

Writing on the wall: How the use of technology can open dialogical spaces in lectures



Kristine Ludvigsen^{a,*}, Ingunn Johanne Ness^b, Sue Timmis^c

^a University of Bergen, Faculty of Psychology, Department of Education, Christiesgt. 13, PO Box 7807, 5020 Bergen, Norway

^b SLATE, the centre for the science of Learning & Technology, Faculty of Psychology, University of Bergen

^c University of Bristol, School of Education, Helen Wodehouse Building, Berkeley Square, Clifton BS8 1JA, United Kingdom

ARTICLE INFO

Keywords:

Dialogical space
Higher education
Peer discussions
Technology
Feedback
Lectures
Creative knowledge building

ABSTRACT

This article discusses experiences using an online collaborative whiteboard to provide dialogical spaces (Wegerif, 2013) for students to reflect on their understanding of concepts in lectures in two higher-education courses: one in psychology and the other in teacher education. When describing dialogical spaces, the following terms are crucial: opening (how the dialogical space is enabled), widening (how many different voices and perspectives it allows for) and deepening (the extent of critical reflections that it provides). The research question is: ‘What kind of affordances are there in using a collaborative whiteboard to support the dimensions of opening, widening and deepening dialogical spaces in lectures?’ Audio recordings of peer discussions, material produced in lectures, focus-group interviews with students and course evaluations from teachers are used to examine the activities through the analytical lenses of opening, widening and deepening dialogical spaces. The focus is on how creative knowledge processes are stimulated through dialogue. Based on the two cases, we argue that opening dialogical spaces provides students with rich possibilities to reflect on concepts and develop arguments, thereby providing feedback on students’ understanding of course content. Students bring a range of perspectives and experiences to the scene, thereby widening such spaces. For lecturers, the critical point was to deepen the spaces and orchestrate a dialogue with students. We found the concept of a dialogical space to be fruitful for planning and assessing discussion-based activities in the context of the lecture format.

1. Introduction

This article discusses the affordances of using a collaborative online whiteboard (flinga.fi) for opening, widening and deepening dialogical spaces (Wegerif, 2013) in the context of lecturing in higher education. Creating dialogical spaces in educational settings requires engaging students in activities where ideas, perspectives and voices can confront and challenge each other (Dysthe, 2006). The crucial dimensions for describing dialogical spaces are the concepts of opening (how dialogical spaces are enabled), widening (how many different voices and perspectives each space allows) and deepening (the extent of reflections that these spaces provide).

Despite criticisms that the traditional lecture format is passive and fails to activate students’ learning processes (Freeman et al., 2014), and that the format is subject to structural constraints (Bligh, 1998), it is a commonly used teaching method in higher education (Friesen, 2011; Harrington & Zakrajsek, 2017). Research literature on lectures has an increased emphasis on the value of students being active in constructing their knowledge (Cavanagh, 2011; McQueen & McMillan, 2018; Roberts, 2017). Common ways for lecturers to promote

* Corresponding author.

E-mail addresses: Kristine.Ludvigsen@uib.no (K. Ludvigsen), Ingunn.Ness@uib.no (I.J. Ness), Sue.Timmis@bristol.ac.uk (S. Timmis).

<https://doi.org/10.1016/j.tsc.2019.02.007>

Received 31 July 2018; Received in revised form 29 December 2018; Accepted 22 February 2019

Available online 10 April 2019

1871-1871/ © 2019 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

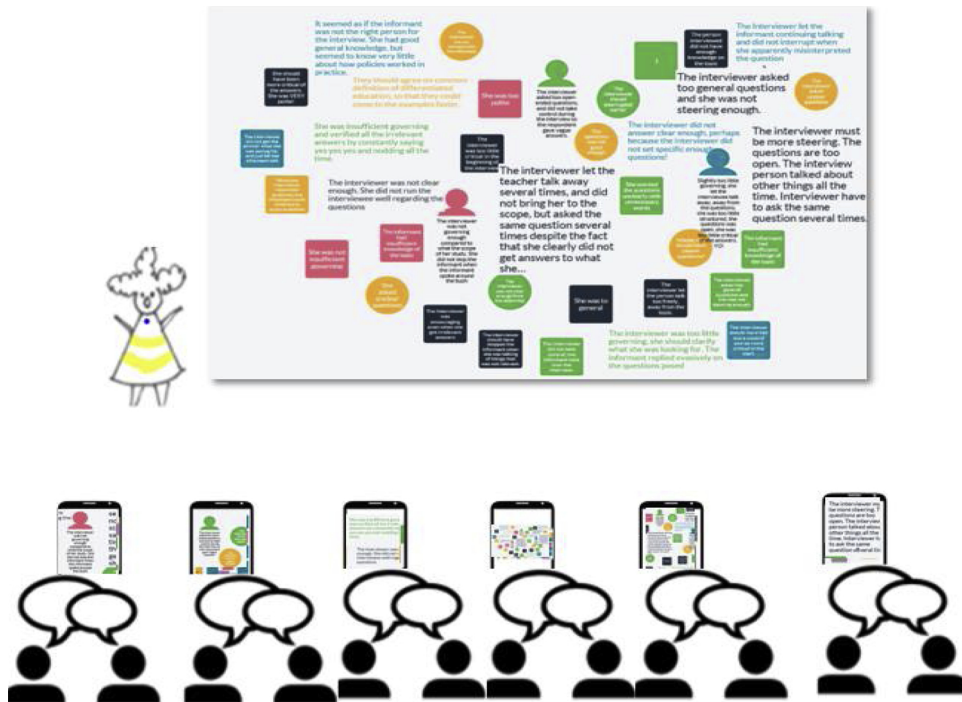


Fig. 1. The interface of the collaborative whiteboard in a lecture hall.

spaces for students to reflect on their understanding of content in the lecture, is to include peer and whole-class discussions, questions (Mazur, 1997) or to engage students in writing assignments (Stead, 2005). By participating in discussion-based activities, students can articulate, justify and develop their reasoning and assess their ideas in relation to others by questioning their own and others' arguments (Wegerif & Yang, 2011). Sharing information in a group also allows for increased sensitivity to different possible ways of thinking, as well as co-creation of knowledge (Littleton & Mercer, 2013). So, how and why should we do this in lectures?

During lectures, different activities and tools hold different potential to facilitate a dialogical approach to teaching. Flinga (<https://flinga.fi/>) is one such tool, an online collaborative whiteboard where students can share ideas via their phones or other online devices and send them to a shared online screen projected during the lecture (Fig. 1). The link is shared via an access code and students do not need an account to access the link. In addition to text, the application allows participants to post pictures or models, as well as to make drawings or create links between contributions. The contributions can be presented in different shapes and colours, and can be moved, edited or connected. The students and the lecturer can navigate around the board and work on different areas simultaneously. Content can be exported so that students and teachers can review and use it as a resource. The website's technical interface is illustrated in Fig. 2 below:

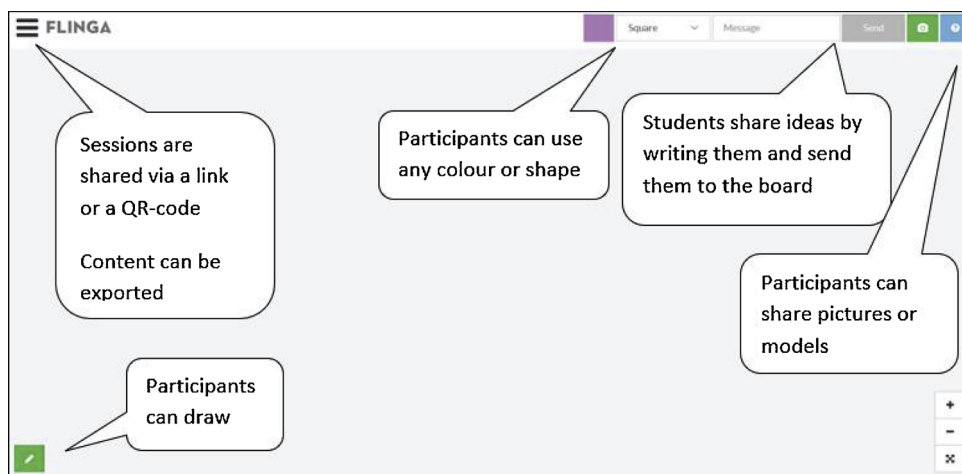


Fig. 2. Technical description of the interface.

Writing on shared screens, or using other technologies that allow students to post comments and questions in lectures, supports increased interaction among students, and between students and lecturers (Baron, Bestbier, Case, & Collier-Reed, 2016; Bry and Pohl, 2017; Cacchione, 2015; Ebner, Lienhardt, Rohs, & Meyer, 2010; Gao, Luo, & Zhang, 2012; Jeong et al., 2015; Neustifter, Kukkonen, Coulter, & Landry, 2016; Ruismäki, Salomaa, & Ruokonen, 2015; Yates, Birks, Woods, & Hitchins, 2015). This supports reflective thinking, collaboration and co-creation of knowledge (Sandström, Eriksson, Lonka, & Nenonen, 2016) while providing a safe, informal, process-oriented learning atmosphere (Elavsky, Mislan, & Elavsky, 2011; Yates et al., 2015). Studies have found that students ask more questions in a shared-screen environment than they do during traditional lectures (Pohl, Gehlen-Baum, & Bry, 2012) and that they feel ownership of the discourse that plays out in these activities (Sandström et al., 2016). By reading other students' questions, a student might become aware of others' challenges. This might create a sense of connectedness and a feeling of shared work to understand concepts (Aagard, Bowen, & Olesova, 2010; Baron et al., 2016; Pohl, 2015).

