Creating Spaces for Formative Feedback in Lectures

Understanding how use of educational technology can support formative assessment in lectures in higher education

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Thesis for the degree of Philosophiae Doctor (PhD)
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The etymological meaning of the word contingent is:
'dependent upon circumstances, not predictable with certainty'.[1]

Synonyms are:
Crossroads, possibilities, occurrences, eventuality, probability, turning point, juncture, opportunities, something that is unexpected, uncertainty.

The writing of this thesis has been a single long moment of contingency: hundreds of small moments that gave the project its direction. In all those moments, key people have challenged and shaped my thinking. First, I would like to thank the students who participated in the lectures, in the interviews and in the recorded peer-discussions. I have been listening to your conversations for hundreds of hours, and, like a fly on the wall, while listening I felt as if I were exploring a secret: the moment that happens when one asks students to turn to a neighbour and talk for a few minutes. Thank you for your trust and for allowing me to enter your worlds.

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[1] https://www.etymonline.com/word/contingent

Abstract

In this thesis, I examine how the use of educational technology has the potential to create moments of contingency and, through those moments, to transform the premises for formative assessment in lectures. The main research question was: What affordances are there in using participatory tools to support formative assessment in lectures?

In my research, I set out to explore an intervention in which a student response system (Turning Point) and a shared online whiteboard (Flinga) were used to support a formative assessment in the context of lectures in two university courses, one in psychology and one in teacher education. A design-based research approach (Barab & Squire, 2004) and a sequential mixed methods design (Ivankova, 2014) were used to explore these activities. The thesis is situated within a sociocultural perspective in which knowledge processes are viewed as social processes of co-construction of knowledge through dialogue (Wertsch, 1993).

In the three articles issuing from this research, I seek to examine technology-supported formative assessment in lectures from different angles and using different methods (Survey, interviews, recordings of peer discussions, analysis of material produced in lectures and focus group interviews with students and lecturers). In the first article (Ludvigsen, Krumsvik & Furnes, 2015), we used a sequential mixed-methods design to examine student perceptions and the use of feedback when student response systems were used in lectures for an undergraduate methods course. Most of the students valued the possibility of receiving feedback on their understanding during lectures to reflect on their learning, and they especially emphasised that explaining their thinking while discussing questions with their peers was valuable as a feedback space, in addition to feedback generated through the technology used and from the lecturer. Students mostly used feedback to 'check things up', 'discuss with peers' and 'focus reading'.

To examine what is achieved in these discussions, in the second article (Ludvigsen, Krumsvik, & Breivik, 2020), we explored the audio-recorded discussions in detail. We used the framework of exploratory talk (Littleton & Mercer, 2013) as a lens through which to examine patterns of talk in 87 peer discussions. In 68 of these discussions, students were able to create spaces in which to exchange and elaborate on each other's ideas and understanding of concepts. However, in the remaining cases, students engaged in superficial discussions, only referring to the number (the numbered alternatives in multiple-choice questions) without any further elaboration or justification. In the analysis of this material, we also found that in the majority of the discussions, students expressed uncertainty, or they were guessing. This led us to question the quality of the inferences to be drawn, based on the activities, and we argued for the use of tools that would allow complexity and questions to surface.

In the third article (Ludvigsen, Ness, & Timmis, 2019), we explored the affordances of using an online collaborative whiteboard to open, widen and deepen dialogic spaces in lectures, using interviews with students and lecturers, audio recordings of peer discussions and material produced in lectures as data sources. Based on two cases, we argued that this technology has the potential to transform the lecture into a 'dialog space' (Wegerif, 2013) for students to participate in activities in which they can connect new ideas to their previous knowledge and experiences. We argued that opening dialogical spaces provide students with rich possibilities for reflecting on concepts and developing arguments, providing feedback on students' understanding of course content.

Across the articles, we suggest that moments of contingency can be made explicit when using technology-supported formative assessment activities in lectures. When students share knowledge, questions and ideas, it becomes possible for them to become aware of each other's thinking in ways that would not otherwise be possible in a lecture environment. Students find this experience to be valuable in supporting their learning in lectures and in their coursework. This thesis contributes to educational research and practice by showing how the use of participatory tools supports students'

learning process in lectures, and how it influences students' work outside of the lectures. Second, it offers insight into the micro-processes that occur between students when they engage in peer discussions and reveals how the tools used facilitate interaction: between students in the group, across groups and between the students and the lecturer. Third, the thesis offers practical guidance on how to use participatory tools to facilitate formative assessment in large lectures.

List of publications

Article 1:

Ludvigsen, K., Krumsvik, R. & Furnes, B. (2015). Creating formative feedback spaces in large lectures. *Computers & Education,* 88, (C), 48–63. Doi: 10.1016/j.compedu.2015.04.002

Article 2:

Ludvigsen, K., Krumsvik, R. & Breivik, J. (2020). Behind the scenes: Unpacking peer discussions and critical reflections in lectures. *British Journal of Educational Technology (BJET).*

Article 3:

Ludvigsen, K., Ness, I. & Timmis, S. (2019). Writings on the wall: Bringing student voices to the lecture. *Thinking Skills and Creativity.* 34, 1-18. Doi: 10.1016/jtsc.2019.02.00

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Article 3: Writings on the wall: Bringing student voices to the lecture.

Appendices (In English and Norwegian)

Appendix A: Tools used in this project

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[2] All figures are made by the author. The cartoons are made by Tove Patterson

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1. Introduction

As I raised my hand to ask questions (...) I felt the fight/flight response just kicked into pulse. Anxiety. I thought, 'Lord! Now I am going to die'. It's a relatively unpleasant experience, of course. So, it does happen every time, even just thinking about asking questions (Ludvigsen, 2017, p. 1).

You do have a tendency to sit and think, 'It is just me'. It's really embarrassing. Sure, people have a tendency to do just that. This applies to almost everything. (Jon) (Krumsvik & Ludvigsen, 2012, p. 48).

Have you experienced this, yourself? You are in a lecture hall, and the lecturer asks; 'Does anyone have any questions?' The lecturer looks around. You have more questions than you would like to admit. You worry that you are the only one who has not understood. You are afraid to waste someone else's time. You nod. Or, you are the lecturer. You look around the auditorium, looking at the students' faces. 'Does anyone have any questions?' Quiet. A few students are nodding. You go on. The quotations above illustrate a common situation: students that are afraid to speak and structural barriers for lecturers and students to interact. Despite these barriers, and established knowledge about the value for students of being active participants in the learning process, lectures are the most common forum for teaching for undergraduate students in Norway.

In this thesis, I examine how the use of educational technology has the potential to create moments of contingency[3] and, through those moments, to transform the premises for formative assessment in lectures. The main research question was: What affordances are there in using participatory tools to support formative assessment in lectures?

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[3] Moments of contingency can thus be interpreted as activities that raise students' or teachers' awareness of the students' understanding, to adjust teaching and learning

This introduction presents the background and previous research on how participatory tools support formative assessment in lectures and the rationale for the study, then I introduce its aim, the research questions and the research design.

1.1 Background

The debate on the value of lectures has been polarised (French & Kennedy, 2017; Harrington & Zakrajsek, 2017). On one hand, common arguments for the pedagogical value of lectures are that they allow a structured approach to the subject or discipline; that they have the 'capacity to build a sustained and complex argument' over the course of a semester (French & Kennedy, 2017, p. 647); that they can stimulate and challenge students, that they promote an environment in which students have to engage to process ideas and perspectives; that they can support the creation of a 'sense of community' among students and lecturers and that they are 'cost-effective' (French & Kennedy, 2017). Also, lectures have been proven to be of high value for first year students (Harrington & Zakrajsek, 2017). On the other hand, they have been characterised as passive, ineffective and 'obsolete' (French & Kennedy, 2017, p. 639). The lecture has been questioned, criticised and under debate for decades, with particular criticism for being monological and for being a mode of transmission (Bloom, 1953; Friesen, 2011; Laurillard, 2013) supporting a superficial approach to learning (Cavanagh, 2011; Prosser & Trigwell, 2014). Lectures have also been criticised for failing to engage students and being subject to structural constraints, such as limited opportunities for students and teachers to interact (Cavanagh, 2011). These arguments illustrate that the value of the lecture is under dispute.

However, a lecture can take a multitude of forms. The format has shown to be dynamic; throughout history the lecture has changed its shape to adjust and include valued educational practices and tools (Friesen, 2011). Today, the lecture might represent a merging of various modalities, such as voices, text, pictures and videos, with a varying degree of interaction between students and the lecturer underpinned by

different pedagogies and shaped by the various disciplines in which the lecture plays out (Harrington & Zakrajsek, 2017). Additionally, lectures can be grouped into different genres. Regardless of genre and the activities chosen, a lecture may also be performed well or badly (Harrington & Zakrajsek, 2017). Also, the lecture as a genre is increasingly employed outside of formal education in popular culture, e.g., in podcasts and TED Talks. Telling stories is an activity grounded in human nature. For these reasons, it is difficult to argue for or against lectures as a general phenomenon.

French and Kennedy (2017) conclude that 'the lecture remains a valuable pedagogical tool that with improvements could offer even greater value to students. The capacity to improve lectures might depend upon a stronger recognition of their capacity to integrate active and interactive techniques' (p. 651). This view is reflected in a growing body of literature within higher education, emphasising the inclusion of student-centred activities to encourage students to construct their knowledge (Damşa et al., 2015; Harrington & Zakrajsek, 2017; Nerland et al, 2018; McQueen & McMillan, 2018). The literature on active learning shows an emphasis on activities that foster critical reflection – through activities in which students articulate their understanding, connect new ideas with their previous knowledge and experiences, and construct their knowledge in collaboration with their peers (Cavanagh et al., 2016; Lumpkin, Achen, & Dodd, 2015; Prince, 2004). The research literature that uses the term 'active learning' in the context of lectures uses it as a broad term, often poorly conceptualised and without a clear definition (Arthurs & Kreager, 2017). However, certain key characteristics are generally found: that such approaches allow students, through different activities, to reflect on, apply or test out their knowledge in authentic situations or cases collaborating with peers in a way that makes their thinking visible and allows various forms of feedback on the learning process. Examples include writing one-minute papers, making mind maps, pairing up to share thinking, reviewing and comparing notes, or collaborating with peers in activities such as peer- and whole-class discussions, inquiry-based learning or problem-based learning, often supported by some kind of digital tools (Arthurs & Kreager, 2017; Harrington &

Zakrajsek, 2017; Hyun, Ediger, & Lee, 2017; McMillan, Loads, & McQueen, 2018). There is a considerable body of empirical research showing that active approaches support students' learning in different ways (Cavanagh et al., 2016; Harrington & Zakrajsek, 2017; Hyun et al., 2017; Lumpkin et al., 2015; McMillan et al., 2018).

Along with this optimistic use of the term 'active learning', critical voices maintain that there is no such a thing as 'passive' learning and that therefore the divide between active and passive learning represents a false dichotomy (Dall'Alba & Bengtsen, 2019). Critics point out that one cannot necessarily assume a definite relationship between implementing active strategies and improving learning outcomes (Baeten, Kyndt, Struyven, & Dochy, 2010) and that active learning approaches take instructional time that could be used for other activities (Aljaloud, Gromik, Billingsley, & Kwan, 2015). Studies also find that some students question the value of student activities in lectures and prefer the transmission mode of learning (Clinton & Kelly, 2017; Lobo, 2017; McMillan et al., 2018; McQueen & McMillan, 2018). Nevertheless, this research has generated an increased focus on implementing student active learning approaches in practice, research and educational policy.

The white paper *Culture for Quality in Higher Education* (Ministry of Education and Research, 2017) advocates that when lectures are used, they should allow students to be active in constructing their own learning and that technology should be an integrated element if it serves a pedagogical purpose. The white paper emphasises that higher education institutions should work systematically to establish consistency between learning outcomes, teaching and learning activities and formative and summative assessment methods. This concern is reflected in the national strategy for digitalisation (2017–2021). The strategy (Ministry of Educational Research, 2018) asserts that digital tools have the potential to change or create new possibilities for learning and teaching in higher education. To realise this potential, teachers should be able to use digital tools to support active learning and to follow up and assess students as individuals and as a group. These documents display a trust in the use of

educational technology to change the premises for teaching, learning and assessment as a contribution to raising quality in higher education (HE).

Despite the promise of digitalisation, and the elevated expectations higher education institutions have of the potential for digital tools to raise quality, reflection on how the use of technology might change practice is less visible. A recent report, the *Status report on Norwegian Higher Education* (2018), concludes that institutions of higher education do not exploit the opportunities offered by digital tools, and that students only experience digital tools in their study programs to a limited extent. However, a note from Norgesuniversitetet (2018) on the use of digital tools to support active learning in higher education finds examples that institutions use digital tools in a way that exceeds and transforms educational practices. However, the report stresses the need for more research on what characterises high quality for students within active approaches to learning.

Expectations on how digital tools should raise quality in teaching and learning is also high within the institutions of higher education. Aasgaard et al. (2018) found that these expectations are reflected in an analysis of consultation statements submitted by these institutions for the white paper *Culture for Quality in Higher Education* (Ministry of Education and Research, 2017). The consulting hearings explicitly connect the use of educational technology to quality in teaching and learning, often by referring back to policy and without situating these claims in relation to pedagogy or elaborating on how the tools actually might change practices: 'reflection on how digitalization changes premises for learning, knowledge and teaching, is nearly absent' (Aagaard, Lund, Lanestedt, Ramberg, & Swanberg, 2018, p. 8). This situation is summarised in the report as follows:

> Because there is still uncertainty about to which digital practices promote educational quality and how, there is a need to further develop research-based knowledge in the field. Strategic exploration of digital practices adapted to local conditions and disciplines will contribute. Specifically, more knowledge is needed on how different types of tasks, work types, digital

resources, and not least forms of assessment are best designed to ensure quality (Aagaard et al., 2018, p. 12, *my translation*).

This passage shows that the relationship between digital tools and how they could be used to raise quality in teaching and learning is unclear. It also indicates that the term *educational technology* is understood quite broadly which is a common view: 'Even the most rudimentary definitions of the term 'technology' indicate that its meaning extends far beyond artefacts and devices to include processes, methods, means and applied knowledge' (Friesen, 2013), or as stated by Ross, Morrison, Lowther, (2010): 'educational technology is not a homogeneous "intervention" but a broad variety of modalities, tools, and strategies for learning'. Its effectiveness, therefore, depends on how well it helps teachers and students achieve the desired instructional goals' (Ross et al. 2010, p. 19). These considerations are also reflected in a large meta-analysis addressing what has been learned in 40 years of research into the ways computer technology use affect student achievement in formal face-to-face classrooms, compared to classrooms that do not use these technologies. Tamim, Bernard, Borokhovski, Abrami and Schmid (2011) conclude:

> Thus, it is arguable that it is aspects of the goals of instruction, pedagogy, teacher effectiveness, subject matter, age level, fidelity of technology implementation, and possibly other factors that may represent more powerful influences on effect sizes than the nature of the technology intervention. It is incumbent on future researchers and primary meta-analyses to help sort out these nuances, so that computers will be used as effectively as possible to support the aims of instruction … we feel that we are at a place where a shift from technology versus no technology studies to more nuanced studies comparing different conditions (Tamim, Bernard, Borokhovski, Abrami & Schmid, 2011, p. 17).

Reviews on how educational technology influences teaching and learning in higher education find that technology often is used to fit into conventional practices by replicating them or extending them rather than taking the opportunity to challenge and transform them (Henderson, Selwyn, & Aston, 2017; Kirkwood & Price, 2014; Lillejord, Børte, Nesje, & Ruud, 2018; Pimmer, Mateescu, & Gröhbiel, 2016). This is summarised by Henderson and colleagues: 'Digital technologies are clearly not

"transforming" the nature of university teaching and learning, or even substantially disrupting the student experience' (Henderson et al., 2017, p. 1578). These findings align with a review by Pimmer and colleagues, which also argues that the creative potential of educational technology is not being utilised (Pimmer et al., 2016). Drawing on these sources, it seems likely that the potential of using digital tools to transform and challenge educational practices is not being utilised. In addition, that there is a need to examine ways in which different digital tools, in different context and conditions, influence quality in teaching and learning. This, then, is the landscape in which this thesis is situated.

1.2 The current project

In this research project I set out to explore activities in which a student response system (Turning Point) and a shared online whiteboard (Flinga) were used to support formative assessment in the context of lectures in two university modules, one in psychology (2012–2016) and another in teacher education (2017). The tools and how they are used are further explained in each of the three articles and in Appendix A. In the following, these tools will be referred to as either 'clickers', 'student response systems' or the 'online collaborative whiteboard'. The term 'participatory tools' comprehends a variety of such tools. Participatory tools are often used to assess prior thinking, provoke new thought, elicit misconceptions, stimulate whole-class or small-group discussions, review course material, apply knowledge in different contexts, support self-assessment and guide problem solving (Beatty & Gerace, 2009).

To apply participatory tools implies a movement from an understanding of the lecture as a space in which lecturers talk and students listen, towards promoting an environment that includes activities where students can participate as they connect new ideas to their previous knowledge and experiences, visualising knowledge in different modes. How different participatory tools can support student learning in the context of lectures has been extensively covered in the two last decades. In the

following section, I provide an overview of research on the use of participatory tools to support formative assessment.

1.3 Research on participatory tools to support formative assessment – an overview

This section presents an overview of research literature on the use of participatory tools to support formative assessment in lectures. The object is to describe what characterises this field of research within which my work is situated, to provide an overview of its main arguments, identify discussions, and highlight areas for future research (Grant & Booth, 2009). For this overview, I have used a triangulation approach (Onwuegbuzie & Frels, 2016), that included literature search for peer-reviewed articles in various databases, including Eric and Web of Science. Search strings (Appendix B) were developed to identify relevant research in the period (2014–2019).

Additionally, I have included articles from my personal archive, collected from 2011–2019. This archive includes articles found in references lists and literature reviews and also 'grey literature', theses and reports; articles provided by supervisors, colleagues and reviewers; previous publications from this field of study (Krumsvik & Ludvigsen, 2012, Ludvigsen & Egelandsdal, 2016) and a recent literature review on how student response systems support formative feedback in lecture (Egelandsdal, Ludvigsen & Ness, 2019). Articles in which the object of study was to support formative assessment, feedback and interaction in lectures are included in this overview. I excluded research articles addressing feedback and interaction in online courses and adult education. In the following, I first provide the characteristics of the field, affecting the rationale for this project. Second, I present key findings, including what is agreed upon by researchers and also some questions that are under debate. Third, I show the relevance of the choices regarding research questions and methodology approaches in this project.

Characteristics of the research literature

Student response systems are adapted within different disciplines and across various contexts; they are most often used in the natural sciences (Bruff, 2011). Typically, a particular technology is applied to overcome constraints within the context of the lecture, such as the large number of students or other barriers to interaction, and to support engagement with course content through student activity (Egelandsdal et al, 2019). Participatory tools are also used to address pedagogical or didactical challenges connected to the discipline in which the activities are embedded. Another characteristic is that the technologies to support such activities are moving targets: the focus of the attention within the research literature is on the newest developments, as such literature ranges from using text messages, through handheld student response systems, including social media backchannels, to applications tailored to support interaction in educational settings (Baron, Bestbier, Case, & Collier-Reed, 2016). Most of the literature draws conclusions based on self-reported data, such as surveys or interviews, or uses a comparative design to determine if one activity is better than another using quasi-experimental pre-post design. There is a lack of studies using ethnographic designs (Crompton & Burke, 2018; De Gagne, 2011; Pimmer et al., 2016). This trend reflects the general picture of research on higher education: surveys and interviews are among the most frequently used methods, while ethnographical approaches are underrepresented (Haggis, 2009; Tight, 2013). Such studies are essential because there might be a gap between how activities play out and the lecturers' and students' perceptions of them (Nielsen, Hansen & Stav, 2016).

In line with research on educational technology in general (Crompton & Burke, 2018; Friesen, 2013; Hew, Lan, Tang, Jia, & Lo, 2019), there often is a lack of pedagogical theory underpinning studies on the use of participatory tools in lectures (Chien, Chang, & Chang, 2016; Han, 2014; Shapiro et al, 2017). Using a pedagogical framework is important to be able to assert how the use of digital tools can raise quality in education.

How participatory tools support learning: Key findings.

In this section, I present key findings from research on how the use of student response systems support student learning in lectures, drawn from literature reviews (Aljaloud et al., 2015; Boscardin & Penuel, 2012; Castillo-Manzano, Castro-Nuño, López-Valpuesta, Sanz-Díaz, & Yñiguez, 2016; Egelandsdal, Ludvigsen, & Ness, 2019; Good, 2013; Kay & LeSage, 2009; Keough, 2012; Liu et al., 2014; MacArthur & Jones, 2008; van der Kleij & Adie, 2018). The most consistent finding across these reviews is that students in general report positive attitudes towards the use of participatory tools in lectures. Furthermore, they indicate that the use of such tools makes the lecture more enjoyable, increases engagement and attention and also stimulates and increases interaction. Additionally, it supports formative assessment and allows a contingent approach to teaching based on feedback.

Critical issues raised in these reviews are: that these activities take time that could have been used for other activities, that less content is covered, and that it is demanding for the lecturer to create good questions (Aljaloud et al., 2015). Students are often critical if the technology is used for a summative purpose or to check trivial knowledge (Good, 2013; Kay & LeSage, 2009). It is also noted in the literature that it might be challenging for lecturers to follow up student responses in a formative way (Kay & LeSage, 2009), as well as technical challenges (Aljaloud et al., 2015).

An ample body of studies attempts to measure how using such participatory tools may influence student learning outcomes. This literature reports mixed findings. However, four meta-studies (Castillo-Manzano et al., 2016; Chien et al., 2016; Hunsu, Adesope, & Bayly, 2016; Nelson, Hartling, Campbell, & Oswald, 2012) conclude that the use of student response systems supports student learning in terms of various measures of learning outcomes as well as exam scores. However, the literature also acknowledges that the reasons for these findings are less well understood. Chien et al. (2016) identify opportunities for students to explain themselves, possibilities for feedback, the testing effect and the value of answering questions to be among the potential reasons that could account for the positive findings. The meta-analysis by Hunsu et al. (2016)

shows that the positive outcome of clicker interventions is moderated by how they are used and the context in which they are used. In a review concerning the use of student response systems and learning outcomes in health education, Nelson et al. (2012) found that the use of student response systems improves learning outcomes, however, this improvement was found to be greater for interventions in traditional, non-interactive lectures than when introduced in lectures already using other active learning approaches (Nelson et al., 2012). Such findings suggest that positive learning outcomes may be achieved through increased interaction, not necessarily through technology per se (Anthis, 2011; Liu et al., 2014). Even though meta-analysis finds such tools to support student learning outcomes; there is an ongoing debate regarding the reason for such findings.

How participatory tools support formative assessment and interaction
A growing body of empirical research suggests that the use of student response systems in lectures can enhance both the quality and the quantity of peer discussions (Chien et al., 2016; Egelandsdal & Krumsvik, 2018; Mazur, 1999; Smith et al., 2009). When they make their thinking explicit in peer discussions, students will be exposed to different ways of thinking, which can help them become aware of their own understanding and make better-informed decisions about their learning process (Chien et al, 2016; Dawson et al., 2019). Again, the question how educational tools support interaction in lectures is seldom explored using ethnographic approaches. Chien et al. (2016) therefore argue that peer discussion should be examined from a social aspect: 'Future studies are needed to investigate how students interact with peers within the context of clicker integrated instruction. Research on this line will also be helpful to understand how the use of student response systems meditate the process and outcome of peer discussion' (Chien et al., 2016, p. 15).

There is a consensus in the literature that the use of student response systems supports formative assessment and feedback processes, thereby supporting a contingent teaching approach in lectures (Aljaloud et al., 2015; Chien et al., 2016; Dawson et al., 2019; Pimmer et al., 2016). These systems provide opportunities for students to

receive feedback about their understanding of course content (Chien et al., 2016; Dunn, Richardson, Oprescu, & McDonald, 2013; Hunsu et al., 2016; Pagano & Paucar-Caceres, 2013). Furthermore, they provide lecturers with a more sensitive awareness of their students' understanding of the course material, which can be used to adjust teaching (Egelandsdal & Krumsvik, 2019; Fies & Marshall, 2006; Reimer, Nili, Nguyen, Warschauer, & Domina, 2016). Often it is assumed a straightforward relation between the collection of answers and the process of providing feedback, as these quotes illustrates:

> One of the key benefits of using an ARS is that instruction can be modified based on student feedback gathered throughout a class (…) If feedback from a majority of students indicates that confusion or misconceptions are evident, an experienced instructor can offer alternative explanations of the concepts in question (Kay Le Sage, 2009, p. 822).

> When the students evaluate their own performance and identify areas for improvement, they take steps that improve their academic performance (Aljaloud, 2015, p. 319).

> Overall, the findings indicate students perceive that clickers provide a high level of feedback (Keough, 2012, 828).

Research on peer discussions based on recordings also shows that votes do not necessarily offer an accurate picture of student understanding (James & Willoughby, 2011; Nielsen, Hansen-Nygård, & Stav, 2012; Wood, Galloway, Hardy, & Sinclair, 2014). This can lead to misleading feedback, both for students and for lecturers.

To get a more sophisticated picture of students' ideas, different tools for collecting qualitative data (text) are available. The process of sharing ideas in a written post supports reflective thinking, collaboration and the co-creation of knowledge (Baron et al., 2016; Gao, Luo, & Zhang, 2012; Neustifter, Kukkonen, Coulter, & Landry, 2016; Seglem & Haling, 2018; Yates, Birks, Woods, & Hitchins, 2015; Rasmussen, 2016; Sandström, Eriksson, Lonka, & Nenonen, 2016), increased understanding of course content (Kim et al., 2015) and opportunities for students to get feedback on their understanding (Baron et al., 2016; Cacchione, 2015; Kim et al., 2015; Yates et al.,

2015). By reading other students' questions, a student might become aware of the challenges others face which they may share (Baron et al., 2016; Pohl, 2015). This provides a safe process-oriented learning atmosphere (Elavsky, Mislan, & Elavsky, 2011; Yates et al., 2015), which is a key in supporting a formative feedback practice.

Participatory tools allow for different possibilities for students to articulate their thinking and thus to enable certain types of inferences to be drawn. Applying such tools can therefore allow students – together or alone – to demonstrate their understanding of knowledge, phenomena and ideas by presenting them in various ways (Pachler, Daly, Mor, & Mellar, 2010). No technology is in itself formative, but can be used in a *formative way*: 'It is the learners and teachers as human actors who ultimately determine the formative effects of engaging with technologies, but technologies can shape the potential for this to happen' (Pachler et al., 2009, p. 21). The formative aspect lies in taking advantage of technological opportunities to make the reflections of the students visible (Pachler et al., 2010) through interaction and problem solving (Egelandsdal et al, 2019).

Despite the large body of literature on how student response systems support formative assessment, Egelandsdal and Krumsvik (2019), found that even though the majority of the students experienced clicker lectures as making them more aware of their understanding of the material, only half of the students reported using this feedback in their coursework. A study from Krumsvik and Ludvigsen (2012) found that use of the student response system increased students' awareness of their own understanding, however, they offered few examples of how the activities in the lectures influenced subsequent course work. Other studies show that the use of student response systems has little influence on preparation for class or work in other areas (Boyle & Nicol, 2003; MacGeorge et al., 2008).

Understanding how tools shape feedback practices and how and to what extent students make use of the feedback such activities provide is crucial for research into feedback in higher education in general (Johnson, 2012; Bound & Carless, 2018;

Evans, 2013). How students make sense of and utilise the feedback provided in such activities is a vital issue when examining the potential for participatory tools to support formative assessment (Egelandsdal et al., 2019; Fluckiger, Vigil, Pasco, & Danielson, 2010; Krumsvik & Ludvigsen, 2012; Nicol, Thomson, & Breslin, 2014).

This overview shows that clicker interventions can play a vital role in promoting a climate for formative assessment. They can provide a space for students to reflect, which invites them to engage in self-assessment. Furthermore, the activities offer room for peers to share each other's ideas and co-construct knowledge. Most importantly, they can serve as a catalyst for lecturer and student interaction, and allow a contingent teaching approach (Egelandsdal et al., 2019). This overview of previous research has identified three areas that are critical for research on this topic: First, the need to explore how these in-lecture activities support students in their work outside of the lecture, second, the need to address how the tools support learning by exploring the micro-processes occurring during the activities and third, the need for situating the research into a theoretical framework. The next section presents the aim and the research questions of the present study.

1.4 Aim and Research Questions

Formative assessment is a process of engaging students in activities that make students' understanding visible so that students and teachers can use this information to shape learning and teaching activities (Black & Wiliam, 2009). When using technology to support formative assessment practices, questions to address include: to what extent and how can the technology support the lecturer to create learning tasks that provide insight into students' thinking? Also, in what ways can students be given opportunities to share their thinking and understanding with each other and with the teacher? What kind of information about students' thinking is made visible by these activities and for whom, and what opportunities do students and teachers have to draw inferences based on these activities so that they can be used to shape teaching and

learning? (Furtak, Glasser, & Wolfe, 2016). Examining the micro processes occurring during the activities to find out what is achieved in them is important for being able to recognise the potential for discussion-based activities in lectures and is vital for being able to make informed decisions on how to use participatory tools to support the processes of teaching and learning.

The aim of this thesis is to examine how the use of educational technology has the potential to create moments of contingency and, through those moments, transform the premises for formative assessment in lectures[4].The overarching research question for this thesis is: What affordances are there in using participatory tools to support formative assessment in lectures? The question is specific to formative assessment and addresses how the use of technology can create spaces for feedback in the context of the lectures and how students perceive these activities in relation to their learning. The research questions from the three articles developed as the study progressed, as elaborated in the methods section below. The guiding questions for each of the articles are as follows:

- How do students in large lectures experience the feedback from these learning activities? How do the students make use of this feedback to support the learning activities they are engaged in? (Study 1)

- What characterises peer discussions when student response systems are used to support peer discussions in lectures? (Study 2)

- What affordances are there in using a shared collaborative whiteboard to support *opening*, *widening* and *deepening* dialogical spaces in lectures? (Study 3)

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[4] In this thesis, the term 'lectures' is used to refer to both medium-sized classrooms, with 40-100 students, and large classrooms, with 100-150 students (Denker, 2013).

These overarching research questions are related to the articles in a coherent way, with three studies seeking to examine the overall research questions from different angles and using different methods. The first study used a survey and an interview to examine how the use of a student response system supported a formative feedback practice in lectures. Findings from this study informed the decision to record and analyse discussions in the second study. Again, findings from this study were the point of departure for our decision to examine the use of shared online whiteboards to open dialogical spaces in the third study. The figure below (Figure 1) illustrates how the studies are connected:

STUDY 1	STUDY 2	STUDY 3
'Creating formative feedback spaces in large lectures'	**'Behind the scenes: Unpacking peer discussions and critical reflections in lectures'**	**'Writings on the wall: How the use of technology can open dialogical spaces in lectures'**
The article explores student perceptions and the use of feedback in lectures.	*The article explores the quality of technology-supported peer discussions in lectures.*	*The article discusses the use of online collaborative whiteboards to provide dialogue in lectures.*

Figure 1. How the studies are connected.

Together, the data and analysis allow me to discuss affordances for using participatory tools to create moments of contingency in lectures. Based on the findings from these three articles, this thesis contributes to educational research and practice by showing how the use of student response systems can influence students' work outside of the lecture. Second, it offers an insight into the micro-processes that occur between students when engaging in peer discussions, and how the tools used facilitate interaction between students in the group, across groups and between the students and

the lecturer. Third, it offers practical guidance on how to facilitate formative assessment in large lectures. The study thereby addresses the gaps in research that were introduced in the overview of previous research. In the following section, I will describe the overall research design and provide an overview of the scope of the three articles and the methods employed in each.

