International Journal of Educational Research 99 (2020) 101501

Contents lists available at ScienceDirect

International Journal of Educational Research

journal homepage: www.elsevier.com/locate/ijedures

The distribution and productivity of whole-class dialogues: Exploring the potential of microblogging

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ARTICLE INFO

Keywords:
Productive dialogues
Whole-class
Participation
Technology-supported learning
Microblogs
Design-based intervention
Mixed methods

ABSTRACT

Productive whole-class dialogues typically involve few students, meaning that many are not given opportunities to learn and think together through talk in this kind of classroom activity. We applied mixed-methods within a design-based framework to explore the potential of a microblogging tool, Talkwall, for supporting teachers (N = 13) and promoting distributed, productive whole-class dialogues in lower secondary classrooms in Norway.

We found that Talkwall could promote distributed and productive dialogues and strengthen participation as a collective endeavour through (a) connecting learning activities and (b) helping the teacher facilitate students' exploration of their thinking. We illustrated how this potential can materialise in a context where ground rules for productive dialogues were explicitly referenced by the teacher.

1. Introduction

In the literature, there is consensus that productive dialogues in the classroom are important for students' learning (Mercer & Littleton, 2007; Resnick, Asterhan, & Clarke, 2015; Snell & Lefstein, 2017). However, a series of studies have problematised the apparent rule of thumb: many students do not participate in whole-class dialogues (Black, 2004; Clarke, Howley, Resnick, & Rosé, 2016; Sedlacek & Sedova, 2017). Clarke et al. (2016) argued that this situation casts 'a shadow on dialogic instruction' (p. 29), and they encouraged further exploration of whether classroom discourses can be developed in ways that better distribute productive whole-class dialogues. A relevant strand of research for addressing this challenge proposes integration of dialogic pedagogy and digital technology.

Digital technologies and infrastructures are becoming increasingly common in classrooms at all levels of the education system, especially in Western countries. Consequently, it is critical to continuously explore the relations between ways of using these technologies and learning processes in the classroom. Although it is widely recognised that digital technologies can both hinder and support learning through mediation of action (Rasmussen & Ludvigsen, 2010; Wegerif, 2007), there is consensus that learning is more likely to be supported when the technology is used with a clear, pedagogical rationale (Koehler & Mishra, 2009; Mercer, Hennessy, & Warwick, 2017).

Microblogging is an example of a digital technology with educational potentiale to strengthen participation, engagement and

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https://doi.org/10.1016/j.ijer.2019.101501
Received 11 May 2019; Received in revised form 1 October 2019; Accepted 5 November 2019
Available online 23 January 2020

meta-cognitive awareness (Gao, Luo, & Zhang, 2012). Rooted in social media, it is considered to be one of the newest features of Web 2.0 (Hsu & Ching, 2012). As the term suggests, microblogging is a short text-based personal publication, and it involves either a single post or a series of posts that serve as a conversation between readers and writers (Hsu & Ching, 2012). To our knowledge, no studies to date have explored the potential of microblogging to address the specific challenge of involving more students in productive whole-class dialogues (Major, Warwick, Rasmussen, Ludvigsen, & Cook, 2018).

1.1. Productive dialogues

Students talk in various ways in the classroom, yet not all kinds of talk have equal educational value (Mercer & Littleton, 2007; Michaels, O'Connor, & Resnick, 2008; Nystrand, 2006). A large body of work, most of which adopts the sociocultural position that discourse is fundamentally social and interactional, has focused on identifying the types of talk that are especially productive for the development of students' thinking and learning.

There is reasonable agreement regarding the core characteristics of such talk and the nature of the communicative norms from which it is believed to emerge (Hennessy et al., 2016; Resnick, Asterhan, & Clarke, 2018). First and foremost, students take part in productive dialogues collectively. Mercer (1995) coined the term 'interthinking' to describe the power of thinking together, which is produced when reasoning is evident in talk and when ideas and perspectives are formed into coherent lines of inquiry through elaboration, justification and constructive critique. This kind of collective exploration of multiple ideas and perspectives is made possible by establishing communicative norms in the classroom where thinking together is encouraged. These norms are sometimes referred to as ground rules (Mercer & Littleton, 2007). In a classroom where ground rules are established, participants share certain obligations and accountability to standards of reason, the value of disciplinary knowledge and the learning community (Michaels et al., 2008). Compelling empirical research links productive dialogues to academic achievements in math and science (Adey & Shayer, 2015; Alexander, 2018; Mercer, Dawes, Wegerif, & Sams, 2004), logic and reasoning (Kuhn & Zillmer, 2015; Mercer, 2008), English (Alexander, 2018), and reading comprehension (Lawrence & Snow, 2010; Wilkinson, Murphy, & Binici, 2015).

1.2. The distribution of dialogues in whole-class

A series of studies have problematised how dialogues in general are typically poorly distributed in whole-class (Black, 2004; Clarke et al., 2016; Sedlacek & Sedova, 2017). When problematising this issue, there is a danger of not acknowledging the value of active listening among less talkative students. We do not claim that active listening in whole-class cannot be beneficial for learning. However, when only a few students are involved in the dialogue, many are excluded from learning through talk in an activity where the reciprocal nature of classroom communication is potentially played out at its richest (Wells & Mejía-Arauz, 2006). Moreover, in whole-class, the teacher can effectively monitor, support and model dialogues that are especially productive for learning and thinking (Kerawalla, 2015). This might be especially important for students who need extra support.

There may be various reasons why students do not take part in whole-class dialogues. For example, they may not perceive their ideas as valuable; according to Clarke et al. (2015), who conducted a study with high school students in the US, the first step towards conceptualising oneself as a legitimate speaker is the perception that one's ideas as having value to others. Moreover, students' primary justification for choosing to talk or remain silent was their perceived level of knowledge about the subject matter (Clarke et al., 2015). It is worth noting that underlying students' perceptions are epistemologies and norms in which knowledge is perceived as something belonging to individuals and individuals should bring this knowledge to the table only if they perceive it to be worthy of collective exploration. The fear of educational failure or inadequacy is therefore closely linked to what individuals do and say. In a primary school in England, Snell and Lefstein (2017) illustrated that similar perceptions of individual abilities as prerequisites for participation can shape the way teachers approach students in whole-class dialogues. For example, students that were believed to have less to offer were sometimes given less cognitively demanding questions because teachers wanted to protect low-ability students from losing face (Snell & Lefstein, 2017).

