimension would include students' proactive behaviours to support learning. The emotional dimension: students' feelings and acceptance of the teacher's instruction. The cognitive dimension: students' self-regulative abilities, concentration, and higher cognitive functions. The social dimension relates to students' communication, interaction, and sense of support and inclusion in academically oriented learning activities (Bond & Bergdahl, 2022; Wang et al., 2017). The engagement dimensions are overlapping and interdependent. For example, a student may approach a teacher and talk about an everyday experience, and the teacher may reply and connect the topic to the intended subject of learning. In this case, the interaction fills two purposes: it is relationship building, and the dialogue instigates learning. While Stahl (2006) proposes that learning is dialectic and that there is a relationship between individual and social knowledge-building, general social engagement may not always be directed toward learning and may thus not be cognitively challenging or promote learning (Lu, & Churchill, 2014).

On the other hand, students with social anxiety are still learning in a social situation, even though their social engagement (i.e., co-creation, collaboration, interaction) is inactive (Bergdahl, 2022a). While engagement is influenced by teacher leadership, efficacy, managing of engagement and disengagement, educational mode, and resources (Bergdahl & Bond, 2021), aspects of friendship and safety are also important for the student's social engagement in learning (Panadero & Järvelä, 2015). Despite the importance of the social dimension, it has been identified as an under-researched area (Cobb, 1994, Hadwin & Järvelä, 2011) and is not widely included in the

conceptualisation of engagement (Henrie et al., 2015). Research reveals that social engagement in learning includes a range of indicators, interaction, reflection, and collaborative learning activities and not only individual knowledge building, but the conceptualisation does not always differentiate between internal and external facilitators and indicators that reflect socially constructed activities (see Table 1).

Table 1
Social engagement in learning

Authors	Theoretical foundation	Suggested indicators /facilitators
Bond & Bergdahl, 2022	Social dimension of engagement	Collaborating and interacting with teacher and peers, shared knowledge building, asking for help and caring for others.
Bowden et al. 2021	Engagement theory	A student's positive social, cognitive, emotional, and behavioural investments made when interacting with their tertiary institution and its focal agents (such as peers, employees and the institution itself)
Finn & Zimmer, 2012	Social dimension of engagement	The quality of interactions with peers around instructional content.
Lu & Churchill, 2014	Constructivist theory	Being active in interacting with others, sharing ideas and collaborating on learning tasks for the purpose of co-constructing knowledge; feeling a sense of learning community.
Wang & Kang, 2006	The "MM" Model: Cybergogy for Engaged Learning	Personal attributes, learner's social-cultural context, community-building, and communication.
Waters & Gasson, 2006	Community of inquiry, COI	Interaction, collaboration, debate, negotiation, cooperation, social loafing

One challenge in facilitating online engagement is that the conditions for online teaching differ from teaching in a traditional classroom. Furthermore, as students' engagement is affected by the context, the digital conditions need to be included to inform practitioners with digital tools and resources (Bergdahl et al., 2020; Halverson, 2016). Disengagement from learning can be reflected as withdrawal, lack of effort and focus, boredom, or maladaptive behaviours (Fredricks et al., 2004; Halverson, 2016; Wang et al., 2017). Furthermore, disengagement may trigger a downward spiral, in which truancy escalates into absenteeism, which may lead to drop out. Indicators of social disengagement have been found to have a stronger explanation value than indicators in the other engagement and disengagement dimensions (Bergdahl et al., 2020). While students can make decisions that influence their social engagement, these are not always the best for their engagement.

For example, students often choose peers with the same level of engagement as themselves, meaning that peer or group dynamics can promote engagement in or disengagement from learning (Grønborg, 2013).

A sociocultural perspective on engagement

A sociocultural approach holds that individual activities are socially situated and that there is reciprocity between context and actions and reactions of the student, which affect engagement (Hickey & Granade, 2004). Two central ideas in sociocultural theory, as proposed by Russian philosopher Vygotsky, are the zone of proximal development (ZDP) and the use of a more knowledgeable other (MKO) to support learning (Vygotsky, 1978). With ZPD, Vygotsky suggested that the entry-level (of a subject to be mastered) should be placed at the ceiling of student understanding. Vygotsky visualised a student who received just enough support (by an MKO) to gain new levels of understanding and emphasised interaction, language, and scaffolding to enable such outcomes (ibid.). Indeed, it is hard to imagine any engagement emerging in a vacuum (Kahu, 2013; Quin, 2017). Even though social cognitive tenants may be approached as individual aspects of learning, they may also be approached using sociocultural theory (Hickey & Granade, 2004). At the same time: learning itself is socially situated (e.g., Lave, 2009; Viberts & Shields, 2003).

Individuals signal who they are in social situations and connect to each other and the teacher. "An individual level of engagement is often positioned within a binary relationship, while at a social level, engagement is represented as a dynamic social process involving influences and outcomes" (Johnston, 2018, pp. 19-20). Does that mean that there is no social engagement in learning? Traditional cognitive theory separates the mind from the surrounding world (Lave, 2009). In a learning setting, interactions and dialogues may reflect a general school engagement, but these may not reflect academic engagement, i.e., engagement in learning. Thus, learning takes place in a social setting, in which there are verbal and non-verbal interactions. Vygotsky (1978) emphasised that shared knowledge develops through collaboration, communication, and activity. Separating social engagement in learning from general social engagement is important if the aim is to understand the social dimension of the "engagement-in-learning-construct". Efforts have been made to disseminate how engagement can be approached at different levels (Bond & Bendelier, 2019; Symonds et al., 2019). For example, Wang and Hofkens (2019) found that engagement directed toward learning (i.e. academic engagement) and general school engagement (i.e., after-school engagement) would influence each other and academic achievement. Other scholars have explored how engagement is influenced by

interactions and the environment (Bergdahl & Bond, 2021; Wang et al., 2019) and how intra-and interrelated dynamics within the engagement and disengagement constructs influence each other and co-occur (Bergdahl, 2022a). Such approaches contribute to understanding how sociocultural factors may foster engagement or trigger disengagement.

Knowledge building and engagement

A constructivist approach holds that a student can progress further with a more knowledgeable other than s/he could alone (Scardamalia & Bereiter, 2010). Such social interaction is not general but aims to support knowledge building and progression. Introducing the term knowledge building (Scardamalia & Bereiter, 1994), their research sought to advance the understanding of knowledge building as a construct that relates to intentional knowledge creation and construction to serve a community (Scardamalia & Bereiter, 2010). Expanding on their ideas, Paavola et al. (2004) proposed three metaphors for learning where commonalities in different approaches were identified to assert that a social process is key for knowledge-creation as "social interaction provides essential cognitive resources for human cognitive accomplishment" (p. 546) which is also in line with Vygotsky (1978). Through the three metaphors, learning can be characterised as 1) knowledge acquisition, 2) social participation, and 3) knowledge creation through processes requiring gradually deepening individual, social, and artefact-mediated engagement in learning. Paavola et al. (2004) continue by describing the iterative nature of knowledge building and progression; and how learning evolves through several attempts to process and master a subject. They conclude that when two students share partial ideas, the social interaction supports their collective understanding. A part of the relation to sociocultural theory and constructivism, this approach can be linked to learning theories on process-oriented, and product-based learning, where process-oriented approaches can support gradual improvement in, for example, writing skills (Sarhady, 2015), and a product-oriented approach can support (for example) theoretical and practical understanding (Hidayat, 2017). Both approaches can be adopted at different phases in learning, depending on the subject and purpose. Regardless of the approach, there is an implicit expectancy of qualitative social interaction embedded in the learning context (Allen et al., 2011). It is here that social engagement in learning becomes fundamental.

Engagement dimensions overlap and are interdependent, but it remains unclear how they overlap (Pekrun & Linnenbrink-Garcia, 2012; Philp & Duchesne, 2016) or how they can be understood in different phases of knowledge building. To move toward this direction, this paper explores how teachers frame social engagement based on their experiences and observations of students in online learning and further examines how these conceptualisations overlap and differ.