1.5 Teaching design

In the three articles, the lecturers used different variations of a teaching design referred to as 'video case, discussion, voting' (Ludvigsen, Krumsvik & Furnes, 2015, p. 51), 'video case, discussions, voting and writing' (Ludvigsen, Krumsvik & Breivik, 2000, p. 9), and 'discuss and write' (Ludvigsen, Ness & Timmis, 2019, p. 7). These different approaches are illustrated in Figures 2, 3 and 4. An example of the online collaborative whiteboard is illustrated in appendix C.
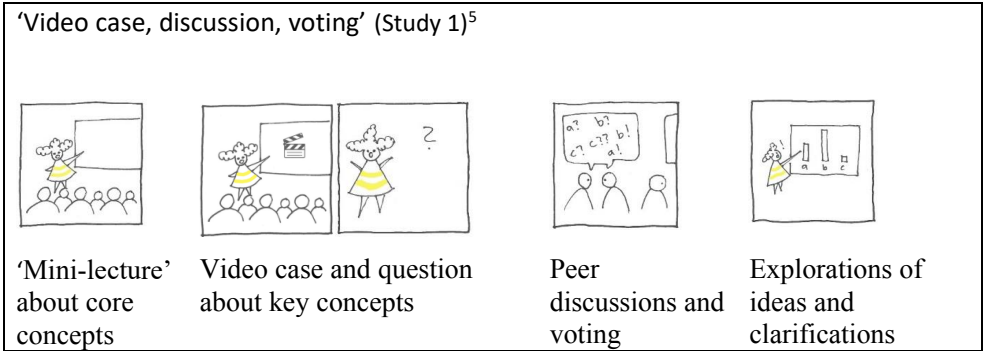
Figure 2. The teaching design for Study 1.

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[5] This design was developed by Rune Krumsvik

'Video case, discussions, voting and writing' [6](Study 2 and Study 3)

| 'Mini-lecture' about core concepts | Question about key concepts | Peer discussions and voting | Explorations of ideas and clarifications | Questions for peer discussions | Exploration of ideas shared in Flinga |
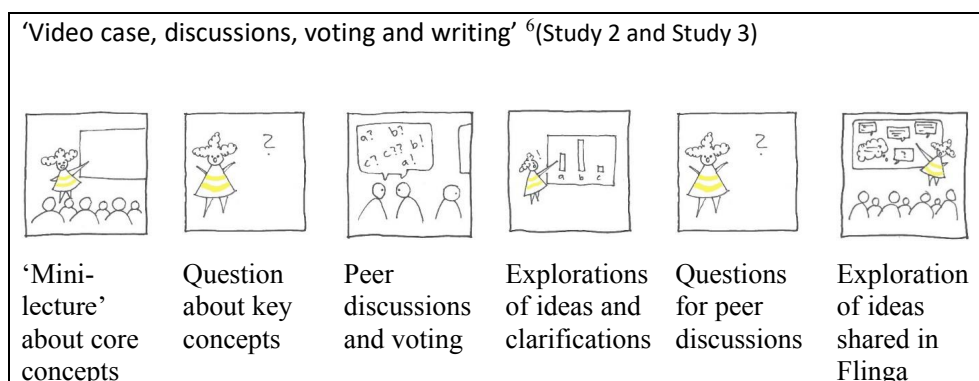
Figure 3. The teaching design for Study 2 and Study 3.

'Discuss and write'[7] (Study 3)

| «Mini-lecture» about core concepts | Questions for peer discussions | Exploration of ideas shared in Flinga |
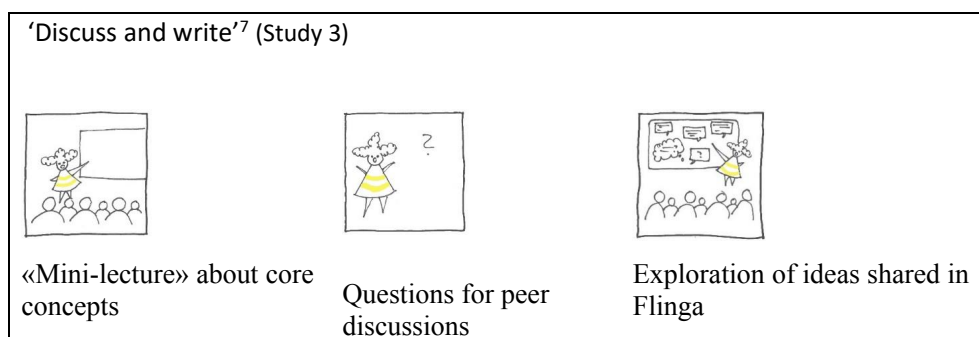
Figure 4. The teaching design for Study 3.

1.6 Research design

This thesis is part of a larger research project entitled 'Formative Assessment in Higher Education'[8], situated within the Digital Learning Communities (DLC) Research Group[9] in the Department of Education at the University of Bergen.

In this project, a particular focus has been placed on exploring how discussion-based activities support formative feedback in lectures and the role of technology in

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[6] This design was developed and examined as a part of this PhD-project
[7] This design was developed and examined as a part of this PhD-project
[8] https://app.cristin.no/projects/show.jsf?id=516274
[9] https://www.uib.no/fg/dlc

promoting interaction between students and lecturers (Egelandsdal, 2018; Egelandsdal et al., 2019; Egelandsdal & Krumsvik, 2017; Egelandsdal & Krumsvik, 2017; Egelandsdal & Krumsvik, 2019: Krumsvik & Ludvigsen, 2013; Krumsvik, 2012; Krumsvik & Ludvigsen, 2012; Ludvigsen, & Egelandsdal, 2016; Ludvigsen, Krumsvik, & Furnes, 2015; Ludvigsen et al., 2020; Ludvigsen et al., 2019; Krumsvik, 2012).

To address the study's research questions and to explore these interventions, we have been inspired by design-based research in creating our research design (Barb & Squire, 2004). Sequential mixed methods are employed as a methodological framework (Ivankova, 2014; Johnson, Onwuegbuzie, & Turner, 2007). This design is chosen to address the nature of the research questions. Different approaches to support formative assessment allow for different affordances of different digital tools to be discovered. Originally, the concept of affordance was used to describe an object and how a subject relates to it. Gibson (1977) argues that an affordance is both real and relational; the affordance exists, regardless of the need or ability to put it to use. Participatory tools are flexible, and they can be used for an array of purposes. The idea of an affordance 'presupposes' a relation between a certain tool and its purpose in a specific context (Cave, 2016, p. 72). A gap might exist between the theoretical potential made available by using a particular technology, the extent of that potential that a teacher or lecturer can identify and understand, the extent to which teachers can capitalise on and try to realise that potential in their teaching and the reality of how the technology and the activities developed to engage with it play out among students, considering both intended and unintended outcomes (Kirschner, Martens & Strijbos, 2004). While the concept of affordances is broad, it is also a narrow concept in that affordances exist in relation to a specified purpose. Cave (2016) explains it in this way: 'that is a thing that adumbrated a purpose or indefinite set of purposes; only a particular use and a particular context can select the *relevant* purpose' (Cave, 2016, p. 51). In this sense they are relative to the values, purposes or rationales for using them, as well as the lecturer's knowledge, skills and experiences (Dohn, 2009). What is more, any

affordance is dependent on the participants in the situation: in this case, how dynamic learning activities play out between lecturers and students. This implies that an affordance cannot be established in advance; rather, they emerge within the context in which they are embedded (Dohn, 2009; Bloomfield, 2010).

Using a sequential mixed methods approach, including data collection using surveys, interviews, audio recordings of peer discussions as well as material produced in lectures, allows for thick description and encourages complexity to surface (Barab & Squire, 2004). This allows the affordances of using participatory tools to support formative assessment in lectures to be explored, 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 this introduction, I have provided the background for this project, its rationale, aim, research questions and research design. The table below (Table 1) offers a summary of the aim, research questions, data collection methods and theoretical framework applied in the three articles. In the section that follows, the analytical framework relating to formative assessment and feedback, exploratory talk and dialogic spaces will be introduced.

	Study 1	Study 2	Study 3
Aim	The aim of the thesis is to examine how the use of educational technology has the potential to create moments of contingency and, through those moments, to transform the premises for formative assessment in lectures.		
Research questions	What affordances are there in using participatory tools to support formative assessment in lectures?		
Title	**'Creating formative feedback spaces in large lectures'**	**'Behind the scenes: Unpacking peer discussions and critical reflections in lectures'**	**'Writings on the wall: How the use of technology can open dialogical spaces in lectures'**.
Journal	*Computers & Education*	*British Journal of Educational Technology*	*Thinking Skills and Creativity*
Research question	How do students in large lectures experience feedback? How do the students make use of the feedback to support the learning activities they are engaged in?	What characterises peer discussions when student response systems are used to support peer discussions in lectures?	What affordances are there in using an online collaborative whiteboard to support *opening*, *widening* and *deepening* dialogical spaces in lectures? How do teachers perceive learning opportunities in these spaces?
Data	• Survey (n=148) • Individual qualitative interviews (n=6)	• Audio recordings of 87 peer discussions	• Work produced in lectures • Recordings of 15 peer discussions • Focus group interview with students • Focus group interview with teachers
Theoretical framework	Formative assessment Feedback Self-regulated learning	Exploratory talk	Dialogical space Creative knowledge processes
Findings	Findings illustrated various ways students applied feedback in their coursework. Student emphasised discussing questions with their peers as offering valuable spaces for them to get feedback on their understanding.	In 68 of the 87 discussions, students were able to create spaces in which to exchange and elaborate on each other's ideas. In one-third of the discussions, students' reasoning was less visible.	Opening dialogical spaces provides students with rich opportunities to reflect on concepts and to develop arguments. Students bring a range of perspectives and experiences to the lecture, thus widening the space. For lecturers, the critical objective was to orchestrate a dialogue with students.

Table 1. *Overview of the PhD project*

2. Theory

The aim of this chapter is to elaborate further on the theories used in each of the three studies. The chapter is in two parts. In the first part, the concepts of 'moment of contingency',' formative assessment' (Black & Wiliam, 2009) and 'feedback' (Hattie & Timperley, 2007) are introduced, and the literature is drawn on to describe the characteristics of high-quality feedback practices in higher education. In the second part, I present theories of dialogic teaching, and elaborate on how the concepts of 'exploratory talk' (Littleton & Mercer, 2013), and 'dialogic space' as is interpreted by Wegerif (2007; 2010; 2013). The chapter thus provides a conceptual framework to discuss the research question introduced.

2.1 Formative assessment and feedback

Moment of contingency

How formative assessment can stimulate learning is a growing field of research. Assessment practice has seen two changes. First, there has been a shift in focus from assessment at the end of a learning process, assessment of learning, to an activity which takes place during the course, assessment for learning (Zeng, Huang, Yu, & Chen, 2018). Second, assessment has also changed from an activity primarily exercised by the teacher to one in which students and peers are key actors in the process (Boud & Molloy, 2013). Black and Wiliam (2009) defined formative assessment as a process in which: 'evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was elicited' (Black & Wiliam, 2009, p. 9). Formative assessment might be continuous and synchronous, embedded in the learning activities within seminars or lectures, or asynchronous, as written comments on assignments (Baird, Andrich, Hopfenbeck, & Stobart, 2017). The basic principles of implementing formative assessment are to

create activities to make student learning visible and that information from these activities can be used by students and lecturers to shape learning and teaching (Black & Wiliam, 2018). Black and Wiliam (2009) refer to those activities as moment of contingency. The etymological meaning of the word contingency is: 'dependent upon circumstances, not predictable with certainty'.[10] Synonyms are: Crossroads, possibilities, occurrences, eventuality, probability, turning point, juncture, opportunities, something that is unexpected, uncertainty. A premise for creating moments of contingency is an uncertainty concerning what the next step in the instructions would be: '*a point in the instructional sequence where the instructor can change direction in light of evidence about the students' achievement, thus allowing her to adapt the instruction to better meet their learning needs*' (Wiliam, 2006, p. 285). Moments of contingency can thus be interpreted as activities that raise students' or teachers' awareness of the students' understanding, to adjust teaching and learning. Moments of contingency might be planned or occurring spontaneously. To create, recognise and capitalise on those moments as an integrated part of learning activities helps teachers adjust their teaching to the needs of their students and help students to take decisions on their learning process. Also, the teacher and students should be able to draw inferences based on the formative assessment activities. Different activities allow different types of knowledge to be visible, both qualitative and quantitative, and thus can extend or put limits on the inferences that can be drawn (Furtak et al, 2016). Inferences are based on what we can observe, and thus they are characterised by uncertainty (Bennett, 2011; Black & Wiliam, 2018; Furtak et al, 2016).

Feedback

Feedback forms the core of formative assessment and has been shown to be an important factor in student learning (Black & Wiliam, 1998; Hattie & Timperley, 2007; Shute, 2008). The purpose of feedback is to bridge the gap between current and desired performance (Sadler, 1989). For effective feedback to occur, students need to

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[10] https://www.etymonline.com/word/contingent

know the standard or goals for their learning, compare the goals with their own work and take action to close the gap (Sadler, 1989). The role of feedback in 'closing the learning gap' is frequently suggested in the literature. However, this has also been an issue for critique (Egelandsdal & Riese, 2020, Ninomiya; 2016; Torrance, 2012; Moeed, 2015) because it suggests a linear picture of the learning processes and represents a teacher-centered transmission view of learning (Egelandsdal & Riese, 2020). Hattie & Timperley (2007) define feedback as:

> ...information provided by an agent (e.g., teacher, peer, book, parent, self, experience) regarding aspects of one's performance or understanding. A teacher or parent can provide corrective information, a peer can provide an alternative strategy, a book can provide information to clarify ideas, a parent can provide encouragement, and a learner can look up the answer to evaluate the correctness of a response. Feedback thus is a "consequence" of performance. (p. 81).

Hattie and Timperley (2007) posed the feedback-related questions, 'Where am I going?', 'How am I doing?' and 'Where to go next?'. They also argue that feedback has an influence on four levels (p. 87). First, feedback addresses the task level (often corrective of performance and addressed to individuals or to groups). Second, feedback addresses the process level (including cues on the learning process or strategies needed to improve performance). Third, feedback addresses the self-regulation level (being able to monitor and regulate one's own learning process, including a student's ability to 'create internal feedback and to self-assess' (p. 95) and a student's role in creating feedback and seeking help). Lastly, feedback addresses the self, referring to evaluation of the student as a person. The purpose of formative assessment and feedback is to support self-regulated learning (Black & Wiliam, 2009; Clark, 2012; Hattie & Timperley, 2007). Self-regulated learning refers to 'a process whereby learners set goals for their learning and monitor, regulate and control the actions, cognition and motivation needed to achieve them' (Pintrich and Zusho, 2002, p. 64). The relation between the theories on feedback and self-regulation are discussed

by Winnie and Butler (1995) and Black and Wiliam (2009) as an interplay between external and internal feedback:

> feedback is information with which a learner can confirm, add to, overwrite, tune, or restructure information in memory, whether that information is domain knowledge, meta-cognitive knowledge, beliefs about self and tasks, or cognitive tactics and strategies (Winne & Butler, 1995, p. 5740).

> A formative interaction is one in which an interactive situation influences cognition, it is an interaction between external feedback and internal production by the individual learner. This involves looking at the three aspects, the external, the internal, and their interactions (Black and Wiliam, 2009, p. 24).

The phases within the self-regulated learning model posed by Zimmerman and Labuhn (2012) coincide with Hattie and Timperley's (2007) questions mentioned above and help to explain how formative assessment supports self-regulated learning (Andrade, 2010; Clark, 2012).

Although there is considerable evidence that feedback supports learning (Hattie & Timperley, 2007) and that students value feedback, the literature also recognises that feedback can influence learning in a negative way (Hattie & Timperley, 2007; Kluger & DeNisi, 1998). Experiences with feedback is among the areas where students are dissatisfied (Price, Handley, Millar, & O'donovan, 2010). Students often struggle to make sense of the feedback they receive; this phenomenon is referred to as the 'feedback gap' (Evans, 2013). Among the reasons for the feedback gap is that students do not know the value of receiving feedback. Moreover, they do not know how to use feedback and do not have the skills to use feedback. Additionally, they do not understand the feedback itself or do not trust it (Johnson, 2012). Another reason emerges when they do not recognise the information as feedback (Havnes, Dysthe, Smith & Ludvigsen, 2012). Another issue is that students often do not have a sophisticated notion of feedback, connecting it to a hierarchical approach – that it is

teachers who are responsible for providing feedback to students (Carless & Boud, 2018). To be able to use feedback, students have to recognise its value, be able to make judgments about quality in their own and other students' work, manage emotions and affect connected to feedback processes (Steen-Utheim & Wittek, 2017) and take action to address feedback, as well as recognising that feedback might come from different sources (Carless & Boud, 2018). Despite a large volume of research emphasising the value of feedback for student learning, and how to establish good practices, there are still unresolved questions concerning how students make sense of and use feedback.

The related concepts of formative assessment and feedback are understood differently according to different perspectives on learning (Baird et al., 2017; Hattie & Gan, 2011). A behaviouristic view of learning emphasises the learning aims and testing knowledge, and the role of feedback is as a corrective. This view is related to a transmission of knowledge, a 'telling approach', in which students are viewed as receivers of information (Baird et al., 2017; Evans, 2013; Boud & Molloy, 2013). From this perspective the task is closed, the focus is on right or wrong and the teacher has the main role of identifying gaps in students' learning and telling them how to close the gaps (Ajjawi & Boud, 2017). An example of this might be the introduction of the 'teaching machines'[11] in 1920s-1950s, (Benjamin, 1988; Skinner, 2016)[12]. From the cognitive perspective, the focus moves to the student, with an emphasis on self-regulated learning, in which the student should monitor their learning and practices should support metacognitive awareness (Andrade, 2010; Baird et al., 2017).

Viewing formative assessment and feedback from social constructive perspectives, feedback should be ongoing, used to support students in their learning and

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[11] https://www.youtube.com/watch?v=jTH3ob1IRFo

[12] The teaching machine including disks, in where content was divided into 30 small parts. Students answered questions and received instant feedback of the correctness of their answers. After completing the 30 tasks, the program started over again, displaying only the parts with incorrect answers (Skinner, 1968).

included in the steps in the learning process to support learning (Shepard, 2000; Black & Wiliam, 2009). This perspective focuses on how formative assessment plays out moment to moment, with practices emphasising active approaches through dialogue, self- and peer-assessment, feedback cycles, visible learning and 'shared experiences' (Evans, 2013; Carless, Salter, Yang & Lam, 2011). A sociocultural perspective on learning emphasises feedback practices as an active co-constructed process between peers and teachers with an emphasis on collaboration, interaction, tools and identity, and in which the goals and criteria for success are negotiated (Baird et al., 2017; Evans, 2013). These perspectives and practices often overlap and are not mutually exclusive, and several researchers argue that they should be connected (Andrade, 2010; Baird et al., 2017; Evans, 2013). Baird et al, (2017) argue that theories on learning and theories of assessment practices have developed as two different fields, and there should be a stronger correspondence between theories of learning and theories on assessment.

Formative assessment and feedback in higher education
In higher education, feedback has been connected to giving oral, written or technology-supported feedback on written work, assignments, presentations and projects (Winstone, Nash, Parker, & Rowntree, 2017; Winstone, Nash, Rowntree, & Parker, 2017). It is formal, planned and often asynchronous. This thesis, however, focuses on immediate, formative assessment activities played out in a face-to-face lecture setting, using a dialogical format (Black & Wiliams, 2009: Furtak et al. 2016; Ruiz-Primo, 2011).

Based on the work of a number of scholars in the field (Biggs & Tang 2007; Boud & Molloy, 2013; Carless, 2016: Carless & Boud, 2018; Carless, Salter, Yang & Lam, 2011; Evans, 2013; Nicol & Macfarlane-Dicks, 2006), a formative feedback practice in higher education is aligned to the purpose of learning; should be an ongoing process and should be used to shape teaching; should support to create learning tasks that make student learning visible; should encourage reflection and should support students' capacities to judge the quality of their own work and of their own progress (Andrade,

2010; Boud & Soler, 2015; Evans, 2013). Feedback should be viewed as a process, and the focus should be placed on self-regulated learning (Andrade, 2010; Boud & Molloy, 2013; Carless & Boud, 2018; Carless et al., 2011; Evans, 2013; Nicol & Macfarlane-Dick, 2006). A summary of principles for effective feedback practices are included in Figure 5.

Make thinking visible	• create moments of contingency
Opportunities for monitoring learning	• Create feedback processes in which students in interaction with each other are encouraged to keep track of and evaluate their own learning
Feedback from different sources	• Facilitate feedback from various sources • Include opportunities for self and peer-assessment
Support self-regulated learning	• Students are producers and users of feedback • Support students in developing the skills they need to plan own learning
Dialogical	• Challenge and open for different perspetives and create own questions • Open for students to voice their ideas
A continuous process	• Embedded in course activities and aligned to the learning outcomes and summative assessments
Should be used to shape learning and teaching	• the activities should be used by students and lecturers to shape teaching both in the short term and in the longer term

Figure 5 Key features of high-quality feedback practices in higher education.

For students to be able to judge their own learning and learning processes, it is important to let them identify themselves as active learners in a reflective process which develops over time (Boud & Falchikov, 2007; Winstone & Boud, 2018). This implies a dialogical approach where feedback is viewed as a conversation (Ajjawi & Boud, 2017; Boud & Molloy, 2013). Several definitions of what constitutes dialogic feedback are suggested within the literature. The definitions offered by Carless (2016)

aligns with my own position: 'Feedback is a dialogic process in which learners make sense of information from varied sources and use it to enhance the qualities of their work and learning strategies' (Carless, 2016, p. 1). This definition opens the way for different feedback practices and emphasises that feedback comes from varied sources (e.g., teachers, peers and others or played out as an inner dialogue) and that students use it to make decisions on their learning process. To be able to adjust formative feedback practices towards more dialogical approaches, the dialogical perspective and its implications must be considered (Carless, 2016; Steen-Utheim & Wittek, 2017). In the next section, I sketch out perspectives based in dialogical approaches to teaching and suggest their relevance to formative assessment.

2.2 A Dialogue Approach to Teaching

To understand what dialogue is, it is common to contrast it with monologue (Linell, 2009). While the monologue perspective is single-voiced or closed and minimises the possibilities for responsiveness, the dialogical perspective includes multiple voices and creates possibilities for responsiveness, criticism and challenges (Bakhtin, 1984). A dialogue always includes more than one voice or perspective, and the meaning of the dialogue is created in the space between them (Wegerif, 2013). The term dialogue covers a range of different social practices and is often used as equivalent to conversations or verbal exchanges between individuals. However, in the field of education, the concept of dialogue is conceptualised as 'a certain sub-type of conversation' (Howe, 2017, p. 326). A dialogical account of teaching emphasises the active role taken by students in the process of constructing their own learning (Alexander, 2006), and involves activities in which students and teachers are 'building on, questioning and exploring each other's ideas in a way that allows for co-creating of knowledge' (Mercer, Hennessy, & Warwick, 2010). This calls for a teaching design that supports a safe climate for students to share their ideas, exploring their ideas through open-ended and higher order questions (Mercer, Hennessy, et al., 2010). In the context of education, dialogue refers to conversations among students and between

students and teachers that have certain qualities or characteristics that distinguish such approaches from other 'interaction' or 'talk'. Drawing on Hennessy et al. (2016), examples of such qualities are discussions where participants invite elaboration and reasoning as they express their ideas. Also, they may make their reasoning explicit, give reasons for arguments, ask for justification and provide examples and elaborations.

In different traditions, this type of dialogical practice has been conceptualised in various ways. Examples include *'accountable talk'* (Michaels, O'Connor, Hall & Resnick, 2010), *'exploratory talk'* (Littleton & Mercer, 2013), *'dialogical teaching'* (Alexander, 2006), *'Dialogic inquiry'* (Wells, 1999)*, 'Dialog spaces'* (Wegerif, 2013). Although these frameworks are conceptualised differently, they have something in common: 'opening up a shared space so different perspectives can interact and new learning can occur' (Wegerif & Major, 2019, p. 113). In this thesis I have used the frameworks of exploratory talk (Study 2) and dialog spaces (Study 3) as theoretical lenses to explore the discussion transcripts, as discussed both in the methods section and within each of the articles. In the following section, I elaborate on the idea of exploratory talk, the idea of a dialog space and how they are connected.

Exploratory talk

Mercer (2004) refers to three modes of talk; disputational talk is characterised by disagreements, interruption and individual decision-making. Students are not following up on each other's questions, or their contributions and utterances are short, without any justification and often confrontational (Mercer, 2004). Cumulative talk is characterised by 'repetitions, confirmations and elaborations', and uncritically building on each other (Mercer, 2004, p.46). Exploratory talk is characterised by students who engage critically with each other's ideas, arguments or reasoning that are explicit or accountable within the discussion, students offering alternative views or hypotheses, and participation with the purpose of 'joint consideration' (Mercer, 2004, p. 46). In exploratory talk, participants pool ideas, opinions and information and think aloud

together to create new meanings, knowledge and understanding (Mercer, Hennessy, & Warwick, 2019). The three modes of talk are illustrated in Figure 6.

Disputational talk   Cumulative talk   Exploratory talk
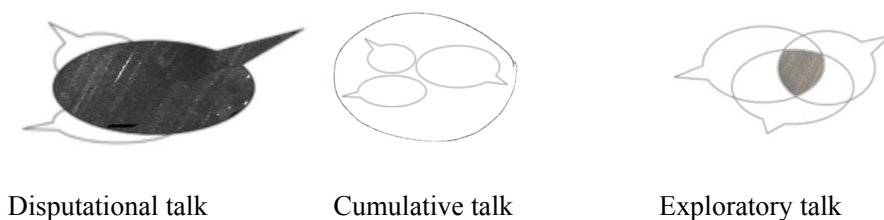
Figure 6 Modes of talk.

Littleton and Mercer (2013) argue that when people participate in 'exploratory talk', three different processes take place. The first is appropriation, the process of sharing information in the group, which allows for increased sensitivity to different possible ways of thinking. Students can articulate and present their thoughts, and they can assess their thinking considering the ideas of others. Participants share their knowledge, and the group can come up with ideas and solve problems that exceed the capacity of each individual (Littleton & Mercer, 2013). The second process is co-construction, in which co-regulation is used to share, comment on, justify and challenge ideas with the purpose of building knowledge together, referring to the processes occurring when ideas are critically reflected upon in a group and creating a joint understanding. By engaging in 'interthinking', the process in which ideas are reflected on within the group towards a shared goal, new knowledge is created among the participants (Littleton & Mercer, 2013). The third process, transformation, involves engaging in exploratory talk, through which participants learn how to discuss and obtain a metacognitive awareness of how to reason (Littleton & Mercer, 2013).

Dialogical spaces

The concept of 'dialogical spaces' is used in different disciplines and varied contexts. Examples include collaborative knowledge building supported by technology (Cook, Warwick, Vrikki, Major, & Wegerif, 2019; Dysthe, 2015; Pifarré, 2019; Pifarre & Kleine Staarman, 2011) to support classroom dialogue (Mercer, Hennessy, et al., 2010;

Mercer, Warwick, Kershner, & Staarman, 2010). It is used in different subjects such as mathematics (Langer-Osuna & Avalos, 2015) and writing instruction (Jesson, Fontich, & Myhill, 2016). Furthermore, it is applied in a physical, material way in subjects such as art (Moate, Hulse, Jahnke, & Owens, 2019; Vass, 2019) and sports (Knijnik, Spaaij, & Jeanes, 2019). Another area is for collaboration in professional learning (Anagnostopoulos, Smith, & Nystrand, 2008; Wood & Su, 2014). The concept of 'dialogic space' is defined in different ways. Broadly understood, it is the 'quality of thinking together' (Moate et al., 2019, p. 168), or it has been elaborated by Jesson and Myhill (2016) as:

> opportunities for meaning making within a conversation; the site in which a range of voices interact (…) dialogic space is both influenced by and influential for the knowledge of the participants. Within a dialogic space, knowledge generation can be seen as emerging from the process of participating, which is in turn influenced by the knowledge of the various participants (Jesson et al., 2016, p. 156).

Jessen et al. (2016) also suggest that the dialogical spaces can be seen as a 'constantly shifting shape' (p. 156), wherein the participants shape the space at the same time as the space shapes the participants: 'a space might be created for the interaction of participants' voices, within which individual cognition or perspectives of the participants may change, and those changes in cognition or perspective might in turn influence the shape of the space' (Jesson et al., 2016, p. 156). The dialogical space arises from and depends on the ideas contributed by the participants.

Teo (2016, p. 48) conceptualises a 'dialog spaces' as a space 'for students to actively participate in and critically engage with discussion and thereby take ownership of their learning'. The idea of opening dialogical spaces in teaching align to, and are also often conceptualised as different approaches to 'dialogic teaching', such as 'dialog teaching' (Alexander, 2006), 'interthinking' (Mercer & Littleton, 2007) and 'dialogic inquiry' (Wells, 1999). The idea of a dialogical space also identifies with broader philosophical

ideas such as 'intersubjectivity', (Pifarre & Kleine Staarman, 2011) as well as Buber's (1878-1965) notion of the 'space of the in between' (Vass, 2019; Wegerif, 2019). Even though ideas of a dialogical space are conceptualised in different ways in different contexts, their common core is an intent to open up spaces to share ideas and also to question, scrutinise and critique those ideas. This is formulated by Teo (2016):

> Equally, it has to do with whether the true value of learning lies in the acquisition of knowledge structures or the cultivation of a dialogic stance, which acknowledges the multiplicity of perspectives and multifaceted nature of knowledge and values an open-mindedness to not only accept and accommodate, but embrace and celebrate, 'otherness' and 'outsideness', difference and ambivalence (Teo, 2016, p. 60).

The concept appears to represent flexibility and therefore offers an interesting metaphor to use in exploring interactions in lectures. Wegerif (2013) refers to the appearance of different perspectives as the 'dialogic gap': '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). Drawing on Wegerif (2010; 2013), a dialogical space is both a philosophical idea and a practical idea about how to facilitate dialogue in an educational setting. When describing dialogical spaces, 'opening' refers to designing teaching to allow students to exchange ideas in the first place. 'Widening' refers to how many possible voices and perspectives are available. 'Deepening' refers to the degree of reflection on the perspectives and on the dialogue process itself (Wegerif, 2010). By providing a variety of perspectives, one can increase the degree of reflection. When deeper reflection occurs, the number of perspectives can be increased (Wegerif, 2010). In the widening of the dialogical space, differences might become visible, and one can question assumptions and ideas. In this way, the space of dialogue can deepen (Wegerif, 2013). This is also described by Teo (2019):

> This grappling and wrestling, manifest through earnest probing, questioning and challenging, may or may not lead to agreement or even conciliation, but

should broaden and deepen one's views and lead to an honest revaluation of
one's idea or position in relation to those of others. In this way, knowledge is
co-constructed, understandings recalibrated, and learning deepened.
(Teo, 2019, p. 172)

Littleton and Mercer (2013) describe the relationship between interaction and individual thinking by referring to Vygotsky (1896-1934) that language is both a psychological and a cultural tool. Individual understanding is dependent on social interaction (Mercer, Hennessy & Warwick, 2019, p. 3). The dialogical space is both collective and individual at the same time, or as formulated by Wegerif (2013): 'this space is not just a property of the group and they are sitting together but it is also something that each individual can take away with them' (p.151).The idea of 'interthinking' is associated with the concept of 'dialogical space' (Wegerif, 2013). In relation to dialogical space, cumulative talk is characterised by harmony, repetitions, uncritical confirmations, providing a widening of space, while exploratory talk provides a deepening of the space (Wegerif, 2013).

An ongoing debate addresses the question whether dialogue should be seen as an end in itself and whether it can be fruitful to use dialogical approaches in a teaching design guided by more or less fixed learning outcome descriptions (Dysthe, 2011; Matusov & Wegerif, 2014). Within 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 (Strickland, 2019). In the context of lectures, the intersection between formative assessment and a dialogical approach to teaching lies in the emphasis on creating a 'moment of contingency'. The relevance of opening, widening and deepening dialogical spaces for the concept of the moment of contingency is discussed in Chapter 5. Taking the dialogue perspective into account when defining a moment of contingency, I would describe them as *activities that open for students to voice their opinions, to articulate different ways of knowing and different viewpoints as well as stimulating students to create their own questions in an ongoing conversation.*

In the next section, the overall research design is presented and discussed.