To overcome these challenges and involve more students in productive whole-class dialogues, one strand of research proposes integration of dialogic pedagogy and digital technology.

1.3. The distribution of productive whole-class dialogues and the role of digital technology

A robust finding through decades of research is that the educational potential of digital technology in classroom contexts is a matter of pedagogical integration (National Academy of Sciences, National Academy of Engineering, & Institute of Medicine, 2018). This insight has led to the development of theoretical models like the Technological Pedagogical Content Knowledge-model (TPAC) (Koehler & Mishra, 2009) that aims to clarify the interconnected and complex nature of successful technology-use in classrooms. The emphasis on human thinking and learning as deeply embedded in social practices and mediated through artefacts corresponds to a sociocultural stance on how we understand technology-mediated actions (Wertsch, 1998).

Research on the role of digital technology in supporting classroom dialogue, however, is still in its infancy (Mercer et al., 2017). A recent scoping review examined 72 studies published between 2000 and 2016 regarding this topic (Major et al., 2018). The review identified how various kinds of digital technologies may enhance or challenge classroom dialogues. Among the key findings were

substantial variations in both the kinds of digital technologies applied and the aspects of the pedagogical context that were emphasised in the analysis. More than half of the studies involved tools for students and teachers to communicate via text, audio or video using a computer or interactive whiteboard (Mercer, Hennessy, & Warwick, 2010; Warwick, Mercer, & Kershner, 2013). When digital technologies enhanced classroom dialogues, they improved accessibility and versatility by mediating interaction. Many tools also allowed for the creation of a shared 'dialogic space' (Wegerif & Yang, 2011) and content represented in multimodal ways could support knowledge co-construction, metacognitive learning and scaffold understanding by exposing students to alternative perspectives. When such technologies hindered classroom dialogues, a lack of technical skills among students and teachers was often reported as a distraction that made it difficult for teachers to frame dialogue activities as learning activities. Of particular relevance to our study is the review's finding that only 13 of the 72 studies explicitly addressed learner inclusion and participation. Further, none of these 13 studies addressed the challenge of involving more students in productive whole-class dialogues.

In a different study, Rasmussen and Hagen (2015) found that a whole-class dialogue supported by a microblogging tool encouraged learning among all participants, even reluctant bloggers. This finding is consistent with the work of Gao et al. (2012), who reviewed 21 studies on the use of microblogging technology in education and found that it could strengthen participation, engagement and meta-cognitive awareness. Adding to this body of research, Ebner, Lienhardt, Rohs, and Meyer (2009) identified a key advantage of microblogging technology in educational settings:

it is not the transfer of information or status messages that are crucial factors, but rather, the opportunity to be a part of someone else's process by reading, commenting, discussing or simply enhancing it. Microblogging can help users to be partially and virtually present and to be part of a murmuring community, that is working on a specific problem without any restrictions of time and place. (p. 98)

If microblogging technology can strengthen participation in whole-class dialogues as a collective endeavour and make thinking more transparent and accessible, it seems reasonable to assume that this technology can also help the teacher to facilitate distributed processes of interthinking among students. Such a tool can help students to 'be part of someone else's process' (Ebner et al., 2009 p. 98) and draw attention towards what students can do together, rather than the perception that one's private ideas are not worthy of collective exploration. Also, the fear of insufficient knowledge and understanding of what is being discussed may be reduced if the knowledge production supported by microblogging technology gives students a stronger sense of exploring ideas and perspectives *together*.

1.4. The current study and research questions

This study reports from the first iteration of the design-based intervention Digital Dialogues Across the Curriculum (DIDIAC). The overall aim of DIDIAC is to explore if/how micro blogging technology can be integrated into teachers' practices in ways that support the development of a dialogic classroom culture in lower secondary classrooms in Norway and England. During this first iteration, teachers took part in workshops and reflective sessions on how to develop ground rules for productive dialogues, and they were introduced to the micro blogging-tool Talkwall, especially designed by researchers in our team to support dialogic teaching and learning in the classroom.

In this study, we pay specific attention to how teachers can integrate Talkwall into their practice to make whole-class dialogues distributed and productive. We focus on the Norwegian context as recent studies have found that Norwegian teachers extensively use whole-class dialogues in primary and secondary classrooms, which are known to be technology-dense (Gilje et al., 2016). Moreover, although Norwegian classroom culture is sometimes portrayed as informal and involving high levels of student participation, recent studies have found that student utterances and questions usually address practical and/or procedural issues and seldom involve inquiry, reasoning or elaboration of the topic under discussion (Klette & Ødegaard, 2016; Wiig, Silseth, & Erstad, 2018).

Two research questions will be addressed in this study:

RQ1. How did teachers typically use microblogging in whole-class dialogues, and to what extent does this usage have the potential to make whole-class dialogues distributed and productive?

RQ2. How did microblogging mediate communication in a distributed and productive whole-class dialogue?

2. Design and methods

The DIDIAC project draws on design-based research principles grounded in collaborative partnership between teachers, researchers and technology developers (Lund, Rasmussen, & Smørdal, 2009; Roschelle & Penuel, 2006; Sandoval & Bell, 2004). In DiDiAC, all interventions are situated in real educational contexts. Teachers act as co-researchers by tailoring pedagogic approaches to subject discourses, developing new classroom practices, forming new tasks and activities and adapting the tools and resources to their own needs. The two core elements of the project, the teacher development program and the micro blogging-tool Talkwall, are presented in the following two sections.

2.1. The teacher development program

Based on selected resources adapted from the Thinking Together approach (Mercer & Littleton, 2007), we designed a teacher development program that consisted of workshops and reflective sessions. A total of four workshops were conducted between September and December 2017. During these workshops, the teachers were introduced to the rationale behind a dialogic pedagogy and ways to develop and maintain ground rules for productive dialogues. Also, the teachers participated in group discussions and practical exercises. We started recording teachers' lessons in January 2018. Between January and June 2018, the teachers participated in two reflective sessions in which video recordings of their lessons were discussed with other teachers and researchers. The aims of these sessions were to identify elements of practice that aligned with a dialogic ethos and to collectively reflect upon areas for further development.