METHODOLOGY

Methodological approach

This study adopted an exploratory, investigative, and longitudinal Mixed Methods study (Creswell & Clark, 2011) on how teachers reflected on how learners are interacting with online learning. The study was designed as follows: an in-depth starting interview was followed by two to three weeks of diary reflections on engagement in online learning, and a second follow-up interview where teachers expressed their understanding of learner engagement. The data were interpreted using a phenomenographic approach (Han & Ellis, 2019) in combination with a Natural Language Processing methods and topic modelling (Grün & Hornik, 2011). The methodological ensemble employed here can be characterised as computational phenomenography. More precisely, a typical iterative process (e.g., Han & Ellis, 2019) of a phenomenographic approach was conducted supported by computational methods to identify description categories, searching for collective meaning across the corpus as well as examining the interrelations and distinctive elements of the identified description categories instead of merely presenting them descriptively. Research has identified challenges related to large-scale qualitative data and a need for techniques to visualise and interpret broader-scale observations and interviews (Cao et al., 2011). In addition to the research questions, this study undertakes a methodological exercise in utilising computational techniques to analyse interview data supported by a human reading of the data. These methods can be further expanded to larger data corpora, analysis of which is beyond reasonable human effort. Moreover, computational data-driven analyses can be used to triangulate human coding and reveal patterns that may remain undiscovered in manual analysis.

Participants and context

Purposive sampling was employed (Denscombe, 2014). The study was conducted within a research and development program in Sweden, where dedicated teachers and principals from eight municipalities were involved. From these municipalities, twelve teachers agreed to participate in the study (see Table 2).

Table 2
Participant background data

Gender	Subject	Teaching of level	Years teaching	Form	Class-size	No. students/ lesson	Int. 1 (min)	Int. 2 (min)	Tot. Int. (min)
Female	Health and social care	Upper secondary	3	Remote	26	4/3	83	45	128
Female	Foreign languages	Elementary	22	Remote	8	4/3	48	30	78
Female	Foreign languages	Elementary	10	Remote	9	4/3	57	45	102
Male	Mathemat-ics, physics	Upper secondary	23	Hybrid	7	4/3	45	40	85
Female	Native language	Upper secondary	5	Remote	3	3/3	90	35	125
Female	Natural sciences	Adult education	3,5	Distance	10	4/3	62	60	122
Male	Natural sciences	Elementary	20	Hybrid	16	4/3	75	35	110
Male	Social sciences	Adult education	14	Distance	21	4/3	70	45	115
Male	Psychology	Upper secondary	13	Hybrid	15	4/2	57	48	105
Female	Swedish language	Upper secondary	2,5	Distance	8	4/3	68	32	100
Female	Social sciences	Upper secondary	15	Distance	6	4/2	48	32	80
Female	Foreign languages	Upper secondary	16	Distance	13	3/3	77	55	132

Following Barbour (2018) we define remote education as supplemental to online learning, where students are "enrolled in a brick-and-mortar school but take one or more courses from an online provider to supplement their face-to-face learning" (p. 25). In remote education, students are co-located in one (or more) classrooms with a tutor who facilitates synchronous interaction with the remote teacher. We use the concept of distance education to describe synchronous or asynchronous modes of distribution of teaching and learning that takes place when the students participate in a planned learning activity separated from their teachers (Rumble, 2019) and peers and participate from another place than the school. Finally, hybrid education refers to teaching on-site and online students simultaneously (Raes, 2019).

Data collection and analysis

Interview data and diaries were collected over three months (February-April 2021). To explore how teachers frame the social dimension, we analysed the two data sets from this perspective as follows. All interviews (n= 24) were recorded using Zoom, making up a total of 21.5 hours (1045 minutes) which were subsequently transcribed. Using Content Analysis (Gilbert et al., 2014), the data were coded using the lens of social engagement, where sections of meaning were used as the unit of analysis (Yin, 2014). The identified sections were extracted into two document-term matrices.

The document-term-matrix for dataset 1 consisted of 12 documents (1 for each participant) and 4442 terms, of which 1054 were unique, and sparsity was 83%. The document-term-matrix for dataset 2 consisted of 12 documents (1 for each participant) and 1231 terms, of which 472 were unique. Sparsity was 85% (the full matrices in the original language can be downloaded from https://osf.io/5uw9k/?view_only=edd78c6267ba498f969f67a078abbc2c along with code). Then, the data analysis was approached using computational natural language processing methods following a tidy text mining approach (Silge & Robinson, 2017). The analyses were conducted using R programming language (R Core Team, 2021) and Rstudio (Rstudio Team, 2021). The main packages utilised were 'tidytext' (Silge & Robinson, 2016), 'udpipe' (Wijffels, 2021), 'topicmodels' (Grün & Hornik, 2011), 'ldatuning' (Murzintcev, 2020) as well as supporting packages from the 'tidyverse' -collection (Wickham et al. 2019).

Following a typical process of text data analysis, we first tokenised the data into single terms by row and lemmatised the terms using lemmas provided by the Swedish "Talbanken" (https://universaldependencies.org/treebanks/sv_talbanken/index.html) and removed common stop words utilising pre-made dictionaries. After this, the remaining most common stop words were listed and manually flagged to be removed utilising a manually constructed stop word list.

Topic modelling is an unsupervised method to classify a set of documents to understand the content further. The topic modelling algorithm we relied on in the present study was Latent Dirichlet Allocation (LDA, Blei et al. 2003), which assumes that each document (here, interview segment) is a mixture of topics themselves are a mixture of terms. Thus, the topics can overlap. While there is no gold standard for extracting the best number of topics, we approached the topic enumeration empirically. That is, we computed models with a varying number of topics from 1 to 10 and examined four metrics (Arun et al. 2010; Juan et al. 2009, Deveaud et al. 2014; Griffiths & Steyvers, 2004) designed to help in deciding the "correct" number of topics utilising a 'FindTopicsNumber' helper function from 'ldatuning'-package (Murzintcev, 2020). After selecting the number of topics to proceed the topic model was estimated, and the prevalence of the topics in the data was examined utilising the gamma coefficient representing the prevalence of each topic in the documents. In addition, the substantive meaning of the topics was examined by exploring the top 10 terms that were likely to be generated by each topic represented by the beta coefficient, as well as comparing the logarithm ratio of betas between terms (with a minimum probability to be generated by either of the topics of .005) in the selected topics to examine their differences more closely. The analysis was conducted in the original language; terms were translated into English for figures only.

Qualitative interpretation of the topics was approached by triangulating the computational findings with human understanding of the data. The analysis process was continuously discussed between the authors, and all translations of terms into English were cross-checked. The authors revisited the dataset to clarify a term's meaning (see Appendix A). For example, when the translation was unclear, e.g., the term "klara" (dataset 1) could have different meanings (i.e., able to do a task, having completed a task), or the context was unclear, e.g., "programming" (dataset 2). We then repeated the analysis procedure for the second dataset (Sample 2) that was collected after the intervention to examine the topics reflected by the teacher posterior to the intervention. Finally, the authors linked the topics to social engagement aspects as described in teachers' lived experiences.

RESULTS

Teachers' conceptualisation of social engagement prior to the intervention

To examine teachers' conceptualisation of social engagement prior to the intervention, we first estimated topic models for dataset 1. The metrics (see Figure 1) suggested by Juan et al. (2009) and Deveaud et al. (2014) propose that a six-topic model could be used to sufficiently explain the data, whereas the other metrics were uninformative. We decided to proceed with six topics.