3. Methods

In this chapter, the overall research design is presented and discussed, as are the decisions taken for data collection and analysis within each of the three articles. Research ethics and validity of the study are discussed throughout the chapter and again in its final section.

3.1 Design-Based Research and Mixed Methods

The overall methodology of the study is inspired by a Design-Based Research approach (DBR). DBR seeks to unpack 'the messiness of real-world practice' (Barab & Squire, 2004, p. 3). DBR is characterised by being conducted within a single setting and includes cycles of testing and improvements of practice; as an approach, it aims to increase theoretical insight as well as insight into improving course design. To address the complexity of an authentic learning environment, DBR often uses mixed methods research (MMR) (Anderson & Shattuck, 2012; Barab & Squire, 2004). Figure 7 illustrates the characteristics of a DBR process as described by Anderson and Shattuck (2012), Barb and Squire (2004) and Wang and Hannafin (2005) and how this process was executed in this project.

| | 1. The challenge is identified in terms of practice, research and policy.

2. The intervention is informed by literature on formative assessment and feedback and tested in an authentic setting.

3. MMR (survey, interviews, audio recordings and focus group interviews) is used to explore the intervention.

4. Practice is adjusted by refining the teaching design. |
|---|---|

Inside the circle diagram:

1. Identify challenges
2. Develop teaching design
4. Adjust and refine practice and develop new insights
3. Explore the intervention in an authentic context

Figure 7. Design-based research cycle.

The point of departure for the project is to address a challenge identified from practice as well as from research: to change the lecture from a transmission mode of teaching to include more active approaches to learning and to provide opportunities for student feedback. The project was initiated and developed by Krumsvik in 2008–09 as a result of didactical innovation, followed up by a successful grant application[13] for funding in 2010. The aim of the project was to explore techniques to evaluate students' understanding in lectures as mediating tools to support formative assessment and feedback. From this funding base, he initiated the DBR project on 'formative assessment in higher education', where the purpose was to examine and develop these activities, in which a teaching design based on authentic assignments, discussions and student response systems plays a key role in transforming lectures towards a more student-centred way of organising learning and teaching in lectures. The pedagogical design consisted of cases, videos, discussions and voting options developed by

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[13] Seed funding

Krumsvik. In 2011, I started my PhD-project to explore this design and to develop it further, as a part of the ongoing design-based research project.

To capture the complexity of an authentic learning environment, this project uses a sequential MMR approach in which quantitative and qualitative elements (survey, interview and observation) are integrated into the design for the purpose of obtaining a better understanding of the phenomenon being studied. This thesis is based on a sequential mixed methods design, which means that one phase of the study (the qualitative) is informed by another phase (the quantitative) (Fetters, Curry, & Creswell, 2013; Ivankova, 2014). The mixing of methods was done to minimise weaknesses (the strength of one method could compensate for the weaknesses of another) and 'complementation' (the different methods should shed light on the activities from different angles) (Johnson & Onwuegbuzie, 2004). The literature on MMR explains it as a 'type of research in which a researcher or team of researchers combine elements of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration' (Johnson, Onwuegbuzie, & Turner, 2007, p. 123). Following this, the value of using DBR and MMR is that this approach allows the activities implemented for supporting formative assessment to be examined from different angles (Krumsvik & Ludvigsen, 2013).

3.2 A Pragmatic Approach

DBR, with its emphasis on problems in authentic contexts and openness to using different methods to explore interventions, is situated within a pragmatic approach to research (Juuti, Lavonen, & Meisalo, 2016; Wang & Hannafin, 2005). The research process is driven by the research question (Morgan, 2007), which addresses practical problems in an authentic context (Feilzer, 2010) and emphasises cycles of abductive reasoning. It is the research question that gives direction to the data collection methods

and analyses used (Feilzer, 2010). In a pragmatic account of research, the researcher is concerned with temporary, authentic problems in a specific social context (Schoonenboom, 2017). A pragmatic approach to research aims to solve problems, and choices of methods and analysis are guided by the problem (the research question) it is supposed to solve, rather than a certain ontology or epistemology (Schoonenboom, 2017). Morgan (2007) argues that a pragmatic approach to research is abductive in its nature: research moves between induction and deduction, 'first converting observations into theories and then asserting those theories through action' (Morgan, 2007, p. 71). If what the researcher finds does not fit with what they knew before, the new insight is used as a point of departure for new questions (Schoonenboom, 2017).

By taking a pragmatic account of research, researchers are free to use the best methods available to address the research questions they face, instead of being restricted to one particular way of conducting research (Feilzer, 2010; Morgan, 2007). Pragmatism is not connected to a particular research method (Feilzer, 2010). Several scholars have suggested that MMR can be founded in pragmatism (Biesta, 2010; Morgan, 2007). This fits a design-based approach, which is characterised by the identification of a problem by researchers or practitioners in context, then addressing the problem by implementing new practices and exploring the opportunities and constraints of these practices, using different methods, in an iterative, open-ended process. The insights gained can be used to refine and develop educational practices and theories (Juuti et al., 2016; Pool & Laubscher, 2016) that align to a pragmatic approach to research (Feilzer, 2010). Figure 8 illustrates the coherence between the research approach, data collection methods, data and analysis and Figure 9 shows how the

different phases in the project informed each other.
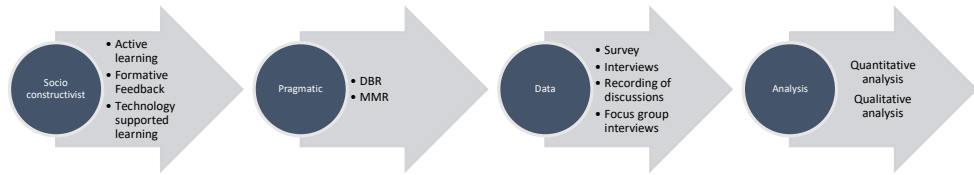
Figure 8. Coherence in the research design in the thesis.
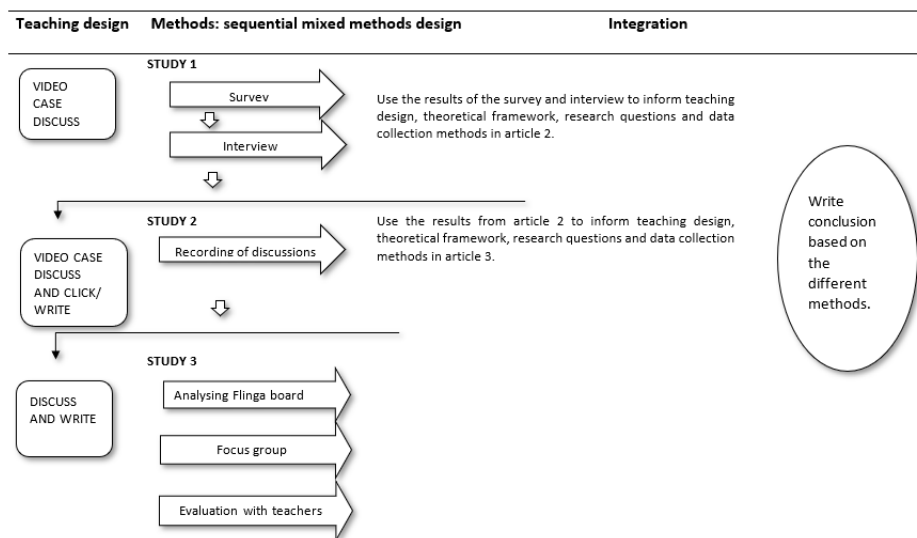
Figure 9. DBR and mixed methods research design.

In educational research, ethical questions arise at each step in the research process (Tangen, 2014). On a macro level, ethical issues are concerned with the design of the study and its value for society (Stutchbury & Fox, 2009). At the micro level, ethical questions are concerned with how individuals who participate in research are affected by it (Stutchbury & Fox, 2006). Other issues include the balance between protecting participants and the integrity of the research and the researcher (Tangen, 2014; Sikes,

2006). Tangen (2014) poses three domains based on guidelines for research ethics. These are based on The Norwegian National Committee for Research Ethics in the Social Sciences and the Humanities (NESH, 2006). The three domains are (a) the internal quality of the research, including the validity of the conclusion and suggestions for practice, (b) protection of the participants, and (c) the value, risk and relevance of the research for society, including individuals, groups and institutions, as well as for policy-making. Discussion of ethical considerations relating to these domains are included throughout.

3.3 Design of the Study

This study is based on a sequential mixed methods design (Ivankova, 2014). In sequential design it is common to collect data in distinct phases. The purpose of the qualitative data is to explain and elaborate quantitative findings. This purpose can be identified as both a 'complementary' and an 'explanatory purpose' (Greene, Caracelli, & Graham, 1989, p. 259). In this thesis, the sequential nature of the studies should be thought of as a metaphorical conversation, in which one phase of the study informs the next phase, and a metaphorical dialogue, going back and forth between the data sets to investigate the research questions (Bazeley & Kemp, 2012). Therefore, the integration occurs sequentially when the results of one phase inform teaching design, research questions and data collection methods in subsequent phases (Ivankova, 2014). The integration of different types of data occurred in different stages throughout the project. The first instance was in the planning of the project, when qualitative and quantitative research questions were introduced. Second, the results of the survey informed the development of the interview guide in article 1. Third, the findings from article 1 informed the choice to observe how discussions played out amongst the students and to include the online collaborative whiteboard in Study 2. The results from Study 1 and Study 2 informed the research question and decisions taken in Study 3. Integration also occurs on the method level (Fetters et al., 2013), as the sample from the qualitative phase was selected from the sample in the quantitative phase.

Another aspect of integration in how the data are reported is that, in Study 1, findings from different points in the study are reported sequentially in the order in which they were collected, to address each of the research questions, which is in line with a contiguous approach (Fetters et al., 2013).

To bring clarity to the sequence of data collection (Onwuegbuzie & Johnson, 2006), in this context the interface 'refers to any point in a study where two or more data sets are mixed or connected' (Guest, 2013, p. 5). This aspect is illustrated in the procedural diagram (Ivankova, Creswell, & Stick, 2006), Figure 10.
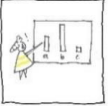
ARTICLE	PHASE	PROCEDURE	PRODUCT	TEACHING DESIGN
Study 1: 'Creating Formative Feedback Spaces in Large Lectures'	Formulating the purpose of the study Collect and analyse quantitative data	Develop survey questions, collect data during lectures using student response systems	Quantitative and qualitative questions are introduced. Analysis of survey (n=148) using SPSS22 • Factor analysis • Mean difference analysis (t-test) • Correlation analysis	Study 1:
	Use findings from the survey to develop an interview guide.			
	Collect and analyse qualitative data	Qualitative interviews from the same sample were conducted (N=6).	Thematic content analysis Draw conclusions based on qualitative and quantitative data	
	Findings from Study 1 were used to inform the research questions and the research design for Study 2.			
Study 2: 'Behind the scenes: Unpacking peer discussions and critical reflections in lectures"	Collect and analyse qualitative data	Audio-record and transcribe 87 peer discussions	Confidence Use of subject specific language Analyse pattern of talk	Study 2 and 3: Discuss, click and write
	Findings from Study 1 and Study 2 informed research questions and research design for study 3.			
Study 3: 'Writings on the wall: How can technology open dialogic spaces in lectures"	Collect and analyse qualitative data	Mind maps Focus group interview (n=1) Flinga boards	Analysis of students creating mind maps of their experiences. Thematic analysis of phenomena described in the interviews.	
EXTENDED ABSTRACT	Write a conclusion based on the three studies			

Figure 10. Procedural diagram.

In sequential mixed methods design, the most important dimensions to address are the *research question, timing* and *the purpose of the mixing*, and how the phases inform each other (Guest, 2013; Leech, 2012; Sandelowski, 2003). In the following section, the different methods of data collection and analysis are described, focussing on the timing of the data collection and the purpose for using the different methods. This is followed by a description of how the phases are connected to each other, focussing on how one phase informed the questions asked and methods used in subsequent phases.

3.4 Study 1: Research process

The purpose of this article was to address whether and how a student response system could create opportunities for a formative feedback practice in large lectures and thereby support students' ability to monitor their learning, as well as to provide insight into how students engage with the feedback in their coursework. In the first phase, quantitative data were collected using a survey. In the second phase, qualitative data were collected. The purpose of using interviews was to explain and elaborate findings from the survey, which can be referred to as both a complementary and an explanatory purpose (Greene et al., 1989, p. 259). In this way, we were able to secure validity for our results and to draw more robust conclusions than if we had used one method in isolation.

Survey
The survey was developed from a survey used in a previous study to assess students' perceptions of feedback and learning outcomes in large lectures (Krumsvik & Ludvigsen, 2012). One of the findings from this study was that students used clicker questions to identify concepts they did not understand. However, the earlier questions did not address how students might use this information in their subsequent coursework. This informed our choice to develop items for the current study, addressing students' use of feedback. Informed by the literature, a survey was developed addressing three broad themes: perception of the lecture as a space for

feedback, students' use of feedback in coursework, and dialogue with peers and lecturer. The items were developed to target core characteristics of formative feedback practices as described in literature and how they were conceptualised in our teaching design. The scales were reviewed by an international expert in the field of formative assessment and feedback. This strengthens the construct validity, again, by being transparent and providing the reader with the items included in the two scales included in the article. The wording of the questions was developed with the guidance of an expert in quantitative methods.

An ethical question can arise in the interface between the protection of the participants and the integrity of the research (Tangen, 2014). In the planning stage of the project, a survey was developed that captured various items to give a nuanced picture of student perception and use of feedback. However, the survey turned out to contain too many questions and would have taken approximately 20 minutes to complete. The research team concluded that this time should be used for teaching and learning activities, so several of the items were removed. To protect the students' time, the survey could have been given to the students after the lecture; however, opportunities would then have been missed to obtain student reflections in the moment, during the lecture. It is also likely that there would have been a lower response rate. This choice might have reduced the quality of the survey and the amount of data to be used to draw a valid conclusion; on the other hand, it protected the students, the factor that we decided must be given the most weight. We contextualised the data collection methods we used, so they could get a hands-on experience of the method in use, and also showed them a possible way of collecting data for their own bachelor's projects. In this way we have balanced the integrity of the research and the wellbeing of the participants.

The sample
The sample was purposive and voluntary (Creswell, 2012). All the students who attended the last of the five lectures were asked to answer the survey at the end of the lecture. The students were asked to rank their degree of agreement with different statements/claims using a seven-point Likert scale. We used the student response

system to collect data in real time immediately after the lecture, which provided anonymity. Prior to the data collection, the students were given a verbal orientation about the purpose of the survey and how the data would be stored. In this project, clickers were handed out to the students randomly (students picked them up when entering the room), and the clickers were not associated to any particular IP-addresses or anything that could possibly identify the students. It also allowed a high response rate, as nearly all of the students participating in the lecture participated in the study.

Analysis

The data collected from the student response system were exported to Excel files and imported to SPSS. To analyse the data from the survey, we used factor analysis, descriptive data analysis, mean difference analysis (t-tests), and correlation analysis. These analyses were conducted using SPSS Statistics 22 software. Details about the analysis are presented in the article. When students reported that they used feedback, the score was high in the general questions (if the use of feedback clickers indicated what they need to work on), while the answers to questions targeting more specific use of feedback (such as whether it influenced their reading) were distributed across the scale. An explanation for this finding is that there might be other ways of using feedback that the specific survey questions were unable to capture. This created a point of departure for the qualitative phase, to explore how students utilised feedback and to obtain a nuanced picture of the students' uptake of feedback.

Interviews

At the end of the last lecture, we invited the students to participate in a semi-structured interview (Kvale & Brinkmann, 2009). The interview guide had three broad themes of investigation: *How clicker questions and peer discussions supported the learning of concepts during the lecture, how students used feedback in their coursework and what role the technology played in these two processes.* The invitation was provided verbally, at the end of the last lecture, and by e-mail (Appendix D). Six students volunteered and, as such, the sample was characterised as *a convenience sample*, 'based on a specific purpose, rather than randomly' (Teddlie & Tashakkori, 2003, p.

713) and can be referred to as a member-checking and sample integration activity (Onwuegbuzie & Johnson, 2006). The interviews lasted from 40 minutes to approximately one hour and were conducted the week after the last lecture. The students were asked to identify the most crucial aspect of how the activities supported their learning, with the interviews held in a semi-structured format (Kvale & Brinkmann, 2009). To secure the validity and check my interpretations of the data, the discussion was summarised at the end of each interview. Again, one ethical question is the protection of the students' time (Tangen, 2007). In this case, participating in an authentic qualitative interview provided an opportunity for the students to get 'hands-on' experience with qualitative methods, which is a benefit for learning qualitative methods (Creswell, 2012). The opportunity to discuss their own learning strategies might also be a useful experience for students, so we considered the interview to be a potentially interesting experience for the students.

The interviews were transcribed and then analysed using thematic analysis (Creswell, 2012). We used NVivo 11 to organise and code the transcribed interviews. The transcripts were coded by looking for different themes and sub-themes (Braun & Clarke, 2006). This was done in the following steps: first, reading the transcript carefully and coding for different themes (nodes). Second, the nodes were organised so that similar nodes were merged. Third, we created a node structure for different categories with main themes and sub themes under each category. For transparency, we chose to include this list of categories and themes in the article.

The article included all the items in the questionnaire and described how the items were situated within theory and informed by literature. The mean scores for each of the items were also included. Readers were also provided with the interview guide for the qualitative phase. Therefore, it would be possible for others to replicate the study in another context or to judge whether a similar pedagogical intervention would be suitable in another context.

3.5 Study 2: Research process

Article 1 indicates that use of the student response system can promote increased quality and quantity of peer interaction. Students found that participating in peer discussions provided them with an opportunity to argue for their views, listen to others' arguments, discuss each other's understanding of concepts, identify alternative ways of thinking about concepts, get feedback on their understanding, and ask questions for clarification. However, there might be a gap between how a student perceives an activity and how the activity unfolds (Nielsen et al, 2016). This possibility informed our research questions and our decision to use observation of peer discussions as a source of data for article 2. In article 2 (Ludvigsen et al., 2020), our purpose was to examine how students share their thinking and what characterises peer discussions when student response systems are used for formative assessment in lectures.

To address this question, we recorded the peer discussions as they occurred. Recording peer discussions allows an in-depth exploration of the micro-processes occurring when peers discuss and would contribute to the field by providing insights that are closer to the phenomena under investigation (Creswell, 2012). The purpose of conducting this observation was 'complementary', to gain insight that cannot be captured using surveys and interviews, as well as 'triangulation', to be able to draw valid conclusions across the three studies (Greene et al., 1989, p. 259). In retrospect, I think this choice was important because it allowed us to draw more nuanced conclusions on what was achieved in the discussions.

The recorded discussions were collected during six lectures in two subsequent semesters. The sample was based on voluntary participation, and the students received written and verbal information before the lecture. Audio recorders were distributed at the beginning of each lecture. Some groups decided to record their discussions, while other groups chose not to record their discussions. The use of audio recorders may have affected the quality of the discussions (e.g., students may have tried their best to

engage in a productive discussion or were afraid to talk if they were unsure). Therefore, recording the discussions raises definite issues of validity. In all research in which participants know that they are being observed, this knowledge might change their behaviour (Creswell, 2012). Thus, the conclusions drawn might be influenced. This consideration must also be taken into account in this project. An ethical question arose, that the students might have found the questions stressful to discuss or that they might not speak as freely as they would have if the discussions had not been recorded. Again, the students were learning about qualitative research methods; therefore, volunteering to participate in interviews would give them valuable experience in understanding the challenges and opportunities of using audio-recording of discussions as a method (Cooper, Fleischer, & Cotton, 2012; Cooper, Chenail & Fleming, 2012).

Analysis of peer discussions

Our central interest was to examine how students share their thinking and build knowledge together and how the technologically-mediated activities support the discussions. Therefore, we used sociocultural discourse analysis, a framework developed by Mercer and his colleagues (Littleton & Mercer, 2013). The concepts of exploratory talk were operationalised in this study through the coding scheme presented in Table 3. This coding scheme was inspired by the 'Cam–UNAM Scheme for Educational Dialogue Analysis (SEDA: ©2015), developed by Sara Hennessy and Sylvia Rojas-Drummond' (Hennessy et al, 2016, p. 42). The rationale for this, and a description of the analysis procedure, are provided in the article (Study 2).

To secure construct validity, I presented excerpts and analysis of the peer discussions in several seminars and workshops within the National Graduate School in Educational Research community, involving experts in the field of higher education and in interaction analysis.

The data analysis revealed a considerable number of occurrences of uncertainty in a majority of the discussions, even though the students voted for the right answer (in questions with only one correct answer) or a reasonable answer (in questions allowing

multiple correct answers). Thus, the aggregated answers could give teachers an incomplete picture of the students' understanding. To establish formative assessment practices that embrace this uncertainty, we argued that opportunities to share thinking are vital.

3.6 Study 3: Research process

The purpose of this article was to discuss the potential of the online collaborative whiteboard to support *opening*, *widening* and *deepening* dialogical spaces in lectures. The need to collect qualitative responses was identified in Study 1 and 2. Across two cases, we have used the concept of opening, widening and deepening dialogical spaces as analytical concepts.

Recording of discussions

The procedure for recording the discussions was the same as described in article 2. As suggested by Wegerif and Yang (2011), an analysis of a dialogical space should examine: (a) the extent to which the activities facilitate opening, and (b) the extent to which perspectives and voices can be presented, confronted and challenged. It is along these dimensions that the concept of dialogical space is conceptualised in the article and thus was used as an analytical framework. The procedure for analysing the discussion transcript is explained in the article.

One ethical question arising in this phase was ensuring that the students were portrayed in the best possible way (Stutchbury & Fox, 2009). Learning new things is hard, and some of this struggle to learn is displayed in the recorded discussions. When this struggle is transcribed, episodes can seem funny and may not give an accurate picture of the situation as it appears in the recordings that capture tone and context more effectively. If students were to read the transcript, or the transcripts were taken out of their context, the group of students could potentially feel intimidated, or perhaps stigmatised, even though the transcripts are anonymised. In this project we have taken

these questions into consideration when deciding which discussions to include in the articles.

Focus group interviews

In case 1, the sample of students that participated in the audio-recorded discussions (article 2) were invited to the focus group interview (Creswell, 2012) in article 3. This can be referred to as a member-checking and sample integration activity (Onwuegbuzie & Johnson, 2006). The first and the second authors of the article both acted as interviewers. In the focus group interview (interview guide in Appendix E), the students were first asked to write two maps, one that covered experiences from the discussions supported by a student response system and another that covered experiences from the discussions supported by Flinga. They were given 10 minutes to draw the mind maps (see Appendix F). The mind maps were used as a point of departure for the next phase of the interview, in which each of the students presented the points made by their maps. Next, we focussed the discussion on how the two activities were different in the ways they supported learning inside and outside of the lecture. At the end of the interview, to support interaction among the participants, the students were asked to discuss and agree on some suggestions for practice, which they wrote down. Students volunteered to participate in the interview. As in the other studies, the interview provided students with 'hands on' experience in qualitative methods and an opportunity to reflect on their learning strategies. For this reason, I argue that the students' time was well spent. However, participants who volunteered might be more favourable towards this pedagogical approach, than those who did not volunteer. This must be taken into consideration when interpreting the interview results.

In case 2, the teacher education course, the primary sources of data were the lecturers course evaluation and material produced in the lecture. In the evaluation, the material which was produced (the Flinga board) was used as a point of departure for the discussion on the lecturers' experiences, focussing on how they perceived the technology to support activities for students to share their thinking (the widening

dimension), and how they approached the perspectives presented (the deepening dimension). The opening, widening and deepening of dialogical spaces was used as a lens through which to analyse their experiences and identify challenges. An ethical question to be addressed concerned the situation of my colleagues (Sikes, 2006), who might feel vulnerable in this context or that the interview took away time from other activities. Nevertheless, their experiences with using and reflecting on affordances for the online collaborative whiteboard to open, widen and deepen dialogical spaces might be of interest for their teaching practice in other courses.

Before the analysis of the focus group discussion, we conducted an analysis of the mind maps by grouping similar themes together into broader themes, concerning how the activities were described by the students participating in the interview. The focus group discussion was transcribed verbatim and provided 20 pages of material. NVivo was used to code and analyse the interview; the analysis of the focus group was done by thematic analysis (Braun & Clarke, 2006; Creswell, 2016) supported by NVivo. Each utterance or series of utterances illustrating one quality were coded. If an utterance was describing more than one quality, the same utterance was coded to different nodes. Following this we grouped together similar themes in which we gave names that condensed the content of the node in a single phrase, for example, '*you get different views*'. For clicker-supported discussions and for Flinga-supported discussions similar but also different themes emerged, which were displayed in the article (p. 7). Even though the concepts of opening, widening and deepening dialogical spaces made up our theoretical framework, it was not straightforward to place the different themes into the headings of 'widening' and 'deepening', because the content coded under the different themes most often included ideas that concerned both widening and deepening. However, quotations from the students were displayed in the article to illustrate how the activities supported the opening, widening and deepening of dialogical spaces.

To be able to draw (even) more robust conclusions, the material should contain more discussions supported by the online collaborative whiteboard. Among the reasons for

the limited number of discussions were the acoustics in the lecture hall, which made poor recordings. However, the discussions that we were able to capture, were found to be interesting and they did show some shared characteristics.

3.7 Validity

In both quantitative and qualitative research, researchers must draw inferences concerning phenomena that are not visible and tangible, but are dependent on our interpretations (Kleven, 2008). Construct validity 'is about the quality of correspondence between something observed and something which cannot be directly observed' (Kleven, 2008, p. 224). Threats to construct validity are referred to as construct underrepresentation and construct irrelevance: when research fails to capture dimensions in the construct or captures phenomena which are not relevant for the construct – 'At the same time, the measurement is too broad and too narrow' (Kleven, 2008, p. 224). In order to pay attention to construct validity, the concepts used, such as feedback, exploratory talk, dialogical spaces, are operationalised in each of the articles.

Judging validity in studies that use MMR is complex. Questions of validity must be assessed for each of the methods applied within a study and also to judge the quality of the design (Ivankova, 2014), how the methods are integrated, and the extent to which the studies allow integrated conclusions to be drawn (Teddlie & Tashakkori, 2003). In MMR, questions on validity should address both the study design, the distinct phases and the extent to which the mixing of methods minimises weaknesses and allows the drawing of integrated conclusions (Onwuegbuzie & Johnson, 2006). In sequential mixed methods design, in which one phase is built on another, validity is especially important because the quality of one phase affects the conclusions that can be drawn and consequently the quality of the research questions and design for the next phase (Ivankova, 2014). It is also important to address the extent to which and how the qualitative phase can explain and add depth to the quantitative phase (Ivankova, 2014)

and to what degree it is useful to compare or to triangulate the quantitative and qualitative samples. This is referred to as the 'the problem of integration' (Onwuegbuzie & Johnson, 2006, p. 54), which refers to the degree to which it is useful to compare or triangulate quantitative samples with small qualitative samples, what kind of data sets or findings one should emphasise and how conflicting findings should be dealt with.

In DBR, findings should be shared within the field of practice, both in a local context and in other contexts (Anderson & Shattuck, 2012; Wang & Hannafin, 2005); as such, the value of the research is limited to the extent to which the results of the research can 'inform and improve practice'. Questions about external validity reflect to the extent that others can make use of the research: not only its findings but also the pedagogical design. To secure validity is a core concern in research in general and plays a particular role in DBR because the purpose of interventional research is to improve and refine educational practices (Spencer, Ritchie, Lewis & Dillon, 2003; Stutchbury & Fox, 2009). If our suggestions for practice are based on incorrect assumptions, they might provide misleading suggestions for practice and potentially affect large groups of students and teachers in a negative way. Since the purpose of DBR is to improve practice, the connections between an intervention, methods, conclusions and suggestions for practice and the data itself should be examined carefully. In the articles, we have provided rich descriptions of the context and the teaching design, as well as the participants, the research design and the procedures for data collection and analysis of data. Providing this information makes it possible for the reader to judge whether the intervention will fit into a particular context and what modification(s) must be done to apply the intervention in different contexts (Anderson & Shattuck, 2012). However, a balance has been attempted in reporting the 'complexity, fragility, and messiness' (Barb & Squire, 2004, p. 4) of the local context in a way that could make it valuable and relevant for practice in another context. This research has demonstrated its relevance for local contexts. Findings from the project have been used to support and encourage other lecturers to include some of these activities in

different forums at the University of Bergen. Approaches based on Study 1 are used in courses on mixed methods, which is also a validation of the work from the standpoint of practice as well as from the research community (Kvale & Brinkmann, 2009).

Validity in qualitative research is often referred to as 'trustworthiness', and is fundamental to the credibility of the researcher (Kvale & Brinkmann, 2009). A key question to discuss is the credibility of the findings. In this project I, together with my co-authors, have investigated the research questions by collecting and analysing different types of data. This allowed us to draw more robust conclusions than by using one source of data only. This is clearly illustrated by the recorded discussions, because they showed pitfalls that were not presented in the interview data, and as such allowed us to nuance the optimistic conclusions drawn in article one. Another question concerning validity is what is gained, and potentially lost, by using different sources of data. The argument for using these different methods was that it allowed complexity to surface, which is aligned with the arguments in favour of MMR in the first place. Using different methods has contributed to knowledge concerning how these technologically-mediated activities support student learning, providing a window into the micro-processes of how the activities play out, and these insights are essential to get a more nuanced understanding of the discussions (Figure 11). Because of this nuanced understanding, I am better able to develop and refine the teaching design and draw robust conclusions.

Study 1: Factor 1 (survey) 'How feedback impacts learning during lectures' (p. 59).
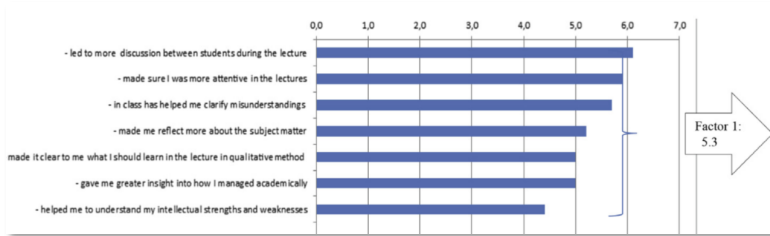
Study 1 and 3: Quality of the discussions as described in interviews:

- they had to come to an answer
- opportunities for students to explain their thinking
- argue for their views
- listen to others' arguments
- identify alternative ways of thinking
- distinguish these discussions from 'talk'
- Space for feedback

Study 2: Condensed models of the discussions (p. 16-17).
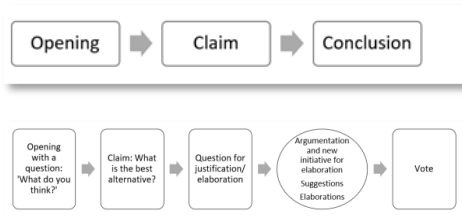
Study 3: Multiple layers of interaction (p.10).
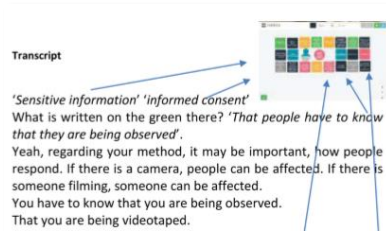
Figure 11: How using a sequential mixed method design contributed to nuanced understanding

On the other hand, using fewer or only one source of data would have allowed me to go deeper into the data and the data collection methods and the methods for analysing and interpreting the data. Clearly, using multiple methods comes with a price. It demands skills in each method, is time consuming and gives a complex dataset, which can be a challenge to handle.