2.2. Microblogging to support dialogues

During the workshops that took place between September and December 2017, the teachers were introduced to the microblogging tool Talkwall[1] and its key functionalities.

Talkwall is designed in accordance with principles of dialogic pedagogy, and it aims to encourage learning through communication and sharing of ideas in a classroom context. Through the tool, ideas become transparent. Talkwall is a browser-based technology, meaning that it can be used by anyone who has access to a computer, tablet or smartphone with an Internet connection. Although Talkwall can be used in various ways, the teacher usually starts a session by formulating a task. A pin code is automatically generated and is used by the students to log into the correct session as individuals or groups. The interface has two distinct features that are shared by all participants: a feed on the left side and a wall in the middle of the screen. When students make contributions, they are automatically accessible to all participants through the feed. Any participant can select any contribution in the feed and 'pin' it, that is, move it to the wall. Each participant has their own wall and can organise contributions as they please (e.g. based on criteria specified by the teacher). The teacher has access to all participants' walls and can filter contributions based on hashtags or the student or group that produced it.

Talkwall is a generic tool in the sense that it can be integrated into learning activities in various ways. The teachers were encouraged to experiment with Talkwall in the classroom as they developed practices since we wanted to facilitate ways of integrating Talkwall in the activities that were as varied and pedagogy-driven as possible (Illustration 1).

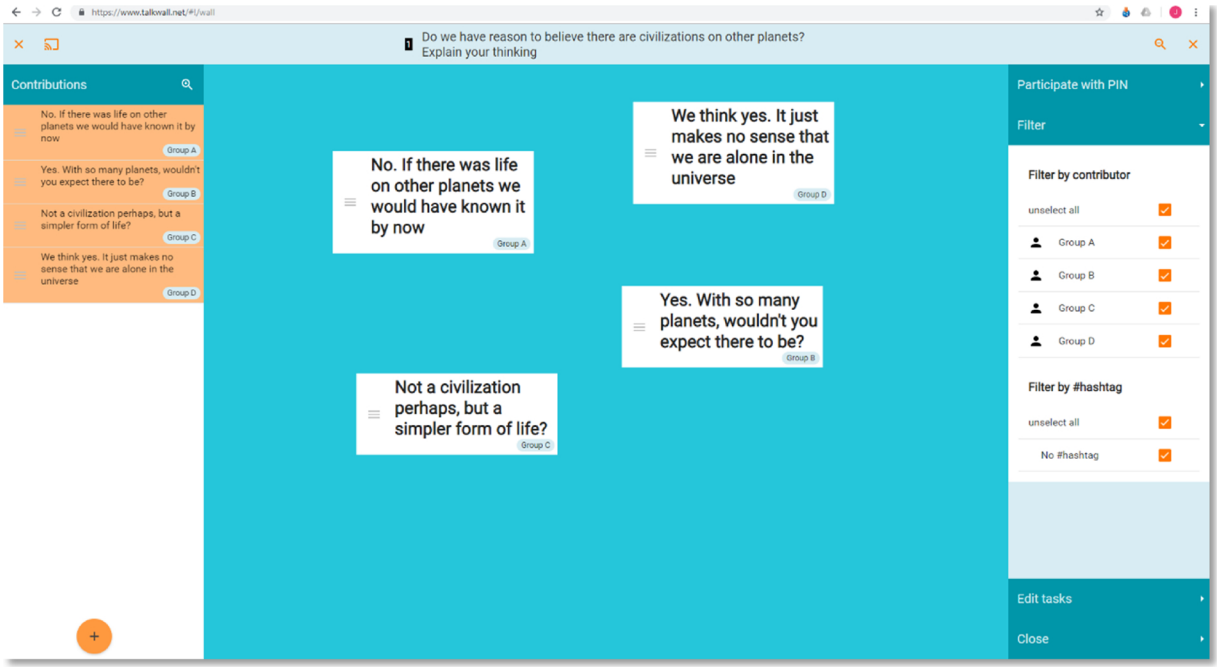

Illustration 1. A screenshot of Talkwall in action. This is the teacher's interface, which can be projected onto an interactive whiteboard. The teacher has pinned four student groups' responses to the task at the top of the screen. The teacher can filter contributions by the contributor or hashtags.

[1] Talkwall is developed by researchers at the University of Oslo and is being continuously refined based on feedback from teachers. The tool is free to use for everyone, and the source code is open.

2.3. Participants

A total of 13 teachers and 210 students from four lower secondary schools in Norway participated in this study. The teachers volunteered to participate based on an offer the researchers sent to the schools. The teachers were varied in terms of experience, age and gender. All schools were in the Oslo area.

2.4. Data sources

This study draws upon multiple data sources: (1) video recordings of lessons, (2) transcriptions of video-recorded lessons, (3) written contributions (logs) from Talkwall.

Thirty-five lessons were video-recorded and transcribed over a six-month period (January to June 2017). We aimed to record three lessons per teacher, but due to practical issues (i.e. sick leave and parental leave), only two lessons were recorded for four of the teachers. All written contributions in Talkwall were automatically saved on a computer server.

2.4.1. Categorisation and data reduction

For every minute of each lesson, we categorised the ongoing learning activity as individual work, group work or whole-class work. Drawing upon Mortimer and Scott (2003) whole-class activities were further categorised as either interactive or noninteractive. Interactive activities involve dialogue between speakers. For example, the teacher and her students may consider ideas together, or the teacher may select one idea to explore together with her students. Noninteractive activities, however, involve only one speaker. For example, the teacher may summarise or explore ideas in the form of a traditional lecture. We only included interactive whole-class dialogues that involved Talkwall, as we were interested in how Talkwall mediates social interaction. These dialogues were further divided into episodes, which serve as the basic analytical unit. Each episode consisted of a specific type of activity and has its own topic. Change in the activity type or topic marked the beginning and end of episodes.