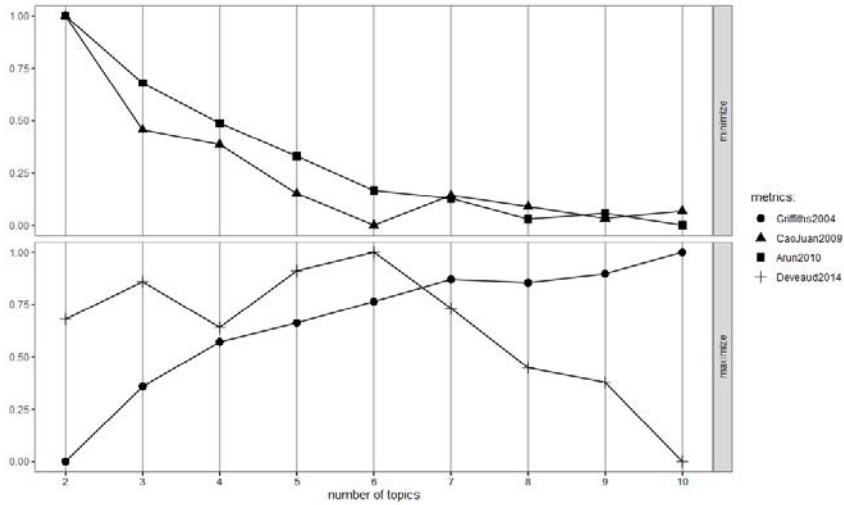

Figure 1. Dataset 1: Results plotted from the 'FindTopicNumber' - helper function.

Topics extracted

The overlap in terms between the topics is illustrated in Figure 2, and the top terms most likely generated by each topic are illustrated in Figure 3.

When framing social engagement, the following topics were identified: Topic 1: Teacher-student interaction; Topic 2: Peer collaboration; Topic 3: Pro-learning behaviour; Topic 4: Student-content interaction; Topic 5: Co-creation and shared cognition and Topic 6: Individual cognition. The most prevalent topic based on the average gamma values across the corpus was Peer collaboration which showed an average prevalence of ~23% of the teachers' descriptions. Individual cognition was the second most prevalent, with an average gamma of ~18%. Topics 3-5 were equally prevalent with ~17% each, and Teacher-student interaction was the least prevalent with ~9%.

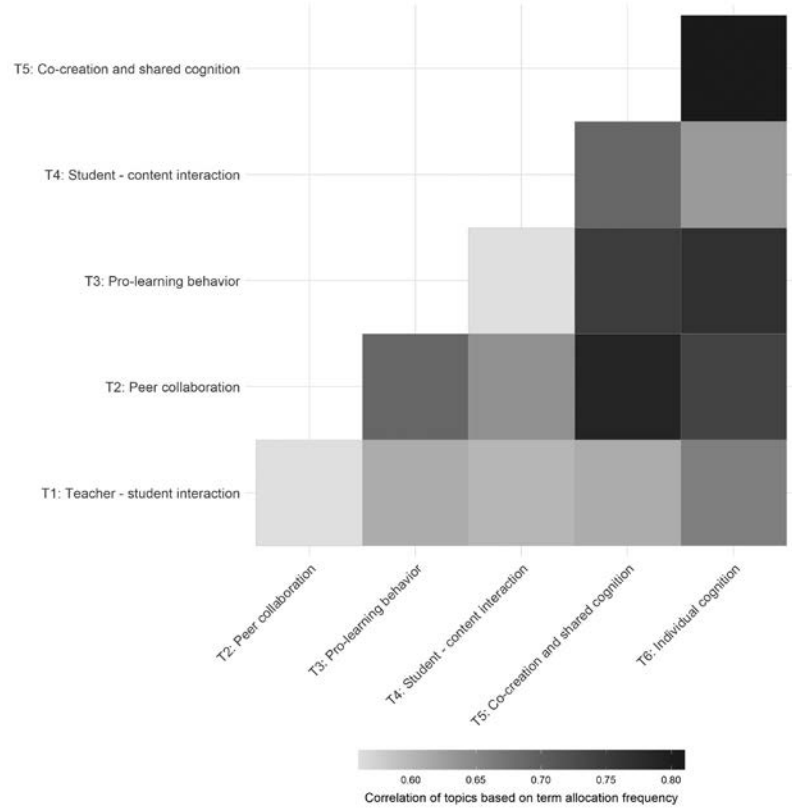

Figure 2. Overlap of topics based on term counts.

Based on the correlation between the topics based on term counts (see Figure 2), we conclude that the most substantial overlap in content between topics was between Co-creation and shared cognition and Individual cognition, Pro-learning behaviour and Individual cognition, as well as Peer collaboration and Co-creation and shared cognition. Co-creation and shared cognition show the strongest correlation with individual cognition and Peer-collaboration; results suggest that it is a core concept when approaching social engagement. Social engagement seems to build extensively on both Peer collaboration and Individual cognition. Unsurprisingly, Co-creation and shared cognition require individuals to be cognitively engaged. On the other hand, Peer collaboration alone may be insufficient to capture social engagement as cognitive elements are needed. The second highest correlations were found between Pro-learning behaviour and Individual cognition.

This supports the previous indication: that individual engagement is critical for social engagement. Teacher-student interaction has the least overlap. This suggests that when we try to construct the experience of social engagement, Teacher-student interaction can be viewed as a separate component. This is logical as it focuses more on the teacher's work than on students' social engagement in learning.

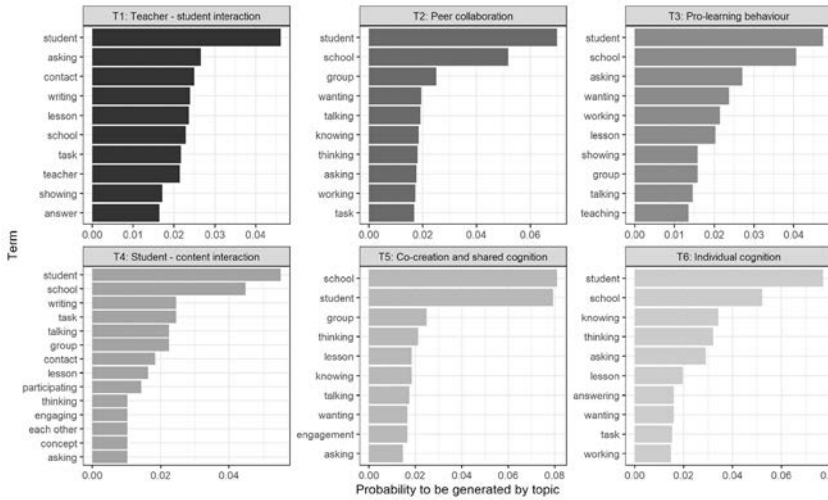

Figure 3. Dataset 1: Top terms generated by each topic related to social engagement in learning.

All topics focused on the student ('student' was the most common term, see Fig 3). The second most prevalent term (for topics 2-5) was 'school.' This serves as ecological validity: the teachers were talking about student social engagement in the school context. Stating the most common terms first, Teacher-student interaction contained interactive terms such as 'asking,' 'contact,' and 'writing' and reflected activities of connectivity between teacher and students. Peer collaboration included terms like: 'willingness' and 'participation' linked to group activities: 'group,' 'wanting to,' 'talking,' 'knowing,' and 'thinking.' In Pro-learning behaviour, the most common terms were action verbs and contextual terms that signal engagement in learning: 'asking,' 'wanting,' 'working,' and 'lesson.' Student-content interaction, on the other hand, may reflect a more traditional understanding of learning at school where students focus on mastering a subject, with terms like 'writing,' 'task,' 'talking,' 'group,' 'contact,' 'lesson,' and 'participating.' Surprisingly, teachers framed social engagement as individual and

shared cognition. For example, in topic 5: Co-creation and shared cognition, teachers use terms like: 'group,' 'thinking,' 'lesson,' 'wanting,' 'knowing,' and 'asking.' In topic 6, the most common terms are related to Individual cognition: 'knowing,' 'thinking,' 'asking,' 'lesson' (without mention of peer-group), further underlining the close relationship between shared and individual cognition and social engagement. While figure 3 reflects the potential reciprocity between the six aspects of social engagement, it also provides initial insights into the overlap between engagement dimensions, which was explored further.