In retrospect, a timely question to ask is whether the project would be easier to manage using fewer methods and fewer data sources. Clearly, using different data sources to address the research question adds complexity, and depth; at the same time, there is a danger that by covering so much in a single project, I did not have time to go deeply into each of the methodological approaches, and this might decrease the quality of the work. Following the nature of a sequential design, my choice had been to explore the initial research questions by zooming in to the paths found to be most interesting to explore as the study evolved. With these limitations in mind, I would argue that the insights into the micro-processes occurring when the activities unfold makes an important contribution to understanding how applying such tools potentially supports students' knowledge building process in lectures. As previously mentioned, this project is a part of a larger one, where the MMR research design for study one was piloted in Krumsvik (2012) and in Krumsvik and Ludvigsen (2012). For that reason, the main research design was already being used and piloted within the research group. To put the research into a MMR framework, I also received guidance from Professor Burke Johnson, who was also an external member of the Digital Learning Communities Research Group (DLC) while I was doing this work. Professor Johnson has been included in different steps in this research project as a part of a pragmatic validation process (Kvale & Brinkmann, 2009). The support that I have received from the research community has been valuable, and also increases the credibility of the study.

Based on an analysis of the discourse concerning the value of educational technology in support of learning, Selwyn (2013) argues that educators working with educational technology are often underpinned by and situated in 'progressive education ideals and/or social constructivist and socio-cultural models of learning' (Selwyn, 2013, p. 10). Furthermore, that digital tools are 'fitting neatly with a number of values and interests relating to the nature and organization of learning' (Selwyn, 2013, p. 10). I can identify with this. In recent years, I have frequently used online collaborative whiteboards and other tools (see Ludvigsen & Egelandsdal (2017) for an overview) in

lectures and seminars. Insights gained from these activities are difficult to ignore and can, in the worst-case scenario, contribute to drawing biased conclusions (Sikes, 2006). Nevertheless, the use of these tools has provided me with insights that are valuable, that can helpfully identify important phenomena in the data and also guide interpretations. The credibility of this study is fundamentally strengthened by my interest and expertise in the domain as well as my digital competence and long research experience in this field. I am not neutral, neither can I put a parenthesis on these experiences. Instead, they can help in recognising and raising relevant questions.

4. Findings

This chapter provides an overview of the main findings in each of the three articles.

4.1 Article 1

Ludvigsen, K., Krumsvik, R. & Furnes, B. (2015). Creating formative feedback spaces in large lectures. *Computers & Education*, *88*, 48–63.

The purpose of this article is to examine to what extent and how students experience the practice of technology-enhanced feedback and to what extent and how they use feedback to support the learning activities in which they are engaged. Findings from the survey (n=148) showed a positive correlation between the extent to which students reported that they used clickers to reflect on their learning and the extent to which they reported that they used the feedback in their coursework. The majority of the students reported that they like to get feedback on their understanding during lectures but that they do not apply the feedback in their coursework to the same extent.

Students in the qualitative sample emphasised discussions of questions with their peers as offering a valuable space for them to get feedback on their understanding of course content. The fact that students had to choose an answer for each question ensured that peer-to-peer conversations were more focussed and productive. The students using feedback in their coursework employed it as a guide to how they are progressing, as a way to focus their reading, as a way to identify concepts they did not understand or as a signal to change their learning strategies. The technology (the clicker and the questions) played an essential role in changing the dynamics of the lecture on different levels; these activities transformed it into a space for reflection and self-assessment, a room for peers to exchange perspectives and elaborate on each other's ideas and a catalyst for teacher–student interactions. This research project contributes to the available knowledge on how students use feedback from such interventions, which is

vital to improve practice when using participatory tools to support formative assessment.

4.2 Article 2

Ludvigsen, K., Krumsvik, R. & Breivik, J. (2020). Behind the scenes: Unpacking peer discussions and critical reflections in lectures. *British Journal of Educational Technology*.

The purpose of this article was to examine the characteristics of peer discussions when a student response system was used to support peer discussion. We used the concept of exploratory talk (Littleton & Mercer, 2013) as a lens through which to examine the patterns of talk in 87 peer discussions, and made these observations: Almost all of the discussions focused on the assignment. The students expressed uncertainty in a majority of the discussions (68 of 87), and insecurity was evident with all types of questions. The students structured their discussions around the answer options. The alternatives were used both to open (clarify and explain concepts) and to shut down discussions (by referring to numbers only). Characteristics of exploratory talk were identified in 62 discussions; most of the exploratory discussions were generated by questions allowing for more than one correct answer. With the incorporation of student response systems into formative assessments, the students' use of such systems to facilitate their understanding of the course material should be carefully examined. It is vital that the lecturer include opportunities to gain insights into the reasoning behind the students' answers.

4.3 Article 3

Ludvigsen, K., Ness, I. & Timmis, S. (2019). Writings on the wall: Bringing student voices to the lecture. *Thinking Skills and Creativity.*

In this article, we explored the affordances of using a shared online collaborative whiteboard to open dialogic spaces within lectures. Across the two cases examined, we found that students used the shared whiteboard in lecture classes to bring a wide range of perspectives and experiences to the discussion, and thus a possibility of opening the space occurred. Engaging with the collaborative whiteboard allowed student voices to become visible and provided a nuanced picture of students' understanding. For the widening dimension, students emphasised that they brought in content and experiences not covered in books or lectures and that these activities made them aware of nuances and different ways of thinking. For deepening the dialogical space, students emphasised that they valued the ability to take the discussion in a direction they found to be interesting. We observed that students discussed other students' posts and began sorting posts on the whiteboard as soon as they arrived on-screen.

4.4 Findings across the articles

The majority of the students value the possibility of receiving feedback on their understanding during lectures to monitor their learning, and they emphasise that explaining their thinking while discussing questions with their peers is valuable as a feedback space, in addition to feedback generated through the technology used and the lecturer (studies 1 and 3). Across the studies, we argue that moments of contingency can be made explicit when using technology-supported formative assessment activities in lectures; students find them to be valuable in supporting their learning in lectures and in their coursework both inside and outside the lectures (studies 1 and 3). These activities support feedback on the task level and the self-regulation level by providing feedback on what is important to learn and the student's progress towards these goals. Opening dialogical spaces provides students with rich opportunities to reflect on concepts and to develop their arguments, and thus to get feedback on their understanding of course content during the lecture (studies 2 and 3). Students frequently articulated their uncertainty in the discussions. This implies that the discussions are worthwhile for students to test out their knowledge and that there is an

insecurity of drawing conclusions based on the students' responses, especially for multiple choice questions (Study 2 and 3).

5. Discussion, implications and conclusion

In this thesis, I examine how the use of educational technology has the potential to create moments of contingency and, through those moments, to transform the premises for formative assessment in lectures. The main research question was: What affordances are there in using participatory tools to support formative assessment in lectures?

In the section that follows, affordances will be discussed according to the findings across the three studies. As acknowledged in the introduction, there is no such thing as a 'traditional lecture'. My references to 'traditional lectures' in the next section refer to the way they have been described here by students, in their own context.

> 'you are not expected to be asked' 'you are just sitting get the knowledge to you' 'it is only talk talk talk' 'there is no time to stop and think' 'it is often a monologue' 'it is just feeding of information' (…) 'it is a little break' 'easy to talk about other things' (Ludvigsen et al., 2015, p. 58).

These quotations depict a lecture format that can be characterised as: a forum where lecturers talk, students listen and take notes, there are few questions, and there is not much interaction or the discussions among peers are unstructured.

The discussion is organised into three parts. In the first part, I focus on the affordances of the activities to create moments of contingency. This section will be discussed in terms of widening, deepening 'dialogic spaces', following Wegerif (2013). In the second part, I discuss how activities in the lectures influence students' work in the lecture and outside of the lectures, using the notions of feedback developed by Hattie and Timperley (2007) as a lens to discuss the empirical findings across the three studies. In the third part, I discuss the potential for these activities to transform formative assessment in lectures. Based on this discussion, in the fourth part, I will suggest implications for theory, practice, research and policy that result from these observations, before offering my conclusion.

5.1 Dialogical spaces as moments of contingency

A vital question when examining formative assessment activities is, to what extent do they provide students with opportunities to share their thinking, and what opportunities become available to students and teachers to draw inferences through these activities to shape teaching and learning–referred to as moments of contingency. I will use the metaphor of 'dialogical space' to discuss affordances, as perceived by students and lecturers, and through observed interactions and material products. The quality of those moments will be determined by focussing on the affordances of the tools to open, widen and deepen dialogical spaces. During the discussion that follows, I will highlight some of the empirical data from the articles to bring the discussions to life and to enter into dialogue with the voices of the participants in the studies. I continue the discussion by focussing on the potential for these activities and tools to transform and challenge established practices.

Widening and deepening
The alternatives in a multiple-choice question might be powerful means to make differing viewpoints visible and open up a discussion space, by providing a framework to scaffold the discussion. By making their thinking explicit, to themselves, their peers and their lecturers, students were exposed to differing viewpoints. In lectures, this provides opportunities for students (as well as for lecturers) to compare experiences, ideas and understandings shared by other participants, and therefore to reconsider, nuance or question their own assumptions. Displaying contributions on the online collaborative whiteboard supports plenary discussions and allows students to analyse their own contributions in light of the contributions of others. This process opens up the potential to unpack differences between alternate ways of understanding a phenomenon and thus provides a widening of the dialogical space. Study 3 (p. 9) shows that students are trying to add things that are not yet written, thus contributing to a widening of the dialogic space:

S2: I feel that everything is said.

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).

Also, seeing the contributions of others, students become more aware of each other. From the recorded discussions in Study 3, we found that students assessed contributions on the collaborative whiteboard to bring new perspectives into the group, contributing to a widening of the dialogical space. Students are both open to and critical of other groups' contributions, as they argue for or against them (Ludvigsen et al., 2019, p. 10):

S2: What is written on the green there? 'That people have to know that they are being observed'

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.

Ideas from other groups thus serve as voices in the discussions and support students in joint knowledge building and developing a nuanced understanding. Using the online collaborative whiteboard extends the possibilities for interactions among students and between students and lecturers by allowing different layers of interaction between students in peer groups, between contributors on the shared whiteboard, and between the contributors on the whiteboard, individual students and the lecturer. Making alternative perspectives or viewpoints visible allows students to use each other's contributions as resources for their own thinking, as also identified by Major et al., (2018). This promotes the co-creation of knowledge, self-assessment, and opening up dialogical spaces where ideas can be 'scrutinised and challenged' (Major et al., 2018, p. 2007). The option to store contributions allows teachers to review diverse ideas and offers the possibility of extending class discussions as a continuous process. When students post their ideas, the ideas from their discussions become concrete and subject to analysis, which contributes to deepening the dialogical space.

The lecturers in Study 3 found it both enjoyable and challenging to approach the deepening dimension; they both sorted and elaborated on student posts. Structuring content, or asking students to structure it, positioning one contribution in relation to someone with a similar or different perspective, may be particularly stimulating for stimulating dialog in the lecture. It also enhances student engagement with posts on the wall and thus with each others' contributions, as previously also observed by Cook et al. (2019). Another way of deepening the space is to ask new questions to push thinking along by including questions that invite to deepening (Herman & Nilson, 2018). Examples of such questions are: *What would an exception be? What are the assumptions behind your claim? What is an implication of your post? How confident are you in your claim? When would the claim not be supported? What is an example of your claim? Can you re-formulate your claim into a question? How do you know?* (Brookfield & Prenskill, 2012). Asking students to justify, explain and elaborate on their (or one of their peers') perspectives opens possibilities for more sophisticated ways to unpack differences in perspectives and thus to make complexity visible, providing a deepening of the dialogical space.

Both the widening and deepening of dialogical space make differences visible and have the potential to encourage students to engage in reflection. The posts on the online whiteboard can be viewed as 'seeds' (Scott et al., 2006) or 'thinking devices' (Wells, 2000) for dialogue between students and lecturers, and they can be re-viewed, improved and explored further, in the moment or during time.

To go from an approach to teaching using closed questions towards including different perspectives in which all could potentially be valid, practice moves 'from identifying with a closed image towards identifying with infinite openness and the potential of the process of dialogue itself' (Wegerif, 2013, p. 57). Seeing one's own contributions (posts) in interaction with other perspectives allows one to examine them from a distance, literally, as from a 'third-person perspective' or 'observer's perspective', as also illustrated in Study 3 (p.8) , in which students are comparing the post on the wall with ideas they discussed, kind of as a validation of their own ideas:

S 1: There, it is the one we had, not the one we wrote, but what we talked about

(reads) "how closely can you observe a person?"

Sitting in a lecture, seeing one's own words from a physical distance, the position of a witness (Wegerif, 2013) is materialised. What participants witness is how their own ideas change meaning when put in dialogue with other ideas. This materialisation is particularly prone to occur when others move, comment on and modify a person's contributions or link their own ideas. This highlights the dimension of deepening, the non-verbal activities in which students post thoughts in a certain place regarding the content of contributions and when teachers help coordinate these contributions, without explicitly commenting on the movement of the contributions. Seeing this happening from a distance changes the focus from oneself to the issue under investigation. Based on Study 2 and 3 we found that the different tools have different potential for widening and deepening dialogical spaces (Table 2).

Table 2. *Affordances of different activities to support widening and deepening of dialogic spaces*

	DISCUSSIONS SUPPORTED BY MULTIPLE CHOICE	DISCUSSIONS SUPPORTED BY FLINGA
WIDENING DIALOGICAL SPACES	- Different perspectives between students in peer groups - Alternatives represent different perspectives - Different perspectives in whole class discussions	- Awareness of nuances in contributions - Bringing in ideas not covered in books - A multitude of different perspectives
DEEPENING DIALOGICAL SPACES	- Discussing alternatives - Explain and justify own or other students' contributions - Alternatives structure the discussions - Follow-up by the lecturer - Focused discussion	- Discussing other students' posts - Contributions are connected to research and theory - Contributions are sorted and connected - Contributions are elaborated by the lecturer and students - Students focus the discussions towards what they find interesting

While it is important to discuss how dialogical space can open, the cases where the dialogue was not opened or where it collapsed are equally important. Study 2 shows that the alternatives offered in multiple-choice questions have the power to trigger and open discussions but may also discourage students from articulating their knowledge and sharing their thinking – for example, when they were only referring to numbers: 'sure, it has to be b'. By analysing the discussions in Study 2 we found that in 25 cases, the qualities identified as 'exploratory talk' were not evident. When the students knew the answer, there might be no reason for dialogue and the discussion was shut down before it started. One consequence, then, is a superficial approach to the content

rather than opening up a space for further reflection, as also is raised as a concern by Shapiro et al (2017). This was also the case when students were simply guessing at an answer without elaborating, or where they only told each other what to vote without offering an explanation.

When students started placing a post in the shape of a heart or posted funny pictures, or they started moving each other's posts, the technology was not transparent but became an object of discussion and also a distraction. Consequently, the tool itself (the online collaborative whiteboard) in some cases became a threat to the opening of dialogical space in the student groups. The students also found it difficult to open discussions in this format, because they did not have a starting point for their group as they did in the multiple-choice format. As this is a part of a DBR project, a further direction in which the design could be developed would be to scaffold the discussions by structuring the activities in ways that prompted a more productive opening and more effective structure of the discussion.

Quality of feedback

Drawing on the work of Nicol and Macfarlane-Dick (2006), among others, a formative assessment practice should deliver high-quality information to students on their performance. This feedback might come from various sources: from a teacher, a book or a peer or through inner dialogue (Hattie & Timperley, 2007). In Study 2 and in Study 3 we found a high occurrence of expressed uncertainty during discussion with peers, and also guessing in the immediate moment before voting. In response to this I argue, in line with previous literature that feedback provided by technology, using aggregated responses, might be fragile. Forms of practice where we draw conclusions about students' learning based on aggregated responses are characterised by uncertainty. To ensure that valid inferences can be drawn from activities as a basis for feedback, a careful examination must be made of the questions used and threats to the validity of possible inferences should be examined. To use such tools as a means to improve quality, the quality of the inferences that can be drawn should be examined at the outset. In addition, learning is often not visible and tangible, but rather it tends to

be unfocused and messy and to feature moments of struggle and uncertainty on the part of learners (Dall'Alba & Bengtsen, 2019) as also illustrated in Study 2 and 3. To establish formative assessment practices that embrace this uncertainty, opportunities to share thinking are vital. In any activities created for the purpose of formative assessment, engaging in dialogue with students allows more sensitivity towards students' ideas, which helps in drawing inferences.

To embrace activities that allow both aggregated and qualitative answers, or to include different ways of displaying knowledge such as in the form of drawings or pictures, might allow a more sophisticated picture of students' thinking and ways of knowing to emerge, and thereby allowing other inferences to be drawn. Dall Alba & Bengtson, (2019) argue that underneath what is visible or apparent 'holding everything together, we might become aware (…) disconnected thoughts, broken arguments and doubt' (Dall'Alba & Bengtsen, 2019, p. 1486), maintaining that these should be encouraged and are important for learning. They further argue that instead of the attention to aspects of the learning that are visible, tangible and measurable, attention should also be placed towards learning that is emerging and 'not-yet-formed' (p. 1483), as also shown in Study 2 and 3. Allowing different forms of knowledge representation (pictures, drawings, words, sentences, and arguments, for example) would make visible things that are not yet clear, or even not yet articulated. This encourages a 'playful sensibility (…) where the intent isn't to interrogate students about their ideas and goals but to play together with possibilities and different ideas and see where they might take us' (Renshaw, 2017, p. 90). Drawing on Study 2 and Study 3, I argue that when students' responses are received through systems without the lecturer intending to unpack the reasoning behind the number, valuable opportunities for learning are neglected. However, drawing on the three studies, the discussion activities occurring in the groups are valuable, as perceived from students (Study 1 and 3) and as we can see from the recorded discussions (Study 2 and 3), regardless of how they are picked up by the lecturer.

The relevance of opening dialog spaces for formative assessment

Black and Wiliam (2009) point out that dialogue might be played out between 'strongly steered' and 'relaxed freedom' and assert that 'formative assessment cannot flourish at either end of this spectrum. The optimum balance … may lie at different points along it' (Black & Wiliam, 2009, p. 24). However, affordances – using a technology and activities to support the creation of moments of contingency – depend on their intended purposes and what learning outcomes the instructor aims to address by facilitating discussions (Furtak et al, 2016; Ruiz-Primo, 2011). By connecting the concept 'moment of contingency', to the idea of a 'dialogical space', this thesis draws attention to the quality of such spaces, which is important to be able to develop practice (Nerland et al, 2018; Wegerif, 2013). To include formative assessment activities in lectures demands that students are encouraged to share their thinking, in which the possibilities to interact are critical (Furtak et al, 2016). Also, understanding is complex (Furtak et al, 2016). By opening dialogical spaces, and acknowledging both the widening and deepening dimensions, this complexity is allowed to surface. That would yield real opportunities for a reciprocal connection between lecturers and students and strengthen the possibilities for contingent teaching.

The value of student response systems is the potential for moments of contingency to open up between the students when they discuss questions in peer groups, as well as the potential to open a dialogue involving the whole class. For a continuous dialogue, in which the lecturer is included, the online collaborative whiteboard is promising. Using collaborative online whiteboards, it is possible to maintain open moments of contingency, and further to expand them in various directions, and with different degrees of reflecting on the ideas.

The ideas of dialogical space and moments of contingency arise from different theoretical fields and use different terms to describe similar processes. Even though formative assessment and a dialogue approach to teaching have different aims, one thing is similar: the acknowledgement of making thinking visible. Opening a dialogue

space has its own value, however, and can support students in their progress towards their learning objectives by creating rich opportunities for feedback and self-reflection.

This thesis contributes with insight to the field by bringing these two ideas together.

One objection, or at least a reasonable question, at the end of this project might therefore be: is it superfluous to talk about dialogical spaces and moments of contingency in the same time? I argue that the answer is no. Opening dialogical spaces has its own value and its own aims. The concept of moments of contingency emphasises that these activities should be used to support and adjust learning and teaching activities. In other words, seeing the idea of dialogical spaces through the lens of moments of contingency, 'moments of contingency' help us draw attention to how these activities could support student learning and provide opportunities for contingent teaching while aligning practices to learning outcomes, formative and summative assessment. Seeing the idea of moments of contingency through the lens of a concept such as dialogical spaces offers a framework to examine critically the moments and brings a more nuanced understanding of what they can be. How these ideas help shed light on each other is illustrated in the figure 12.

Seeing the idea of moment of contingency through the lens of dialogue spaces:

Provides a framework to examine critically the moments we create. Also helps to bring a more nuanced understanding of what they can be. It moves the discourse on how the use of technology can support formative assessment, from short immediate feedback cycles, towards the establishment of dialogue that evolves over a longer span of time.

Seeing the idea of a dialog space through the lens of moment of contingency

Helps us draw attention to how these activities could support students' learning, provide opportunities for contingent teaching and help align activities to learning outcomes, formative and summative assessment.

Moments of contingency → Dialogical space

Figure 12: How Moment of contingency and dialogical spaces shed light on each other.

By seeing the two concepts each through the lens of the other, I argue that these concepts are interrelated and that they can be used simultaneously in a lecture setting to realise each other's potential. It helps identify affordances:

'you may say in particular cases, "I knew that already", or "there are other theories for that"; I would reply: "yes but you haven't seen them from this angle before". In some cases, the shift of angle may be relatively slight but it is nevertheless critical it reconfigure the whole field (...) the moments, or, more

modestly, an instrument that makes a difference, a vehicle that takes you further[14]' (Cave, 2016, p. 72).

More specifically, viewing moments of contingency from the point of view of dialogue space moves the discourse on how the use of technology can support formative assessment from short immediate feedback cycles towards the establishment of meaningful dialogue that evolves over a longer span of time, as emphasised by Carless (2019) to be important in formative feedback practices. These concepts therefore signify the interface between theories of dialogue and those of formative assessment and feedback.

5.2 Perception and use of feedback

The following section is in two parts: first, I discuss how students experience these activities as spaces for feedback. Then, in the second section I discuss how students utilised feedback in their work. Both parts make reference to the different levels at which feedback operated: on the task level, the self-regulation level and the process level (Hattie & Timperley, 2007).

Feedback on the task level
Discussions among peers were highlighted as valuable for reflecting on one's own understanding. In Study 1, students in the qualitative sample emphasised the role of discussions as a space for feedback, where they could explain their thinking to their peers and elicit feedback on their understanding. One student explained: 'I notice that I cannot answer the questions until I discuss them out loud […] You argue with someone about why [your ideas] are right, and then suddenly you find arguments for why it is right and why it is wrong' (Ane) (Ludvigsen et al., 2015, p. 47). The act of explaining to a peer is a way of explaining their perspectives to themselves: 'Even though you remember the words, then you should explain it to others, then they ask

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[14] The etymological meaning of the term "affordance" is "further" (Cave, 2016)

what it means, and then you realise that you did not know, then you notice' (S3) (Ludvigsen et al., 2019, p. 11). Articulating their thinking through explanations to their peers helps students to reflect on their learning, as stated by another student: '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, then I realise if I understand' (S2) (Ludvigsen, et al., 2019, p. 11). The quotations illustrate how students are drawn into reflection on their own thinking and understanding.

When their activities were supported by the online collaborative whiteboard, students experienced the feedback as directly connected to their ideas and therefore personal. Many of the contributions were similar, though with nuances, so feedback on one post was feedback to many. The possibilities for students to voice their thoughts, ideas and questions allowed both lecturers and students to gain insight into each other's thinking, which would not otherwise be possible. When the perspectives were connected in various ways, new insights might appear, which again created new possible spaces for feedback and co-creation of knowledge. Seeing their own contributions among those of other students constructs spaces in which students can receive feedback, as also recognised by Yates, Birks, Woods and Hitchins (2015), Baron et al. (2016), Kim et al. (2015) and Cacchione (2015). By reading other students' contributions, a student might become aware of challenges identified by others, which they may also share, as recognised by Baron et al. (2016) and Pohl (2015). Therefore, these activities have the potential to draw students into questioning their own assumptions and those of others. Examples of this frequently arose in Study 3, where students were reading and commenting on other students' posts. Students found that seeing each other's posts created an enjoyable atmosphere, as also recognised by others (Baron et al., 2016; Pohl, 2015). This support helps to create a safe environment for students to voice their opinions, which is important for establishing formative assessment practices.

Feedback on the self-regulation level
Feedback also addresses the self-regulation level, supporting students in regulating their learning process and enhancing a student's ability to 'create internal feedback and

to self-assess' (Hattie & Timperley, 2007, p. 95) and a student's role in creating feedback and seeking help. Different aspects of the activities encourage students to engage in self-assessment and to reflect on these concepts. In the activities examined, students perceive feedback from different elements of the intervention, such as being asked questions, explaining their own understanding and listening to peers. They can compare understandings with each other and assess their own thinking while considering their peers' perspectives. It is especially the act of listening to themselves when they speak that is highlighted as a way to assess their own understanding. Self-explaining is recognised within the body of cognitive-oriented literature – referred to as self-explanation (Bielaczyc, Pirolli, & Brown, 1995) – and is also identified in sociocultural theories as being important for learning (Littleton & Mercer, 2013).

The act of writing also offered a space for students to reflect on their ideas and assess themselves. Things they thought they knew did not appear equally clear when they would formulate their thinking into writing. Students found this activity to be more challenging than simply being asked to discuss the content of lectures. Because many contributions would be similar in content, offering feedback to one of the groups might provide feedback for several, and also be relevant for students with divergent answers. Writing is an essential part of reflecting on one's own thinking (Stead, 2005). Thus, when the goal is to gather divergent perspectives, collecting written answers might be of high value. The dynamics of writing in combination with discussions could potentially create rich opportunities to articulate students' thinking and understanding, as was shown empirically in Study 3: Such spaces are important in terms of co-creating of knowledge and self-assessment.

Mostly by identifying important concepts, and being aware of key concepts, these activities provide both feed-up (Hattie & Timperley, 2007) and feedback on what students do not understand and need to pay closer attention to. Most of them address this by 'checking things up' with their peers or the lecturer, or by looking up things on the Internet. This occurs in the lecture, during breaks or immediately after the lecture. In these cases, feedback from the intervention (questions, discussions, follow up)

allows them to monitor their progress and encourages them to address misunderstandings; as such, this feedback operates on a self-regulative level (Hattie & Timperley, 2007). Implementing these activities is thus valuable in helping students to reflect on their own learning during lectures, while these activities influence feedback on all three levels identified.

Feedback on the process level

Feedback can identify misunderstandings or areas that are difficult, however, this does not always help students to identify how to approach these issues. We also have fewer, but still interesting, examples of students using feedback in a more strategic way, for example to change the way they learn. For example, they may experience the role of asking questions while working or recognise the value conjunction question at the end of book chapters; both are examples of how these activities could influence how students work. Some students said that they had become aware of the value of asking questions to themselves while reading or of the value of working with conjunction questions in their textbooks. Others reported that it changed the way they read before the lecture, that they read more carefully or in a more detailed way or formulated questions to themselves while reading. One of the students reconsidered her overall learning strategies and began formulating questions to herself while reading: 'I'll do that for the rest of my life, in my work life as well; if I should learn something, I can ask questions' (Ludvigsen et al., 2015, p. 50). Another student suggested that explaining something might be used as a strategy for assessing one's own understanding: 'You can use it as a method to find out that you did not understand as much as you thought you did' (Ludvigsen et al., 2019, p. 11). As such, she discovered explaining, or thinking aloud, as strategies for learning. This shows that these activities have influence on the process level. However, this outcome is not explicitly addressed in the teaching design; rather, it is a consequence of students' awareness of how these activities support their learning; this might influence their strategies as shown in Study 1 and Study 3. Through these activities, students learn strategies they can use, which

goes beyond the learning required in a course, which are important in establishing formative feedback practices (Evans, 2013).

In Study 1, we found that the majority of the students reported that they like to receive feedback on their own understanding during lectures but that they do not apply the feedback to their own coursework to the same extent, which is in line with the findings of previous literature (Johnson, 2012; Evans, 2013). We also found a positive correlation between factor 1 and factor 2, indicating that students who reported using clicker questions to monitor their learning during the lectures also reported using feedback to support their learning outside of the lectures to a greater extent than students who did not report using clicker questions to monitor their learning during the lectures. This finding is not surprising: some students found that they were on track, and so they saw no reason to elaborate further on these issues. This finding was reflected in the qualitative sample. In addition, students who provided examples of how they used feedback in their coursework used the information from the activities to check whether they were on track, to focus their reading and to address concepts with peers or the lecturer, or look up things on the internet, when their understanding was unclear. This might also indicate that students that were aware of these activities as opportunities for feedback, were also more likely to use feedback in general, as emphasised by Carless and Boud (2018). It is thus important for lecturers to help students to identify the potential value of these activities as crucial spaces for feedback. Students used information received from engaging in questions to plan strategically which topics they needed to address in assignments, and one student changed her learning strategies. These findings were reflected in Study 3. Students used questions in the lectures to identify what they needed to work on. They described their own learning process: 'I read, look on the Internet, ask my friends if they have some ideas or something, and then I get to sort things out' (S4) (p. 21), and 'Then you notice that you did not understand as much as you thought you did, then you go and read more, or ask' (S2) (Ludvigsen et al., 2019, p. 21). An interesting finding from Study 1 and Study 3 was that students in the sample were able to articulate how these

activities support them in connecting what happens in the lectures to their out of lecture activities. Three quotations demonstrate this:

> It is like the connection between the PowerPoint and lectures, and the theme (…) essentially, the line between me and the curriculum, and between me and the lecturer. (Ludvigsen et al., 2015, p. 57).

> (...) 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) (Ludvigsen et al., 2019 p. 21).

> 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) (Ludvigsen et al., 2019 p. 21).

The large body of literature on technology in the classroom focusses on the immediate value of using participatory tools to support learning in lectures (Egelandsdal et al, 2019). These quotations have shown the potential for these activities to be aligned with other course activities, and thereby to support students in their study process. Important questions then include: How could we provide better opportunities to get students to exploit the epiphanies students experience in these activities in additional contexts outside the lectures?

This thesis has shown how the use of participatory tools can influence students' regulation of the learning process (Zimmermann & Labuhn, 2012). It supports the forethought phase by helping students to become aware of course goals or to help them create their own goals. It also influences the performance control phase by opening moments of contingency (MOC). Discussions with peers and teachers allow them to assess their own understanding. Also, it influences students to engage in self-reflection, for example by reconsidering their learning strategies. These findings can be summarised in Figure 13. The figure illustrates how the activities supported

feedback (Hattie & Timperley, 2007) that potentially might influence different phases in the self-regulated learning model posed by Zimmerman and Labuhn (2012).

- Adjust reading strategies[15]
- Discover new[16] strategies
- Focus coursework

Self-reflection (Feed-forward)

Forethought phase (Feed-up)

MOC

Performance control (Feed-back)

- Awareness of course goals
- Awareness of what is important to learn
- Decide on their own goals

- Monitor their own understanding
- Activities as feedback spaces[17]
- 'check things up'[18]
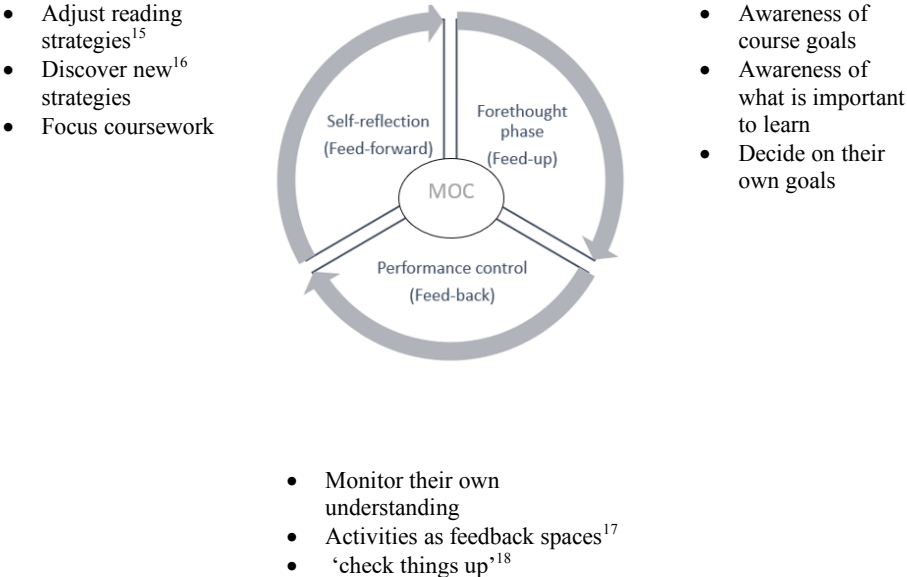
Figure 13. How the activities influence the different feedback questions.