2.4.2. Operationalisation of constructs and data analysis

Two constructs were operationalised in this study. The first construct, productive dialogues, was operationalised using an adapted version of the Cambridge Dialogue Analysis Scheme[2] (CDAS). The original CDAS draws on the extensive Scheme for Educational Dialogue Analysis (SEDA), which was developed by Hennessy et al. (2016) to 'represent and operationalise commonalities among some key theorists in the field' (p. 16). In the current study, six coding categories (see Table 1) were translated from English to Norwegian by members of the research team. All episodes were separately coded by two coders on a turn-by-turn basis to determine the presence or absence of each code. Disagreements were identified and resolved through discussion. We chose this approach to assess reliability because each code in our material occurred a limited number of times; some codes occurred only 1–2 times per episode[3] . Each code could be used only once per turn, but several types of codes could, in principle, be used in the same turn. However, this was not true for a combination of EL and RE, as the coding rules stipulated that these codes could not appear in the same turn; RE would trump EL. The average frequency of each code per minute was calculated.

The second construct in this study, distribution of productive dialogues, was operationalised as the average frequency of new students entering the whole-class dialogue with a productive turn per minute. Here, we define a productive turn as one in which at least one of the codes related to productive dialogue is observed.

Our research questions concern whether the ways teachers integrate Talkwall into their practices carry potential for developing

Table 1
Coding categories and definitions.

Codes	Definition
Elaboration invite (ELI)	Invites elaboration, evaluation and clarification of one's own or another's contribution.
Elaboration (EL)	Involves elaboration, evaluation and clarification of one's own or another's contribution and adds substantive new information or a new perspective.
Reasoning invite (REI)	Explicitly invites explanation, justification of a contribution or speculation (regarding new scenarios), prediction or hypothesis.
Reasoning (RE)	Involves explanation or justification of one's own or another's contribution by drawing upon evidence.
Querying (QU)	Involves doubt, full/partial disagreement and a challenge or rejection of a statement.
Coordination (C)	Involves synthesis or summarisation of collective ideas (including one's own and others' ideas) as well as proposition of a consensus view after discussion.

[2] CDAS was recently used to perform systematic coding of spoken dialogue in British Primary schools in a large-scale project funded by the UK Economic and Social Research Council (ESRC) (Howe, Hennessy, Mercer, Vrikki, & Wheatley, 2019; Vrikki, Wheatley, Howe, Hennessy, & Mercer, 2018)

[3] Shaffer (2017) notes that the methods typically applied when using statistical measures to determine the degree of inter-reliability can be problematic, especially when codes are rare. In the case of Cohen's kappa, others have pointed out how its sensitivity to the distribution of marginals, known as the kappa paradox, biases statistical estimates when codes are rare (Feinstein & Cicchetti, 1990).

distributed and productive whole-class dialogues in secondary classrooms. We applied a mixed-methods approach because we were interested in examining the general characteristics of episodes (research question 1) as well as the mediation of communication at the interactional level (research question 2).

Descriptive statistics and correlational analysis were used to answer research question 1. To answer research question 2, we draw upon the principles for analysing interaction described by Mercer et al. (2004). These principles have previously been used to analyse interaction in contexts mediated by digital artefacts (see, e.g., Mercer et al., 2010). The extracts presented in this article were translated into English and transcribed using the strategy described by Mercer (1995) making the talk and interactions as non-technical as possible to 'make them accessible to audiences outside the community of language researchers' (pp. vii–viii).

3. Results

In this section, we present how the teachers typically integrated Talkwall into their practices in 35 lessons and 64 whole-class dialogue episodes extracted from these lessons, and we determine whether the typical ways of integrating Talkwall have the potential to make whole-class dialogues more distributed and productive. We then draw attention to the distribution and productivity of the dialogues. Based on our aggregated findings, we investigate a specific episode to gain insight into how Talkwall mediates communication at the interactional level in a context where dialogues are distributed and productive.

3.1. General characteristics of Talkwall use

All teachers planned and carried out various kinds of Talkwall-supported activities in their classrooms. We identify the general characteristics of these activities (i.e., the quantity and quality of Talkwall use) and present five findings that we believe are relevant to our study.

Finding 1: Talkwall was extensively used. The average proportion of time that the tool was used in the 35 lessons from which the 64 episodes were extracted was $\bar{X}$ = 0,60 (SD = 0,18). The high average proportion and relatively small standard deviation suggests that most teachers and students experienced Talkwall over time and across activities. This is important because neither the teachers nor their students had experience with the tool before the intervention. Although it was designed to be easily integrated into teachers' practices, Talkwall still involves some degree of technical complexity that must be mastered for its educational potential to be achieved. Our first finding indicates that teachers and students devoted critical time and effort to using Talkwall in the classrooms, yet this was not a guarantee that all teachers could use the tool to draw learners into productive forms of dialogue.

Finding 2: A substantial amount of written Talkwall contributions were produced by the students. The average number of Talkwall contributions produced by the students per lesson was $\bar{X}$ = 55,20 (SD = 49,65). This finding is important not only because it illustrates one way in which time was spent on Talkwall but also because we know that these texts were contributed to a technological platform on which ideas are inherently transparent. The high standard deviation suggests substantial variation across lessons, which can be partly explained by the fact that student contributions were the result of both individual and group efforts.

Finding 3: The students' Talkwall contributions were largely on-task[4] . The average proportion of on-task student contributions was $\bar{X}$ = 0,89 (SD = 0,14). This finding is important because it highlights the quality of students' contributions. It seems reasonable to assume that on-task contributions have greater educational potential than off-task contributions. Also, this finding suggests that teachers generally succeeded in framing Talkwall activities as learning activities.

Finding 4: When Talkwall was used in whole-class dialogues, it was typically used to connect these dialogues to prior collaborative learning activities. Talkwall was used to connect whole-class dialogues to prior learning activities in 96 % of episodes. In most episodes, the prior learning activities were collaborative activities in which small groups of students were tasked with discussing a topic or problem and then blogging about their groups' conclusions, evidence or statements. These contributions were then used in various ways, including as a reference in the upcoming whole-class dialogue (81 % of episodes). This finding is important because it illustrates that the way in which the tool was most commonly used allows cognitive resources to be connected and shared across different learning activities in the classroom. Moreover, the participants have a sense of shared ownership of these ideas as the resources are the result of collaborative processes.