Topic comparison

As some topics are semantically related and overlapping (see also Figure 2), these were further analysed in pairs to examine which term differentiated the topics most.

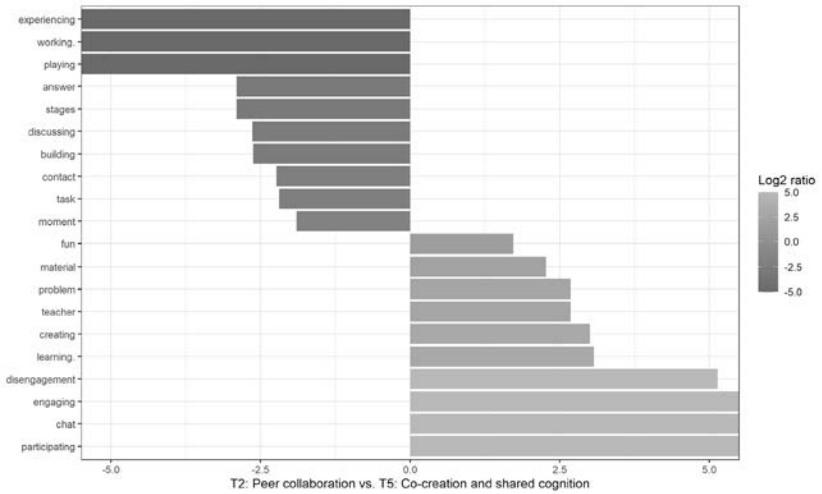

Figure 4. Dataset 1: Log2 beta ratio of terms between Topic 2 and 5. Negative values indicate that the term is more likely to be generated by the topic "Peer collaboration." Positive values indicate that the term is more likely to be created by the topic "Co-creation and shared cognition."

For this purpose, Peer Collaboration was contrasted with Co-creation and shared cognition; Pro-learning behaviour was contrasted against Individual cognition, and Co-creation and shared cognition was contrasted against Individual cognition. Figure 4 reveals the relation between Peer Collaboration, Co-creation, and shared cognition. When discussing Peer Collaboration, teachers were more likely to include terms like:

'experiencing,' 'working,' and 'playing' than when discussing Co-creation and shared cognition. When addressing Co-creation and shared cognition, the terms' participating', 'chatting,' 'engaging,' and 'disengagement' were more likely to be used.

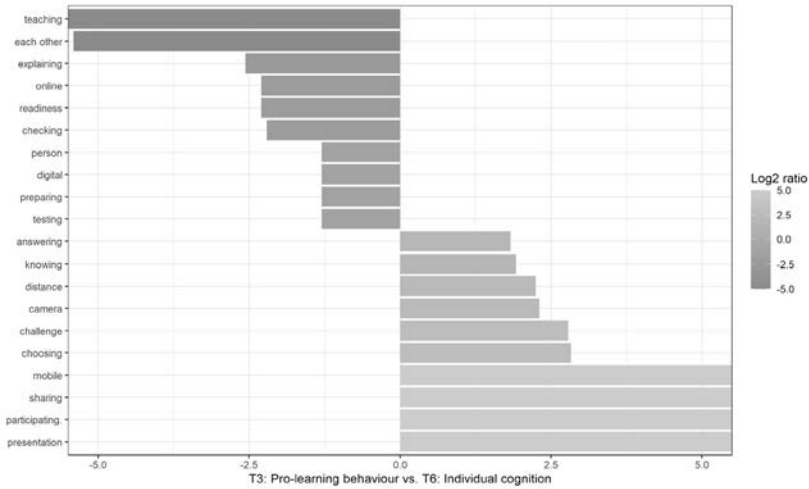

Figure 5. Dataset 1: Log2 beta ratio of terms between Topic 3 and 6. Negative values indicate that the term is more likely to be generated by the topic "Pro-learning behaviour." Positive values indicate that the term is more likely to be created by the topic "Individual cognition."

Figure 5 reflects the relation between Pro-learning behaviour and Individual cognition. Interestingly, both are related to individual activities and factors and are largely overlapping regarding the most common terms, which is why the comparison is particularly interesting. Considering the differences, when teachers framed Pro-learning behaviour, they used a higher frequency of terms like 'teaching,' 'each other,' 'explaining,' 'readiness,' and 'checking.' Individual cognition was more likely than Pro-learning behaviour to be framed using terms like 'presentation,' 'participating,' 'challenge' and (referring to learning via a video conference application:) 'camera,' 'distance' (referring to distance education), followed by 'knowing' and 'answering.' Together these reflect interdependent factors where digital resources, teacher instruction, and individual choice of actions all are related to pro-learning behaviours needed online, which may be a foundation for collaborative aspects of social engagement online.

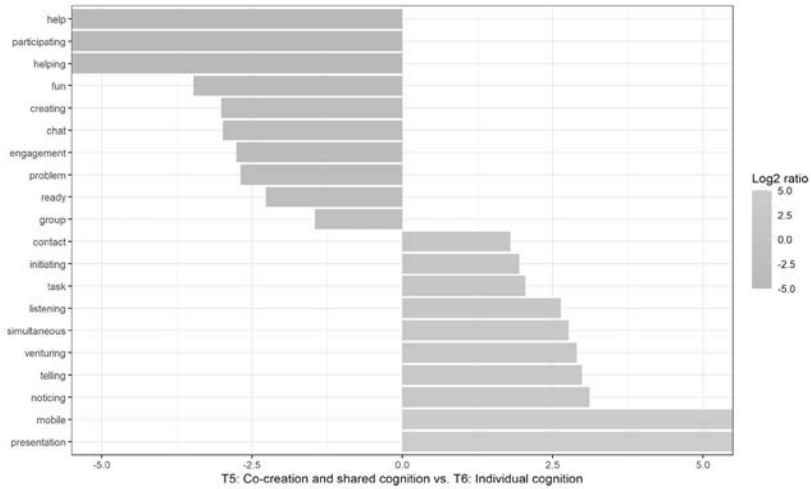

Figure 6. Dataset 1: Log2 beta ratio of terms between Topic 5 and 6. Negative values indicate that the term is more likely to be generated by the topic "Co-creation and shared cognition." Positive values indicate that the term is more likely to be created by the topic "Individual cognition."

When comparing co-creation and shared cognition and Individual cognition, the terms that were more likely to be generated from a discussion around Co-creation and shared cognition were related to 'helping,' 'participating,' having 'fun,' and being 'engaged' as well as 'creating.' In turn, the terms that differentiated Individual cognition from Co-creation and shared cognition were 'presentation,' 'noticing,' 'telling,' 'venturing,' and 'initiating', all reflecting individual aspects of learning and engagement.

Teacher discovery process

The intervention was longitudinal as it followed an interview- diary- interview design, which allowed several weeks for diary writing and reflections on student engagement in learning. To assist teachers' focus on engagement, a pre-printed diary was handed out in which the teachers reflected on their students' engagement in online learning. A first analysis of the data (published in Bergdahl, 2022b) revealed changes in how teachers talked about students' online engagement during the intervention: that most of the teachers increased the use of term engagement between the first and second interviews and decreased their use of related constructs, such as motivation. This indicated a process in which teachers moved from describing what engagement is to describing temporal phases of the learning process. Following this hypothesis, we approached dataset 2.

Teachers' conceptualisation of social engagement after the intervention

The topic modelling process was repeated for dataset 2 using the same analytic approach to examine the teachers' conceptualisation of social engagement after the intervention. We selected two topics, (see Figure 7).