While the objective of such technology is to create opportunities for students and teachers to interact, all interactions cannot be referred to as dialogical (Dysthe, 2006). Exchanging ideas in peer discussions and externalising thoughts on a shared screen allow for different perspectives and opportunities to engage in dialogues (Rasmussen & Hagen, 2015; Rasmussen, 2016). Using a collaborative online whiteboard potentially could transform lectures by allowing students to share knowledge, questions and ideas in ways that otherwise would not be possible. When students share their ideas, these ideas can be reflected upon and connected to build collaborative knowledge. Examining micro-processes that occur during activities to find out what is achieved in them, is important in recognising the potential for discussion-based activities during lectures and is vital in making informed decisions on how to improve teaching design (Wegerif, 2013). In this study, we explore how using a shared online collaborative whiteboard allows students to share their thinking and reflect on course concepts from lectures. The guiding research question was: What kind of affordances are there in using a collaborative whiteboard to support the dimensions of opening, widening and deepening dialogical spaces in lectures? To address this question, we explore interactions that using such technology affords, as well as how students and lecturers perceive them.

In the following section, we present the concept of *creative knowledge processes* among different voices, as presented by Ness (2016); the idea of *dialogical space*, as interpreted by Wegerif (2013); and how we use the *affordance* concept. The discussion is based on two empirical cases: Case 1, 'Qualitative Methods', in which the collaborative whiteboard was used to support peer and whole-class discussions in an introductory course in qualitative methods for undergraduate psychology students, and Case 2, 'Different Paths to Learning', in which the collaborative whiteboard was used to support peer and whole-class discussions in lectures in an undergraduate teacher-education programme. In both cases, the concepts of opening, widening and deepening dialogic spaces are used as analytical tools to examine affordances of using the technology.

1.1. Creative knowledge processes

The concept of *creative knowledge processes* refers to the processes involved in the creative tension between perspectives. The concept comes from research on groups working toward developing innovative ideas (Ness, 2016). Within the sociocultural perspective, creative knowledge processes are inherently social, as ideas develop through a combined and relational process of co-construction of meaning and knowledge enhancement through dialogue. The concept is rooted in empirical research on creative-knowledge development (Ness & Søreide, 2014), which has a Bakhtinian understanding of knowledge development and refers to how knowledge among learners is created when different voices confront and acknowledge each other. When different voices confront each other, new knowledge and ideas emerge between learners. Ness (2016) coined the term *Room of Opportunity* to describe how when social languages meet, differences emerge, and we get what Bakhtin refers to as 'alterity'. To create something new, it is insufficient merely to have many voices, i.e., voices must confront each other and create dissonance as well (Bakhtin, 1984; Ness & Søreide, 2014). Creativity peaks in the Room of Opportunity when participants engage in dialogue and push the boundaries of everyone's knowledge (Ness, 2016). When participants challenge each other, ask open questions and explore different perspectives, creative knowledge processes are stimulated.

1.2. Dialogical spaces

Wegerif and Yang (2011, p. 1) draw from Bakhtin (1895–1977) when they define a dialogical space as 'possibilities that open up when two or more incommensurate perspectives are held together in the creative tension of a dialogue'. Bakhtin's view on dialogue includes both an ontological and epistemological understanding (Ness, 2016; Wegerif, 2013). For Bakhtin, dialogue is both 'a fact of life' and an ideal to strive for (Ness, 2016, p. 33). The concept of *dialogue* is connected to the concept of *polyphony*, a process in which different voices interact, with the tension between voices acknowledged (Ness, 2016). Wegerif (2013) uses the term 'dialogic gap' to refer to the appearance of different perspectives: 'The moment there are at least two perspectives, then the gap between them opens up the possibility of an infinite number of possible new perspectives and new insights' (Wegerif, 2013, p. 21). In the interactions among different perspectives, these perspectives can develop further, and new perspectives might emerge (Wegerif, 2013).

Utterances are the core of all dialogues (Bakhtin, 1984). Since voices respond to someone or something in the past, present or future, one can talk about voices as more or less dialogical or more or less monological (Bakhtin, 1984). While the monological perspective is single-voiced or closed, minimising the possibilities for responsiveness, the dialogical perspective allows for a multitude of voices, and opens the possibilities for challenge, responsiveness, and criticism (Bakhtin, 1984; Bakhtin and Slaattelid, 1998). A dialogue must include multiple voices and/or perspectives, and its meaning resides in the spaces between them (Wegerif, 2013).

Drawing on Wegerif (2013), a dialogical space is both a philosophical idea and a practical idea of how to facilitate dialogue. In an

educational setting, a dialogical space can be viewed as practical, such as during a lecture, where students can be encouraged to share their ideas for reflection (Wegerif, 2013). When describing dialogical spaces, *opening* refers to designing teaching environments that allow students to exchange ideas. *Widening* refers to how many possible voices and perspectives are available (Wegerif, 2013). By asking students to raise their hands, it is possible to gain a few perspectives. By asking every student to share an idea, we widen the space extensively. *Deepening* refers to the degree of reflection on perspectives, and on the dialogue process itself (Wegerif, 2013). Different degrees of reflection on perspectives may exist, from a teaching design that is open to differences but only lists perspectives and ideas, to a design that attempts to group, compare, contrast or connect ideas to a broader discourse (Scott, Mortimer, & Aguiar, 2006). In teaching design, the degree of reflection on ideas might evolve over time – during a lecture or across or between lectures, e.g., merely by starting to collect different ideas and reflecting on them in a later sequence (Scott et al., 2006).

By providing a variety of perspectives, one can increase the degree of reflection. With deeper reflection, you can increase the number of perspectives (Wegerif, 2013). With the widening and deepening of the dialogical space, differences might become visible, and one can question assumptions and ideas (Wegerif & Yang, 2011):

‘Viewed from the outside, all dialogues are different, but experienced from the inside, they all share something in common, which is the infinite potential to be drawn into self-questioning and reflection, which we referred to as the idea of the infinite other as a potentially emerging voice within all dialogues’ (Wegerif & Yang, 2011, p. 2).

Another idea from Bakhtin is that of the *superaddressee*. Drawing on Wegerif’s (2013) interpretations, a *superaddressee* is present in the dialogue by virtue of being able to listen to himself or herself while speaking. Listening to yourself as if you were another person, and considering what you say from the perspective of a *witness position*, allows you to assess your own thinking and understanding (Wegerif, 2013, p. 48).

In a dialogical approach to teaching, tension always exists between the infinite possibilities for multiple voices to appear and the reified closure that accompanies structured learning outcomes, formative and summative assessments (Biggs & Tang, 2011). Drawing on Alexander (2017), p. 5, a dialogical approach to teaching should be characterised by being: a) collective, ‘a site of joint learning and enquiry’; b) reciprocal, with students given opportunities to voice their thoughts, ‘listen to each’ other and ‘consider alternative viewpoints’; c) supportive, in which students can voice ideas freely and c) cumulative; “participants build on their own and each other’s contributions and chain them into coherent lines of thinking and understanding”; and d) purposeful, with discussions planned and structured toward certain learning outcomes (Alexander, 2017). To open and orchestrate dialogical spaces in lectures, the lecturer needs to consider the extent to which, and ways in which, students can share their thinking and understanding with each other and the lecturer, in order that students and the lecturer can reflect upon these different perspectives, and the extent to which these activities address and support the intended learning outcomes.

1.3. Affordances

In lectures, different activities and tools hold different potentials to facilitate a dialogical approach to teaching. Different approaches on how to stimulate dialogue allow for different affordances to be discovered. A gap might exist between the theoretical potential for using a particular technology, and the potential that a lecturer can identify and understand, the extent to which a lecturer can realise that potential in their teaching, and the reality of how the use of technology plays out, intended or unintended, among students (Kirschner, Martens, & Strijbos, 2004). Therefore, an affordance cannot be set in advance; it emerges in the context in which it is embedded (Bloomfield, Latham, & Vurdubakis, 2010). Exploring technological affordances to open dialogical spaces requires that technical features, the technology’s purpose, underlying theoretical assumptions on how students learn and notions of how to stimulate dialogue are addressed. In this article, affordances of using technology will be discussed both as a theoretical potential, as perceived by students and lecturers, and as affordances that we can identify when analysing interactions and material produced in lectures.

1.4. Analytical tools

Across the two cases, we used the dimensions of opening, widening and deepening dialogical spaces as analytical concepts. As suggested by Wegerif and Yang (2011), an analysis of a dialogical space explores the extent to which the activities facilitate opening an environment in which ideas, perspectives and voices can be presented, confronted and challenged. Wegerif argues that in spoken and written text, ‘it is even possible to feel the space opening, widening, deepening and closing down – each shift often as a direct shift of what people say and the way they say them’ (Wegerif, 2013, p. 152). For this article, we examine the extent to which the activities allow thinking/ideas to be shared, and the extent to which they allow for a different degree of critical reflection among perspectives.

2. Context and methods

In this section, we describe the research design, the participants and how the data were collected and analysed. The teaching design for the two courses is described in Sections 3.1 and 3.2.