Finding 5: During Talkwall-supported whole-class dialogues, Talkwall was typically projected onto the teacher's interactive whiteboard and the teacher often asked for justification and elaboration regarding students' contributions. This finding is important because it suggests a way in which the tool may directly affect both the nature and structure of dialogues in the classroom. First, when teachers ask for justification and elaboration, they are more likely to facilitate productive dialogues among their students. We confirmed this hypothesis with a correlation analysis. For each episode, the number of teachers' invitations to either elaborate or engage in reasoning was summarised and correlated with the number of students' elaborations and instances of reasoning. We identified a strong positive correlation between the two (r = .798, p = .000). Second, we should recognise that although this correlation implies a teacher-centred communication structure, it is not necessarily the teacher's voice that is important when Talkwall is used in this manner, but the students' voices, which are accessed by the teacher through the tool. In this way, Talkwall may support the teacher in transferring authority to students' ideas and perspectives and in facilitating students' exploration of their thinking.

[4] For a Talkwall contribution to be considered on-task, it must be coded as an attempted response to the task, even if it is only a single word.

3.2. The productivity and distribution of dialogues

General characteristics of the dialogues in the Talkwall-supported whole class episodes (i.e. distribution and productivity) are presented in Table 2.

On average, one new student entered the whole-class dialogue with a productive turn per minute (SD = .55). The most frequent code for productive dialogues across all episodes was elaboration, which was identified 1,30 times per minute (SD = .79). The next most frequent was reasoning, which was identified 1,09 times (SD = .75). Invitation to elaboration was identified 0,73 times (SD = .56), and invitation to reasoning was identified 0,56 times (SD = .45). Querying was only identified 0,17 times per minute (SD = .35). There was practically no code coordination in our data, so we chose to exclude this variable in further analyses.

Table 2
Means, standard deviations and other characteristics of key variables.

	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Distribution	64	,13	3,23	1,01	,07	,55
Invitation to elaboration (ELI)	64	,00	2,63	,73	,07	,56
Elaboration (EL)	64	,00	4,07	1,30	,01	,79
Invitation to reasoning (REI)	64	,00	1,76	,57	,06	,45
Reasoning (RE)	64	,00	3,14	1,09	,09	,75
Querying (QU)	64	,00	2,15	,17	,04	,35
Coordination (C)	64	NC	NC	NC	NC	NC
Valid N (listwise)	64					

NC = Not calculated due to lack of presence.

As revealed by the range of occurrences of each code and standard deviations, there was substantial variation across episodes. Some variation was expected, especially in terms of the distribution of productive dialogues, depending on the extent to which teachers intended to include students in the dialogues. It is not unlikely that some teachers adopted goals other than building a dialogue with students (e.g. checking students' acquired knowledge). In addition, as we included episodes of different durations, some variation is simply due to variation in episode duration. Although we have operationalised our codes as average frequency per minute, varying episode durations still have an effect. For example, one would expect that the probability that formerly silent students will speak decreases as the group of students who have spoken during the episode increases over time. In other words, the frequency of new students entering the dialogue will decrease as the episode goes on. These kinds of dynamics cannot be captured by a mean value. We confirmed this with a correlation analysis and identified a moderate negative correlation between episode duration and distribution ($r = -.559$, $p = .000$). It is also likely that the extent to which ground rules varied between classrooms had implications on the distribution and productivity of dialogues.

It was expected that codes related to elaboration and reasoning would be dominant, in line with the finding we highlighted earlier (i.e. teachers typically ask their students to elaborate upon or reason regarding Talkwall contributions in whole-class dialogues and students' responses often involve elaboration or reasoning). Although it is probably more difficult to express disagreement in whole-class dialogues compared to small groups, the low frequency of querying was surprising. This finding suggests that although students elaborate and reason, there are few instances in which they can adopt a critical stance towards each other's ideas and perspectives. We did not expect a high frequency of code coordination, yet it was somewhat surprising that this was not present at all in our material. In other words, although students could elaborate and reason, there were practically no instances in which they could summarise collective ideas or propose a consensus view after discussion.

3.3. Episode selection for qualitative analysis

We identified the general characteristics of the ways in which Talkwall was used in the classroom that suggest the tool's educational potential and relevance to our study. We also identified substantial variation in the productivity and distribution of dialogues. Together, these findings suggest that the most common way of using Talkwall, on an aggregated level, is associated with great variations in whole-class dialogues. Given the focus of our study, this justifies the need for a more fine-grained interactional-level analysis of *how* Talkwall is used to connect learning activities and support the teacher in facilitating students' exploration of their thinking in a context with distributed and productive dialogues. To identify an episode with the necessary characteristics, we expressed distribution as a function of productivity[5] in a scatterplot. We excluded episodes lasting ≤ 10 min to make sure there was sufficient time for a reasonable number of students to potentially join the dialogue (Fig. 1).

[5] In this scatterplot, productivity is an aggregated variant of the previous codes for productive dialogues. That is, it expresses the average frequency of *any* productive code per minute in the episode.

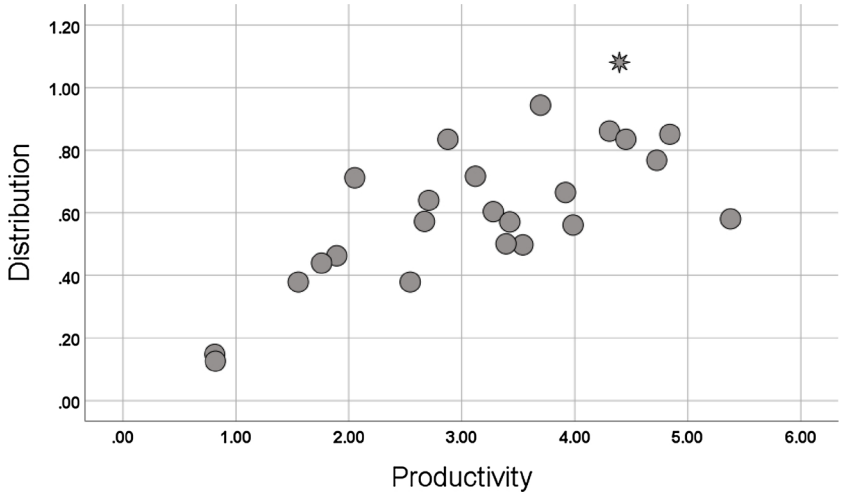

Fig. 1. Distribution as a function of productivity. The dots represent episodes lasting ≥ 10 min. The episode selected for qualitative analysis is marked with the star symbol.