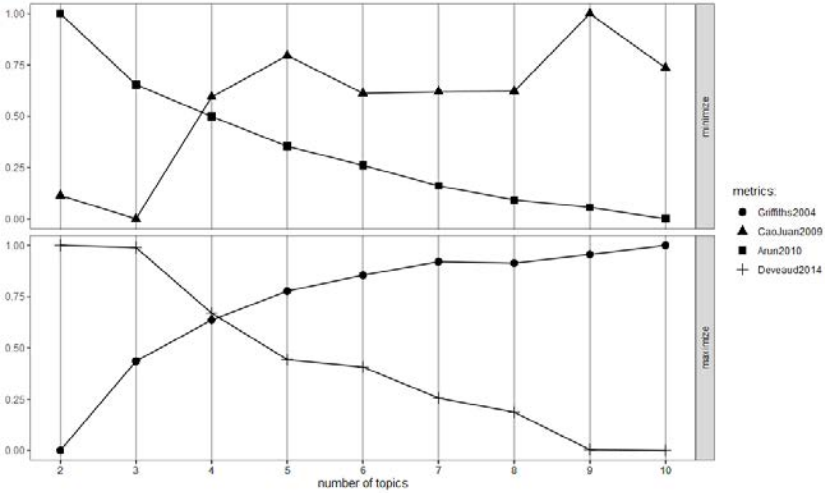

Figure 7. Dataset 2: Results plotted from the 'FindTopicNumber' - helper function.

Topics extracted

The top terms most likely generated by each topic in dataset 2 are illustrated in Figure 6.

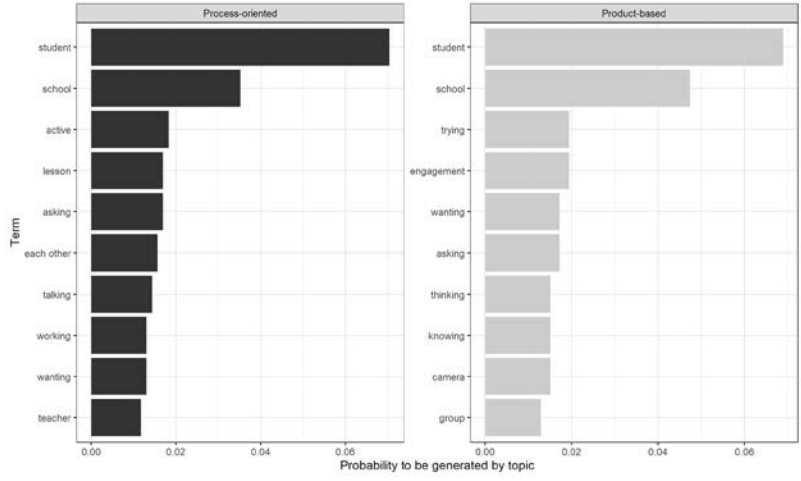

Figure 8. Dataset 2: Top terms generated by each topic.

The topics were equally prevalent. The correlation between the topics was modest at .40. Analysis of the topics identified from the second dataset collected after the intervention revealed that Topic 1 reflected Process-oriented learning with a focus on terms like: 'active,' 'lesson,' 'asking,' and 'each other. In turn, Topic 2 seemed to reflect talk centring more on Product-based learning, with terms like 'trying,' 'engagement,' 'wanting,' 'asking.' However, the most common terms in both topics were student and school.

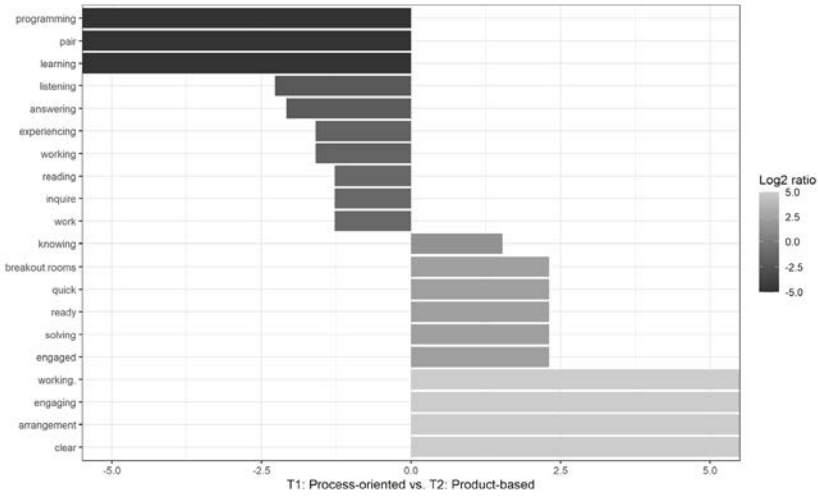

Figure 9. Dataset 2: Log2 beta ratio of terms between Topics 1 and 2. Negative values indicate that the term is more likely to be generated by topic 1, Process-oriented learning. Positive values indicate that the term is more likely to be created by the second topic: Product-based learning.

Comparing these two topics with the logarithmic ratio of beta (Figure 9) indicated that after the intervention, when teachers described social engagement, it was more likely that terms like 'learning,' 'inquiry,' 'experiencing' were generated from the process-oriented topic than in product-based topic. In the Product-based topic, terms like 'knowing,' 'solving,' 'arrangement,' and 'clear' stood out. We refer to these as temporal phases as it is likely that learning activities focus on theoretical knowledge and production at different phases of learning, even though they may be parallel, sequential, or logically ordered. Thus, the second dataset reveals a shift in teachers' talk about social engagement towards a micro-level of temporal phases of the learning process. Further, the term that differentiated the Process-oriented topic from the Product-based topic the most was, somewhat surprising, 'programming.' In Sweden, there has been a recent surge in programming in schools.

> "I work with programming in the subject of Technology because many students are interested in video games. I found Scratch from the Internet foundation and other teachers' videos on YouTube. [Using them] the students can engage in self-study, and I can also learn because I do not master programming /…/This is something that they [the students] get caught up in, and actually work with." (ID: G2)

Several teachers mentioned programming as an example of a learning activity where the teacher and students, in parallel, were trying to understand and develop their know-how. Programming skills can be related to writing skills, as both may reflect progression processes.

In conclusion, based on the topics identified after the intervention, it seems that the social dimension of engagement is here, both depicted as a shared process of searching for mutual understanding (through listening, experiencing, enquiring, answering) and as arriving at a product, such as 'solving' or 'knowing.' As such, we find that the Process-oriented topic is more linked to procedural knowledge as the teachers' talk generated from the topic reflected terms related to facilitating processes (how), whereas the talk generated by the Product-based topic reflected declarative knowledge as the terms were more linked to facilitating knowing (what) (cf. Ennis, 1994).

How did the teachers describe social engagement at the intervention's beginning and end?

We identified six topics from the first set of teachers' descriptions of student engagement in the distance-, remote- and hybrid learning: 1) Teacher-student interaction, 2) Peer collaboration, 3) Pro-learning behaviour, 4) Student-content interaction, 5) Co-creation and shared cognition, and 6) Individual cognition. While the teachers' work characterised teacher-student interaction, the other topics reflect different aspects of learning. As such, the data reflect both traditional and emerging approaches to teaching and learning. For example, we found that Pro-learning behaviour and Student-content interaction reflect what is typically associated with elementary (and traditional) elements of learning, where a student focuses on the topic at hand and exerts the effort to master that topic. In the second dataset, collected at the end of the intervention, the teachers framed social engagement in more nuanced ways, using concepts reflecting different temporal aspects of social engagement and focusing on the intertwined dynamics of process and product in learning. As digitalisation has evolved, new ways of facilitating interaction, social presence, collaboration, and even creation have emerged. The intentional design to facilitate social engagement can be reflected in Peer

collaboration and Co-creation and (individual and shared) cognition and can be linked to theories of social engagement that highlight the necessity of interaction, collaboration, and (Bond & Bergdahl, 2022; Finn & Zimmer, 2012, Lu & Churchill, 2014; Wang & Kang, 2006). Overall, the topics identified from the first dataset showed a more scattered set of differently overlapping descriptions of student activity and engagement in distance-, remote- and hybrid learning. In contrast, the second dataset painted a more coherent picture of two conceptually and empirically related aspects of social engagement, and by suggesting temporal phases of social engagement.