2.1. Data and analysis

The research reported in this article is part of a larger design-based research (DBR) project, initiated in 2011, in which the particular focus has been to explore how discussion-based activities support creation of a formative feedback practice in lectures

Table 1
Descriptions of the two cases.

CASES	DATA AND ANALYSIS
<p>Case 1, 'Qualitative Methods': A qualitative-method course for undergraduate psychology students in which a student response system (Turning Point) and a collaborative writing tool (Flinga) were used to support peer discussions to reflect on a concept in qualitative methods.</p>	<ul style="list-style-type: none"> ● 15 audio-recorded and transcribed peer discussions supported by an online collaborative whiteboard. Each of the discussions was the unit of analysis. ● Focus-group interview with four students. Each turn during the interview was the unit of analysis. ● The concepts opening, widening and deepening are used as analytical lenses. ● Seven Flinga boards: Analyses of written contributions from students ● Evaluations from teachers in which we discussed the experiences. We used the dimensions of opening, widening and deepening dialogical spaces as an analytical lens for analysing our experiences and identifying challenges.
<p>Case 2, 'Different Paths to Learning': lectures in a teacher-education programme.</p>	

within higher education (Krumsvik, 2012; Krumsvik & Ludvigsen, 2012; Ludvigsen, Krumsvik, & Furnes, 2015; Egelandstad & Krumsvik, 2017; Ludvigsen & Krumsvik, in review). DBR emphasises using different approaches to examine learning and interactions in an authentic setting (Barab & Squire, 2004) and includes cycles of testing and improvements in practice, increased theoretical insight, as well as insight to improve intervention (Anderson & Shattuck, 2012). In this project, the intervention was to make a literature-informed adjustment to an already established practice.

2.2. The two cases

In Case 1, 'Qualitative Methods', the principal source of data was audio recordings of peer discussions and a focus-group interview with students. In Case 2, 'Different Paths to Learning', the principal data source was teachers' course evaluations and material produced during lectures (Table 1).

2.2.1. Analysing Flinga-supported discussion

The discussions that Flinga supported were conducted through a close reading of the transcripts, using the dimensions of widening and deepening to identify the discussions' characteristics, as illustrated in the example below (Table 2).

2.2.2. Analysing the focus-group interview

We conducted a focus-group interview with four of the students participating in the discussions to identify how they perceived the use of the online collaborative whiteboard to support their learning. The sample is based on voluntary participation, and can be characterized as a *convenience sample*; 'based in a specific purpose, rather than randomly' (Tashakkori & Teddlie, 2003, p. 713). At the beginning of the interview, the students were asked to create a mind map of their experiences. The resulting mind maps are shown in the figure below (Fig. 3).

Issues raised in the mind maps were used as a point of departure for the discussion. The focus-group discussion was transcribed verbatim and provided 20 pages of material. NVivo was used to support a thematic analysis of the focus-group interview. In NVivo, codes are referred to as nodes. To analyse the interview, we coded each turn. If a student raised several ideas, the turn was coded at various nodes. In total, 25 nodes emerged, which we grouped into 14 broad themes (Table 3). Even though this article focuses on the use of the collaborative whiteboard, we also included students' perceptions on the use of the student response system because using the student response system was part of the teaching design.

The guiding research question was: What kind of affordances are there in using a collaborative whiteboard to support the dimensions of opening, widening and deepening dialogical spaces in lectures? To address this question, we first describe some of the discussions' characteristics that the collaborative whiteboard supports. Second, to illustrate how the activities supported the dimension of opening, widening and deepening dialogical spaces, we present examples from three of the peer discussions, which were chosen because they illustrate how using the online collaborative whiteboard has the potential to open a shared space of reflection in the lecture. Third, we describe students' experiences with the activities.

While Case 1 focused on students' interactions and how they perceived activities to support their learning processes, case 2 focused on how the lecture built on students' voices. In both cases, the concepts of opening, widening and deepening are used as analytical lenses. In the following section, we provide a description of how the data were analysed.

2.2.3. Teachers' evaluation

Case 2, 'Different Paths to Learning', reports on four lecturers' experiences using the online collaborative whiteboard to support discussion-based activities in lectures. To examine the lecturers' experiences, we arranged for an evaluation meeting, which was conducted in three parts. First, the lecturers were shown the Flinga boards from their lectures. We used the Flinga board as a point of departure for a discussion of their experiences with the activities. Second, we discussed the experiences along the dimensions of widening and deepening dialogical spaces and what challenges they faced in using the online collaborative whiteboard to support discussion. The meeting was audio-recorded, transcribed and analysed.

Table 2
Analysis of the transcripts.

Line	Student	Transcript	Comments
1	S1	So, if you observe someone, and they do not know, if it is hidden	Line 1: S1 opens the discussion by suggesting an ethical dilemma.
2		observation, and then something critical happens, maybe it's an	
3		ethical dilemma whether to intervene or not? It was a bit that	
4		example he (the lecturer) took with the gang members	
5		Drug trafficking	
6	S2	Yes. Mm	
7	S3	There may be less serious things then. Where is the limit for when	Lines 8-21: The students elaborate on the dilemma (deepening and widening).
8	S2	to report []?	
9		[] It is something you saw.	
10	S1	But, at the same time, you should stay in the situation, what are	
11	S3	you doing?	
12	S2	I think, if it illegal, you have to intervene, you can not.	
13	S3	You must.	
14	S4	Basically, you should do that, but what if it is not illegal? But	
15		something that is ethical semi-critical then? I do not have an	
16		example at the moment.	
17	S3	Something else: Journalists get into drug cases and so, then it is	Line 21: S1 suggests they should read other posts. They read one aloud and discuss the grammar (widening). Lines 23-26: They decide what to write.
18		often that people admit they are drug sellers or such things, but the	
19		journalists should not bring it further	
20	S4	It's a about getting insight into such things too to learn from it.	
21	S1	Should we read what others have been written?	
22		(...)	
23	S2	Yes, but should we write something about the limit, when to	Line 27-28: S2 continue to elaborate on the questions (widening).
24		intervene?	
25	S1	We can write: 'Were are the limit of interfering in critical	
26	S2	situations?'	
27	S2	For example, if you follow a gang then, and they suddenly want to	
28		... shoot down a person, then it's a very, it's actually very.	



Fig. 3. Mind map of students' experiences of using Flinga in lectures.

Table 3
Nodes and themes in the qualitative analysis of the focus-group interview.

MODE	NODES	THEMES
Student response systems	'You want to achieve' 'Feedback on right and wrong' 'Helped me understand' 'Connected to coursework' 'Address feedback' 'Alternatives open up the discussion' 'You eliminate' 'When you explain something for others, you explain it for yourself' 'You listen' 'You get different points of view' 'Use questions in coursework' 'it is an active way of working with the material'	Easy Feedback on right/ wrong Structured discussions Self-assessment Self-reflection Co-creating knowledge Student active approach Connectedness Align coursework Awareness of differences
Online collaborative whiteboard	'You become aware of other points of view' 'You become aware (of) nuances' 'You contribute to the lecture' 'Challenging when you do not have alternatives' 'We discuss other students' posts' 'To write something, you have to think further' 'Silence breaks for thinking/writing' 'You really want to contribute' 'You have to think more' 'You get feedback on something you have contributed' 'I used other students' contributions in (my) own writing' 'You can work on the material' 'It is activating'	Challenging Feedback on contribution Unstructured discussions Self-assessment Self-reflection Co-creating knowledge Student active approach Connectedness Align coursework Awareness of differences Awareness for nuances Students contribute content

3. Findings

In this section, we present and discuss the two cases before we propose suggestions for future research and practice.

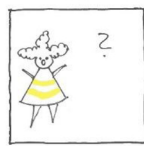
3.1. Case 1: 'Qualitative Methods'

Case 1 is a course in qualitative methods for undergraduate psychology students in which a student response system (Turning Point) and a collaborative writing tool (Flinga) were used to support peer discussions to reflect on a concept within qualitative methods. A core skill in learning about qualitative research is to engage in *critical reflection* (Cooper, Fleischer, & Cotton, 2012; Cooper, Chenail et al., 2012). Critical reflection is important for students to be able to make informed choices on how to approach the different steps of the qualitative research process, such as developing research questions, choosing a sample, conducting interviews and observations, coding, interpreting and analysing data, judging validity and examining possible ethical challenges (Cooper, Fleischer et al., 2012; Cooper, Chenail et al., 2012). To learn qualitative methods, students need to have an active approach and they should be able to connect concepts they learn to their prior knowledge and experiences (Cooper, Fleischer et al., 2012; Cooper, Chenail et al., 2012). Each lecturer started by introducing a theme or a concept, followed by a multiple-choice question inviting students to apply these concepts to different cases or contexts. To expand the opportunities for the exchange and comparison of ideas,

Design of activities during the lecture



'Mini-lecture' on core concepts



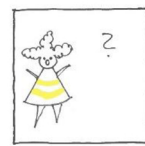
Questions about key concepts



Peer discussions and voting



Explorations of ideas and clarifications



Questions for peer discussions



Explorations of ideas shared on Flinga

Fig. 4. Design of activities during the lecture.

we invited students to voice their ideas on the online collaborative whiteboard by answering prompts such as ‘Share issues regarding ethics in doing observations’. Each lecture contained several sequences with lecturing, discussions of multiple-choice questions and writing. As such, the activities move between a traditional lecture format and opening up spaces for shared reflection on the topics introduced in the lecture, as illustrated in Fig. 4 below.