In the survey (Study 1) students reported using feedback in their coursework to a lesser extent than they reported using feedback to monitor their understanding during the lecture. When students reported that they used feedback, the score was high in the general questions (if the use of feedback clickers indicated what they need to work

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[15] Adjust their reading strategies, read more carefully, work more on topics that are difficult and improve the alignment between activities.
[16] Awareness of the role of articulating ideas, asking and answering questions and writing, as ways to assess their own understanding.
[17] From peer discussions, technology, the lecturer and whole class discussions.
[18] Ask a peer, ask the lecturer, consult the book, check the internet.

on), while the answers to questions targeting more specific use of feedback (such as whether it influenced their reading) were distributed across the scale. In the qualitative interviews (studies 1 and 3), students gave examples of how the activities supported their learning outside of the lecture halls. These examples show that the use of the student response systems supports both short feedback loops – checking out things immediately – and longer feedback loops that included reading and writing. Also, it included awareness of strategies to assess their own understanding.

5.3 The potential for activities to challenge and transform established practices

What is the affordance for participatory tools to transform formative assessment practices in lectures? It depends. Painted with a broad brush: in traditional practices, the lecturer talks to one hundred students. However, including activities to collect students' ideas alters this situation. In this scenario, one hundred students share their thoughts to the lecturer and to each other. Interactions are externalised and move the discourse away from where we sit – the time and space of the lecture – into a new space that exceeds the limitations of the room. Such a space can be referred to as a dialogical space (Wegerif, 2013) or, drawing on work of Pifarre and Kleine Staarman (2011), an intersubjective space. Another metaphor would be Buber's 'space of the in-between' (Vass, 2019; Wegerif, 2019). The discourse is moved from inside each individual's head to a shared space that includes multiple thoughts and perspectives, which is also something that each of the students uses as a reference to develop own

thinking, as in Figure 14.
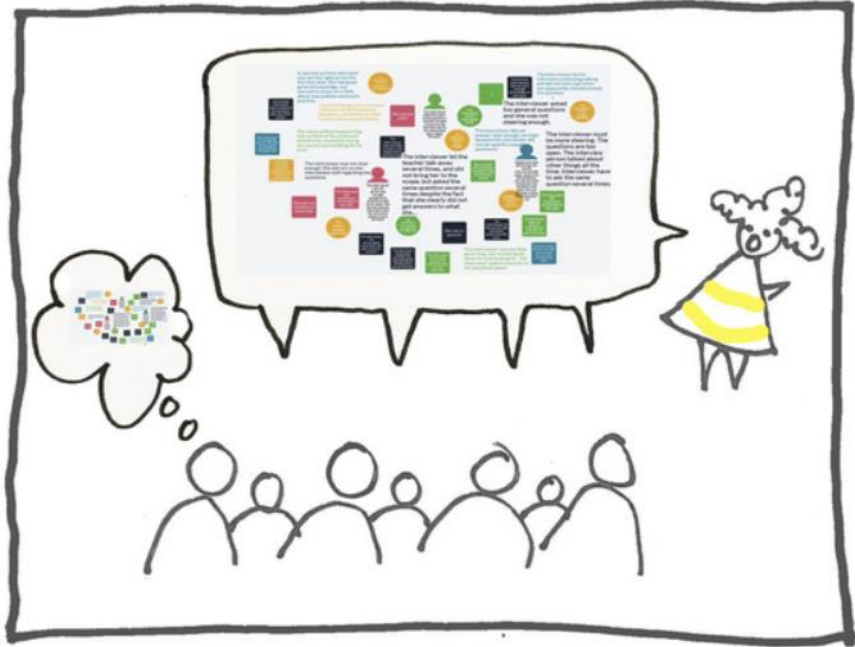
Figure 14. Shared thinking spaces.

For a technology to be disruptive, it must have the potential to improve or alter practice in an unexpected way (Wegerif, 2013, p. 97). I would argue that tools for students to share their thinking carry the potential to challenge, transform and disrupt the experience of both students and teachers. Figure 15 below illustrates this change:
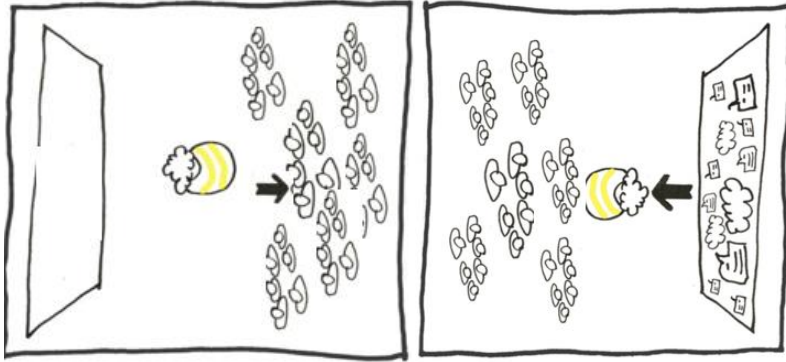
Figure 15. The lecturer talks to one hundred students, vs. one hundred students sharing their thoughts to the lecturer and to each other[19].

The tools one use changes what is visible, for the individual student, the peer group and the class, and thus changes the premises for how to create moments of contingency. With this change another change follows. Instead of viewing collaborative whiteboards as a mean to overcome barriers, teachers can rather to use them to open shared thinking spaces. Such spaces capitalise on and take advantage of the experiences and knowledge of every student participating in the lecture, not only the lecturer's talk. This is radically different from who students described traditional lectures in study 1. However, to find a balance between student activity and the introductions of new ideas, is essential.

By examining activities as they are occurring, studies 2 and 3 were able to capture affordances that were unanticipated. As students, one affordance of using an online collaborative whiteboard can be to joke with each other or the lecturer, which was not the intent. How students shaped a posting as a heart made us aware of the multimodal affordances these tools exhibit. When students posted pictures, it allowed us to become aware of affordances we had not yet considered and to raise new questions: *What if we*

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[19] Figure 15 shows a lecturer talking to hundred students, *vs.* one hundred students sharing their thoughts to the lecturer and to each other. Using the formula: I (n)= n (n-1)/2, the number of interactions is increased from 100 in the first picture to 4950 possible interactions in the second picture.

had asked students to post pictures instead of text? How would that support dialogue in the peer groups and in whole class discussions? Would other ways of knowing become visible? These episodes challenge our perceptions of potential affordances. This is summarised in a passage by Wertsch (1998):

> [A] change in cultural tools may often be a more powerful force of development than the enhancement of individuals' skills. The irreducible tension between cultural tool and agent that defines mediated action means that, when considering how to enhance or change a course of development, the key may often be to change the cultural tool rather than the skills for using that tool (Wertsch, 1998, p. 103).

However, these tools can also be used in a more monological framework of teaching, for example where ideas are only evaluated without exploration of alternative perspectives or where multiple choice-questions have only one correct answer without any elaboration. In such cases, the tools are not given the potential to transform how teaching and learning are organised. Nevertheless, their use must be assessed in relation to its purpose (Cave, 2016). This might call for a qualitative or quantitative approach, depending on what the purpose of creating a moment of contingency is.

5.4 Implications

In this section, I provide the implications of this research project for practice, theory, research and policy.

Implications for practice

Based on theory, literature (Black & Wiliam, 2018; Furtak et al., 2016; Hattie & Timperley, 2007; Littleton & Mercer, 2013; Wegerif, 2013) and empirical findings from the three studies, I outline some suggestions for how to use participatory tools to support formative assessment in lectures that strengthen the likelihood that these in-lecture activities support student learning outside of the lecture. The activities should be aligned with the learning objectives. The key questions to consider are thus to what

extent and how the activities allow students to share thinking and what kind of thinking is being shared. To secure the quality of the inferences that can be drawn from the activities, it could be a strength, to include questions on confidence and/or design an environment where uncertainty and questions might surface and to take time to clarify and elaborate on these questions. To support high-quality discussion, students should be provided with guidelines on how to participate in the discussion and allow open-ended tasks and a supportive climate for students to share ideas. Students should also be aware of their role as producers of and in using feedback, ans the purpose of the activities should be articulated. To encourage students to use the in-lecture activities as resources for their activities outside of lectures, the activities could be connected to assignments or other course elements so that an elaboration of the activities is included in the teaching design. To support feedback on the process level, information on possible approaches to certain topics could be included in the teaching design. Exploring the activities by examining what is achieved in them, so the teaching design can be improved, should be a part of the teaching design itself.

One aim for design-based research is to provide suggestions for and refine educational practices. These suggestions are based on theory as well as research and are informed by lessons learned within the three studies and the discussion within this synopsis. Throughout this project, I have endeavoured to make the context and research procedure transparent; readers can therefore judge whether the principles can be modified to fit their context.

Implications for theory and research
I have contributed to scholarship by showing the link between the moment of contingency and the concept of a dialogue space, as discussed in section 5.1.

This study has placed its focus on the students, their perceptions and how the activities unfold between them. Further studies should explore the role of the lecturer, and how lecturers use quantitative or qualitative information received through these systems to adjust their teaching to the needs of the students. This research was done using a

design-based approach using different methods to explore the intervention. As outlined in the overview of previous research, a large body of research supports the possible benefits of including active approaches to student learning in lectures; however, only a few of these studies use ethnographic design, as is the case for research in higher education in general. Recording students' discussions is important for understanding what is achieved, to arrive at a nuanced understanding and identify affordances as well as constraints to be assessed in relation to the purpose of using the technology.

Further research could compare clicker-supported discussions with discussions alone to discern different patterns of talk. In order to assess how the discussion is affected by clicker use, researchers could include a control group to compare peer discussions in which a student response system is applied and when it is not but otherwise following the same teaching design. To be able to assess how points made earlier in the lecture, in verbal or written form, are picked up in the peer discussion, these activities should be observed for a more extended period.

To examine how the use of the online collaborative whiteboard support student discussions, both in groups and in the whole class, the research design could record each group discussion by using a head camera to video-record the activities. By using video, it would also be possible to connect the discussion to students' contributions on the online collaborative whiteboard and to gain insight into how ideas from the student discussions are reflected in their posts. We could identify how actions played out on the screen feeds, into the peer discussions and to the whole-group dialogue.

Using a student response system to collect quantitative data can also be an effective means of capturing the students' experiences during their learning processes. For qualitative data, the online collaborative whiteboard would also be a potential way to collect qualitative data about students' experiences of an activity when the activity takes place.

The relationship between the dialogue and the writing, and the dynamics between the two modes, should be examined more closely, for example how the written text shapes the spoken dialogue within the lecture. Exploring the dynamics from moment to moment and over time would also be of interest, for example how ideas develop individually, and also how the multitude of ideas create new ideas or new understanding, e.g., in the course of a semester. The boards are temporally situated, and contributions can be moved, removed, edited and linked together and developed during time. To explore how a board or an argument develops, further research should trace editing on the board, to examine how arguments are developed in the moment or during time, or how other students' post influence the content of posts. This would give insight into how such tools support learning over time. Another suggestion is to examine assignments, to see how or whether arguments posted on the board are reflected in students' writing. By examining this, we could unpack how the processes of co-creating knowledge are shaped by using such tools. There is a considerable body of research showing the affordances of using digital tools to support dialogue in the school setting (Mercer et al., 2019; Mercer, Hennessy, & Warwick, 2019), however, more research should be conducted to examine affordances of digital tools to support dialogue in lectures in higher education. For further research, a design-based approach in collaboration with teachers teaching different subjects would be of interest, to explore how the potential affordances of these tools play out in different disciplines and contexts.

In this thesis I have focused mainly on textual evidence; however, the online collaborative whiteboard also allows participants to post pictures and to draw and connect the different modes (picture, drawing etc.). The synergy between the different modes, which expands the possibilities to co-create knowledge in the lecture setting, should be explored further and not be restricted to text. The students value the questions, the discussions and the follow up by the lecturer; however, we see that the use of feedback in students' courses varies outside the context of the lecture setting.

For further research, I also suggest a focus on how the activities in the lectures are embedded in other course activities or used as resources to push thinking forward.

Implications for policy

This study indicates that it would have been more fruitful for policy to employ more sophisticated understandings of the term 'technology'. This is frequently used as a comprehensive term, capturing all types of technology and a multitude of uses. A more nuanced use of the term would provide a more useful framework for discussing the opportunities technology offers to raise the quality of teaching and learning in higher education in general and in lectures in particular. In addition, it could guide leaders, faculties and educators to make decisions about which technologies they could potentially use and why they would use them. Policy makers should pay attention to the qualities of the new spaces these participatory tools might provide, by encouraging lecturers to examine what is achieved within them, so they can refine and develop their practices as a part of their professional development. The use of participatory tools necessitates digital competence among lecturers, and also mandates insight in how these tools can be situated within a pedagogical framework.

Conclusion

This thesis examined the affordances of using educational tools to open moments of contingency in lectures, to take advantage of opportunities to take the lecture towards shared spaces of reflection, and thus be able to support formative assessment in lectures. This opens the possibility for students to voice their opinions and to articulate different ways of knowing and different viewpoints as well as stimulating students to create their own questions. Using student response systems changed the lecture from mere monologue into a form that supports a formative feedback practice by providing the opportunity for students to reflect on the content and their understanding of the content during lectures. Voicing their ideas and explaining and listening to others through the discussions might provide opportunities for students to engage in critical reflection and self-assessment and to receive feedback on their learning and learning process. Opening dialogical spaces provides students with rich opportunities to co-

create knowledge and to reflect on the learning and learning process in lectures. In showing how students incorporate each other's written contributions (from the online collaborative whiteboard) into their discussions, the thesis contributes to unpacking how participatory tools support collaborative thinking in the context of lectures.

I have opened a space: a space that can further be widened, deepened and expanded. So, where do we go from here?

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Creating formative feedback spaces in large lectures

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A B S T R A C T

Large lectures are the predominant way of teaching first-year students at universities in Norway. However, this forum for education is seldom discussed as a context for *a formative feedback practice*. The purpose of this sequential mixed methods study was to address whether and how a student-response system can open for a formative feedback practice in lectures and thereby support students' ability to *monitor* their own learning, as well as supply insight into how students engage with the feedback in their course work. The context for the study was large lectures (150–200 students) in a *qualitative method course* for first-year psychology students. Findings from the survey (n = 149) showed a positive correlation between the extent to which students report that they use clickers to monitor their own learning, and the extent to which they report that they used the feedback in their own course work. However, findings indicate that students valued the *process of monitoring* their own learning *during* the lectures to a greater extent than they actually *used* the feedback in their course work. Findings from interviews (n = 6) illustrated *various ways* students applied feedback in their course work.

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1. Introduction

The Bologna process, new standards for national curricula, increasing diversity among university students, more focus on formative assessment, and the digital revolution are all factors that have changed some of the underlying conditions for teaching, learning, and assessment in today's universities. The Quality Reform in Norway (Ministry of Education and Research, 2000–2001), focuses on frequent feedback to all students on how they are doing and on what they need to do to improve. It is also emphasized that feedback should be *integrated* throughout the courses. Even though there has been a decrease in plenary lectures after the Quality Reform, large lectures dominate the way teaching is organized for first-year students at universities in Norway (Kvernbekk, 2011). Students in higher education value feedback and engaging in dialogue about course work, but lecture theatres and seminars are seldom discussed as a context for a formative feedback practice (Black & McCormick, 2010). This is also reflected in the literature on formative assessment in the area of higher education. Focus has been more on *written work* and peer interaction, and less on classroom dialogue (Black & McCormick, 2010).

Tools designed to enhance interaction in lectures are often referred to as "student response systems" or "polling technologies". These technologies allow the lecturer to collect and analyse student responses to various types of questions posted during lecturing. Results provide feedback about student progress that allows the lecturer to modify explanations and to adjust the focus, methods, progression, and teaching strategies (Schell, Lukoff, & Mazur, 2013). The formative aspect lies in taking advantage of technological opportunities to make the reflections of the students more visible (Pachler, Daly, Mor, & Mellar, 2010) and to create an arena for collaboration between students, teachers and peers.

The intent of this study is to address whether and how a student-response system can open for a formative feedback practice in large lectures, and thereby support students' ability to *monitor* their own learning, as well as supply insight into how students engage with the feedback in their course work. The context for the study was large lectures (150–200 students) in a *qualitative method course* for first-year psychology students. An *explanatory sequential mixed design* was used, where survey and interviews were integrated in the design. In the

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first phase, quantitative data was collected using a survey. The purpose of the survey was to address the extent to which the students perceived that use of student response systems in lectures supported the process of monitoring their own learning in the lecture, as well as the extent to which the students made use of the feedback to support their course work. Second, qualitative data was collected using interviews. The purpose of the interviews was to explore *how* students perceived the lecture as a space for feedback and how they worked with the feedback in their own course work. The purpose of the mixing of methods was to explain and add depth to findings in the survey and allow the students to bring in new perspectives that were not captured in the questionnaire. The research questions that have guided the research are:

1. To what extent and how do students experience the process of monitoring their own learning using clicker questions in lectures?
2. To what extent and how do they apply feedback in their own course work?
3. Is there a relationship between the extent to which students report that use of student response systems support their learning in lectures, and the extent to which they report using feedback in their own course work?
4. How does technology change the conditions for the two processes?

1.1. What characterizes a formative feedback practice?

Feedback is the core of formative assessment and has been shown to be an important factor in students' learning (Hattie & Timperley, 2007). The purpose of feedback is to bridge the gap between current and desired performance (Sadler, 1989). For effective feedback to occur, students need to know the standard or goals for their learning, compare the goals to their own work, and take action to close the gap (Sadler, 1989). There are different traditions of feedback practices. Therefore, the definition of *feedback practice* is dependent on the view of learning and knowledge building (Hattie & Gan, 2011). For example, in a behaviouristic influenced model of feedback, feedback is understood as a monologue or a "*one-way transmission of information from teacher to students*" (Boud & Molloy, 2013, p. 702) The assumption in this approach is that the teacher or other external agent *drives* the student's learning. Whereas, on the other hand, feedback through dialogue is frequently associated with a social-constructivist approach (Evans, 2013) where feedback is viewed as a process, in which students, in dialogue with their peers and teachers are encouraged to monitor and evaluate their own learning process (Boud & Molloy, 2013). In the latter tradition, the purpose of feedback is to develop self-regulated learning (Clark, 2012; Evans, 2013; Nicol & Macfarlane-Dick, 2006). Self-regulated learning refers to a process whereby the learner sets goals for his/her learning, monitors, regulates and controls the actions, cognition and motivation needed to achieve the goal (Zimmerman & Labuhn, 2012). One central aspect of self-regulation is learners' ability to regulate learning through metacognitive processes. Metacognition refers to "cognition about cognition", and is involved in monitoring and control of various cognitive activities (Koriat, 2007; Metcalfe, 2000). Theories of self-regulated learning also include feedback, self and peer assessment, and "social forms of learning" (Zimmerman & Labuhn, 2012, p. 399). A theoretical lens by which to explore *student engagement* with feedback is Zimmerman's model (Zimmerman & Labuhn, 2012) of self-regulated learning. This framework consists of three cyclic phases. *The first phase,* the forethought phase, relates to the objectives and the planning work needed to achieve the goals. *The second phase,* the performance and control phase, includes metacognitive monitoring and learning strategies. *The third phase,* the reflection phase, is related to the evaluation of outcomes in relation to the effort put in, or adjusting strategies (Zimmerman & Labuhn, 2012). These phases can coincide with Hattie and Timperley (2007) questions "where am I going?", "how am I doing?", and "where to go next?" (Andrade, 2010).

In recent years, there has been an increased focus on feedback and how to give feedback, and a large body of literature has emerged providing evidence for effective feedback practice (Evans, 2013; Hattie & Timperley, 2007; Shute, 2008). Based on the works of Boud & Molloy, 2013; Nicol and Macfarlane-Dick (2006), Carless, Salter, Yang, and Lam (2011), Orsmond, Maw, Park, Gomez, and Crook (2013), and Evans' (2013), a formative feedback practice in higher education is characterized, i.a., by:

- Feedback should clarify good performance and be aligned to the purpose of learning and learning objectives;
- Support the process of creating learning tasks that make student learning visible and encourage reflections around evidence of learning;
- Feedback processes where students together with their peers are encouraged to monitor and evaluate their own learning;
- Feedback processes where feedback from various sources is used to support student learning;
- Students are encouraged to engage in feedback in dialogue with their peers and teachers;
- Feedback processes that support students in skills for planning their learning; and
- Feedback should be an on-going process and be used to shape teaching.

Despite agreement that feedback practices should be characterized by dialogue, students often experience limited opportunities to actually engage in real feedback dialogues, for example to explain their thoughts, or to pose questions to their tutor (Blair & McGinty, 2013). Students often experience that the feedback they receive is insufficient when it comes to applying it in their own learning process, and they also find the interpretation and use of feedback to be problematic. This is referred to as *the feedback gap,* the "gap between receiving and acting on feedback" (Evans, 2013, p. 94). There are various reasons why students do not use feedback: they do not find it helpful in addressing what they need to work on; they do not understand the feedback or how to apply it. It is also common that students use feedback only as an indicator of how they are doing, rather than engaging with feedback in their own course work (Jonsson, 2012). Therefore, when studying formative feedback practices, it is vital to examine how students engage with feedback in their own learning process (Fluckinger et al. 2010; Nicol, Thomson, & Breslin, 2014). How students engage with feedback is a core area of research on formative feedback practices.

1.2. Can feedback clickers support a formative feedback practice in lectures?

Digital technologies represent new opportunities and approaches to teaching, learning and assessment in higher education. E-assessment refers to any type of digital technology that is used for the purpose of formative and summative assessment (Evans, 2013; Stödberg, 2012). Research on e-assessment concludes that essential for its success is the way technology is integrated in the course design and how it is used (Evans, 2013). Questions to be asked when using technology to support a formative assessment practice is to what extent and how

the technology can support different feedback processes that involve students and peers in dialogues on qualities of learning, provide dialogue on how to close the gap between current and desired performance and support the process of creating learning tasks that make student learning visible and encourage reflections around evidence of learning (Black & Wiliam, 2009).

Previous studies have found that using clickers in lectures can increase student engagement and participation (Han & Finkelstein, 2013; Oigara & Keengwe, 2013), that students read more (Lantz, 2010), and that they are more focused during class (Cain, Black, & Rohr, 2009). Even though most of the literature in this field report an increase in self-reported learning outcome when clickers are used (Nelson, Hartling, Campbell, & Oswald, 2012), studies show mixed results when it comes to objective learning outcome (e.g. tests or exam score). A review on the effect of clicker use on learning outcome (Nelson et al., 2012) found evidence to suggest that use of feedback clickers may improve both short term and long term learning, but stated that the findings were more apparent in studies that compared lectures using feedback clickers with traditional (non-interactive) lectures. This result indicates that the positive results might be related to the active learning in general rather than the use of clickers.

Several authors have suggested that there is an improvement in the *quality* of peer discussions, along with an increase in the *quantity* of these discussions (Caldwell, 2007; Kay & LeSage, 2009; Mollborn & Hoekstra, 2010; Nielsen, 2012). Again, some authors have indicated that it is the process of *asking questions* (Anthis, 2011; Morse, Ruggieri, & Whelan-Berry, 2010) or *an interactive lecture style* that promotes student engagement, not necessarily the technology *per se*. Other findings indicates that the use of technology added a dimension beyond asking questions in lectures or engaging students in peer discussions (Krumsvik & Ludvigsen, 2012). Studies that analysed peer-discussion in clicker questions revealed that even when the majority of the students responded correctly, some had misunderstood the concept they were discussing (James & Willoughby, 2011; Nielsen, 2012). This shows that there is an uncertainty involved in interpreting students' responses to clicker questions and that the results of a clicker session *can* be misleading for the students as well as for the lecturer (Nielsen, 2012). A key to the formative feedback practice is to allow students to monitor their own learning. If, as in these cases, what is visible to the students and the teachers is based on the wrong assumptions, it would result in misleading feedback. When studying these technologies, one must ensure that certain vital questions are asked: "Do clickers provide good enough evidence of students' understanding of different concepts? What is actually visible, and to whom? How can results be used to shape teaching and learning?"

Despite the large body of literature on student response systems focussing on how students like or experience the feedback *during* lectures (Voelkel & Bennett, 2014), there is less literature on how students *apply* the feedback to their own course work or how student response technology supports students in changing their learning strategies. Some studies show that the use of clickers has little influence on preparation for class or work outside class (Boyle & Nicol, 2003; MacGeorge, et al., 2008). Regarding how student response systems can support formative feedback practices in lectures, there is a need to investigate how students engage and work with feedback, both in lectures and in their course work.

2. Context of the study

The context of the study is a course in qualitative method for first-year psychology students (bachelor degree), organized in the spring semester of 2013. The learning objectives of this course were to equip students with knowledge on how to design and conduct qualitative research and analysis. Furthermore, students should have knowledge on strengths, weaknesses and ethical dilemma of various qualitative approaches, as well as the scientific basis of qualitative methods and how they differ from quantitative research design and data collection methods. They should also know how to design different phases within a qualitative research project and how qualitative research design can be integrated with quantitative approaches.

2.1. Overall course design

The course was organized in five lectures (2 x 45 min), followed by four seminars and self-studies supported by a course website and a Facebook page. Out of the 350 students who were enrolled in the course, 220 were usually following the lectures which were given as doublets every week. Exam was organized at campus and students could choose to write an essay in either qualitative or quantitative method. The examination paper in qualitative methods, spring 2013 was to give an account of a qualitative research design model and discuss what kind of function the research question has in this model. How the particular teaching and learning activities in the course were aligned to the formative and the summative assessment task is presented in Fig. 1.

2.2. Question driven lecturing design

To encourage students to monitor and evaluate their own understanding of concepts, students were asked to discuss conceptual questions in peer groups; then each student used a clicker to give their own answers. Clickers were delivered when the students entered the lecture hall. In the first lecture, there was a short briefing about the technology and the purpose of using clicker questions in the course. Every lecture had 4–6 feedback loops, as illustrated in Fig. 2.

The formative assessment activities (the questions) in the lecture were aligned to the learning objectives of the course (knowledge, skills and general competence). The purpose of the questions was twofold, first to address core concepts in the course work readings and the lecture material. Second to apply these concepts from course literature in different cases or contexts (written or video-cases). Examples of questions are presented in Fig. 3.

Students used 1–2 min to discuss the questions. A display of the results was supposed to be a driver for a plenary class discussion, comments, questions and clarification. This allowed the lecturer to modify explanations, adjust his focus, methods, progression and teaching strategies. The lecturer's adjustment was depending on the students' responses. In all cases, an explanation of the question and the alternatives was given. An example of an assignment (clicker question) is to watch a video clip of a qualitative interview (Gibbs, 2013). Students are asked to assess the interview in light of ten criteria for conducting good qualitative interviews presented by Kvale and Brinkmann (2009). Figs. 4 and 5 give an example of a reflection question and the corresponding student responses. Displayed answers are used as backdrops for a plenary group discussion.

Learning Objectives	Teaching and learning activities	Spaces for formative feedback	Summative assessment
	Question driven lectures	• SRS-feedback • Lecture feedback • Peer discussions • Whole class discussions • Questions and clarifications	
The learning objectives of this course were to equip students with knowledge on how to design and conduct qualitative research and analysis (see p. 9 for more details).	Seminars	• Peer and tutor feedback on student essays. • Discussions on course work	Written exam
	Self-study	• Possibilities to ask questions • Possibilities to self-assessment (quiz) • Display of clicker questions results	

Fig. 1. Course design.

Fig. 2. Question driven lectures.

Examples of questions addressing course work	Applying concepts in various cases:
Questions addressing: • differences between qualitative and quantitative methods • characteristics of qualitative methods • differences between qualitative and quantitative research design • validity or selection procedures in qualitative research • theoretical frameworks in qualitative research	Questions were students are supposed to: • assess different research situations • connect different research designs to different research questions • discuss and develop research questions • assess different types of research questions • assess validity and validity threats

Fig. 3. Examples of questions.

Fig. 4. Reflection question.

Fig. 5. Students' responses to reflection question.

3. Methods

3.1. The present study: A mixed method research approach

Design Based Research (DBRC, 2003) is used as the overall research design for the study. Using both qualitative and quantitative data in this design based research allows us to study interventions such as ICT supported feedback practice from different perspectives. More specifically, the study is grounded on a mixed methods research design (Johnson, Onwuegbuzie, & Turner, 2007) where the quantitative and qualitative elements (survey and interview) are integrated in the design.

3.2. The quantitative phase: Developing the survey

The purpose of the quantitative phase was twofold. First, to address the extent to which the students perceived that use of student response systems in lectures supported the process of monitoring their own learning in the lecture, as well as the extent to which the students made use of the feedback to support their course work. Second, we wanted to address whether there is a relationship between the extent to which students reported that they used clickers to monitor their own learning, and the extent to which they reported that they used the feedback in their course work.

In the first phase, quantitative data was collected via a survey. The survey was developed from a previous survey, used in a study assessing students' perception of feedback and learning outcome in large lectures (Krumsvik & Ludvigsen, 2012). This study concluded that students used clicker questions to identify concepts they did not understand. To explore these questions further we developed a survey and an interview guide addressing three broad themes: *Perception of the lecture as a space for feedback*, *student use of feedback in course work* and *teacher and peer dialogue*.

In the first category; *Perception of the lecture as a space for feedback*, questions were developed to capture the extent to which students experienced clickers to support them in monitoring their understanding of course topics, grasp the purpose of what they were supposed

to learn, clarify misunderstandings, give them insight in their strengths and weaknesses, or make them reflect more on the subject matter. For the second category; *student use of feedback in course work*, we developed general survey questions addressing different ways students used feedback in their course work, e.g to read more, to clarify concepts they did not understand, to improve the way they study, to discuss with peers. In the third category; *teacher and peer dialogue,* questions addressed to what extent and how feedback clickers supported the teacher and peer dialogue. Fig. 6 visualizes how the quantitative and the qualitative components are linked together, and how the two components are supposed to shed light on each other:

The survey was also designed to explore any differences that might exist in students' opinions relating to a number of characteristics: age, motivation, preference for presentation tools, gender, grade and academic experience. To ensure good quality in the wording of the questions, external experts in quantitative methods were consulted. We asked the students to rank degrees of agreement with different statements/claims using a seven point Likert scale. To be able to capture students' reflections about their experience, feedback clickers were used to collect data in real time immediately after the lecture. All students who attended the last of the five lectures were asked to answer the survey.