We selected the episode marked with a star symbol because it exhibits the highest distribution value (1,08) and one of the highest productivity values (4,39). This means that the frequency with which new students productively entered dialogues was highest in this episode, and the dialogues were among the most productive relative to other episodes. The selected episode lasted for 13,88 min, and 75 % of the 20 students productively entered the dialogue during the episode. Reasoning was the dominant code attributed to productive dialogues among the students. Although all teachers in our study but one set ground rules for productive dialogues in their classes, the teacher associated with this episode differed from the others in how systematically she made explicit reference to the ground rules in every recorded lesson and, often, several times during learning activities. We present two coded extracts of spoken dialogue and illustrate students' Talkwall contributions in the selected episode.

3.4. Contextualising the episode

The episode was extracted from a lesson on the characteristics of different genres of writing in a Norwegian class. The lesson objectives were presented by the teacher at the beginning of the lesson and were both subject-specific and related to the ground rules for productive dialogues. The students had to distinguish between four genres of writing (reader's letter, short story, autobiography and biography), linking texts to genres and providing evidence supporting their views. In addition, when students talked with one another, every student had to be asked to express their opinion, everyone had to look at and listen to those who were speaking, and groups had to discuss all alternatives before reaching a conclusion.

As a preparation for the whole-class dialogue episode we selected, the teacher handed out four different texts numbered 1–4 and instructed her students to discuss, in groups of three, which text(s) belonged to which genre(s). Each group had to share their views on Talkwall using iPads while discussing the task. During the preparation phase, the teacher explicitly challenged the students to provide evidence supporting their views. A total of 64 Talkwall contributions were produced by the groups, all of which were related to the task.

3.5. Extract 1: the teacher facilitates students' exploration of their own thinking

The following extract is derived from the beginning of the episode. The teacher has just instructed her students to end the group discussions and put away their iPads. Talkwall is projected onto the teacher's interactive whiteboard (Illustration 2). The five contributions that the teacher has pinned are easily visible to everyone in the classroom on the interactive whiteboard. The contributions, which are translated and reproduced in Illustration 3, are the result of group discussions during the preparation phase.

Turn	Edited transcript		Dialogue codes
1	**Teacher**	….But what are the differences here? What makes these contributions different from each other? *(pointing to the five Talkwall contributions on the wall)*	**REI**
2	**Sara**	Some have written only one thing.	**RE**
3	**Teacher**	Yes. Some have written only one thing, others have done it differently. Other things? Holly?	
4	**Holly**	Ehm, some have provided only one evidence, while others have provided more evidence.	**RE**
5	**Teacher**	Yes. Great. Liam?	
6	**Liam**	Everyone says different things.	**RE**
7	**Teacher**	Yes, everyone has contributed, which is good. It looks different, because, after all, you are different groups and different people.	**RE**

Illustration 2. Talkwall is projected onto the teacher's interactive whiteboard.

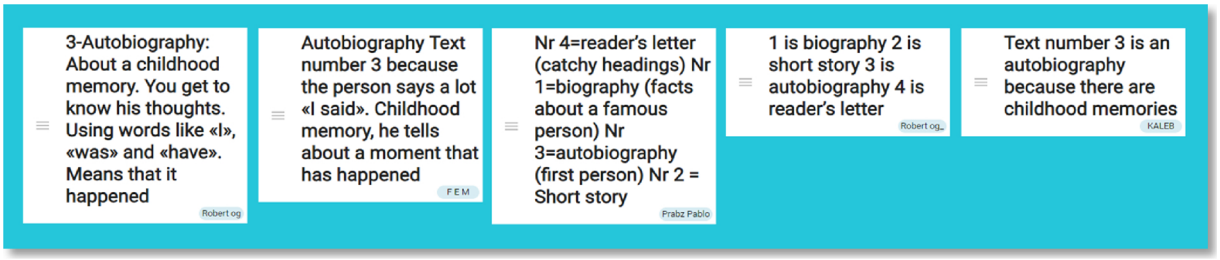

Illustration 3. Translated and reproduced Talkwall contributions. These are the five contributions that are visible on the teacher's interactive whiteboard in Illustration 2.

*The coding rules stipulated that only the dominant invitation should be coded when there were a series of invitations. In this extract, turn 1 is the dominant invitation, so turns 3 and 5 are not coded.

In the beginning of the extract, the teacher identifies that the Talkwall contributions differ and explicitly invites her students to reason about the nature of this difference (turn 1). In the following turns, students point out several distinctions between the Talkwall contributions (turns 2, 4 and 6) before the teacher concludes and notes that difference is to be expected (turn 7).

Comments

The high frequency of distributed reasoning is evident. Five of the seven turns (turns 1, 2, 4, 6 and 7) are coded as productive, and three students (Sara, Holly and Liam) contribute with productive turns. The extract thus illustrates how Talkwall can support a teacher in facilitating students' collective exploration of their thinking in a way that leads to productive and distributed dialogues.

First, with visual support from Talkwall, the teacher maintains an explicit focus on the differences between multiple contributions throughout a longer sequence of turns. The teacher also uses the tool to signify commitment to a dialogic ethos in which difference is considered both legitimate and desirable. It is this sustained focus on difference that leads to a series of productive student responses.