3.1.1. Characteristics of discussions

The 15 discussions were characterised by different activities, e.g., students finding out how the interface worked, quiet breaks for writing, and deciding what to write (as in Example 2). Students typically discussed a problem that they identified themselves (as in Example 1). In addition to their discussions, the students read or analysed other students’ posts as they appeared on the screen (as in Example 3).

Example 1: Widening and deepening the discussion

The first discussions (Example 1) illustrate both a widening dimension, in which they introduce different perspectives, and a deepening dimension, in which they elaborate on these perspectives before introducing new topics to the discussion.

Line	Student	Transcript
1	S2	This thing works!
2	S1	I was thinking, for example, you are in the toilet, you can be observed in parts of your
3		life, but not all parts of your life, in a way, or in the shower, there are certain places
4		that you will not.
5	S2	You will not observe.
6	S1	That it is not ethical; it is important to not continue the observation.
7	S2	Yes, I get your point. I understand.
8	S1	Or, when you sleep. As long as you agree, then it is OK. I am thinking about ‘Paradise
9		Hotel’ and ‘Big Brother’, when they are filming in the shower and...
10		Yes.
11		Filming in the shower – How did they come to that idea? Why do people say ‘yes’ to such
12	S2	things?
13		Yes.
14	S1	Yes, but being observed affects behaviour as well.
15	S2	You would never come 100 percent in a situation, with an observer, that is not
16	S1	affecting the setting.
17		Yes, just the fact that someone is observing; the behaviour will be, at least a bit
18	S2	adjusted, but they say that with time...
19		After some time, then it is OK.
20	S1	Then it is OK; that might be right.
21	S2	But, anyway. So ...
22	S1	Then, it is this: If you observe something, if you observe something criminal, from the
23	S2	observer’s point of view?
24		What should you do? (sound of writing)
25	S1	Like teachers that observe that students have bruises.
26		but they have not seen how it happened, but still, they are in a situation. That they have
27	S2	to do something.
28	S1	‘If a teacher observes ...’ (sound of writing)
29	S2	Then, there is one more thing, or maybe it was something I thought of, or something
30		you said.
31	S1	That, about doing something criminal?
32	S2	No, I wrote that. I was thinking, it might be a problem with observation, but it might
33		not be an ethical problem, that an observer is present, and the subject changes the
33		behaviour. It might not be an ethical problem.
34	S1	Not an ethical problem, but a validity problem.
35	S2	Yes, right, so maybe.
36		(Sound of Writing)
37	S1	There, it is the one we had, not the one we wrote, but what we talked about... (reads):
38		‘How closely can you observe a person?’

The discussion above opens when S1 introduces a familiar topic, examples from reality TV, then discusses whether situations exist in which one should not be observed (lines 1–13). The discussion widens with more elaboration on the phenomenon of being observed in reality TV. From this, they move the discussion toward observation challenges in the context of research and conclude that people tend to change behaviour when they are being observed (line 14). However, the students agree that this effect fades over time (lines 19–21), which is an example of how they deepen their discussion. Then S2 widens the discussion by introducing a new topic: What if you observe something that is illegal (line 23–25)? They pause to write, then resume when S1 follows up with an

example of this by referring to teachers: If they see students with bruises. S2 is completing the statement from S1 by adding that they are obliged to take action (line 27). S2 agrees, and S1 writes down the post. S2 elaborates further on the phenomenon of changing behaviour by questioning whether it is an ethical problem (line 34). Again, S1 is completing S2's utterance and suggesting it is a validity problem, rather than an ethical problem, which is an example of deepening in the discussion. They are also reading other groups' posts on the same topic (line 38), thereby broadening their own discussion.

Example 2: How viewing other students' posts contributes to widening perspectives on the board

The discussion below illustrates how the student, in silence, analyses the board and tries to introduce a new perspective and thus contributes to widening the dialogical space.

Line	Student	Transcript
1	S2	I feel that everything has been said.
2	S1	Yes. I am sure there is something important that is not said yet (sounds of writing, i.e., tapping on the computer for two minutes).
3	S2	When people go out in the Sahara, or not in the Sahara, to observe
4		animals, maybe there are animals that suffer, that are in pain, that are
5		having a difficult time, maybe they are dying, are very sick, suffering.
6		You cannot intervene. What happens if you observe a family, and the
7		husband has raped his wife or something – do you do anything, or...?
8		What are the ethical lines? When do you...?
9	S1	Yes.
10	S2	Do you intervene? Do you stop the observation and help in the
11		situation?
12	S1	Yes, that was a good point. Maybe we should write that. I do not think
13		that anyone else has written that. Like if something is happening.
14	S2	There it came! First, I wrote that...
15	S1	Yes. (reads) 'If one observes something criminal, what should one do?'

The two students are watching ideas as they appear on the screen. S1 indicates that everything is said already (line 1), and S2 replies that there must be important things that are yet to be said (line 2). After this, the students take a quiet break, during which we only hear typing. After two minutes, S2 presents an ethical question about when to stop an observation and intervene in a critical situation (lines 4–11). S1 agrees and suggests they share the idea on the whiteboard. This example shows that by assessing other students' contributions, they search for ethical challenges other than what was presented, and are therefore able to widen the dialogue space by making contributions to it.

Example 3: How students use contributions from another group to widen their own discussion

The next example shows how students broaden their discussion by reading and assessing other students' contributions. In the example, two students discuss ethical considerations in conducting qualitative interviews. The assignment is: 'Share issues regarding ethics in doing observations'.

Line	Student	Transcript
1	S1	'Sensitive information' 'informed consent'
2	S2	What is written on the green there? 'That people have to know that they are being observed'.
3		
4	S1	Yeah, regarding your method, it may be important, how people respond. If there is a camera, people can be affected. If there is someone filming, someone can be affected.
5		
6		
7	S2	You have to know that you are being observed.
8	S1	That you are being videotaped.
9	S1	What is written there? 'Problems regarding informed consent with children'.
10		
11	S2	Yeah, in that case, then you have to tell the parents.
12	S1	Do you have anything more? Do you think of anything?
13	S2	'Be careful to interpret quotes without verifying the meaning with the interview person'.
14		
15	S2	We can look further. I would say that what is important is the interpretation you are doing, from what is said and how it is said, because it is not everything that is said that is described properly – yeah, in a way, regarding misunderstandings.
16		
17		
18		
19	S1	It might be irony behind (it), which might be hard to capture.
20	S2	Or body language – are you (an) introvert, extrovert, open, talk freely?



This discussion illustrates how other students' contributions feed into their discussion. The two students are reading contributions displayed on the board. In line 1, S1 is reading two posts without commenting on them. S2 reads a third post, in which they elaborate (lines 4–8), before they read and comment on a fourth contribution (line 9). S1 asks S2 whether he or she has anything to add. S2 reads a new post which they discuss in more depth. This example illustrates that ideas from other groups' discussions feed into their discussion and serve as a catalyst for S1 and S2's discussion, thereby providing both a widening and deepening of the discussion.

3.1.2. Students' perceptions

The students experienced discussions supported by the student response system as spaces for them to develop their thinking to help elicit a more nuanced understanding, as stated in the focus group interview: 'I have had my opportunities to show what I know. They can show what they know. We can compare with each other, and then we get a broader understanding of what it is all about' (S4). The students emphasised the value of contributing different perspectives and understandings to the group: 'One reads different things, you know different things, you notice different things, you get different perspectives than you maybe know' (S1). Students value the process of explaining their understanding to peers because it makes them aware of their own thinking, as in the quotes below:

It is then (that) I realise that I have understood it in a way. I can sit and read or hear and believe that I understand these things. But, if you are to formulate yourself, with no help in front of you (e.g. notes or books, etc.), then I realise if I understand (S2). Even though you remember the words, when you should explain it to others, then they ask what it means, and then you realise that you did not know, then you notice (S3).

Students emphasised how they listened to themselves as they explained concepts to their peers, becoming aware of their understanding from a 'witness position' (Wegerif, 2016, p. 32). This also might be the case when a student reads his or her post on the screen and sees his or her contribution at a distance and in the context of other students' contributions, as Sandström et al. (2016) noted. Students used the discussions to reflect on their understanding and identify aspects that they needed to review. Below is a sequence from the interview.

- S4 When you explain something for others, then you explain for yourself, then you can use it as a method to find out that you did not understand as much as you thought you did.
- Interviewer: *If you find that you do not understand, do you do anything then?*
- S2Hmmm.
(laughter)
- S4 I get stressed. I try to identify what I do not understand and try to close the gaps.
- Interviewer: *How do you do that?*
- S4 I read, look on the Internet, ask my friends if they have some ideas or something, and then I get to sort things out.
- S3 Yes, if you try to close the gap, you find (what) you had (while) discussing (it).
- S2 Then you notice that you did not understand as much as you thought you did, then you go and read more, or ask.

In the focus group interview, we asked the students to make a mind map of their experiences of using Flinga in their lectures. The main perspectives reflected in the mind maps were that they could participate by contributing with their ideas and that they became aware of different viewpoints.