Regarding ethical considerations on collecting and storing of research data, this project was approved by the Norwegian Social Science Data Services (NSD). Participation was voluntary, and before the data collection started, the students were given a verbal orientation about the purpose of the survey and the storing of data.
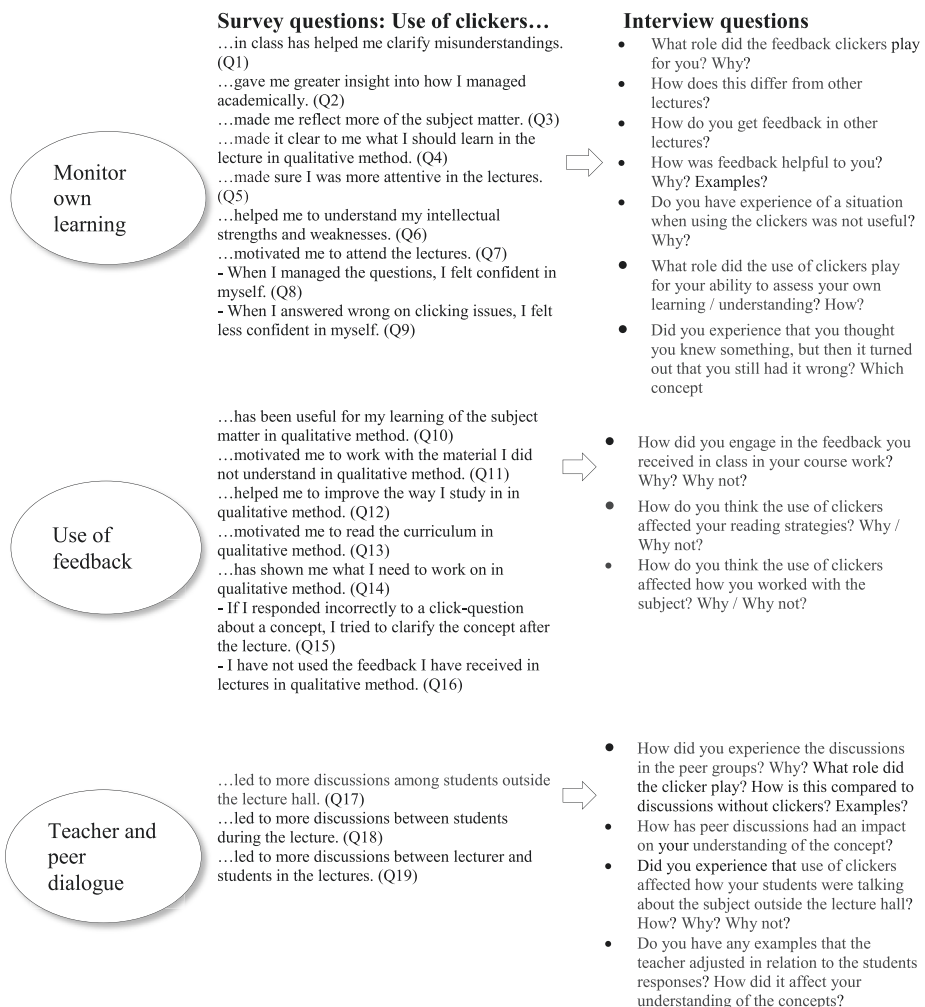

Fig. 6. Survey and interview questions.

3.3. The qualitative phase

The purpose of the interview was to understand *how* students perceived the lecture as a space for feedback and how they worked with the feedback in their course work. Phenomenological or ethnographic approaches can offer deeper insight into the thoughts and explanations given by those who are engaged in the process of monitoring and regulating their learning processes than what can be captured using questionnaires alone (Dinsmore, Alexander, & Loughlin, 2008). Results of the survey were used to develop an interview guide for the second phase. Some of the questions regarding monitoring and peer interaction were used in our previous work (Krumsvik & Ludvigsen, 2012). The interview guide had three broad themes of investigation: *How clicker questions and peer discussions supported the learning of concepts during the lecture, how students used feedback in their course work, and what role the technology response system played in these two processes.*

Six semi-structured interviews were conducted. The sample is based on voluntary participation, and the sampling can be characterized as purposive (Teddlie & Tashakkori, 2009). We have chosen informants from the quantitative sample to the follow-up interviews. Students were recruited by invitation in the end of the last lecture and invitation by e-mail to all the students participating in the course. Six students volunteered. Of the six students, all girls, four were first-year students (Ane, Ingrid, Karen and Marie) and two students with more than one year of experience (Hege and Stine). All the informants had high grades from upper secondary school. The semi-structured interviews lasted from 40 min to more than one hour, and were conducted the week following the last lecture. The interviews were analyzed using a thematic analysis in Nvivo10. The six transcripts were coded by looking for different themes and sub-themes. The number of sources coded, how many references coded in each particular category and underlying themes are illustrated in the screen shot below (Fig. 7).

3.4. Integration of qualitative and quantitative data

The purpose of the mixing of methods was to explain and add depth to findings in the survey and allow the students to bring in new perspectives that were not captured in the questionnaire. This purpose can be characterized as both "complementary" and explanatory (Greene, Caracelli, & Graham, 1989, p. 259) and the study can be characterized as a sequential, explanatory mixed-method design. In this study, we prefer to use the metaphors *conversation* and *dialogue*, with the metaphor *conversation* referring to how one part of the study informs the next phase, and the metaphor *dialogue* refers to going back and forth between the two data sets and investigating the research questions (Bazeley & Kemp, 2012).

Onwuegbuzie and Johnson (2006) argue that "*because mixed research involves combining complementary strengths and non-overlapping weaknesses of quantitative and qualitative research, assessing the validity of findings is particularly complex; we call this the problem of integration*" (Onwuegbuzie & Johnson, 2006, p. 48). The integration occurred in different stages throughout the entire project. First, in the conceptualizing phase, qualitative and quantitative research questions were introduced; then when the results of the survey informed the development of the interview guide and in writing the conclusion based on both qualitative and quantitative data. We have aimed to address the same research question, however from different angles. Acknowledging both the quantitative and the qualitative tradition we have strived to be transparent regarding our research design, the stages of the data collection, data analysis and integration. The model below (Fig. 8) visualizes the design of the study.

Nodes			
Name		Sources	References
1.Lectures - Reflect on own understanding		6	119
Active engagement		6	19
Compare results with peer		5	8
Examples of adjsutments in lecture		6	16
Peer discussion Thinking together (listen and argue)		6	14
Reflect on own understanding during the lecture		6	62
2. Lectures - Motivation		6	33
3. Lectures - Compare with traditional		6	67
Fear for speaking in large lectures		4	12
Harder to monitor own learning without clickers		5	22
Likes anonymity		3	3
More commitment than without clickers		3	7
Peer discussios more focused discussion		4	7
Traditinal lectures as passive		6	16
4. Use of feedback in course work		6	49
Ask more questions and change study habits		1	4
Discuss with peer during breaks after lectures		4	15
Focus reading		6	21

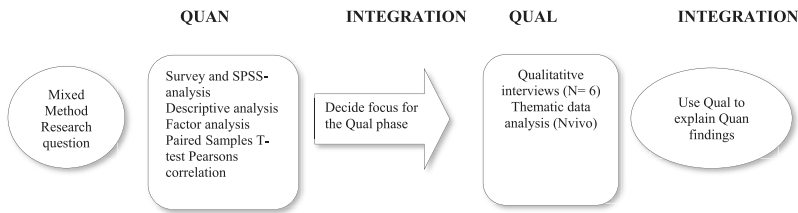**Fig. 7.** Screen print from NVivo10, illustrating themes coded.

Fig. 8. Sequential mixed methods design.

4. Data analysis: Findings from the quantitative phase

To analyse the data from the quantitative phase we used factor analysis, descriptive data analysis, mean difference analysis (t-test), and correlational analysis. We conducted all analyses using SPSS statistics 22.

4.1. Participants

The sample consisted of 149 participants (women = 118, men = 21, missing = 10). 25% of the students were younger than 20 years, 63% of the students were 20–25 years old and only 6 of the students were 25 or older. All of the students had received high grades from upper secondary school, and the majority of the students (70%) were highly motivated to succeed the course. Of the students participating in this study, 73% were first year students. When asked about the extent to which they preferred presentation tools, 47% preferred some use while 53% preferred much use.

4.2. Results of factor analysis

Although the sample is small (N = 149), the assessment of the suitability of the data for factor analysis KMO (Kaiser-Meyer-Olkin Measure of Sampling Adequacy) was .807, and Bartlett's is significant (p < .000). Based on theory pertaining to formative assessment and in an effort to bring a simpler structure to the 19 items that were included in the survey, we performed a confirmatory factor analysis. This analysis revealed two factors related to the timing for feedback. The first factor with questions regarding how feedback impacts learning during the lecture named *How feedback impacts learning during lecture* (Factor 1). The second factor with questions regarding how feedback impacts learning outside the lecture, named *How feedback impact learning outside the lecture* (Factor 2). Questions addressing peer and teacher dialogue turned out to have a Cronbach's Alpha too low to represent a separate scale. However, one of these items, Q17, is included in factor 1.

Factor 1, *How feedback impacts learning during lecture*, (Cronbach's Alpha = .74) consisted of items Q1, Q2, Q3, Q4, Q5, Q6 and Q18 and addressed how students used feedback to monitor their own learning during the lecture. Table 1 shows the distribution of responses of the variables in factor 1.

Factor 2, *How feedback impact learning outside the lecture* (Cronbach's Alpha = .71) consisted of items Q10, Q11, Q12, Q13, Q14 and Q15 and addressed the use of feedback to support students' course work. In this case, the majority of the responses were positive only on the general question addressing the usefulness of feedback clickers to indicate what they need to work on, while the answers to other questions targeting more explicit use of feedback are much more diverse. Table 2 shows the distribution of responses of the variables in factor 2.

4.3. Descriptive statistics, mean differences, and correlational analysis for factor 1 and factor 2

Mean score on factor 1 (How feedback impacts learning during lecture) and factor 2 (How feedback impact of learning outside the lecture) was 5.3 (SD = .97) and 4.2 (SD = 1.09), respectively. A Paired Samples T-test showed that the mean difference between these two factors was significant [$t(146) = 1.10$, p > .000]. This indicates a gap between factor 1 and factor 2, meaning that students are more likely to report that they use feedback during lectures to monitor their own learning, but that they do not apply the feedback to their own course work to the same extent.

Table 1
How feedback impacts learning during lecture (factor 1).

	Agree (%)			Disagree (%)			
Q1: Use of feedback clickers in class has helped me clarify misunderstandings	34.2	34.2	13.7	8.9	3.4	4.1	1.4
Q2: Use of feedback clickers gave me greater insight into how I managed academically	16.6	24.1	30.3	15.9	6.2	2.8	4.1
Q3: Use of feedback clickers made me reflect more on the subject matter	20.7	31.0	22.8	13.8	6.2	2.1	3.4
Q4: Use of feedback clickers made it clear to me what I should learn in the lecture in qualitative method	11.8	27.1	36.1	12.5	6.3	3.5	2.8
Q5: Use of feedback clickers made sure I was more attentive in the lectures	43.2	30.1	15.1	4.1	2.7	2.7	2.1
Q6: Feedback clickers helped me to understand my intellectual strengths and weaknesses	11	16.4	21.2	20.5	20.5	5.5	4.8
Q 18: Use of feedback clickers led to more discussions between students during the lecture	61.6	17.8	11.0	4.1	2.7	0.7	2.1

A seven-point Likert scale was used.

Table 2
How feedback impact learning outside the lecture (factor 2). Questions in factor 2.

	Agree (%)			Disagree (%)		
Q 10: Use of feedback clickers has been useful for my learning of the subject matter in qualitative method	40.1	23.1	21.1	6.1	6.1	3.4	0
Q 11: Use of feedback clickers motivated me to work with the material I did not understand in qualitative method	7.6	11	24.1	20.7	17.9	7.6	11.0
Q 12: Clickers helped me to improve the way I study in qualitative method	2.7	6.8	23.3	21.2	19.9	9.6	16.4
Q:13 Use of feedback clickers motivated me to read the curriculum in qualitative method	2.8	11.8	12.5	16.7	13.9	13.2	29.2
Q 14: Use of feedback clickers has shown me what I need to work on in qualitative method	20.0	26.2	30.3	12.4	6.9	4.1	0
Q16: If I responded incorrectly to a clicker question about a concept, I tried to clarify the concept after the lecture	13.8	17.2	19.3	11.7	10.3	10.3	17.2

A seven-point Likert scale was used.

A correlational analysis (Pearson) showed that there was a strong positive correlation between factor 1 and factor 2 ($r = .68$, p < .000). In other words, students who used clicker questions to monitor their own learning during the lecture also more often used feedback to support their own learning during the whole course. Furthermore, we found a negative correlation between the background variable *student experience* and *factor 1* ($r = -.26$, P <. 001) as well as *student experience* and *factor 2* ($r = -.17$, p < .034), indicating that more experienced students find that clickers supported them in their learning to a lesser extent than less experienced students. Although these correlations were significant, they are weak and should therefore be treated with caution.

5. Qualitative findings

The purpose of the qualitative phase was to examine more in depth how clicker questions and peer discussions supported students in monitoring their own learning during the lecture, how students used feedback in their course work, and what role the student response system played in these two processes. We also wanted to address the feedback gap that had been identified in the survey, in terms of how students use feedback in their learning, but equally important, to ascertain why they do not use feedback. First, we present findings on how students experience the process of monitoring their own learning using clicker questions in lectures. Second, we present how students in the sample used feedback in their own learning process. A presentation of the six students (referred as pseudonyms) is found in Appendix A.

5.1. How do students experience the process of monitoring their own learning using clicker questions in lectures?

Results from the survey showed that the mean score in factor 1 (How feedback impact learning in the lecture) was 5,7, indicating that the majority of the student found that the use of clicker questions during the lectures supported them in monitoring their own understanding. However, what lies behind these numbers? How do students explain this? All the students pointed out that the questions supported them in identifying *key concepts* and *basic ideas* in the field of qualitative methods, and as a summary of the different parts of the lecture and the curriculum. A first-year student used the metaphor of a *key* to explain the meaning of the term clicker question:

It may be the key to pretty much. That is what the clicker questions are. They are the keys. (Ingrid)

Clickers have helped me identify main themes and characteristics (Stine).

A clear aim is connected to the *forethought phase* (Zimmerman & Labuhn, 2012) and Hattie and Timperley (2007) question '*where am I going?*'. All students emphasize that working with questions during the lectures is an active way of engaging with course material while allowing time to reflect on concepts during the lecture:

It is seldom I sit in another lecture and think: Do I really know this? It doesn't happen, because you just sit and take in the knowledge. (…) once it is being told to me, I get the feeling that I know this, right? It sounds logical, everything is put together, so you feel like you can do everything that you're told, but if you are asked questions, you will become all the more aware of what you are unsure of. (Hege)

The quote above is interesting. Hege uses different modes for describing the two contexts: traditional lectures and question-driven lectures. When describing traditional lectures, she refers to a passive mode: *Sit and take in the knowledge.* When describing question driven lectures, she refers to an active mode: *"but if you are asked questions, you will become all the more aware of what you are unsure of"*. She feels a commitment to reflect on and give answers to the questions posed in the lecture. This is a typical quote from all the informants in the qualitative material; they use the questions to monitor their own understanding of concept and themes; *"you maintain more control over what you know and don't know, you have more control, like metacognitions then"* (Karen). This makes it easier for them to know where they need to put in extra effort: *"And then I become conscious of what I am unsure of"* (Ingrid). This quote refers to a metacognitive awareness of one's own understanding during the lectures and is a recurrent view of all the informants in the interviews. The peer-discussions are rated high in the survey and are emphasized in the interviews as being the most useful aspect of using clicker questions during a lecture. Students did experience that participating in peer discussions makes their own and others' understanding of ideas clear. The opportunity to share and argue in favour of their own views, as well as to discuss each other's understanding of concepts allowed them to see alternative ways of thinking about a phenomenon or concept:

Very often there are different opinions. Then you have to argue why. Argue for what you believe, what they mean, so you get different points of view (…) So you get the more insight into how it is possible to think or to look at a problem or a question, other views. (Karen)

This quote is chosen because it is typical of the sample. Karen describes how peer discussions are spaces in which the student gets feedback on his/her own views and understandings, both by arguing for one's own thoughts and listening to the perspectives of others. In the discussion, they can adjust and monitor their own understanding of concepts discussed. One student experienced that she develops her arguments *during* discussions and becomes aware her own understanding:

It means a lot for how you organize your thoughts, for me at least. I notice that I cannot answer the questions until I discuss them out loud (…) you argue with someone about why (your ideas) are right, and then suddenly you find arguments for why it is right and why it is wrong. (Ane)

In the quote above, she describes how she becomes aware of her own and her peers' views, and together they find arguments for reaching a conclusion. Findings based on interviews indicated an improvement in the quality as well as the quantity of peer discussions. When students described quality, four aspects were highlighted. Most important was the fact that the students had to give an answer, and therefore engaged in the process of discussing questions in the first place. They listened to what the others had to say and used this actively to adjust their own understanding and to draw their own conclusions. Questions were used to monitor their own understanding of the concepts under discussion and to evaluate their own learning process. The quotes above are connected to the *performance and control phase* (Zimmerman & Labuhn, 2012), and to the question of '*how am I doing?*' (Hattie & Timperley, 2007). It seems clear that discussions with peers are important in the design and that students value them. The responses highlight opportunities to listen to others and to argue for one's own understanding or views, to keep discussions on track and to seek a joint conclusion.

All the six students emphasized the value of the teacher discussing the results and explaining concepts after a clicker questions session. One student (Marie) argued that how the clickers had affected the lecturer was the most important aspect of using clickers in the lecture:

It is maybe not how it (use of clickers) affects me, but maybe how it affects the lecturer. Because when he sees the results, he gets a good idea of what has been understood, and what has not been well understood, or if something is unclear. If he has been unclear, or if things are difficult, he adjusts his lecture after the results and this is very positive. At least I think so. (Marie).

All the students were aware of that the results of clicker questions allowed the lecturer to adjust his teaching, explain more detailed or comment on the different alternatives. This gave them the opportunity to clarify, argue in favour of their own perspective, ask questions, and the discussions gave them a sense of active participation. Clickers play an important role in this sense:

It's like the connection between the PowerPoints and lectures and the theme. (…) essentially the line between me and the curriculum and between me and lecturer. (Ingrid)

Students are familiar with questions and peer discussions in lectures. However, are they different from clicker questions, and how do students explain this? We asked the students to describe their engagement with questions with and without clickers. Although students are used to questions in other lectures, they do not assess them in a similar way, they maintain that questions *without* clickers are
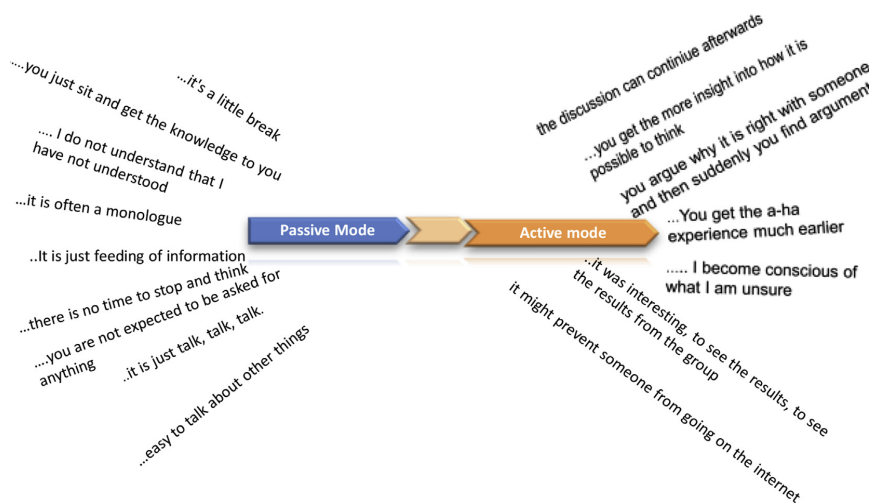

Fig. 9. Passive and active modes.

in some sense different from questions you *actually have to answer* (clicker questions), or as one student said: "*in other lectures you are not expected to be asked for anything*" (Hege). And when there *are* questions in lectures, students do not feel that they actually have to get involved or engage in them. When describing how the use of clicker questions in lectures support their learning, students refer to traditional lectures as passive mode, while the question driven lectures represent an active mode. Again, we find the two dimensions passive and active described. This is evident in all the interviews. In Fig. 9, the quotes are placed along these two dimensions. In passive mode, students in the sample talk about traditional lectures. In active mode, students talk about question driven lectures.

Reading the transcripts, it seems evident that using question-driven lecturing supports students in monitoring their own learning and provides a sense of participation. Clicker questions mediate a space for productive peer discussion. Using clickers moves the lecture from a passive mode to an active mode, enabling students to engage with their own understanding.

5.2. How do students use feedback in their own course work?

The opportunity to provide immediate feedback on the students' understanding of terms and concepts is highlighted as the most important aspect of using feedback clickers. However, there is a difference between becoming *aware* of the terms or concepts that one does not understand, and taking action in order to achieve a greater level of understanding. The interviews showed examples of various ways students addressed feedback in their own learning. One approach is simply to use feedback as a guideline or an indicator of how they are doing. Students with a more active approach used feedback to identify gaps in their own understanding and noted concepts or themes that they needed to look into in more detail. Questions are also triggers for further discussion, and students discussed the questions with their peers after lectures and during breaks.

> You get the a-ha experience much earlier, I think it's very important, especially because you can also talk to others about it right away. Right? (Marie).

An a-ha experience is a typical metacognitive activity and in this case, is a trigger for further exploration. During breaks, questions, alternatives posed and possible explanations for why they answered as they did, are discussed.

> He says we should discuss with the person sitting next to us every time, but the problem is that the discussion can continue afterwards; we continue talking, discussing the issue, we do it anyway. We have to discuss it during the break and stuff like that (Stine)

One stated that when she experiences a gap in her own understanding, her purpose for reading becomes to "*check concepts*" or "*go through the chapter again*". Some of the student said that they "*read in a more focused way*" and "*focus more on details*". Only one of the students had strategies beyond reading more or address difficult topics with her peers or with the lecturer. When Ane identified concepts she did not understand, she wrote assignments connected to these topics: "*I also write about the task, the topics that I knew least. I always do. I always take the most difficult topics, to challenge myself*". In this case, the questions helped to focus her course work.

During the course, Hege changed her learning strategies. First, she started to read in a more focused way; then she questioned herself as she was working with the course material. She has experienced that working with questions in the lectures raised her awareness on how questions supports her to engage with concepts both in the lecture and when she is reading:

> I have noticed that asking questions means a lot for whether I understand (the course material) Right? I become more conscious. (Hege)

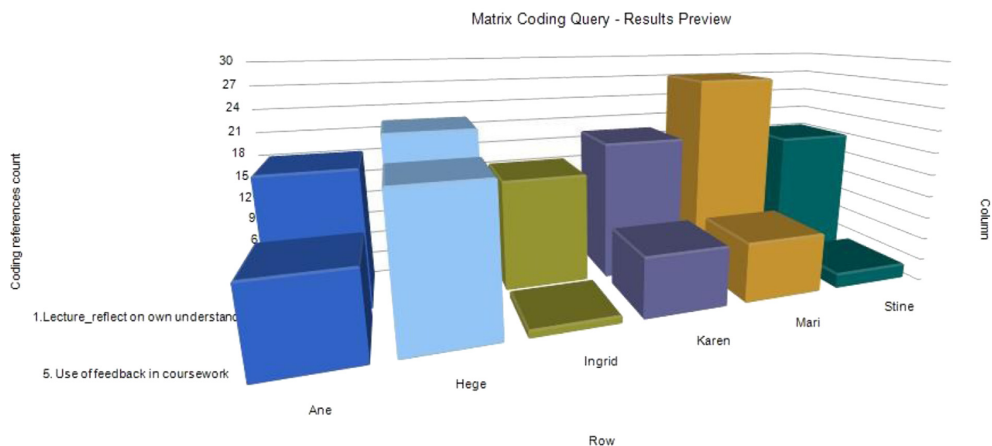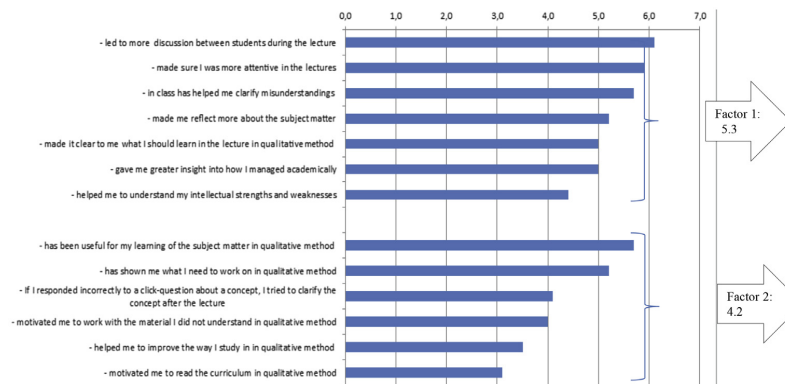**Fig. 10.** Quantification of qualitative data.

QUANTITATIVE PHASE   QUALITATIVE

                                                                           PHASE

Fig. 11. Quantitative and qualitative findings.

Working with clickers has changed her view of learning and how she can learn:

This is something I will carry with me the rest of my life, in my work life as well. If I shall learn something, I can just ask: Ok, did I understand this? Do I know this? Just to check for myself. I will use it the rest of my life. I think it is very nice. (Hege)

This supports the process of monitoring one's own understanding and is a key characteristic of self-regulated learning. The quotes above can be associated with both *the reflection phase* (Zimmerman & Labuhn, 2012) and the question 'where to go next?' (Hattie & Timperley, 2007). The six students apply or emphasize different strategies; some have just one approach, while other applies several approaches. This is illustrated in Fig. 10, which illustrates references coded for the node *reflection on own learning during lecture*, and the node *use of feedback in course work*. The model visualizes how much of the transcript was coded at different themes and illustrates that students in the sample, both as individuals and as a group, are more concerned of how clicker questions support them to reflect on their own understanding during lectures, than actually applying feedback in their own course work.

We have found five approaches by which this practice supports students' work. First and most common, students use feedback to check if their learning is on track. Second, they use it to address difficult concepts with their peers or teacher. Third, they use it to adjust and focus their reading. Fourth, they use questions to identify difficult topics that they need to explore in more depth. Fifth, one student realizes that she need to change her overall learning strategies, in this case, she has discovered how asking more questions supports her learning. The students that did not engage in the feedback experienced that they had given correct (or mostly correct) answers, and therefore felt they didn't need to work more on the concepts. In the model below (Fig. 11), main findings from the quantitative and the qualitative phase are presented.

6. Discussions and conclusion

6.1. How do students experience the process of monitoring their own learning using clicker questions in lectures and how do they apply feedback in their own course work?

In this article, we have had four areas of investigation. The first question was to what extent and how do students experience the process of monitoring their own learning using clicker questions in lectures. Students in the qualitative sample emphasized the reflection questions as a space for feedback, to explain their thoughts and reflect on their own understanding. The questions were developed to address key concepts in the curriculum. Students found that clicker questions supported them in identifying those concepts and allowed them to be active and engage with the concepts during the lecture. Knowing the standards or the objectives of the learning is the key to a formative feedback practice (Hattie & Timperley, 2007). Questions and peer-discussion allowed students to reflect on their own learning process during the lecture. This is an example of how feedback clickers supported the creation of "moments of contingency" (Leahy, Lyon, Thompson, & Wiliam, 2005, p. 6). Clicker questions can create those 'moments', allowing the students to monitor and reflect on their learning during the lecture, or as Clark states: "the blend of monitoring and reflecting which together permit the reshaping of what being worked on while working on it" (Clark, 2012, p. 212). The technology plays an important role because possibilities of giving and getting feedback on answers created a sense of commitment, engagement and participation. Both in

the survey and in the interviews, peer discussion was highlighted as most useful for monitoring one's own understanding and making learning visible. Reflecting on/monitoring one's own understanding through peer discussions created a sense of participation in the lecture. Findings based on interviews indicated an improvement in the quality as well as the quantity of peer discussions when clickers were used to foster peer discussion in lectures. Students said that they listened to what the others were saying and used this actively to adjust their own understanding and to draw their own conclusions. They used discussions to monitor their own understanding of the concepts discussed. All six informants emphasized these aspects. The students found that *both the clicker* and *the question* asked by the lecturer played a significant role in their engagement. The fact that students *have* to choose an answer ensured that peer-to-peer conversations were more focused and effective. An analysis of the conversations between the students could be useful for future studies in order to establish how use of feedback clickers may contribute to the students' brainstorming. Important topics for further research include ascertaining how lecturers are able to make sense of and use the feedback to adjust their teaching, both in the short and long terms.

The second question was to what extent and how students applied feedback in their own course work. The survey questions addressing different ways students used feedback in their course work, for example to read more, clarify concepts they did not understand, improve the way they study, discuss with peers, work on things they do not understand and help change the way they study. Findings in the survey indicated a feedback gap; a majority of the students like to get feedback on their own understanding during lectures, but they do not report that they apply the feedback to their own course work to the same extent. This was also reflected in the interviews and was in line with previous literature (Evans, 2013). It is interesting to note that for the general questions, like "*Use of feedback clickers has shown me what I need to work on in qualitative method*" (Q 10), the majority of the students answer on the left side of the scale (agree) while for the more specific question, "*Use of feedback clickers motivated me to read the curriculum in qualitative method*"(Q13), the majority answer on the right side of the scale (disagree). However, in the interview, five students said that they read more focused. It might be that the clickers were not motivating them to read, but rather changed the way they were reading, something which is not captured in the survey. In another specific question, "*If I responded incorrectly to a clicker question about a concept, I tried to clarify the concept after the lecture*" (Q 16) the student's answers are equally distributed along the scale. About half of the students agree with the statement while the other half disagree. The qualitative findings showed that to ask peers after the lecture or during breaks, as well as checking in the course literature, are examples of strategies students use for clarifying concepts.

In the qualitative sample, all the six students had examples of how feedback supported their course work in a way that allowed them to make adjustments of their learning trajectories. However, the six students had different strategies, from using feedback passively, as a guide on how they are progressing, to using it strategically, to guide reading and to identify concepts for further investigation or for changing learning strategies. Even though this project had a specific focus on use of feedback *outside* of the lecture, it is clear that students were more interested to talk about what happened *in* the lecture than how this supported their course work. To be able to address the feedback gap it is important to know why students do not use feedback. The purpose of the qualitative data was to explain and add depth to the quantitative findings. However, in the interviews we do not have so much data explaining why students did not use feedback in their course work. It might be that the students who agreed to participate in the interviews, were among this group of students that found the clickers to be most useful for their learning. If students are to be able to use feedback, it is also important to design the questions appropriately. Questions designed to support a formative assessment practice should enhance reflection and challenge the understanding of concepts, rather than having only a single correct answer. Another possibility is to use other types of polling technologies, for example to poll texts, pictures, models/drawings or questions. This might change the dynamics of the lecture and open other forums for dialogue. This is yet another area for further research in the area of technology-supported formative assessment in lectures.

We found a negative correlation between the background variable *student experience* and factor 1 (*How feedback impacts learning during lecture*) as well as *student experience* and factor 2 (*How feedback impact of learning outside the lecture*) indicating that more experienced students find that clickers supported them in their learning to a lesser extent than less experienced students. Although these correlations were significant, they are weak and should therefore be treated with caution. Self-monitoring is a core aspect in the process of becoming a self-regulated learner, therefore it is not surprising that first-year students find the question-driven lectures to support them in their learning to a greater extent than more experienced students. Even though it has been a lot of research on first year students' experiences, less of this research is connected to the first year students' experience of feedback practices (Nulty, 2011). First year students face new challenges when they are introduced to an academic culture. In these processes, formative feedback plays an important role, both in clarifying standards to be achieved (Poulos & Mahony, 2008), as emotional support in the students' course work (Robinson, Pope & Holyoak, 2011), and by supporting them in developing the skills needed to become self-regulated learners (Nicol, 2009).

6.2. Is there a relationship between the extent to which students report that they use clickers for monitoring their own learning and the extent to which they use the feedback in their own learning?