Second, as students raise their hands to contribute to the dialogue, a triadic dynamic unfolds in which, throughout the dialogue, the teacher and her students are collectively oriented towards Talkwall as a shared object of inquiry. This creates a distinct structure in the activity that strengthens participation as a collective endeavour. In this extract, individual students do not address other individual students' claims, but are part of a sequence of turns aimed at collective exploration of the contributions produced by groups of students and physically displayed through Talkwall. What is at stake is therefore not what individuals think of each other's claims, but how the students can make sense of the projected Talkwall contributions together. The teacher's commitment to a dialogic ethos and the collective nature of the activity are exemplified when she notes that 'everyone has contributed, which is good' whilst acknowledging that 'it looks different, because after all, you are different groups and different people' (turn 7).

3.6. Extract 2: the teacher's efforts to include a silent student

The second extract considered in this paper is derived from the middle of the episode. Talkwall is still projected onto the teacher's interactive whiteboard, and the same five contributions are visible on the wall. At this point, many students have either been nominated to contribute to the dialogue by the teacher or have taken the floor themselves. However, some students have remained silent. In order to improve the distribution of productive dialogues, the teacher is faced with the challenge of supporting less vocal students in expressing their thoughts. This extract illustrates how the teacher overcomes this challenge with support from Talkwall.

Turn	Edited transcript		Dialogue codes
1	**Teacher**	Is everything in an autobiography true? Anna, is everything true?	
2	**Anna**	Ehm…yes.	
3	**Teacher**	Who is it true for?.	**ELI**
4	**Anna**	Ehm, he who, the person who wrote it.	**EL**
5	**Teacher**	Mhm. Is it true for everyone? What are your thoughts, Anna?	**ELI**
6	**Anna**	It is hard to explain, but I don't think it's necessarily true for everyone.	**RE**
7	**Teacher**	Tell me more about it.	
8	**Anna**	Hm, it's like. No, it is difficult to explain. *(hiding her face in her hands)*	
9	**Teacher**	Yes, it <u>is</u> difficult to explain! Does anyone want to contribute here? Because what Anna is saying is correct. But try to explain why. Jonathan?	**REI**

*The coding rules stipulated that dichotomous questions were not to be coded. In this extract, turn 1 is a dichotomous question and is therefore not coded.

After the teacher's invitation (turn 9) comes a long sequence in which several students try to explain why aspects of an autobiography are not necessarily true for everyone. Anna listens to the students' ideas. When Anna enters the dialogue again, it is not because the teacher challenged her, but because she *asked* to be nominated.

26	Anna	It's like… if for example two people are arguing about the same thing, but they are looking at it from different perspectives, so maybe…()… one says it is correct, but the other one says it's wrong, even though it is the same thing.	RE

At the beginning of the extract, the teacher asks Anna whether everything in an autobiography is true (turn 1). What starts as a dichotomous question, to which Anna simply replies 'yes' (turn 2), turns into an exchange between the teacher and Anna in which the teacher invites Anna to elaborate on her views (turns 3 and 5). Anna expresses difficulty when trying to explain her thinking (turn 8). The teacher acknowledges that explaining is difficult and opens the floor to other students (turn 9). After several students answer the question, Anna asks to contribute to the dialogue and explains her thinking (turn 26).

Comments

Notably, Anna, who was silent until this extract, contributes to the dialogue with both elaboration and reasoning. The extract illustrates how the teacher includes a less vocal student in the dialogue by drawing upon the collective nature of the activity, supported by Talkwall. The teacher is aware that the characteristics of the autobiography genre have been discussed in groups prior to the whole-class dialogue. In addition, all five Talkwall contributions that are visible to everyone in the classroom refer to the autobiography genre. Two of these contributions refer to an autobiography as something 'that has happened; (see Illustration 3). Using this knowledge as a backdrop, the teacher decides to challenge a student who has not yet spoken. By inviting Anna to reflect upon a complex question (turn 1), the teacher indicates her belief in Anna's ability to productively contribute to the dialogue. Saying 'what are your thoughts, Anna?' (turn 5) draws attention to the value of Anna's ideas, and when Anna expresses difficulty explaining (turn 6), the teacher continues to invite responses in a way that frames Anna's thinking as relevant ('tell me more about it', turn 7).

At one point, Anna makes a gesture that expresses her perceived inadequacy (turn 8). This is a critical moment, and the teacher immediately responds by making difficulty an aspect of the activity experienced by all participants, not only Anna: 'Yes, it <u>is</u> difficult to explain!' (turn 9). In doing so, the teacher externalises Anna's 'failure' to express her thinking and turns it into a collective matter, drawing upon the collaborative nature of the activity to remind her students that explaining one's thinking is exactly what *they have all been trying to do.* The teacher then invites other students to contribute to collective exploration of the question, not because Anna could not articulate her thinking clearly enough, but 'because what Anna is saying is correct' (turn 9).

When Anna decides to re-enter the dialogue after listening to other students' turns, she does so on her own initiative (turn 26). This time, she explains her thinking: 'looking at it from different perspectives' (turn 26) can lead to different perceptions of whether something is correct or wrong. Anna's reasoning closely resembles the exploration of difference at the beginning of the episode (extract 1), and the fact that she asked for the teacher's attention suggests that Anna perceives herself as a legitimate speaker with relevant knowledge that should be shared, despite her struggle to explain her thinking at the beginning.

4. Discussion

This study addresses the challenge of ensuring that productive whole-class dialogues are distributed among students. We aimed to explore the potential of the microblogging tool Talkwall to support teachers in addressing this challenge in lower secondary classrooms in Norway. The teachers were encouraged to experiment with Talkwall while developing their practices as part of a design-based intervention.

Our initial aggregated findings suggest that teachers generally succeeded in framing activities with Talkwall as learning activities as students' Talkwall contributions were largely on-task and numerous. In most episodes, the tool was used to connect whole-class dialogues to prior collaborative group activities. During whole-class dialogues, students' ideas were typically projected onto the teacher's interactive whiteboard and used as a reference in the dialogue. We found substantial variation across episodes in terms of

distribution and productivity. Codes related to elaboration and reasoning dominated, and there was a minimal amount of querying and practically no coordination.