Flinga allowed students to contribute to the lecture, alerting them to nuances and an awareness of ways of understanding that differed from their own: ‘Your understanding is one thing, but their understanding is something completely different, on what these things are about’ (S4). ‘I liked that you could see that they had different suggestions (...) When we had a discussion about ethics, then there were lots of different opinions’ (S2). Students appreciated being allowed to share ideas that were not covered in the course readings:

(...) Things are not black and white, or wrong – you can present your own thoughts and ideas. It helps you to understand, and you get the time to reflect on things that you should learn. So, I think it should have been used to a greater extent because it activates the students. Yes. You are not just sitting there, and someone is telling you how things are (S1).

For the students, the process of formulating ideas to share on Flinga was the most valuable way to reflect on what they had learned. This can also be connected to deepening the dialogical space, as two students experienced in the sequence below:

- S2 It gives a deeper processing, as you said; it is not only recognising something. You use your thoughts in another way. You do.
- S1 At first, we sat there, thinking, quiet, we had to think. When the other post came, then we could connect it to things, and eventually, change a bit in the definition, or connect to it.

They had to ‘think further’ or process more deeply: ‘It requires more, having to formulate sentences, and then you have to at least understand what you are talking about’ (S4). This can be connected to a sense of participation: ‘It gives a sense of achievement when you are able to write something. It gives, in a sense, you have contributed something’.

The act of sharing their thinking by writing posts forced them to articulate their thinking and, thus, increased the possibility for questions to appear or, as (Nygaard, 2015, p. 24) stated beautifully: ‘[...] putting word on paper makes us think things through [...] suddenly gaps in logic became visible. Things we thought we knew thwart our every attempt to describe them’. Students emphasised that they became aware of differences and nuances by reading and discussing other students’ posts, and they compared other students’ contributions to their own. Seeing other contributions inspired them to open discussions in their peer groups:

You can focus a little on what you think is interesting, then take the discussion in that direction instead of another direction (S2). It helped to discuss the other students’ posts. It was really very fine, really (S4).

I feel that there was a way to get started then, not necessarily that I think that what they wrote was right, but if I did not agree, I could say, ‘No, what, why did they write this’ or ‘yes, it was really good’. So, we began to discuss what we would write, and what we would not write (S1).

Even though it was quiet from the start (...) you think really hard in a way. You would give input; it takes time to formulate in a good way in writing (...) you actually need, the need to work a bit more with it, to think of anything to write (S3).

The students also emphasised that working on the material connected the lectures to other activities in the course, such as reading and writing, as this students explained:

It helped in writing my exam, and to remember what I had written, and what other students had written. In addition to what was written in the book, I could use it in the discussion, to show that I was able to reflect (...) I noted the post that I found to be most relevant and maybe those that were commented on by the lecturer. I noted them, and used some of them in my exam (S4).

When you are given a chance to work on the material, then you remember it better. When you read the book about something, then you can connect it to the lecture (...) then I can review my notes. I remember this is what I wrote, then I was given an opportunity to connect everything. When I think about other subjects, I think: This is the lecture. This is the book. This is the exam. But now, I get a real thread between everything (S2).

Students found it difficult to discuss ideas with their peers during the Flinga session because of the challenge of formulating ideas into short posts, with no starting point to focus on or structure, like the discussions supported by clickers. Despite this, the students experienced, in both discussion formats, the act of explaining ideas to peers and listening to other perspectives, writing ideas, seeing and assessing other students' posts and hearing lecturers' comments – all as spaces for them to reflect on their own learning and thinking by considering their own understanding. Interestingly, and in line with extant literature (Baron et al., 2016; Pohl, 2015), the students found that using discussion-based activities in the lecture supported a feeling of participation and belonging in a group:

- S3 Maybe it creates a feeling of belonging. It creates connectedness with others.
- S4 In a way, it provides a nicer atmosphere in the lecture, I think.
- S1 You feel you are in a class. Yes, that is true. There are many that go to lectures and do not know anyone.
- S4 A friend of mine, she made a very good friend...while discussing at the lecture. They met there.
- S1 You are forced to turn to a peer.
- S3 (Would) I write that it gives a better feeling of belonging and a nicer experience?
- S2 Yes.
- S4 Yes.
- S1 Mmhmm

At the end of the interview, we asked the students to agree on suggestions on how/why these activities supported their learning. The points were: 1) It provided feedback on their own understanding, and it encouraged thinking for themselves; 2) It gave students more control over their own learning; 3) It should be used in different subjects to provide students with different perspectives; 4) It creates a feeling of belonging.

Students also used the online collaborative whiteboard to comment on the organisation of the course. In a few instances, students posted pictures and jokes. On one occasion, some students made posts into the shape of a heart (see Fig. 5). This illustrates the multimodal affordances of using the collaborative online whiteboard. When this occurred, the lecturer could not see how students were playing with the post, because he had his screen zoomed in on a few posts only. This created an enjoyable atmosphere.

3.1.3. Summary: case 1

Flinga had the potential to open the space in the first place by including the lecturer and by bringing in perspectives from all the student groups. When students are asked to share their views in Flinga, it broadens the dialogical space. This might provide students



Fig. 5. How students used the online shared whiteboard.

Table 4
How use of the technology affords the dimension of widening and deepening.

Widening	Deepening
<p>Students make an effort to add different perspectives to the collaborative whiteboard.</p> <p>Students experienced awareness of nuances in their own and in others' views.</p> <p>Perspectives from all the students participating in the lectures</p> <p>Students include perspectives from other groups in their peer discussions.</p> <p>The lecture is included.</p>	<p>Whole-group discussions were held.</p> <p>Students sort and categorise contributions.</p> <p>Writing adds reflection to the space.</p> <p>It helped students connect to each other's ideas, both in the lecture and in coursework outside the lecture.</p> <p>Lecturer asks for justifications and examples and helps connect the contributions to research literature and theory</p> <p>Students argue for their views.</p>

with a richer picture of possible ways to understand a phenomenon than what is occurring in the peer-group and in whole-class discussions. As illustrated in the case outlined here, the use of shared online whiteboards provided different affordances for creating dialogical spaces. These can be grouped as shown in Table 4.

3.2. Case 2: "Different paths to learning"

The course's objective is to be able to discuss examples from practice in light of research and theory, and to be able to articulate an informed and critical view of different teaching situations. During each lecture, we asked the students to discuss questions in groups and share their ideas on the collaborative whiteboard. Flinga was used to allow students to share their ideas and to connect those ideas to theoretical concepts. Examples of writing tasks were to formulate definitions of students' understanding of a phenomenon, e.g., 'Suggest a definition of learning'. We also asked the students to answer questions or argue for and against statements such as 'All learning is good learning'. To problematise and identify different or conflicting views, we asked the students to discuss practical or ethical issues related to classroom situations presented by video, using questions such as 'What can the teacher do in this situation?'

The pictures below (Fig. 6) illustrate how we used the collaborative online whiteboard in the teacher-education course:

Approximately 30 minutes of the 2 × 45-minute lectures were dedicated to Flinga-supported discussions. The lecturers were using Flinga for the first time. The first author facilitated the process and supported the lecturers by guiding them and the students in using the platform. We visualised this approach in the model below (Fig. 7):

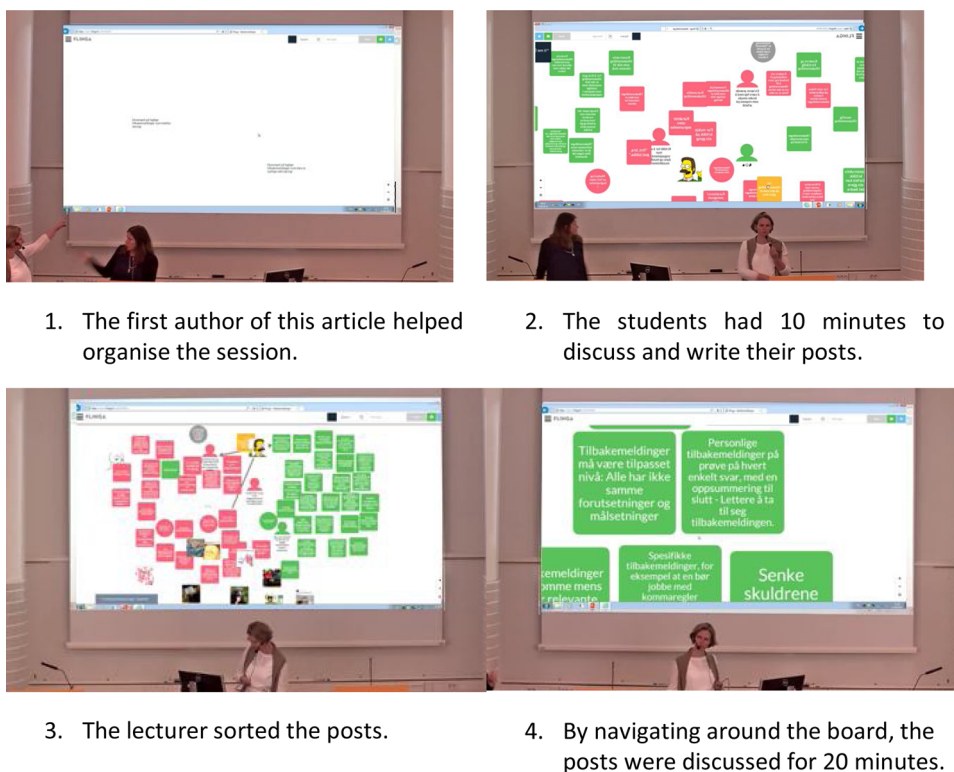


Fig. 6. How we organised the discussion sessions.