DISCUSSION

Linking findings to learning theory and engagement theory

Results reveal that teachers, when discussing their experiences of students' activities in distance-, remote- and hybrid learning, initially framed social engagement as teacher-student and student-content interaction, peer-peer collaboration, co-creation, shared and individual cognition, and pro-learning behaviour. These findings suggest that there are several components to social engagement and that teachers frame social engagement as a phenomenon including both shared and individual engagement components. Interestingly, the results also revealed some change in the conceptualisation as the intervention progressed: then, teachers described student engagement in learning in more focused and nuanced ways: revealing phases in which teachers described social engagement as shared inquiry and Process-oriented learning, and knowing and solving as Product-based learning, which in turn can be seen as facilitating both procedural and declarative parts of knowledge building (Ennis, 1994). Instead of viewing Process-oriented and Product-based approaches to learning as separate (Hidayat, 2017; Sarhady, 2015), we found that these approaches could be used to reflect temporal phases of social engagement in learning.

The results reveal that teachers talked about social engagement in theoretically meaningful ways, relating social engagement to learning theories, especially knowledge building (Paavola, 2004; Scardamalia & Bereiter, 1994) and sociocultural theory (Vygotsky, 1978). It makes sense that learning gains include process-oriented and product-based parts of knowledge building. The presented results align well with the previous ideas forwarded that when people feel aroused when participating, the experience becomes more memorable (Pekrun & Linnenbrink-Garcia, 2012) and that emotionally disengaged students might withdraw behaviorally from schoolwork (Philp & Duchesne, 2016), that students who are bored and do their work mechanically also are more likely to cheat and withdraw from learning activities (Fredricks et al. 2019). Thus, co-existing engagement and

disengagement dimensions are not new, but how the social dimension can be framed at a micro-level and how these aspects may overlap have not been explored similarly. This study expands on previous indications which have suggested that engagement dimensions are interdependent and overlap (Pekrun & Linnenbrink-Garcia, 2012; Philp & Duchesne, 2016) by demonstrating the correlation of overlap between aspects of social engagement.

CONCLUSIONS AND IMPLICATIONS

Building on interviews with teachers, this study explored the social dimension of engagement in online learning based on how teachers reflected their students' engagement during online learning. Overall, the teachers employed a multidimensional framing of social engagement. Previous literature has suggested that social engagement circulate round participation and interaction (e.g., Lu & Churchill, 2014; Waters & Gasson, 2006) and the quality thereof (Finn & Zimmer, 2012) and the satisfaction with how digital technologies are used to enable inclusion, belonging and teacher-student communication (Bergdahl et al. 2020). Our results indicate that, social engagement incorporates both individual and collective factors and actions as well as process- and product-oriented approaches. Further, it can be argued that facilitating social engagement is essential if learning is to expand beyond simple knowledge acquisition toward learning as participation and knowledge creation (Paavola et al., 2004). In line with Paavola, 2004, the results presented here (and furthering the findings of Scardamalia & Bereiter, 2010), the substantive implications of the results are that focusing on and aiming to find ways to utilise digital technologies to foster collaboration, co-creation, and shared cognition are crucial when supporting teachers to facilitate social engagement online. As has been pointed out in previous research: how teachers use digital technologies for learning is critical to facilitating engagement (Hutain & Michinov, 2022).

The results further indicate that using computational techniques can reveal meaningful topics from interview data that are generally in line with a human interpretation of the data. The use of this type of computational data-driven analyses can thus be used to triangulate human coding and reveal patterns that may remain undiscovered in manual analysis. In future studies the techniques applied here should be expanded to larger or multiple datasets. Further studies should also consider the possibility for parallel analysis in conjunction with human coding of parts of the data to be cross-validated with computational results or, for instance, practical reanalysis of pre-existing multiple datasets to gain new insight.

From a substantive point of view, more research is needed to understand how the aspects of social engagement relate to wellbeing, retention, and learning outcomes and if similar relations can be identified with a large-scale sample. The results presented are a first contribution to exploring the interdependency and overlap of indicators of social engagement extracted from teachers' described experiences computationally. Further research could explore what this may mean for engagement theory development and if strengthening students' behavioural and cognitive engagement promotes social engagement or is manifested as a result. Being further explored, understanding how to design for social engagement online may support a move from heuristic practices to intentional instruction.

DECLARATIONS

The authors declare no conflicts of interest. Ethics approval was not required for this study. The authors declared no funding was received for this work.

References

Allen, J. P., Pianta, R. C., Gregory, A., Mikami, A. Y., & Lun, J. (2011). An interaction-based approach to enhancing secondary school instruction and student achievement. *Science, 333*(6045), 1034–1037. http://doi.org/10.1126/science.1207998

Arun, R., Suresh, V., Veni Madhavan, C. E., & Murthy, N. (2010, June). On finding the natural number of topics with latent dirichlet allocation: Some observations. In *Pacific-Asia conference on knowledge discovery and data mining* (pp. 391-402). Springer, Berlin, Heidelberg. http://doi.org/10.1007/978-3-642-13657-3_43

Barbour, M. K. (2018). Exploring K-12 distance, online, and blended learning worldwide. In R. Ferdig & K. Kennedy (Eds.), *Handbook of research on K-12 online and blended learning* (2nd ed., pp. 21-40). Entertainment Technology Center Press, Carnegie Mellon University

Bergdahl, N. (2022a). Engagement and disengagement in online learning. *Computers & Education, 188*. https://doi: 10.1016/j.compedu.2022.104561.

Bergdahl, N. (2022b) Teachers' understanding of engagement in hybrid, remote and distance education. [Lärares förståelse av engagemang i hybrid, fjärr- och distansundervisning]. *Pedagogisk Forskning i Sverige*. ISSN 1401-6788.

Bergdahl, N., & Bond, M. (2021). Negotiating (dis-)engagement in K-12 Blended Learning. *Education and Information Technologies, 27*, 2635–2660. https://doi.org/10.1007/s10639-021-10714-w

Bergdahl, N., Nouri, J., Fors, U., & Knutsson, O. (2020). Engagement, disengagement, and performance when learning with technologies in upper secondary school. *Computers and Education, 149*. https://doi.org/10.1016/j.compedu.2019.103783

Blei, D. M., Ng, A. Y., & Jordan, M. I. (2003). Latent dirichlet allocation. *Journal of Machine Learning Research, 3*, 993-1022.

Bond, M., & Bedenlier, S. (2019). Facilitating student engagement through educational technology: Towards a conceptual framework. *Journal of Interactive Media in Education, 2019(1*), Article 11, 1–14.https://doi.org/10.5334/jime.528

Bond, M., & Bergdahl, N. (2022). Student engagement in open, distance, and digital education. In O. Zawacki-Richter & I. Jung (Eds.), *Handbook of open, distance and digital education*. (pp. 1-16). Springer. https://doi.org/10.1007/978-981-19-0351-9_79-1

Borup, J., Walters, S., & Call-Cummings, M. (2020). Student perceptions of their interactions with peers at a cyber charter high school. *Online Learning, 24*(2), 207-224. https://doi.org/10.24059/olj.v24i2.2015

Buehler, K., Sánchez, B., Vaclavik, D., Rodriguez, E., & Gray, T. (2020). Rules of disengagement: Negative relationships and interactions between adults and youth. *Youth & Society, 52*(6), 1033–1056. https://doi.org/10.1177/0044118X18793157

Bowden, J. L. H., Tickle, L., & Naumann, K. (2021). The four pillars of tertiary student engagement and success: a holistic measurement approach. *Studies in Higher Education, 46*(6), 1207–1224. https://doi.org/10.1080/03075079.2019.1672647

Cao, H., Bowers, S., & Schildhauer, M. P. (2011) Approaches for semantically annotating and discovering scientific observational data. In A. Hameurlain, S.W. Liddle, K.d. Schewe, and X. Zhou (Eds.), *Database and Expert Systems Applications. DEXA 2011.Lecture Notes in Computer Science, Vol. 6860* (pp. 526–541). Springer. doi: 10.1007/978-3-642-23088-2_39.