The third question addressed if there was a relationship between the extent to which students report that use of student response systems support their learning in lectures, and the extent to which they report using feedback in their own learning. The quantitative findings indicated that there was a significant positive correlation between factor 1 (*How feedback impacts learning during lecture*) and factor 2 (*How feedback impact of learning outside the lecture*). This finding is also reflected in the interviews. Students who had examples of how they actively and strategically used feedback to improve their understanding of concepts, also emphasized the value of monitoring their own learning during the lecture, not only as an indicator on how they are doing, but they also acknowledged questions in lectures as a real feedback space that invites them to reflect on their undestatnding of concepts. A goal for further developing of the course design is to support students to recognize different possible spaces for feedback, both in the lectures and outside the lectures.
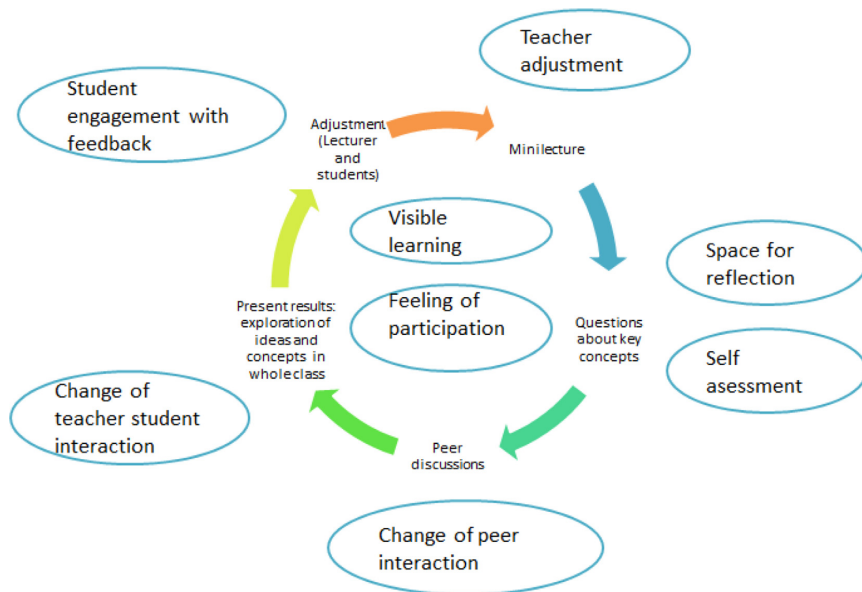
Fig. 12. The role of technology.

6.3. How does technology change the conditions for the two processes?

The fourth question addressed the role that technology played in these two processes. The technology allowed the results to be displayed during the lecture. This created a sense of participation and triggered plenary class discussion. Students experienced possibilities to engage in real feedback dialogues, for example to explain their thoughts, pose questions and challenge the teacher, as emphasized by Blair and McGinty (2013). The technology played an important role in changing the dynamics of the lecture on different levels; a space for reflection and self-assessment, a room for peers to exchange and elaborate on each other's ideas as well as the results served as a catalyst for teacher and student interaction. Fig. 12 illustrates how the questions and the clickers played an important role in the processes of creating a climate for a formative feedback practice in the lecture.

6.4. Implications

In this study, we have aimed at being transparent throughout our research design. This means that it is possible for others to replicate the study in other contexts. We found a mixed method research approach to be useful for addressing students' perception of a formative feedback practice in lectures. Using mixed method analysis allowed us to investigate the research questions from different perspectives. If they had been explored using only one method in isolation, we would not have been able to capture the complexity of the students' experiences. Thus, we tried to develop a coherent research design that is connected to pragmatism as the theoretical paradigm, to mixed method analysis as a strategy of enquiry, and to methods (survey and interviews) for collecting the empirical material to answer the research questions. One important methodological implication of the study is that the study of lectures, using clickers to collect data, can be an effective means of capturing the students' experiences during their learning processes. This improved the validity of the study. One important theoretical implication from the study is that moments of contingency can be made more explicit in this kind of technological learning environments. How clicker questions can facilitate discussions in lectures is an area for further research on technology supported formative assessment in lectures.

Acknowledgements

Appendix A

Presentation of the six students:

Ane	Hege	Ingrid
• First year student	• Second year student	• First year student
• Use of clicker questions is an opportunity to process the material and provide space for reflection.	• More conscious of her own understand of concepts.	• Finds it difficult to talk in large lectures.
• Difficult questions support her learning to a larger extent than easy questions.	• Likes anonymity.	• Questions are keys to understanding the concepts.
• Changed her reading strategies.	• Clicker questions provide an incentive to engage in less interesting topics.	• Discussions: arguing and listening to peers.
• Writes assignments when she identifies difficult concepts.	• Values peer discussions.	• Most important: Clicker is a personal tool, a connection between her, the material and the teacher.
• Peer discussion useful for reflecting on concepts.	• New strategies: works with questions in the textbooks.	
• Discusses questions during breaks.	• Discovered the value of asking questions when learning.	
• Most important: Get feedback on how she is doing.	• Most important: Get feedback on understanding.	

Karen	Marie	Stine
• First year student	• First year student	• Experience from previous university courses
• Finds the subject difficult.	• Clickers made the course material interesting.	• Made it easier to get to know fellow students.
• Afraid to talk in large lectures.	• Does not raise her hand in the lecture because she is afraid to say something wrong.	• Afraid to raise a hand and talk in the lecture.
• Right answers are triggers for her to learn more.	• Easier to remember and apply the concepts and topics she discussed with others.	• Peer discussions: Clicker questions give incentive to reach agreement in discussions.
• When she identifies difficult concepts, she writes and checks them after the lectures.	• Asks other students (during breaks) if there is anything she does not understand.	• A typical lecture (non-clicker) is something you listen to, this one is to participate.
• Peer discussions: allow her to discover different approaches to a problem.	• New strategies: Noted possible clicker questions and read more focused.	• Knowing that she is not alone in not understanding everything, makes it easier to discuss with others.
• Most important: Instant feedback.	• Most important: How use of clickers has affected the teacher.	• Emphasizes the fun.

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II

Behind the scenes: Unpacking student discussion and critical reflection in lectures

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Abstract

This study investigated the characteristics of peer discussions used to support formative assessment in lectures, facilitated by a student response system, in an undergraduate qualitative methods course for psychology students. The intent was to examine the characteristics of peer discussions in which student response systems are used to facilitate the practice of formative assessment lectures. The research was guided by the following research questions: (1) What patterns of talk can be identified in the discussions? (2) How do the students use subject-specific vocabulary in the discussions? (3) How is the students' understanding of the subject matter displayed in these discussions? To examine the characteristics of peer interactions, 87 student discussions were recorded and analysed. The concept of *exploratory talk* (Littleton & Mercer, 2013) was used as a lens to examine the discussions. In 68 of the 87 discussions, the students exchanged ideas and elaborated on their peers' ideas and understanding of the concepts. In the remaining 25 discussions the process of reasoning was less visible. The findings are relevant for teaching designs that aims to use digital tools to facilitate formative assessment.

Practitioner Notes

What is already known about this topic:
- Student response systems can support formative assessment and feedback in lectures.
- The most common approaches used in research on student response systems to support formative assessment is questionnaires or interviews
- Few studies have provided detailed analyses of clicker-supported peer discussions.

What the paper adds:
- Provides insights into the micro-processes in clicker-supported discussions.
- Critically discusses the role of discussions facilitated by student response systems to support formative feedback in the classroom. It also explores their role in making understanding visible for the students and the lecturer.
- The article contributes to scholarship in this field by drawing attention to the qualities of the activities created for formative assessment.
- Discusses the validity of the inferences drawn from the use of student response systems in the classroom.

Implications for policy and practice:
- Analysis of discussions shows that there is not necessarily a correlation between aggregated answers and students' understanding. To ensure that valid inferences can be drawn from activities as a basis for feedback, the questions used and threats to the validity of possible inferences should be critically examined.

Introduction

This study investigated the characteristics of peer discussions facilitated by a student response system (Turning Point) to support formative assessment in lectures, in a qualitative methods course for undergraduate psychology students. A key process in formative assessment is to make learning visible through 'moments of contingency' (Black & Wiliam, 2009, p. 10), situations and activities in which students are encouraged to articulate their thinking and understanding so information generated from these activities can be used to shape ongoing teaching and learning activities. Furthermore, formative assessment should support self-regulated learning (Boud & Soler, 2016; Clark, 2012; Evans, 2013). A vital question when examining formative assessment activities is, to what extent do they provide students with opportunities to share their thinking, and what opportunities become available to students and teachers to draw inferences through these activities to shape teaching and learning (Furtak et al, 2016) –referred to as moments of contingency.

In lectures, formative assessment activities often include the use of different kind of student response system that elicit quantitative or qualitative answers to questions. The value of student response systems to support formative assessment lies in technological opportunities to make the reflections of the students visible through interaction and problem solving (Egelandsdal et al, 2019). Hattie and Timperley (2007) conceptualised feedback as 'information provided by an agent (a teacher, a peer, a book, a parent, oneself, experience) regarding aspects of one's performance or understanding' (p. 81). Asking questions and explaining their thoughts could create awareness and increase the students' understanding of the topic under discussion. Therefore, participation in discussions provides opportunities for

receiving feedback at both the task, often corrective of individual or group performance (p. 95) and self-regulation level, level refers to the students' ability to monitor and to regulate their own learning processes, including opportunities to 'create internal feedback and to self-assess' (p. 95) their progress towards achieving learning goals, which is essential for students ability to make decisions about their learning.

A growing body of empirical research suggests that the use of student response systems in lectures can enhance both the quality and the quantity of peer discussions (Chien, Chang & Chang, 2016). Participation in discussions allows students to argue and to provide justifications, to question their own and others' assumptions, to co-create knowledge, to explain and to clarify the subject matter. When students make their thinking explicit in peer discussions, students will be exposed to different ways of thinking, which can help them become aware of their own understanding and make better-informed decisions about their learning process (Dawson et al., 2018).

Using student response systems provide lecturers with an awareness of their students' understanding of the course material, which supporting a contingent teaching approach in lectures (Chien et al., 2016; Dawson et al., 2018; Hunsu et al., 2016; Liu et al., 2017). Often it is assumed a straightforward relation between the collection of answers and the process of providing feedback:

> One of the key benefits of using an ARS is that instruction can be modified based on student feedback gathered throughout a class (…) If feedback from a majority of students indicates that confusion or misconceptions are evident, an experienced instructor can offer alternative explanations of the concepts in question (Kay & Le Sage, 2009, p. 822).

Inferences are based on what we can observe, and thus they are characterised by uncertainty (Bennett, 2011). Findings derived from recordings of student discussions suggest that voting for the correct option did not necessarily demonstrate an understanding of the topic under discussion, and an incorrect answer did not necessarily indicate inadequate understanding of the concept (Knight, Wise & Southard, 2015; Nielsen, 2012; Wood, Galloway, Hardy, & Sinclair, 2014). This can lead to misleading feedback, both for students and for lecturers (Nielsen, 2012) which might problematise the validity of the inferences drawn from multiple-choice clicker questions designed for formative assessment in lectures. Studies that have used recordings of peer discussions have found that instructing students to argue, instead of simply ask student to discuss can improve argumentation (McDonough & Foote, 2015). The evidence suggests that groups engage in more argumentation when they are required to justify a position rather than merely to discuss a topic (Knight, Wise & Southard, 2015) and that an initial thinking period increases the number of arguments in a discussions Nielsen, Hansen & Stav, 2016). In identifying the features of high- and low-quality discussions (based on the level of reasoning in each discussion), Knight, Wise and Southard (2013), Knight et al. (2015) and James and Willoughby (2011) each found that the quality of discussions was not dependent on the cognitive level of the questions posed.

This current study
The research reported in this article is a part of a design-based research project (Barab & Squire, 2004), that explored the role of discussion-based activities in supporting a dialog approach to formative feedback in the lecture. It also assessed the quality of dialogue among students and between students and lecturers. The point of departure for the project was to address a challenge identified in practice as well as by theory and prior research: the transformation of the lecture from a mode of transmission to a format that includes student

active learning approaches. For this purpose, the project aimed to incorporate case-based activities in lectures to promote critical reflection, to connect the course material to the students' own language and experiences and to provide opportunities for feedback

In three previous studies based on survey and interviews from the same course (Krumsvik & Ludvigsen, 2012, Ludvigsen et al., 2015; Ludvigsen et al, 2019), students claimed that the quality of the discussions had improved, compared to discussions without support of a student response system. The reason for this was that the alternatives in the questions posed helped structure the discussion, and the fact that they had to submit a response made the activities felt more authentic than discussions that did not require a response (Krumsvik & Ludvigsen, 2012). Discussions among peers were highlighted as valuable for reflecting on one's own understanding. One student explained: 'I notice that I cannot answer the questions until I discuss them out loud […] You argue with someone about why [your ideas] are right, and then suddenly you find arguments for why it is right and why it is wrong' (Ane) (Ludvigsen et al., 2015, p. 47). The act of explaining to a peer is a way of explaining their perspectives to themselves: 'Even though you remember the words, then 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) (Ludvigsen et al., 2019, p. 11). Articulating their thinking through explanations to their peers helps students to reflect on their learning, as stated by another student: '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, then I realise if I understand' (S2) (Ludvigsen, et al., 2019, p. 11). The quotations illustrate how students are drawn into reflection on their own thinking and understanding in which are vital in establishing a formative feedback practice in lectures. According to students, discussions provide opportunities for sharing perspectives, arguing, explaining and listening, which are all indicators of high-quality discussions (Hennessy et al., 2016). The discussions were short, lasting only one or two minutes. This created the desire to explore them in greater detail. What would argumentation and explanation look like in these discussions?

In their meta-study of how use of student response systems support learning, Chien et al. (2016) thus argue that peer discussion should be examined from a social aspect: 'Future studies are needed to investigate how students interact with peers within the context of clicker integrated instruction research on this line will also be helpful to understand how the use of student response systems meditate the process and outcome of peer discussion' (Chien et al., 2016, p. 15). Such studies also essential because there might be a gap between how activities play out and the lecturers' and students' perceptions of them (Nielsen, Hansen & Stav, 2012). By exploring the activities as they unfold might give valuable insights into discussions supported by response systems that are not possible to identify using other methods. Recording students' discussions is important for understanding what is achieved, to arrive at a nuanced understanding and identify affordances as well as constraints to be assessed in relation to the purpose of using the technology. Recording discussions helps us pay attention to the qualities of the new spaces these tools might provide. Knowledge of the characteristics of peer discussions stimulated by multiple-choice questions is also essential to inform practice and to promote high-quality discussions (Barth-Cohen et al., 2016; Knight et al., 2015; Wood et al., 2014). Furthermore, understanding how tools shape feedback practices is crucial for research into feedback in higher education in general (Evans, 2013).

The goal of this study thus, was to examine the characteristics of peer discussions facilitated by student response systems to support formative assessment in the lecture. The research was guided by the following research questions: (1) What patterns of talk can be identified in the

discussions? (2) How do the students use subject-specific vocabulary in the discussions? (3) How is the students' understanding of the subject matter displayed in these discussions?

By exploring these questions, the article offers insights into the characteristics of peer discussions supported by student response systems and situating the research within the context of formative assessment.

Context, methods and analysis of the discussions

The context was a qualitative methods course for undergraduate psychology students. For students to judge the choices that must be made when approaching the qualitative research process, critical reflection is crucial (Cooper, Chenail & Fleming, 2012; Cooper, Fleisher & Cotton, 2012). To provide hands-on experience and to address such core concepts as sample, validity and triangulation, the students were engaged in a discussion of authentic case questions. Each lecture started with the introduction of a theme or concepts (a 'mini-lecture'). A question for peer discussion followed; the students were given between one and two minutes to discuss each question. Each student was given a device ('clicker') to respond ('vote') to the multiple-choice questions through a student response system (Turning Point). The answers were aggregated and projected onto the screen for clarification and whole-class discussion.

Two categories of questions were used. In the *textbook questions*, the students were asked to answer a multiple-choice question that addressed the definitions, basic concepts and characteristics of qualitative methods as presented in assigned readings. In the *case questions*, the students answered a multiple-choice question that addressed the procedures involved in qualitative methods and their application in authentic contexts. Both categories included questions that allowed for multiple responses ('multiple responses') and others that had only one correct answer ('closed'). Figure 1 illustrates a case question (Gibbs, 2013), and Figure 2 presents the response.

Figure 1. A question allowing multiple responses).
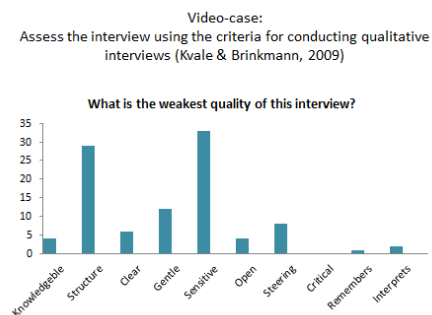
Figure 2. The corresponding responses.

Each lecture included sequences of four to six questions. The lecturer (the second author of this article) is a professor with extensive experience in the use of technology to support and enhance teaching and learning in higher education. Approximately 20 minutes of each lecture was devoted to discussion-based activities. Before the discussions, the students were asked to argue for their views; however, they were not provided guidelines on how to engage in

exploratory talk. The activities were supposed to be dialogic in that they provided students with the space to engage with the material in the peer groups (Wegerif, 2013); they were also designed to gain insights into the students' thinking (to create moments of contingency). However, there is some tension between the infinite possibilities for multiple voices to be part of a dialogue and the closure needed to achieve structured learning objectives. This tension includes completion of the assignment within a teaching design developed to facilitate formative assessment through questions with only one correct answer.

Data collection

Discussions were gathered from six lectures spread over two semesters. In both classes, undergraduate students were given an introductory course in qualitative methods, with the same lecturer, and they discussed the same types of questions using the same course material and within the same context. Discussions were conducted over two semesters of classes so that more discussions could be included in the study than we were able to collect during only one semester. The sample was based on voluntary participation; thus, it was a convenience sample (Creswell, 2012). The students received written and verbal information about the study before the lecture began. Audio recorders were provided at the beginning of each lecture. Students who chose to participate received a short briefing on the recorders; they then decided whether to record a discussion. While 96 discussions were collected, not all of the recordings could be analysed because of audio quality issues. The analysis included 87 discussions distributed across 21 different questions asked in class. 38 of the discussions addressed questions allowing multiple correct answers, and 50 addressed questions with one correct answer.

The study was performed in the authentic context of a lecture. Students were asked to discuss with students sitting beside them; for that reason, the discussion groups consisted of two to four students each. The number of students in each group depended on how they were seated in the auditorium, which reflects common practice in these lectures. An ethical question arose, that the students might have found the questions stressful to discuss or that they might not speak as freely as they would have if the discussions had not been recorded. However, as the students were learning about qualitative research methods in this class, volunteering to participate in interviews would give them valuable experience in understanding the challenges and opportunities of using audio-recordings of discussions as a research method.

Data analysis procedures

The analysis of the discussions followed five major steps. First was listening to the recordings several times to become familiar with the discussions. The material was then transcribed. Most of the discussions were short: between 40 seconds and two minutes. Second, the transcripts were read to examine their characteristics. Patterns of talk were coded using the framework of exploratory talk (Mercer, 2004). Examples of how discussions are coded are provided in Appendix A. Third, the transcripts showed that the students used subject-specific vocabulary in different ways. Three codes emerged through the reading of the discussion transcripts: no use of subject-specific vocabulary, references to subject-specific vocabulary and application or definition of subject-specific vocabulary. Forth, A majority of the discussions revealed student uncertainty. Questions and statements before their 'vote' reflected the emergence of the students' questions and insecurities. Each of these occurrences was coded as 'uncertainty'. In the discussions in which the students knew the answers, indicated their subjective certainty, or stated that the assignment was easy, the transcripts were coded as 'confidence'. Fifth, the distribution of (1) uncertainty and (2) subject-specific vocabulary across the patterns of talk were examined. The steps in this analysis are illustrated

in Figure 3. In Appendix 2, examples of this coding are provided.