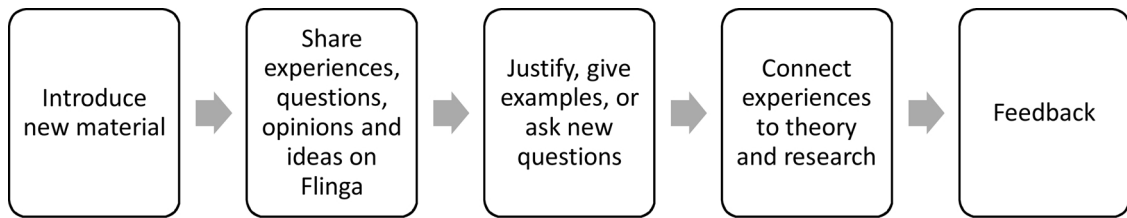


Fig. 7. The structure of a Flinga session.

3.2.1. Lecturers' experiences

In the evaluating meeting with the lecturers, we used the material produced (Flinga board) as a point of departure for the discussion on the lecturers' experiences by focusing on a) how they perceived the technology to support activities for students to share their thinking (widening dimension) and b) how they approached the perspectives (deepening dimension). We also asked them about their experiences in general and finally, we used *widening* and *deepening dialogue spaces* as analytical lenses through which to identify opportunities and challenges.

It was easy for students to bring a wide range of perspectives and experiences to the scene, thereby opening and widening the dialogical space. In the auditorium, the lecturers took the following strategies in engaging with the posts and reflecting on the perspectives: (1) Read a post aloud and ask for examples and elaborations, and connect the ideas to theory, research, and best practice in teaching; (2) Go in depth by unpacking only one of the contributions and invite whole-class discussion; (3) Identify conflicting views to stimulate whole-group discussion; and (4) Ask students to include a written justification or examples to their ideas expressed in their posts. The following section provides examples of the approaches above.

Example 1

A total of 100 students participated in the lecture. The assignment was to provide examples from their own experiences and get feedback. We asked the students to post feedback examples that supported their learning in the green boxes and feedback that was not useful in the red boxes. The students had five minutes to discuss and write their posts. The lecturers sorted out the perspectives as they were posted to the Flinga board (Fig. 5). The posts covered a range of experiences, and the feedback needed to 'be relevant' and 'practical', 'should inform you on how to improve', 'must adjust to the student', 'should not focus on the grade', 'should be specific', 'should use examples', 'should be face-to-face' and should recognise that students have 'different needs and that the feedback should be differentiated' and provide 'clear instructions'. Ineffective feedback focuses 'only on grades' or 'negative things', is 'not relevant', is 'not specific', is 'too critical', uses an 'emoji to be hip', offers 'only positive feedback' or 'no justification' or simply 'too much' feedback. The students' ideas reflect ideas informed by research on formative assessment. By stimulating dialogue among students and trying to unpack the posts shared on the board, the lecturers could connect the experiences to the research by building on students' contributions (Fig. 8).

Example 2

In the example below (Fig. 9), the students were asked to 'suggest a definition of learning'.

Students brought different perspectives to the exercise on how they define *learning*, including: 'to gain knowledge'; 'to

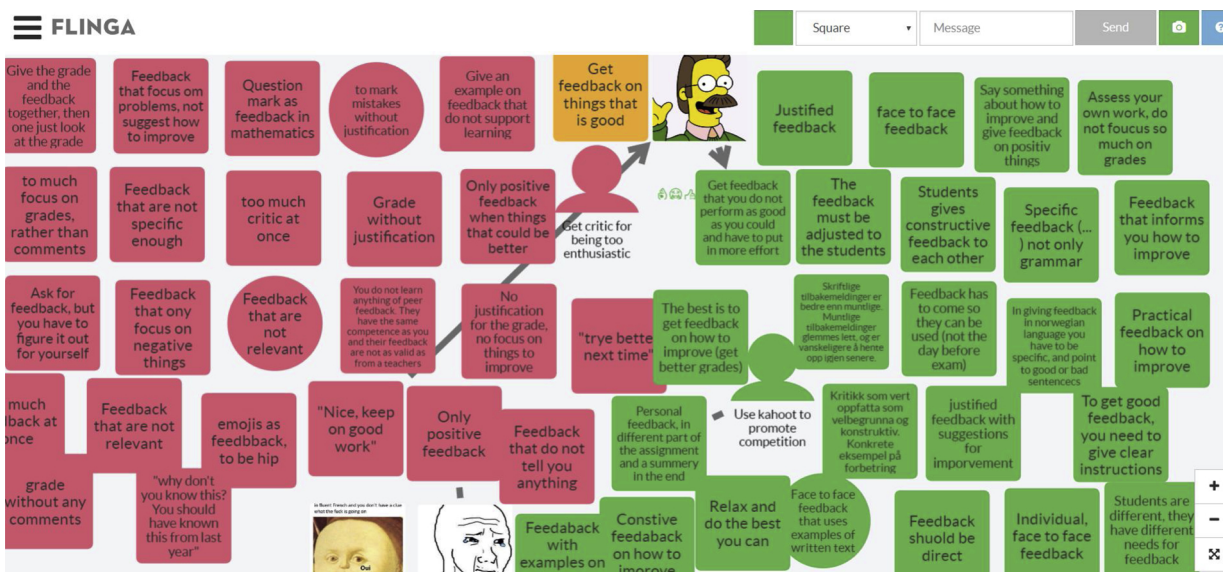


Fig. 8. What are your experiences with feedback? Provide examples of feedback that supports learning and feedback that does not support learning.

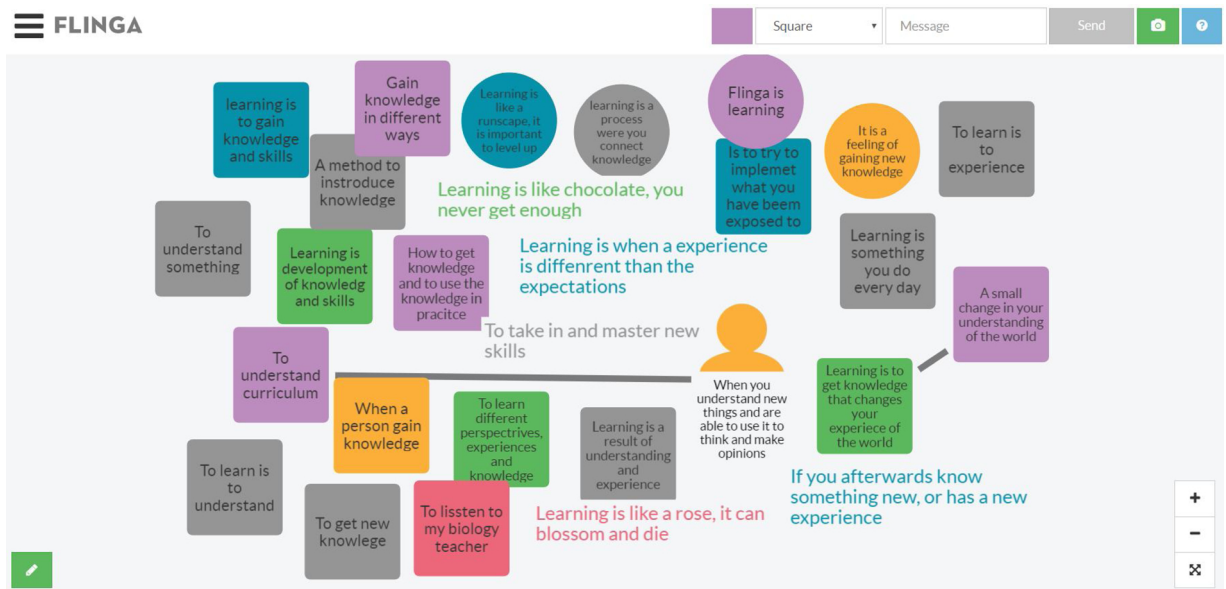


Fig. 9. A Flinga board with posts for the prompt 'Suggest a definition of learning'.

understand'; 'to develop skills'; 'an experience'; 'a process'; 'a small change in understanding; and 'like a rose'. This served as a point of departure for sorting out the different perspectives in light of the acquisition and participation metaphors of learning (Sfard, 1998). By sorting their responses according to these metaphors, students were able to grasp the two ways of looking at learning and also recognise that their own ideas might be reflected within one of the two perspectives. Although many of the posts were easy to place, some fell between concepts. The lecturer explains how she handled this:

I tried to make a grey zone then. These are challenges you might discuss with the students (...) It may open up even more dialogue: You can ask them to move posts, that they are allowed to move the posts, but then they must justify it in one way or another. Your students may disagree. This can be the point of departure for a dialogue (Mari).

Example 3

Another approach was to identify conflicting views and use them as a point of departure for a whole-class discussion. The lecturer asked the students to elaborate on their posts and explain their reasoning. This opened up a discussion in which differing views were confronted. To facilitate the reflective process among students in their peer groups, we asked them to justify their ideas by providing reasons or examples tied to their ideas when writing their posts. By including justifications and examples in the posts, it was easier for lecturers to connect to the students' ideas.