Cobb, P. (1994) Where is the mind? Constructivist and sociocultural perspectives on mathematical development. *Educational Researcher, 23*(7), 13-20. https://doi.org/10.3102/0013189X023007013

Creswell, J., & Clark, V. (2011). *Designing and conducting mixed methods research* (2nd ed.). SAGE Publications.

Denscombe, M. (2014). *The good research guide: for small-scale social research projects.* McGraw-Hill Education.

Deveaud, R., SanJuan, E., & Bellot, P. (2014). Accurate and effective latent concept modeling for ad hoc information retrieval. *Document numérique, 17*(1), 61-84. http://doi.org/10.3166/dn.17.1.61-84

Ennis, C. D. (1994). Knowledge and beliefs underlying curricular expertise. *Quest, 46*(2), 164-175.

Finn, J. D., & Zimmer, K. (2012). Student engagement: What is it and why does it matter? In S. Christenson, A. L. Reschy, & C. Wylie (Eds.), *Handbook of research on student engagement* (pp. 97-131). Springer.

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research, 74*(1), 59–109. https://doi.org/10.3102/00346543074001059

Fredricks, J., Wang, M.-T., Schall Linn, J., Hofkens, T. L., Sung, H., Parr, A., & Allerton, J. (2016). Using qualitative methods to develop a survey measure of math and science engagement. *Learning and Instruction, 43*, 5–15. https://doi.org/10.1016/j.learninstruc.2016.01.009

Fredricks, J. A., Reschly, A. L., & Christenson, S. L. (2019). *Handbook of Student Engagement Interventions: Working with Disengaged Students* (J. A. Fredricks, A. L. Reschly, & S. L. Christenson, Eds.). Elsevier.

Gilbert, L. S., Jackson, K., & di Gregorio, S. (2014). Tools for analyzing qualitative data: the history and relevance of qualitative data analysis software. In J. M. Spector, M. D. Merrill, J. Elen and M. J. Bishop (Eds.), *The Handbook of Research on Educational Communications and Technology* (pp. 221–236). Springer. https://doi.org/10.1007/978-1-4614-3185-5_18

Griffiths, T. L., & Steyvers, M. (2004). Finding scientific topics. *Proceedings of the National academy of Sciences, 101*(suppl 1), 5228-5235. http://doi.org/10.1073/pnas.0307752101

Grün, B., & Hornik, K. (2011). topicmodels: an r-package for fitting topic models. *Journal of Statistical Software, 40*(13), 1-30. https://doi.org/10.18637/jss.v040.i13

Grønborg, L. (2013). One of the boys: Constructions of disengagement and criteria for being a successful student. *International Journal of Qualitative Studies in Education, 26*(9), 1192–1209. https://doi.org/10.1080/09518398.2013.816889

Han, F., & Ellis, R. A. (2019). Using phenomenography to tackle key challenges in science education. *Frontiers in Psychology, 10*. https://doi.org/10.3389/fpsyg.2019.01414

Hadwin, A., & Järvelä, S. (2011). Introduction to a special issue on social aspects of self-regulated learning: Where social and self meet in the strategic regulation of learning. *Teachers College Record, 113*(2), 235–239. https://doi.org/10.1177/016146811111300201

Halverson, L. R. (2016). *Conceptualizing blended learning engagement.* Doctoral Dissertation. Brigham Young University, USA

Henrie, C. R., Halverson, L. R. and Graham, C. R. (2015) Measuring student engagement in technology-mediated learning: A review, *Computers & Education*. Elsevier Ltd, 90, pp. 36–53. doi: 10.1016/j.compedu.2015.09.005.

Hickey, D. T., & Granade, J. B. (2004). The influence of sociocultural theory on our theories of engagement and motivation. In D. McInerney & S. Van Etten (Eds.), *Big theories revisited, Volume 4* (pp. 200-223). Information Age Publishing.

Hidayat, H. (2017). Impact of learning with the production-based learning model in vocational school. *International Journal of Research in Engineering and Social Sciences, 7*(2), 1-6.

Hostetter, C., & Busch, M. (2013). Community matters: Social presence and learning outcomes. *Journal of the Scholarship of Teaching and Learning, 13*(1), 77-86. https://eric.ed.gov/?id=EJ1011685

Hutain, J., & Michinov, N. (2022). Improving student engagement during in-person classes by using functionalities of a digital learning environment. *Computers & Education, 183.* https://doi.org/10.1016/j.compedu.2022. 104496.

Jan, S. K., & Vlachopoulos, P. (2018). Influence of learning design of the formation of online communities of learning. *International Review of Research in Open and Distributed Learning, 19*(4), 1-16. https://doi.org/10.19173/irrodl.v19i4.3620

Johnston, K. (2018). Toward a theory of social engagement. In K. A. Johnston & M. Taylor (Eds.), *Handbook of communication engagement* (pp. 19–32). John Wiley & Sons.

Juan, C., Tian, X., Jintao L., Yongdong, Z., & Sheng, T. (2009). A density-based method for adaptive LDA model selection. *Neurocomputing, 72*(7–9),1775–1781. http://doi.org/10.1016/j.neucom.2008.06.011

Kahu, E. R. (2013). Framing student engagement in higher education. *Studies in Higher Education, 38*(5), 758–773. https://doi.org/10.1080/03075079.2011.598505

Lave, J. (2009). The practice of learning. In Knud Illeris (Ed.) *Contemporary theories of learning: Learning theorists in their own words* (pp. 200-208). Routledge.

Louwrens, N. & Hartnett, M (2015). Student and teacher perceptions of online student engagement in an online middle school. *Journal of Open, Flexible and Distance Learning, 19* (1), 27–43.

Lu, J., & Churchill, D. (2014). The effect of social interaction on learning engagement in a social networking environment. *Interactive Learning Environments, 22*(4), 401–417. https://doi.org/10.1080/10494820.2012.680966

Martin, F., Sun, T., & Westine, C. D. (2020). A systematic review of research on online teaching and learning from 2009 to 2018. *Computers & Education, 159*. https://doi.org/10.1016/j.compedu.2020.104009

Murzintcev, N. (2020). ldatuning: tuning of the latent dirichlet allocation models parameters. r package version 1.0.2. https://CRAN.R-project.org/package=ldatuning

National standards for quality. (2019). *Quality Matters and Virtual Learning Leadership Alliance*. www.nsqol.org.

Paavola, S., Lipponen, L., & Hakkarainen, K. (2004). Models of innovative knowledge communities and three metaphors of learning. *Review of educational research, 74*(4), 557-576. https://doi.org/10.3102/00346543074004557

Panadero, E., & Järvelä, S. (2015). Socially shared regulation of learning: A review. *European Psychologist, 20*(3), 190-203. doi:10.1027/1016-9040/a000226

Pekrun, R., & Linnenbrink-Garcia, L. (2012). Academic emotions and student engagement. In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of research on student engagement* (pp. 259–282). Springer.

Philp, J., & Duchesne, S. (2016). Exploring engagement in tasks in the language classroom. *Annual Review of Applied Linguistics, 36*, 50–72. https://doi.org/10.1017/S0267190515000094

Quin, D. (2017). Longitudinal and contextual associations between teacher-student relationships and student engagement: A systematic review. *Review of Educational Research, 87*(2), 345–387. https://doi.org/10.3102/0034654316669434

Raes, A. (2022). Exploring student and teacher experiences in hybrid learning environments: does presence matter? *Postdigital Science and Education, 4*, 138–159. https://doi.org/10.1007/s42438-021-00274-0

R Core Team (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.