The findings at the interactional level illustrated how Talkwall mediated communication in one episode where dialogues were distributed and productive, and where ground rules were put explicitly to the agenda. Prior to this episode, students were encouraged to collaborate in groups of three and collectively blog about evidence via Talkwall. During the dialogue, the teacher drew attention to the difference between various Talkwall contributions, and with visual support from the tool, the teacher could maintain an explicit focus on this difference throughout a sequence of turns. We also identified a distinct participation structure in which Talkwall functioned as a shared object of inquiry. Individual students did not comment on other individual students' claims or ideas; rather, the students and teacher tried to make sense of Talkwall contributions together. Also, our qualitative analysis showed that the teacher drew upon the collaborative atmosphere when supporting a less vocal student in expressing her thoughts.

Together, both the aggregated and particular findings showed how microblogging can support the teacher in making productive whole-class dialogues distributed by strengthening participation as a collective endeavour. The aggregated findings revealed the potential of most typical ways in which Talkwall was used by teachers, the particular findings illustrated how this potential can materialise at the interactional level in a context where ground rules were put explicitly to the agenda.

When Talkwall is used to connect whole-class dialogues to prior collaborative learning activities, students can enter the dialogue with a conceptualisation of themselves as part of a group effort. When students speak out, they do so not only on behalf of themselves but also because they are accountable to, and identify with, collaborative work that has already been undertaken. This matters for the distribution of dialogues because perceiving that one's ideas have value to others is a key element of students' conceptualisation of themselves as legitimate speakers (Clarke et al., 2015). Moreover, the danger of perceiving that one lacks the necessary knowledge to take part in whole-class dialogue is reduced when students are given the opportunity to prepare for the dialogue with others. This also matters for the distribution of dialogues because knowledge and understanding of the subject matter is found to be the primary justification for students' decision to talk or remain silent (Clarke et al., 2015). The extent to which students perceive themselves as part of a group effort will of course vary, yet setting ground rules like 'every student should be asked about their opinion', 'everyone should look at and listen to those speaking', and 'groups should discuss all alternatives before reaching a conclusion', as in the selected episode, is likely important. From the teacher's point of view, when Talkwall is used to connect whole-class dialogues to prior collaborative learning activities, it means that she can draw upon the outcomes of many small-group discussions in a whole-class setting. How to conduct a transmission from small-group to whole-class that allows for ideas to be jointly constructed, so that small-group outcomes are not confined on the few, is described as a crucial educational issue (Howe & Mercer, 2017).

When teachers, supported by Talkwall, can depart from students' collaborative work in whole-class dialogues, they can support students' exploration of their thinking. In addition, as illustrated in extract 1 from our selected episode, when teachers use the tool in this way, not only does the tool offer visual support but also the structure of participation is affected because both the students and the teacher make sense of students' ideas together and Talkwall is used as a shared object of inquiry. This finding strengthens the notion that the activity is something that students do together, as opposed to participating solely for oneself and for the sake of positioning one's private ideas. Again, the extent to which teachers maintain a focus on students' ideas and create a sense of learning as a collective activity will vary, but drawing attention to the differences between ideas, like the teacher did in our selected episode, meant that the relationship between ideas was emphasised. It is easy to imagine other kinds of organisation that might have had other implications, like reading out contributions one-by-one and judging their quality. This illustrates how similar functionalities offered by a digital tool can have different pedagogical implications dependent on the teacher's intentions with an activity. Developing students' capacities to draw distinctions between facts and opinions was part of the teacher development program, and the teacher in our selected episode uses Talkwall to promote related pedagogical ideas (Warwick, Cook, Vrikki, Major, & Rasmussen, in press).

Finally, as illustrated in extract 2 in our qualitative analysis, the teacher was able to draw upon the overall collaborative atmosphere to support a silent student in productively joining the dialogue. We hypothesise that the collective nature of the activity was critical for the teacher to be able to advocate high standards of reason in the classroom because it allowed her to credibly externalise internal struggle and make it a collective matter. The teacher did not have to avoid challenging some students or ask them less cognitively demanding questions to prevent them from losing face (Snell & Lefstein, 2017). It seems clear that Anna would not have decided to re-enter the dialogue after listening to her peers' dialogue if she had not perceived herself as a legitimate speaker with relevant knowledge *and* as part of her class's effort to think together. As we have illustrated, the way in which the teacher used Talkwall was important to the collaborative nature of the activity that emerged.

Through this study, we have been able to specify how certain functionalities offered by micro blogging technology, when paired with principles of dialogic pedagogy, can strengthen a sense of collectively in whole class dialogues. We have argued that this strengthening of the collective is one way of addressing "the shadow of dialogic instruction' (Clarke et al., 2016, p. 29). But the fact that there was great variation in the productivity and distribution of dialogues across episodes that appeared relatively similar in terms of how Talkwall was used, also suggests that the potential of the tool is likely to be dependent upon many other factors, not least the pedagogical approach of the teacher. This finding is in line with well-established models of how teachers' uses of technology should be perceived as partly embedded in their pedagogical practice (i.e. the TPACK framework, Koehler & Mishra, 2009) and findings by Ertmer and colleagues, demonstrating how teachers' ways of using technology in the classroom is typically closely aligned with their beliefs on the nature of knowledge and learning (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012).

Finally, it is worth noting that the functionalities offered by micro blogging are not exclusively linked to this particular type of technology, as the paste of innovation in the field of educational technology is both rapid and chaotic. In such times, however, it can be argued that the importance of continuously exploring how practice and technology can come together in the classroom in ways that benefit collaboration, participation and learning, is all the more relevant and necessary.

Funding

This work was funded by the Research Council of Norway [FINNUT/Project No: 254761]. The funding source had no involvement in study design; in the collection, analysis and interpretation of data; in the writing of the report; and in the decision to submit the article for publication.

Declaration of Competing Interest

None.

Acknowledgements

We are grateful to the teachers and students who participated in this study, and to anonymous reviewers for their helpful comments on an earlier draft. This work was supported by the Research Council of Norway. Norway [FINNUT/Project No: 254761]. The funding source had no involvement in study design; in the collection, analysis and interpretation of data; in the writing of the report; and in the decision to submit the article for publication.

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