Example 4

One of the teachers used the interface to code the posts as good (green) or bad learning strategies (yellow). (Fig. 7). Students were asked to share their experiences with learning strategies, providing an opportunity to deepen the space by putting ideas in relation to each other. For example, they started to organise related posts together. These actions were unplanned and showed how students shaped the use of technology as the activities spontaneously emerged. In the lecture, the students brought a variety of different experiences, and the lecturer sorted the posts into individual and collaborative learning strategies:

The idea was to ask students about the learning strategies they used. The aim was to sort the responses into different types of learning strategies, such as social and cognitive strategies. I focused on the answers that I thought were most interesting or revealed things that were different and that I wanted to give more depth. That was what I found to be the easiest way to approach it (Jon) (Figs. 8–10).

Across the examples, the students were willing to argue for their beliefs, raise concerns and give examples. The lecturers found it challenging to handle students' individual experiences and focus on theoretical understanding simultaneously. They also felt that they had a limited amount of time to make decisions about how to connect perspectives and conduct analysis on the spot:

I experienced it as a bit intense when it comes too many perspectives on the board. You feel you have a short time to analyse it (...) it is not easy to do an analysis very fast. (...) You may come up with things you are not happy with afterward, or things you can discuss or disagree with (...) I felt I had to hurry to sort and categorise the answers (Mari).

It is nice to think that they will come up with numerous perspectives so that you will say, 'See, there's an example of this!' It is harder in practice when you are in the lecture hall (Jon).

It is the nature of this activity that you cannot prepare for everything and that one must be open to unpredictable things happening. It is a delicate balance between what can be planned and what one has to do spontaneously.

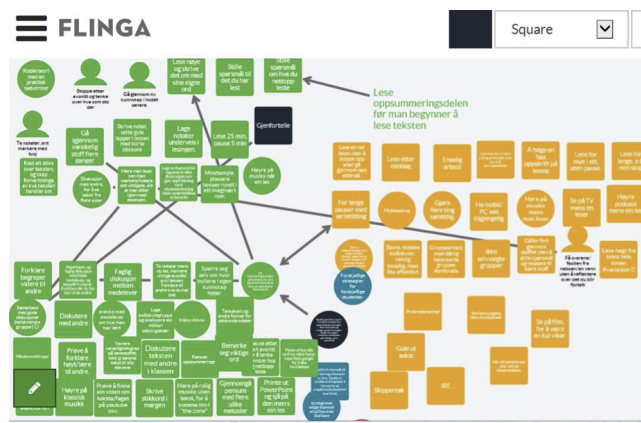


Fig. 10. How the interface is used to code the posts.

Flinga gave me a lecture on students' thoughts. I am delighted with how I managed to utilise this opportunity in the lecture. In retrospect, I think I spent too little time on the follow-up phase (...) I think it requires a good academic overview, a humble and open attitude that one cannot 'do everything' and that you keep calm and keep a cool head when unpredictable things happen (Tomas).

The lecturers also expressed a feeling of discomfort associated with doing something in a new way, be it using the technology itself, not knowing what the students are going to write or being uncertain of whether they manage to orchestrate a dialogue between ideas and how they are able to capitalize on students' contributions.

3.2.2. Summary: case 2

Based on the lecture experiences, it was easy to use the shared whiteboard to support the widening dimension. The critical point was how to approach the deepening dimension: The lecturers found it challenging to do on-the-spot analysis that entailed managing students' experiences and focusing on theoretical understanding simultaneously. Based on this insight, we would work systematically toward developing a design with greater dialogue among ideas by using structures in the interface to support reflection on perspectives within the peer groups, as well as in the whole-group discussion. To develop our teaching design we would view widening and deepening the dialogue space as a process that continues beyond the time and space of the lecture section.

4. Discussion and conclusion

Opening the dialogical space occurs by inviting students to voice their opinions and ideas in written posts. Taking this further, by asking students to justify, explain and elaborate on their perspectives allows for more sophisticated ways of unpacking differences in perspectives, thereby allowing complexities to surface and providing opportunities to deepen the dialogical space. Using a collaborative, online whiteboard has the potential to transform lectures by allowing students to share knowledge, questions and ideas in ways that otherwise would not be possible. Based on our cases, we argue that the technology has the potential to transform the lecture into a space of dialogue and reflection, open for students to participate in activities where they can connect new ideas to previous knowledge and experiences. Using a collaborative whiteboard can potentially change how students and lecturers interact and how students' ideas interact with each other. We argue that opening dialogical spaces provides students with rich possibilities to reflect on concepts, develop arguments, and obtain feedback on their own understanding of course content. In this method of teaching, creative knowledge processes are encouraged (Ness, 2016), and several possible dialogical spaces can potentially open up.

Based on our two cases, we have illustrated that using the online collaborative whiteboard supports increased interaction among students, and between students and lecturers. This would have been impossible without such technology. The activities supported a process-oriented and safe learning atmosphere for the students to engage in critical reflection. A dialogue space was created, where students could articulate their ideas in peer groups, formulate them into written text, view perspectives from their peers, and discuss with their lecturer. This was also recognised by Yates et al. (2015) and Elavsky et al. (2011). Students gained ownership of the discourse played out, which has also been recognised by Sandström et al. (2016). Students also gained awareness of different views and nuances, along with a sense of connectedness, as was recognised by Pohl (2015) and Baron et al. (2016). This article exceeds previous research by adding insight into the micro-processes occurring among students during the activities. Through our analysis we have shown how the use of such tools provides affordances to open, widen, and deepen dialogue spaces.

4.1. Usefulness of using dialogical-space concept as an analytical tool

We found the idea of a dialogical space to be stimulating as a 'thinking tool' for examining activities to promote dialogue in lectures. We found the concept of *dialogical space* to be connected closely to creativity in the way it stimulates exploration and a

divergent thinking mode. In traditional creativity theory, *divergent thinking* focuses on exploring many possible solutions (Guilford, 1967).

4.2. Implications for practice

Deepening the dialogue space must be viewed as shared work between students and lecturers. It is important to emphasise that affordances arise when everyone participates. Understanding is then created among students and lecturers.

The lecturer's role is essential to facilitate depth when using Flinga, e.g., by helping connect different perspectives and finding conflicting views and opinions. As we found in Case 2, the lecturer needs to be open to unpredictable occurrences and find a balance between what can be planned and what one must do spontaneously. Another way of thinking about deepening spaces is that text produced in lectures might bridge other lectures and course activities. A widening of the space might serve a purpose in one lecture, while in the next lecture, the lecturer can elaborate on the perspectives and add more depth. This method of teaching corresponds to the concept of 'just-in-the-moment teaching' (Novak & Patterson, 2010), in which digital tools are used to provide insight into how students understand a topic before the lecture.

Processes for reflecting on perspectives might be viewed as a continuous process in which the lecturer can connect with students' perspectives and use them to calibrate students' discourse, moment to moment, in or across courses, and for students to review content after lectures and during other course activities.

An important aspect of helping students co-construct knowledge is to address the underlying conditions for this to succeed, i.e., they must be open with each other, curious about each other's opinions and perspectives, view each other as resources in the discussions and not as 'threats' and have respect for each other's opinions (Ness, 2016). We suggest that students become familiar with the tools before they use them during lectures, and students should understand the activities' purpose. To save valuable time, the links to the shared online whiteboard could be distributed to the students prior to the lecture.

4.3. Limitations and implications for research

This study was conducted in an authentic setting and has several limitations. First, our two cases are small. In case 1, we have only 15 discussions, and the conclusions from case 2 are based on four teachers using the collaborative whiteboard for the first time. Nevertheless, we argue that the data collected across the cases provide valuable insight into affordances of using such tools to open dialogue spaces in lectures and make informed choices on how to improve our teaching design. Another limitation is that we only used audio recordings to capture students' discussions. If we had video-recorded the lectures, we would have had better insights into how the processes played out. Future studies might also record each group discussion by using a head camera to video-record activities to capture how students navigate the shared space, how they approach other students' posts and how different tools (laptops, books, and paper) might influence the affordance of the whiteboard use.

In future designs, the students' discussions could be connected to their contributions to assess how ideas from the discussions are reflected in their posts. Video of the interface as the writing appears also would provide valuable information on how these tools feed into classroom dialogue because we would be able to identify how actions played out on the screen feed into peer discussions, as well as in the whole-group dialogue. The time dimensions also are critical: We suggest that the activities should be observed for a more extended period, e.g., a course, semester or year, to assess how points made earlier in the lecture, verbal or written, are picked up in discussions. The explorative level of creative knowledge processes in the student groups perhaps would vary over a semester. Research on multidisciplinary group members (Ness, 2016) showed that as the group members got to know each other over a period, they also seemed to become more comfortable and active in the group dialogues, enhancing their creativity as a group, as they learned from each other. We suggest research designs that allow for capturing changes in student contributions, both in voicing their opinions and writing down their arguments, as well as whole-class discussions that assess whether they change over time. How activities feed into other course activities (seminars, assignments and exams), how students work individually, how activities afford sharing and reflecting on perspectives in peer groups (among peers) and in whole-class discussions (among students and lecturers), as well as the dynamics among these activities, are worth further exploration.

Declaration of conflicting interests

The author(s) declare no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Funding

This research was funded by the Faculty of Psychology, University of Bergen, and is situated in the Digital learning Communities Research group.