R Studio Team (2021). Rstudio: integrated development for r. Rstudio, pbc, Boston, MA http://www.rstudio.com/

Rumble, G. (2019). *The planning and management of distance education.* Routledge. https://doi.org/10.4324/9780429288661

Sarhady, T. (2015). The effect of product/process-oriented approach to teaching and learning writing skill on university student performances. *International Journal of Language and Applied Linguistics, 1*(2), 7-12.

Scardamalia, M., & Bereiter, C. (2010). A brief history of knowledge building. *Canadian Journal of Learning and Technology/La revue canadienne de l'apprentissage et de la technologie, 36*(1).

Scardamalia, M., & Bereiter, C. (1994). Computer support for knowledge-building communities. *Journal of the Learning Sciences, 3*(3), 265–283.

Silge, J., & Robinson, D. (2017). *Text mining with R: A tidy approach.* O'Reilly. www.tidytextmining.com .

Silge J & Robinson D (2016). Tidytext: text mining and analysis using tidy data principles in R. *Journal of Open Source Software, 1*(3). https://doi.org/10.21105/joss.00037

Stahl, G. (2006) *Group Cognition: Computer Support for Building Collaborative Knowledge*, MIT, Cambridge MA.

Symonds, J. E.; Kaplan, A.; Upadyaya, K.; Salmela-Aro, K.; Skinner, E. & Eccles, J. S. (2019) *Momentary student engagement as a dynamic developmental system*. PsyArXiv. doi: 10.31234/osf.io/fuy7p.

Viberts, A. B., & Shields, C. (2003). Approaches to student engagement: does ideology matter? *McGill Journal of Education, 38*(2), 221-240.

Vygotsky, L.S. (1978) Mind in Society. Harvard University Press.

Wang, M. T., Degol, J. L., & Henry, D. A. (2019). An integrative development-in-sociocultural-context model for children's engagement in learning. *American Psychologist, 74*(9), 1086-1102.

Wang, M.-T., & Hofkens, T. L. (2019). Beyond classroom academics: a school-wide and multi-contextual perspective on student engagement in school. A*dolescent Research Review, 5*, 419–433. https://doi.org/10.1007/s40894-019-00115-z

Wang, M.-T., Fredricks, J., Ye, F., Hofkens, T., & Linn, J. S. (2017). Conceptualization and assessment of adolescents' engagement and disengagement in school. *European Journal of Psychological Assessment, 35*(4), 592.606.https://doi.org/10.1027/1015-5759/a000431

Wang, M.-T., & Hofkens, T. L. (2019). Beyond classroom academics: a school-wide and multi-contextual perspective on student engagement in school. *Adolescent Research Review, 5*, 419–433. https://doi.org/10.1007/s40894-019-00115-z

Wang, M., & Kang, M. (2006). Cybergogy for engaged learning: A framework for creating learner engagement through information and communication technology. In D. Hung & M.S. Khine (Eds.), *Engaged learning with emerging technologies* (pp. 225-253). Springer, Dordrecht.

Waters, J., & Gasson, S. (2006). Social engagement in an online community of inquiry. *ICIS 2006 Proceedings - Twenty Seventh International Conference on Information Systems, 235317,* 711–732.

Wickham et al. (2019). Welcome to the tidyverse. *Journal of Open Source Software, 4*(43), 1686. https://doi.org/10.21105/joss.01686

Wijffels, J. (2021). *UDPipe: tokenization, parts of speech tagging, lemmatization and dependency parsing with the 'UDPipe' 'NLP' toolkit. R package version 0.8.8.* https://CRAN.R-project.org/package=udpipe

Yin, R. K. (2014). *Case study research: design and method* (5th ed.). Sage Publications.

Zhang, J. H., Zou, L. Cong, Miao, J. Jia, Zhang, Y. X., Hwang, G. J., & Zhu, Y. (2020). An individualized intervention approach to improving university students' learning performance and interactive behaviors in a blended learning environment. *Interactive Learning Environments, 28*(2), 231–245. https://doi.org/10.1080/10494820.2019.1636078

Zyngier, D. (2008). Reconceptualizing student engagement: Doing education not doing time. *Teaching and Teacher Education, 24*, 1765-1776. doi: 10.1016/j.tate.2007.09.004

APPENDIX A
TRANSLATION

SET 1

```
topics1tl <- topics1 %>%
mutate(term = case_when(term ==
“elev” ~ “student”,
term == “fråga” ~ “asking”,
term == “kontakt” ~ “contact”,
term == “skriva” ~ “writing”,
term == “lektion” ~ “lesson”,
term == “skola” ~ “school”,
term == “uppgift” ~ “task”,
term == “lärare” ~ “teacher”,
term == “visa” ~ “showing”,
term == “svar” ~ “answer”,
term == “grupp” ~ “group”,
term == “vilja” ~ “wanting”,
term == “prata” ~ “talking”,
term == “veta” ~ “knowing”,
term == “tänka” ~ “thinking”,
term == “jobba” ~ “working”,
term == “handla” ~ “participating”,
term == “engagera” ~ “engaging”,
term == “varandra” ~ “each other”,
term == “begrepp” ~ “concept”,
term == “svara” ~ “answering”,
term == “undervisning” ~ “teaching”,
term == “engagemang” ~ “engagement”,
term == “uppleva” ~ “experiencing”,
term == “arbeta” ~ “working.”,
term == “spela” ~ “playing”,
term == “steg” ~ “stages”,
term == “diskutera” ~ “discussing”,
term == “bygga” ~ “building”,
term == “rolig” ~ “fun”,
term == “skapa” ~ “creating”,
term == “lära” ~ “learning.”,
term == “disengagemang” ~ “disengagement”,
term == “chatt” ~ “chat”,
term == “förklara” ~ “explaining”,
term == “köra” ~ “readiness”,
term == “kolla” ~ “checking”,
term == “förbereda” ~ “preparing”,
term == “prova” ~ “testing”,
term == “distans” ~ “distance”,
term == “kamera” ~ “camera”,
term == “utmaning” ~ “challenge”,
term == “välja” ~ “choosing”,
term == “mobil” ~ “mobile”,
term == “dela” ~ “sharing”,
term == “delta” ~ “participating.”,
term == “hjälp” ~ “help”,
term == “hjälpa” ~ “helping”,
term == “klara” ~ “ready”,
term == “börja” ~ “initiating”,
term == “lyssna” ~ “listening”,
term == “samtidig” ~ “simultaneous”,
term == “våga” ~ “venturing”,
term == “berätta” ~ “telling”,
term == “märka” ~ “noticing”,
TRUE ~ as.character(term)))
```

SET 2

```
topics2tl <- topics2 %>%
mutate (term = case_when(term ==
“elev” ~ “student”,
term == “skola” ~ “school”,
term == “aktiv” ~ “active”,
term == “lektion” ~ “lesson”,
term == “fråga” ~ “asking”,
term == “varandra” ~ “each other”,
term == “prata” ~ “talking”,
term == “jobba” ~ “working”,
term == “vilja” ~ “wanting”,
term == “lärare” ~ “teacher”,
term == “försöka” ~ “trying”,
term == “engagemang” ~ “engagement”,
term == “tänka” ~ “thinking”,
term == “veta” ~ “knowing”,
term == “kameran” ~ “camera”,
term == “grupp” ~ “group”,
term == “programmering” ~ “programming”,
term == “par” ~ “pair”,
term == “lära” ~ “learning”,
term == “höra” ~ “listening”,
term == “svara” ~ “answering”,
term == “uppleva” ~ “experiencing”,
term == “arbete” ~ “work”,
term == “läsa” ~ “reading”,
term == “ställa” ~ “inquire”, # ställa frågor
term == “snabb” ~ “quick”,
term == “klara” ~ “ready”,
term == “rooms” ~ “breakout rooms”,
term == “lösa” ~ “solving”,
term == “engagerad” ~ “engaged”,
term == “arbeta” ~ “working.”,
term == “engagera” ~ “engaging”,
term == “upplägg” ~ “arrangement”,
term == “tydlig” ~ “clear”,
TRUE ~ as.character(term)))
```