Acknowledgements

We would like to thank the participating students, as well as Rune Krumsvik, Olga Dysthe, Jens Breivik, Cecilie Enquist Jensen, Kjetil Egelandsdal, Fride Haram Klykken, Trude Løvskard, Rob Grey, Eva Vass, and the two anonymous reviewers for valuable and inspiring feedback during different stages of the writing process.

References

- Aagard, H., Bowen, K., & Olesova, L. (2010). Hotseat: Opening the backchannel in large lectures. *Educause Quarterly*, 33(3), 2.
- Alexander, R. (2017). Developing dialogic teaching: Process, trial, outcomes. *Paper Presented at the 17th Biennial EARLI Conference*.
- Anderson, T., & Shattuck, J. (2012). Design-based research: A decade of progress in education research? *Educational Researcher*, 41(1), 16–25.
- Bakhtin, M. M., & Slaattelid, R. (1998). *Spørsmålet om talegenrane*. Bergen: Ariadne forlag.
- Bakhtin, M. M. (1984). In C. Emerson (Ed.). *Problems of dostoevsky's poetics*. Minneapolis, MN: University of Minnesota Press.
- Barab, S., & Squire, K. (2004). Design-based research: Putting a stake in the ground. *Journal of the Learning Sciences*, 13(1), 1–14.
- Baron, D., Bestbier, A., Case, J. M., & Collier-Reed, B. I. (2016). Investigating the effects of a backchannel on university classroom interactions: A mixed-method case study. *Computers & Education*, 94, 61–76.
- Bligh, D. A. (1998). *What's the use of lectures?* San Francisco: Intellect Books.
- Bloomfield, B. P., Latham, Y., & Vurdubakis, T. (2010). Bodies, technologies and action possibilities: When is an affordance? *Sociology*, 44(3), 415–433.
- Bry, F., & Pohl, A. Y. S. (2017). Large class teaching with Backstage. *Journal of Applied Research in Higher Education*, 9(1), 105–128.
- Cacchione, A. (2015). Creative use of Twitter for dynamic assessment in language learning classroom at the university. *Interaction Design and Architecture Journal*, 24, 145–161.
- Cavanagh, M. (2011). Students' experiences of active engagement through cooperative learning activities in lectures. *Active Learning in Higher Education*, 12(1), 23–33.
- Cooper, R., Chenail, R. J., & Fleming, S. (2012). A grounded theory of inductive qualitative research education: Results of a meta-data analysis. *Qualitative Report*, 17(52).
- Cooper, R., Fleischer, A., & Cotton, F. A. (2012). Building connections: An interpretative phenomenological analysis of qualitative research students' learning experiences. *Qualitative Report*, 17(17), 1.
- Dysthe, O. (2006). Bakhtin og Pedagogikk. *Norsk Pedagogisk Tidsskrift*, 90(06), 456–469.
- Ebner, M., Lienhardt, C., Rohs, M., & Meyer, I. (2010). Microblogs in Higher Education: A chance to facilitate informal and process-oriented learning? *Computers & Education*, 55(1), 92–100.
- Egelandsdal, K., & Krumsvik, R. J. (2017). Peer discussions and response technology: Short interventions, considerable gains. *Nordic Journal of Digital Literacy*, 12(01–02), 19–30.
- Elavsky, C. M., Mislán, C., & Elavsky, S. (2011). When talking less is more: Exploring outcomes of Twitter usage in the large-lecture hall. *Learning, Media and Technology*, 36(3), 215–233.
- Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafo, N., Jordt, H., et al. (2014). Active learning increases student performance in science, engineering and mathematics. *Proceedings of the National Academy of Sciences*, 111(23), 8410–8415.
- Friesen, N. (2011). The lecture as a transmedial pedagogical form: A historical analysis. *Educational Researcher*, 40(3), 95–102.
- Gao, F., Luo, T., & Zhang, K. (2012). Tweeting for learning: A critical analysis of research on microblogging in education published in 2008–2011. *British Journal of Educational Technology*, 43(5), 783–801.
- Guilford, J. P. (1967). *The nature of human intelligence*. New York: McGraw-Hill. Kim.
- Harrington, C., & Zakrajsek, T. (2017). *Dynamic lecturing: Research-based strategies to enhance lecture effectiveness*. Stylus Publishing, LLC.
- Jeong, Y. J., Ji, S., Lee, Y., Kwon, S., K. H., & Jeon, J. W. (2015). Smartphone response system using twitter to enable effective interaction and improve engagement in large classrooms. *IEEE Transactions on Education*, 58(2), 98–103.
- Kirschner, P. A., Martens, R. L., & Strijbos, J.-W. (2004). CSCL in higher education? A framework for designing multiple collaborative environments. In P. Dillenbourg, J.-W. Strijbos, P. A. Kirschner, & R. L. Martens (Eds.). *Computer-supported collaborative learning: Vol. 3. What we know about CSCL: And implementing it in Higher education* (pp. 3–29). Boston, MA: Kluwer Academic Publishers.
- Krumsvik, R. (2012). *Feedback clickers in plenary lectures: A new tool for formative assessment? Transformative approaches to new technologies and student diversity in futures oriented classrooms*. Dordrecht: Springer191–216.
- Krumsvik, R. J., & Ludvigsen, K. (2012). Formative E-assessment in plenary lectures. *Nordic Journal of Digital Literacy*, 7(01), 36–54.
- Littleton, K., & Mercer, N. (2013). *Interthinking: Putting talk to work*. London: Routledge.
- Ludvigsen, & Krumsvik (2019). *Behind the scenes: Unpacking student discussion in lectures* (in review).
- Ludvigsen, K., Krumsvik, R., & Furnes, B. (2015). Creating formative feedback spaces in large lectures. *Computers & Education*, 88, 48–63.
- Mazur, E. (1997). *Peer instruction*. Upper Saddle River, NJ: Prentice Hall9–18.
- McQueen, H. A., & McMullan, C. (2018). Quectures: Personalised constructive learning in lectures. *Active Learning in Higher Education*. <https://doi.org/10.1177/1469787418760325>.
- Ness, I. J. (2016). *The Room of Opportunity: Understanding how knowledge and ideas are constructed in multidisciplinary groups working with developing innovative ideas* PhD thesis. Norway: University of Bergen.
- Ness, I., & Søreide, G. (2014). The room of opportunity: Understanding phases of creative knowledge processes in innovation. *The Journal of Workplace Learning*, 26(8), 545–560.
- Neustifter, R., Kukkonen, T., Coulter, C., & Landry, S. (2016). Introducing backchannel technology into a large undergraduate course. *Canadian Journal of Learning and Technology*, 42(1), 1–22.
- Novak, G., & Patterson, E. (2010). An introduction to just-in-time-teaching. In S. Simkins, & M. Maier (Eds.). *Just-in-time teaching: across the disciplines, across the academy* (pp. 3–24). Sterling, VA: Stylus Publishing.
- Nygaard, L. (2015). *Writing for scholars: A practical guide to making sense & being heard*. Sage: CITY.
- Pohl, A. (2015). *Fostering awareness and collaboration in large-class lectures*. Doctoral dissertation Germany: Ludwig-Maximilian University of Munich.
- Pohl, A., Gehlen-Baum, V., & Bry, F. (2012). Enhancing the digital backchannel Backstage on the basis of a formative user study. *International Journal of Emerging Technologies in Learning (IJET)*, 7(1), 33–41.
- Rasmussen, I. (2016). *Microblogging as partner(s) in teacher-student dialogues*. *Educational technology and polycontextual bridging*. Rotterdam, Netherlands: SensePublishers63–82.
- Rasmussen, I., & Hagen, Å. (2015). Facilitating students' individual and collective knowledge construction through microblogs. *International Journal of Educational Research*, 72, 149–161.
- Roberts, D. (2017). Higher education lectures: From passive to active learning via imagery? *Active Learning in Higher Education*. <https://doi.org/10.1177/1469787417731198>.
- Ruismäki, H., Salomaa, R. L., & Ruokonen, I. (2015). Minerva Plaza: A new technology-rich learning environment. *Procedia-Social and Behavioural Sciences*, 171, 968–981.
- Sandström, N., Eriksson, R., Lonka, K., & Nenonen, S. (2016). Usability and affordances for inquiry-based learning in a blended learning environment. *Facilities*, 34(7/8), 433–449.
- Scott, P. H., Mortimer, E. F., & Aguiar, O. G. (2006). The tension between authoritative and dialogic discourse: A fundamental characteristic of meaning-making interactions in high school science lessons. *Science Education*, 90(4), 605–631.
- Sfard, A. (1998). On two metaphors for learning and the dangers of choosing just one. *Educational Researcher*, 27(2), 4–13.
- Stead, D. R. (2005). A review of the one-minute paper. *Active Learning in Higher Education*, 6(2), 118–131.
- Tashakkori, A., & Teddlie, C. (2003). *Handbook of mixed methods in social & behavioral research*. Thousand Oaks, Calif: SAGE Publications.
- Wegerif, R. (2013). *Dialogic: Education for the internet age*. London: Routledge.
- Wegerif, R., & Yang, Y. (2011). *Technology and dialogic space: Lessons from history and from the 'Argonaut' and 'Metafora' projects*. Long Papers312–318.
- Yates, K., Birks, M., Woods, C., & Hitchins, M. (2015). #Learning: The use of back channel technology in multi-campus nursing education. *Nurse Education Today*, 35(9), e65–e69.