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┌─────────────────────────┐    ┌─────────────────────────┐    ┌─────────────────────────┐
│ 1. Listen to the        │    │ 2 Code for patterns     │    │                         │
│ recordings,             │    │ of talk                 │    │                         │
│ transcribe them and     │───▶│ Examine the distribution│───▶│ 3. Code for use of      │
│ read the transcribed    │    │ of patterns of talk     │    │ subject-specific        │
│ material to get an      │    │ among the open and      │    │ vocabulary              │
│ overview of the corpus  │    │ closed questions .      │    │                         │
│                         │    │ Code for uncertainty    │    │                         │
└─────────────────────────┘    └─────────────────────────┘    └─────────────────────────┘
```
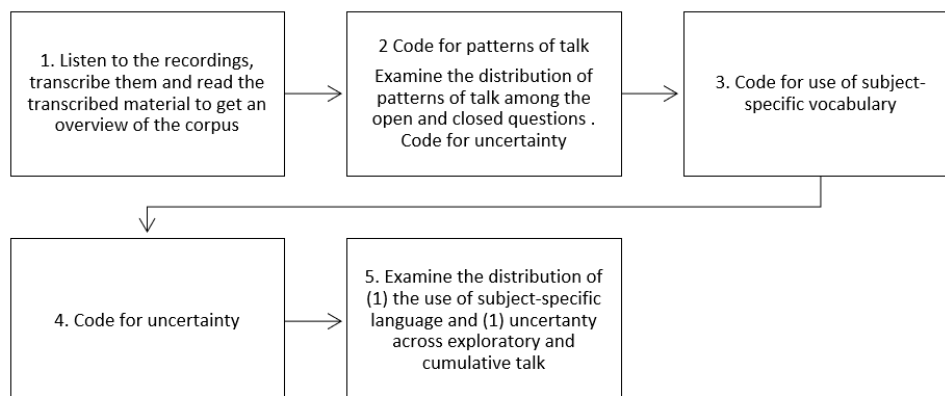
Figure 3. Data analysis procedure.

Analytical framework for examining exploratory talk
Several frameworks are available for analysing the quality of student discussion (for a review, see Hennessy et al., 2016). These frameworks can be distinguished based on their emphasis on changes in individual thinking, emergent understanding within a group or single utterances or episodes of talk (Mercer, Littleton & Wegerif, 2004). The goal in this study was to examine the students' sharing of ideas and their processes of collaborative knowledge building. The unit of analysis was the discussion, and the patterns of talk were examined through sociocultural discourse analysis (Littleton & Mercer, 2013). This methodology is suited to analysing patterns of talk among participants engaged in problem solving (Mercer, 2004). It uses a quantitative approach to compare discussions under different conditions and a qualitative approach to examine student engagement in idea sharing and knowledge co-construction in a specific context (Mercer, 2004). As an indicator of the quality of education talk, Mercer (2004) refers to three modes as prototypes: *disputational*, *cumulative* and *exploratory*. Exploratory talk is characterised by the discussants' critical engagement with one another's ideas. The arguments or the reasoning is explicit or accountable in the discussions. The students offer alternative views or hypotheses, and they participate with the purpose of 'joint consideration' (Mercer, 2004, p. 46). Cumulative talk is characterised by 'repetitions, confirmations and elaborations' that build on one another uncritically (Mercer, 2004, p. 46). By contrast, disputational talk is characterised by disagreements, interruptions and individual decision-making. Students do not ask follow-up questions or make additional contributions. Their utterances are short, lack justification and are often confrontational (Mercer, 2004). The idea of 'exploratory talk' is associated with the idea of a 'dialogic space' (Wegerif, 2013). In a dialogical space, cumulative talk provides a widening of the space, and exploratory talk provides a deepening of the space (Wegerif, 2013).

The framework of exploratory talk is mostly used when examining the quality of talk in schools (Littleton & Mercer, 2013), however, the same pattern of talk has been identified in studies examining the quality of educational dialog in the context of higher education (Havnes, Christiansen, Bjørk & Hessevaagbakke, 2016) and in work place settings (Littleton & Mercer, 2013). Since this framework are mostly used within a school setting, our study is a contribution to bring this literature into analysis of student peer discussions in higher education.

The concepts of exploratory talk were operationalised in this study through the coding scheme (Appendix 2). This coding scheme was inspired by the 'Cam–UNAM Scheme for Educational Dialogue Analysis (SEDA: ©2015), developed by Sara Hennessy and Sylvia Rojas-Drummond' (Hennessy et al, 2016, p. 42). The purpose of the scheme developed by Hennessy et al (2016) was to "distil out the essence of dialogic interactions and operationalise them in the form of a new scheme of systematic indicators for these productive forms of educational dialogue". (p. 42). The SEDA-framework thus describes indicators of qualities of talk (The complete coding scheme can be found at http://tinyurl.com/BAdialogue.). Four of these (invite elaboration or reasoning; build on other's ideas; make reasoning explicit; positioning and coordination) are from our point of view congruent with qualities described as exploratory talk in the literature (Mercer, 2004). Furthermore, it was suited for the material and we found that description of each of the categories were useful for examining qualities in our own context (peer-discussions). We used the condensed scheme as presented on the webpage, however, with some adjustments, for example that qualities described in "positioning and coordination" are put under the heading "make reasoning explicit".

To limit possible biases in researching our own practice (Sikes, 2006) one researcher outside of our own institutions has been involved with the analysis of the discussion. There were two coders. To ensure their understanding of the coding scheme, the coders coded 10 discussions together. The coders then did a close reading of all the discussions and coded each transcript individually regarding 'pattern of talk'. NVivo 11 was used to organise the coding of the discussions. Before analysis, each transcript was coded by assignment type (questions with one correct answer or multiple correct answers and textbook or case questions) in accordance with the coding scheme. In some cases, a discussion was characterised by more than one pattern of talk. They were coded as exploratory if indicators of exploratory talk were present in the transcript. Last, inter-rater reliability for patterns of talk was evaluated using Cohen's kappa coefficient, which was chosen because of the use of categorical rather than continuous coding. The inter-rater reliability, calculated using IBM SPSS Statistics, was a Cohen's kappa coefficient of 0.69, which could be considered a substantial fit (De Wever, Schellens, Valcke, & Van Keer, 2006). Disagreements were resolved after discussion. This was performed by reading the transcript aloud; then, each of the coders provided arguments for their interpretations. In this way, the transcript was discussed carefully, and through this process we also compared these discussions with other discussions we agreed upon. This made it easy to come to an agreement and in this way, we resolved each of the disagreements. To secure the validity of our conclusions and to be open for different possible ways of interpreting the discussion transcript, we have also presented excerpts and analysis of the peer discussions in several workshops involving experts in the field of higher education and in interaction.

Findings

The following section is in five parts. First, we provide a general characteristic of the material. Second, we provide examples of patterns of talk identified in the material. The third section discusses the students' application of subject-specific vocabulary. forth, we present how uncertainty was expressed in the discussions. The fifth section presents the distribution of subject-specific vocabulary and occurrences of uncertainty across the different pattern of talk.

General characteristics
Students used the answer options to structure the discussions, and they argued about the merits of each. In general, the discussions were of high quality. Another characteristic was the students' completion of one another's sentences, a phenomenon that was interesting in this

context because it revealed the students' collaborative thinking processes as presented in the examples below:

Example 1a.

Line	Student	Utterance
1	S1:	The interview guide. It's the questions.
2	S2:	It's the interview question.
3	S3:	In a way, it's the order.

Example 1b.

Line	Student	Utterance
1	S1:	You can measure stress or
2	S2:	Pulse or
3	S3:	Perspiration

Characteristics of cumulative and exploratory discussions
Of the 87 discussions, 25 were coded as cumulative talk. In some of the cases, the students knew the answers; therefore, discussion was not required. In others, they focused more on finding the right answer than making their reasoning visible to their peers: they did not justify or explain their claims. Only a few students addressed clarifications or justifications of the arguments, and in some cases follow-up questions were not asked. Subject-specific terms were used only at a superficial level, and the reasoning was visible only to a limited degree, as indicated in Example 1.

Example 1. Cumulative talk

Line	Student	Utterance	
1	S1:	It's not Two. It has to be One or Two? One?	
2	S2:	Yes.	
3	S1:	It can't be Two.	The students did not use
4	S2:	No, because they're going to find out. . . .	subject-specific terms or
5	S1:	One, or Three?	argue for their claims.
6		Hmm.	
7	S3:	I think it's Number One.	
8	S2:	Should we choose One then?	
9	S1:	I think so. I'll go for that.	
10	S2:	It's not Number Two. And it's not Number Three.	
11	S3:	Then it has to be Number One.	
12	S1:	I choose Number One.	

In Example 1, the discussion was characterised by *cumulative talk*. The students did not use subject-specific terms. They suggest answer alternatives by referring to their number, rather than explaining and presenting reasons for their suggested alternatives.
The dramaturgy was simple: (1) opening, (2) suggestions for voting, and (3) votes.

Exploratory talk

In 62 of the 87 discussions, the students exchanged ideas and elaborated on one another's ideas and understanding of course concepts. In making their ideas visible, the students enabled others to connect to these ideas, to build on them, to criticize them and to argue for or against them, thereby allowing for the development of multiple perspectives. The most striking characteristic of these discussions was students building on one another's arguments to come to a consensus. This was evident when they were arguing for one another's claims and completing one another's sentences. Second, the students' reasoning was visible to everyone in the group. This feature became evident in their justifications of their own or their peers' claims. Third, they asked for clarifications, or they addressed concepts that were unclear. However, there were only a few examples of the students being critical of one another's arguments. In the next discussion (Example 2), the group discussed the question after watching a news report about the off-task use of information and communication technology (ICT) in upper-secondary schools. The question invited the students to identify the features of quantitative and qualitative research questions.

Example 2: Exploratory talk

Line	Student	Utterance	
1	S1:	What do you think?	
2	S2:	I think Number Four?	
3	S1:	Why?	
4	S2:	Because the relationship is	VIDEO CASE: 'What is adequate for this teacher's experiences as well as in line with qualitative research questions?'
5		quantitative, and to *what extent* it's	1. Is Facebook in class a disturbing factor for teachers?
6		also quantitative, and	2. To what extent do teachers find Facebook to be a disturbing factor in their lessons?
7		the first is also totally yes or no	3. Is there a relation between student use of Facebook and the teachers' class management?
8		questions.	4. How does the teacher at 'Mountain school' experience student' use of Facebook in class?
9	S3:	But how does the teacher experience	
10		the student's off-task ICT use in class,	
11		is qualitative, and then they don't	
12		problematize, and then it's not	
13		normative. Definitely, so? What do	
14		you think?	
15	S2:	I don't know, and I haven't started the	
16		process yet. I spent so much time	
18		reading this thing. Yes, I think Four is	
19		the best option: the point that it's	
20		particular. Experience?	
21	S3:	What is?	
22	S2:	It's qualitative.	
23	S3:	Phenomenological.	

Example 2 was characterised by *exploratory talk.* S2 asked for a justification for choosing Number Four. The sequences of the talk that brought the discussions into the explorative mode were characterised by the opening of the discussion space when S1 asked for a justification for S1's claim, 'I think Number Four.' S2 and S3 followed up by introducing new arguments in support their shared conclusion. The discussions exhibited a typical dramaturgy. First, one of the students invited the others into the discussion, and the students presented their immediate thoughts without explanations or justifications. This mode changed if or when problems were encountered or questions arose; to progress in these situations, the students needed to make arguments or explain their thoughts. This was the most exploratory

part of the discussion. This confirms previous findings that exploratory talk was associated with productive ways of addressing the object of learning (Havnes et al., 2016; Littleton & Mercer, 2013).

Table 1 displays the distribution of the patterns of talk engendered by the closed-ended and open questions. The discussions featuring exploratory talk were most likely to be generated by the questions allowing multiple correct answers,

Table 1: Patterns of talk by question allowing one correct answer and multiple correct answers

	Cumulative (25)	Exploratory (62)
Questions with one correct answer (50)	21	28
Questions allowing multiple correct answers (38)	4	34

Investigating the differences among the groups was beyond the scope of this study. However, it was noteworthy that while some groups engaged in exploratory discussions regardless of the questions, others addressed all of the questions superficially.

Use of subject-specific terms
There were discussions in which the students used no subject-specific vocabulary (3), referred to a course-related concept without any elaboration (33) or applied or defined the subject-related concepts they mentioned (51). In the discussion provided as Example 3, the assignment was to discuss the following question: What are the two most common threats to validity in qualitative research? The possible responses were the following: (1) researcher bias and reactivity, (2) respondent validation and triangulation and (3) internal and external validation.

Example 3. The students applied and defined subject-related concepts

Line	Student	Utterance
1	S1:	It has to be a . . . Excuse me. What do
2		you think?
3	S2:	The researcher's trustworthiness? The
4		influence of the researcher?
5	S1:	Yes. Then it's the two. Yes. It's a
6		common threat with the method in
7		general, isn't it?
8	S2:	However, particularly, in the qualitative,
9		I guess? I think One.
10	S1:	For triangulation.
11	S2:	What is it?
12	S1:	It's something you should use to get
13		good validity, to have different entrance
14		angles, different methods, for example.
15		The way she's here now and making the
16		recording, she could have chosen to ask
17		us how it was to discuss the lecture.
18		Hmm . . .
19	S2:	Moreover, got a response and used it as
20		an answer. But when she also records
21		

What are the most common validity threats in qualitaive methods?

1. The researchers bias and reactivity

2. Triangulation and response validations

3. Internal and external validity

S1 explains the concept of triangulation.

S1 provides an example

22		what's the truth, that strengthens the
23	S1:	validity in a way, so it's the opposite.
24	S2:	It increases the quality.
		Yes. It's not a threat.

The two students discussed the reasons why triangulation was not a threat to validity in qualitative research. This demonstrated the process of proposing both a definition and an example. The students were inviting others into the discussion space and making their thinking visible by both posting questions (S2) and defining the concept and providing examples (S1).

An examination of the distribution of subject-specific terms across the patterns of talk indicated that the discussions coded as exploratory talk were more likely to feature application, definitions or examples than the discussions coded as cumulative (Table 2).

Table 2: Use of subject-specific vocabulary in the discussions

	No use	Reference	Application/Definition/Examples
Cumulative (25)	3	20	2
Exploratory (62)	0	13	49

Uncertainty

Most of the recorded discussions revealed instances of the students' uncertainty. Below is an example of a discussion on the role of the Helsinki declaration.

Example 4. How uncertainty was expressed.

Line	Student	Utterance
1	S1:	Nuremberg. Is it something to do with World
2		War Two?
3	S2:	I don't know what it is.
4	S1:	I think it's One.
5	S3:	Vulnerable group? What's that?
6	S1:	What does that mean?
7	S4:	I don't know, and I just think Nuremberg. I
8		feel it was something with a trial with Nazism.
9	S1:	The Nuremberg convention.
10		I don't know. I remember from
11		history . . . because of all the things that
12		happened in the concentration camps.
13	S2:	That it' s vulnerable groups do you think?
14	S1:	Possibly.
15	S2:	Anyway, what are vulnerable groups?
16	S1:	Yes. That also. Is it children?
17	S4:	Yes. This needs to be specified.
18	S2:	Is it minorities, Sami?

In this example we see that each perspective that was added to the discussions engendered a new question.

In the corpus, there were as many as 20 occurrences of students' explicit statements of not understanding the topic at the moment before giving their votes. The following are examples:

'Honestly, I don't have the slightest idea.' 'We're gambling.' 'I say One, and then what if it's wrong?' 'Frankly, I don't know. My heart says Four.' 'Ah, I don't want him to ask me to explain this.' 'We say Three, and then we have to sink into a hole in the ground if it's wrong.' 'I guess. . . .' 'Should we each take One?' These episodes in the discussions are interesting and important. They indicate that even though the students might have chosen an answer, they had expressed uncertainty about whether it was right or wrong. Table 3 presents the occurrences of articulations of uncertainty in the questions with multiple correct answers and questions with one correct answer.

Table 3: Expressions of uncertainty in the discussions

	Confidence (19)	Lack of confidence (68)
Cumulative (25)	5	20
Exploratory (62)	14	48

Summary of the findings
The analysis showed the following:

- Almost all of the discussions focused on the assignment.
- The students expressed uncertainty in a majority of the discussions (68 of 87), and insecurity was evident with all types of questions.
- The students structured their discussions around the answer options.
- The alternatives were used both to open discussions (to clarify and explain concepts) and to shut down discussions (by referring to numbers only).
- Characteristics of exploratory talk were identified in 62 discussions.
- Most of the exploratory discussions were generated by questions allowing for more than one correct answer.
- The use of subject-specific terms beyond mere references to a concept was most likely to be found in discussions with characteristics of exploratory talk.

The next section focuses on the role of discussions in formative feedback practice. Guidelines for practice and further research are suggested.

Discussion and conclusion
By connecting *moment of contingency'* to *exploratory talk*, we draw attention to the quality of the activities employed to support formative assessment in lectures. The idea m*oments of contingency* emphasises that such activities should be used to support and adjust learning and teaching activities. Analysing *moments of contingency* using the framework of "exploratory talk" enable us to critically examine the quality of the dialogues enabled by this teaching design. This helps us to focus how such activities can enhance contingent teaching and formative assessment.

Our study shows that the alternatives offered in multiple-choice questions have the power both to trigger and open discussions, and to limit discussions. In some of the analysed discussions, students opened up dialogues by using the alternatives as means for clarifying concepts or arguing for their view. In other of the analysed discussions, we found that the alternatives discourages the students from articulating their knowledge and sharing their thinking. For example, some students were simply guessing at an answer without elaborating,

or they told each other what to vote for an alternative without offering an explanation, only referring to numbers: 'sure, it has to be c'. This is similar to findings by Wood et al. (2015), Knight et al. (2013), James and Willoughby (2011) and McDonough & Foote (2015).

When students use the MC-alternatives this way, this leads them to superficial approach to their learning, rather than opening up spaces for reflection. To support formative assessment and deep learning, it is vital to stimulate dialogues were student articulate and share their understanding. This happens when the students use the alternatives as points of departure for clarification and argumentation. Open-ended questions enabled more exploratory talk and should thus be used to create moments of contingency.

A common claim in the research literature on the use of student response systems is that aggregated responses on MC-questions provide feedback to the lecturer about the students' knowledge and understanding (Chien et al., 2016; Dawson et al., 2019; Hunsu et al., 2016; Liu et al., 2017). Our data analysis revealed considerable uncertainty in a majority of the discussions, even though the students voted for the right answer (in questions with only one correct answer) or a reasonable answer (in questions allowing multiple correct answers). Regarding formative assessment, this is important for several reasons: 1) Exploring uncertainty allows students to be aware and reflect on their own understanding. 2) Our analysis demonstrate that conclusions based on clicker responses might be fragile and that the response students given by choosing an answer provides limited information about the students understanding subject concepts. This raises questions about the validity of the inferences that can be drawn from the aggregated responses to clicker questions. Wood et al. (2014), James and Willoughby (2011) and Knight et al. (2013) have expressed similar concerns. Dall Alba & Bengtson, (2019) argue that underneath what is visible or apparent 'we might become aware [of] disconnected thoughts, broken arguments and doubt' (Dall'Alba & Bengtsen, 2019, p. 1486). When this uncertainty is brought to the scene, there is a potential to open 'moments of contingency' and allow the lecturer to enter into dialogue with the students' thinking. We argue that when the students' responses are received through a system without options for the lecturer to unpack the students' reasoning behind their aggregated response, there is a risk to neglect valuable opportunities for learning. In any activities created for the purpose of formative assessment, engaging in dialogue with students allows more sensitivity towards students' ideas, which helps in drawing inferences and strengthen the possibilities for the lecturers to follow up student responses in a formative way. To embrace activities that allow both aggregated and qualitative answers, or to include different ways of displaying knowledge would allow complexities to emerge, and this would provide richer insights into the students' understanding and thereby allowing other inferences to be drawn.

Limitations
This study was conducted in an authentic setting and thus has several limitations regarding design, data collection and analysis. Video recordings of the lectures might have provided greater insights into the quality of the discussions. For example, body language would have been captured, which could provide valuable information. Also, we did not know what each individual student voted. If this information was connected to the discussions, we would be able to assess the quality of the discussions and how students responded. Furthermore, the students recorded their own discussions; therefore, it is possible that they might have chosen not to record some of their discussions if they were unsure of the answers, which could have influenced the results. Some groups decided to record their discussions, while other groups chose not to record their discussions. The use of audio recorders may also have affected the quality of the discussions (e.g., students may have tried their best to engage in a productive discussion or were afraid to talk if they were unsure).

Implications for practice

To create, recognise and capitalise on those moments as an integrated part of learning activities helps teachers adjust their teaching to the needs of their students and help student to take decisions on their learning process. When using student response system as a part of a formative feedback practice, the key questions to consider are to what extent and how the activities allow students to share thinking and what kind of thinking is being shared. To secure the quality of the inferences that can be drawn from the activities, it could be a strength, to include questions on confidence and/or design an environment where uncertainty and questions might surface and to take time to clarify and elaborate on these questions.

To ensure that valid inferences can be drawn from activities as a basis for feedback, the questions used and threats to the validity of possible inferences should be critically examined.

Implications for Research

Future studies should compare clicker-supported discussions and discussions without technology within the same overall teaching design. A following up study could design typologies of questions to investigate more rigorously the influence of question type on student discourse. Further studies should explore the role of the lecturer, and how lecturers use quantitative or qualitative information received through these systems to adjust their teaching to the needs of the students.

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Coding scheme for uncertainty

CODE	Description	Examples
Confident (1)		S1: I first thought of Number Four. S2: Yes. Me too. S1: Because Number Three is qualitative. (...) S2: You must choose someone who's purposeful for what you should study. S1: As he said, you can't take people working on the floor to find out how much time they spend on social media during work hours. I think it's Four. S2: Yes. It has to be that because you should have someone who knows what it's like to be schizophrenic.
Uncertain (2)	Uncertainty is demonstrated in the transcript	S1: Then you have to choose someone with schizophrenia. S1: Nuremberg. Is it something with World War Two? S2: I don't know what it is. S1: I think it's One. S3: Vulnerable groups? What's that? As? What does that mean? S1: I don't know. I just think Nuremberg. I feel it was something with a trial with Nazis. S4: Yes, that's right. S1: The Nuremberg convention. I don't know. I remember from history . . . because of all the things that happened in the concentration camps. S2: That it's vulnerable groups do you think? S1: Possibly. S2: But what are vulnerable groups? S1: Yes, that also. Is it children?
	Uncertainty is directly articulated in the transcript	OR S1: I don't have the slightest clue. S2: Nor do I. Honestly, I don't have a clue.

Coding scheme for use of subject-specific terms

CODE	Description	Examples
No use (0)	Students do not use subject-specific terms	S1: It's not Two. It has to be One? Or Two? S2: Yes. S1: It can't be Two. S2: Because they're going to find out. S1: One, or Three? S2: Hmm. S3: I think it's Number One. S1: Should we take Number One then? S3: I think so. I chose Number One. S2: It is definitely not Two, and neither is it Three. Then it has to be . . . S1: I think it's Number One.
Refer (1)	Students only refer to subject-specific terms	S1: Sure. It's not Two! S2: No. S1: Because that's a **correlation**, and we're not interested in that. S2: No, it should be a **particular phenomenon**. And Number Three is a **general phenomenon**. S1: Yes, it is. S2: And Number Two is a **correlation** then. S1: Yea, and that is definitely wrong. S2: It's **particular research questions?**
Apply/ define (2)	Students provide definitions and examples	S2: For triangulation. S1: What's that? S2: That's something you should use to get good validity, to get different angles, to get different methods, for example. Like her who's recording: She could have chosen to ask us what it was like to discuss the lecture. S1: Hmm. S2: And got answers and used them as a facit. But when she adds records, that strengthens the validity in a way, so that's the opposite. That increases the validity. S1: Yes. And that is not a threat.

Coding scheme for pattern of talk		
Code	**Indicators**	**Examples**
Disputational talk	• Disagreements • Interruptions • Individual decision-making • No use of follow-up questions or contributions • Short confrontational statements without justifications	
Cumulative talk	• Repetitions • Confirmations and elaborations • Uncritical building on contributions	S1: This time we have to have the right answer! It has to be right! [*Quiet*] S2: I am completely exhausted! I can't. [*Quiet*] S2: Isn't it Number One? No. S3: Number one and Number Two are quantitative. S1: Two, quantitative? S3: Yes. Two is quantitative. S2: Then I would go for Number One. S1: Okay. S3: Could be both? S1: No.
Exploratory talk[1]	**Invite elaboration or reasoning:** • Invite elaboration/building on contributions • Ask for explanations or justifications of others' contributions **Build on ideas:** • (Dis)agree with/evaluate others' contributions • Ask for clarifications or elaborations • Build on/clarify own or others' contributions **Make reasoning explicit:** • Explain or justify own or others' contributions • Provide examples, evaluate alternative views, challenge others	S1: I choose sensitive . . . S4: Whether it was . . . or whether she was nervous, or what? S2: Perhaps because she wasn't open at the start and presented what it was all about. So, was the interviewee really like that? She seems . . . maybe she was a little sceptical? S4: Yes . . . S2: Wondering what's going on. S4: Yes. It's what I was wondering: about openness. But she wasn't sensitive. It's sort of even worse. S2: Yeah . . . It's the one I noticed as well. It was both in a way. Nothing compassionate when she said it was stressful, so no: 'Yes, I can imagine. Tell me more about it.' So, in a sense, both that she's somehow sensitive to her feelings, but also that she wasn't in a way picking up . . . S4: Picking up signals. But also, that she didn't talk about it anymore afterwards either.

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[1] *Modes of talk (Mercer (2004). Exploratory talk was operationalised using the SEDA-scheme (Hennessy et al., 2016, p. 27)*

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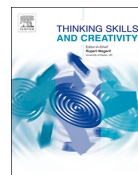
Writing on the wall: How the use of technology can open dialogical spaces in lectures

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A B S T R A C T

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

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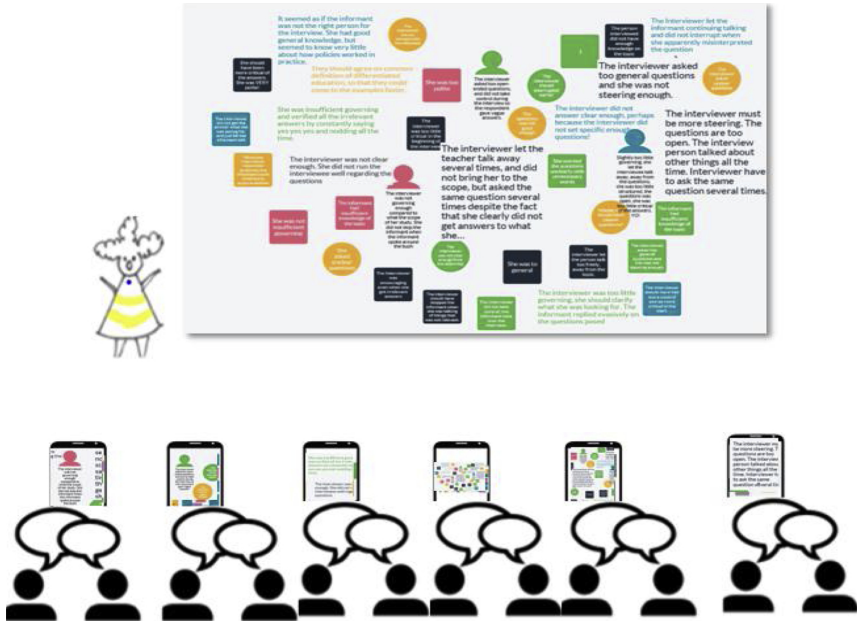
Fig. 1. The interface of the collaborative whiteboard in a lecture hall.

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:
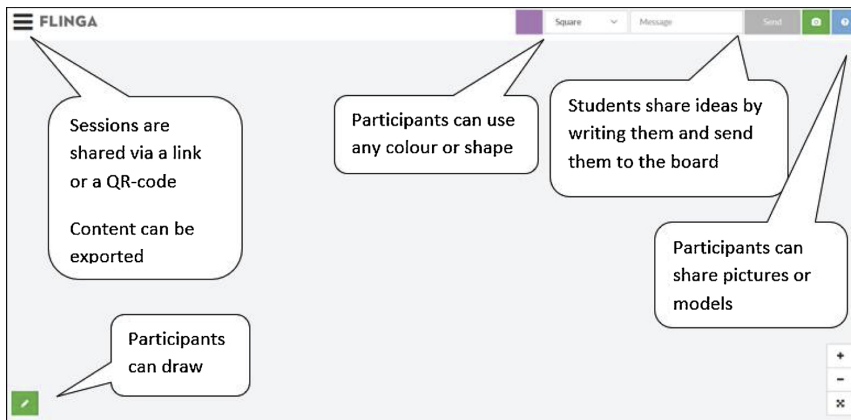
Fig. 2. Technical description of the interface.

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; Bakthin 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 superaddresse. Drawing on Wegerif's (2013) interpretations, a superaddresse 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 theese different perspectives, and the extent to which these activeties 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
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.	• 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.
Case 2, 'Different Paths to Learning': lectures in a teacher-education programme.	• 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.

within higher education (Krumsvik, 2012; Krumsvik & Ludvigsen, 2012; Ludvigsen, Krumsvik, & Furnes, 2015; Egelandsdal & 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
2		observation, and then something critical happens, maybe it's an	discussion by
3		ethical dilemma whether to intervene or not? It was a bit that	suggesting an ethical
4		example he (the lecturer) took with the gang members	dilemma.
5		Drug trafficking	
6	S2	Yes. Mm	
7	S3	There may be less serious things then. Where is the limit for when	
8	S2	to report [ ]?	Lines 8-21: The
9		[ ] It is something you saw.	students elaborate on
10	S1	But, at the same time, you should stay in the situation, what are	the dilemma
11	S3	you doing?	(deepening and
12	S2	I think, if it illegal, you have to intervene, you can not.	widening).
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	
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.	Line 21: S1 suggests
21	S1	Should we read what others have been written?	they should read other
22		(…)	posts. They read one
23	S2	Yes, but should we write something about the limit, when to	aloud and discuss the
24		intervene?	grammar (widening).
25	S1	We can write: 'Were are the limit of interfering in critical	Lines 23-26: They
26	S2	situations?'	decide what to write.
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.	Line 27-28: S2
			continue to elaborate
			on the questions
			(widening).

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

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

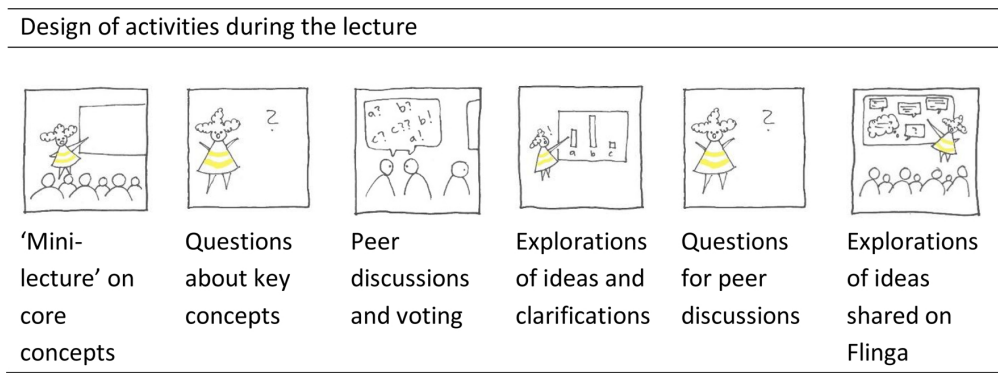| 'Mini-lecture' on core concepts | Questions about key concepts | Peer discussions and voting | Explorations of ideas and clarifications | Questions for peer discussions | Explorations of ideas shared on Flinga |

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 is 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*
3		*that they are being observed'.*
4	S1	Yeah, regarding your method, it may be important, how people
5		respond. If there is a camera, people can be affected. If there is
6		someone filming, someone can be affected.
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*
10		*with children'.*
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*
14		*the interview person'.*
15	S2	We can look further. I would say that what is important is the
16		interpretation you are doing, from what is said and how it is said,
17		because it is not everything that is said that is described properly
18		– yeah, in a way, regarding misunderstandings.
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?*
S2	....Hmmm. (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
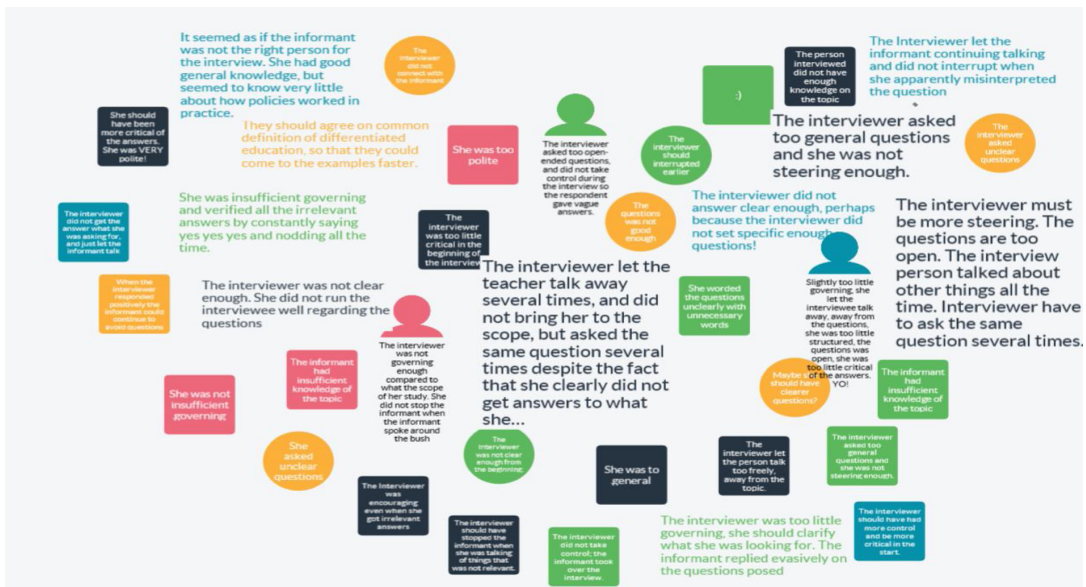

Fig. 5. How students used the online shared whiteboard.

Table 4

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

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

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):
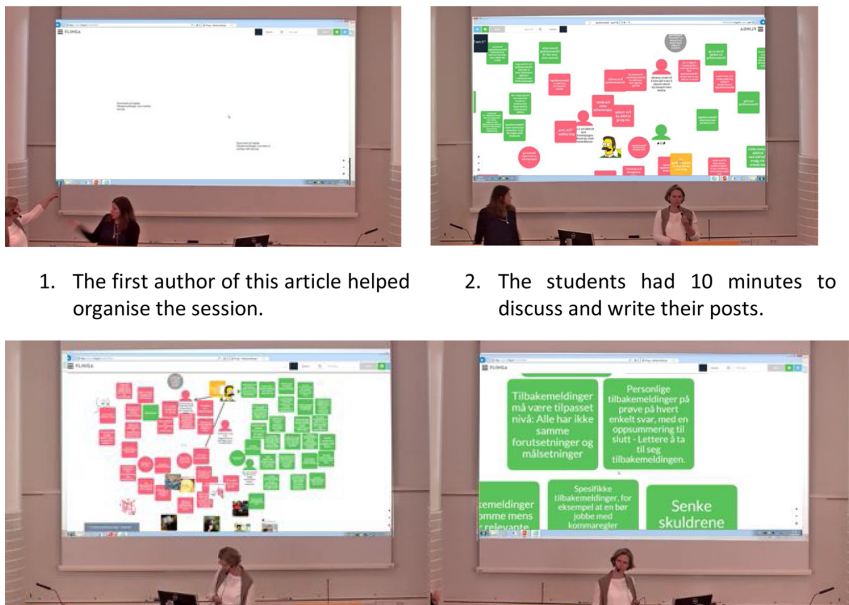
1. The first author of this article helped organise the session.

2. The students had 10 minutes to discuss and write their posts.

3. The lecturer sorted the posts.

4. By navigating around the board, the posts were discussed for 20 minutes.

Fig. 6. How we organised the discussion sessions.
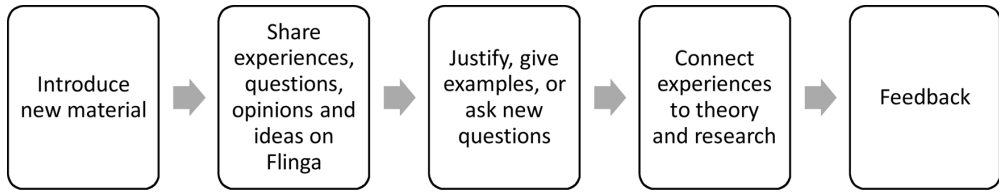
Fig. 7. The structure of a Flinga session.

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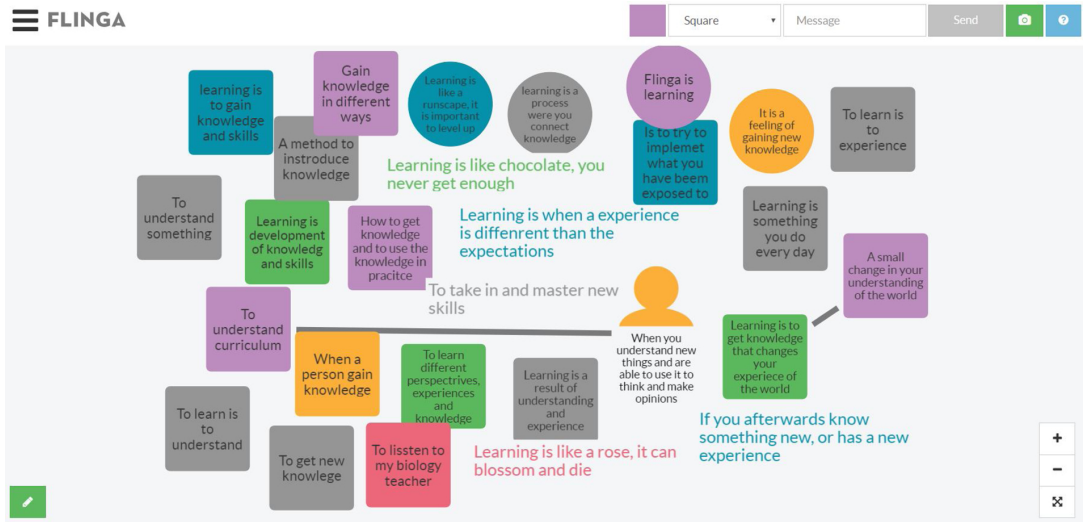
Fig. 9. A Flinga board with posts for the prompt 'Suggest a definition of *learning*'.

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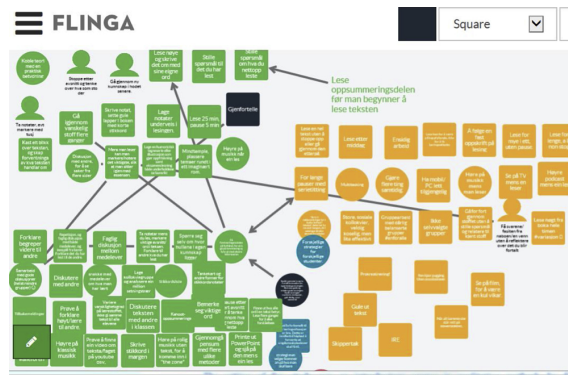
Fig. 10. How the interface is used to code the posts.

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 continiues 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.
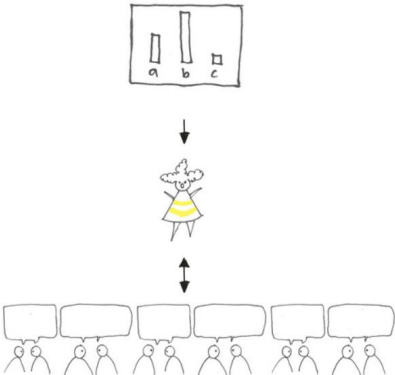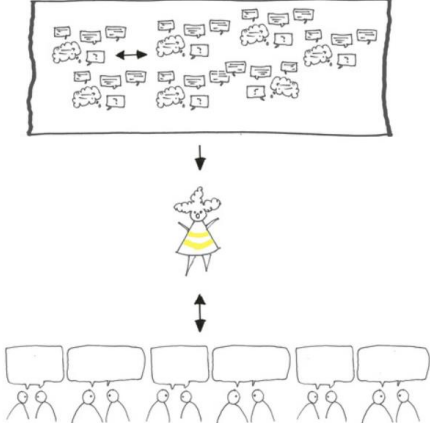
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Appendix A: The digital tools used in this project

Tool	Description
  STUDENT RESPONSE SYSTEM	• The lecturer can pose a multiple-choice question. • Each student is given a device ('clicker') to respond ('vote') • The answers are aggregated and projected onto the screen for follow-up and whole-class discussion
  ONLINE SHARED COLLABORATIVE WHITEBOARD	• The lecturer poses questions • Students can share ideas via their online devices and send them to a shared online screen projected during the lecture. • Participants can post pictures as well as make drawings or create links between contributions. • The contributions can be presented in different shapes and colours, and can be moved, edited or connected.

Appendix B: Search strings used to find research literature

Free search words and thesaurus terms (TH) were used. Based on several test searches, the following three search strings were used:

Context	Lecture* OR Lecture method
Formative assessment and dialogue	"peer* N3 discussion*" OR "class* N3 discussion*" OR "Discussion (Teaching Technique)" OR "Discussion" OR "nongraded student evaluation" OR "Feedback (Response)" OR feedback OR "Formative Evaluation" OR "Student Evaluation" OR "Self Evaluation (Individuals)" OR "self evaluation" OR "Alternative Assessment" OR "alternative Assessment" OR "Informal Assessment" OR "informal assessment" OR "Cooperative Learning" OR "accountable talk" OR "explor* talk*"OR dialog* OR "active learning"
	OR "self assessment" OR "Formative assessment" OR Metacognition OR feedback OR "Feedback (Response)" OR "Interaction" OR "Student Participation"
Technology support	Twitter "mobile technolog*"OR microblog* OR flinga OR samtavla OR talkwall OR "technology N2 education*" OR "Technology Uses in Education" OR "Educational Technology" OR "technology integration" OR OR "shar* screen*" OR backchannel* OR "online N2 whiteboard*" OR "electronic voting system*" OR "Response System*"OR "Audience Response Systems" OR clicker* OR collaboration OR "Cooperation"

The terms 'student engagement', 'student involvement' and 'student participation', which might be relevant to include, were removed because they generated too few specific results. The search strings were combined, and I also search on single terms.

Appendix C: Flingaboard: Is learning always a good thing?

FLINGA | Square ▾ | Message | Send | 📷 | ❓

No, just think of IS

What are we going to do?

If you learn something from a bad experience doesn't mean that what you have learned is bad, but that the situation you learn it in was bad

Paste
Humans have different skills, it is not all that is worth learning. You learn a lot without being conscious, without reflecting on whether it is good or bad.

Learning can be a positive thought-process or meaningless use of human resources

I hope to be able to answer that in 4 years.

Not all knowledge is good knowledge

Knowledge is knowledge

I think it is important to be able to view a case from different perspectives and being able to think critically

Learning is good, but experience is also a good thing

It is a lot of things that makes me sad (fur farming), but we can use what we have learned to do things better

Knowledge is power

How you use your knowledge is important!

Not if you learn to hit someone

It depends on how you use your knowledge

With great knowledge comes great responsibilities!

Who decides what is good knowledge?

It depends on the actions that's follow the knowledge

Think of nazist did

+
−
⛶

Appendix D: Letter to the participants in Study 2 and Study 3

Forespørsel om å delta i forskningsprosjektet" Technology enhanced peer discussions in plenary lectures"

I forbindelse med min doktorgrad ved Universitetet i Bergen, Institutt for pedagogikk, gjennomfører jeg et prosjekt om bruken av feedback-klikkere i forelesninger. I denne delen av prosjektet undersøker vi hvordan studenter bruker gruppediskusjoner i forelesningen. Deltakelse i første del av prosjektet innebærer at dere gir et muntlig samtykker til at diskusjoner dere deltar i forelesningen i kan tas opp digitalt. Du kan når som helst trekke deg eller be om at diskusjonene som du har deltatt i, blir slettet.

Deltakelse i andre del av prosjektet innebærer at dere deltar i et fokusgruppeintervju. Intervjuet blir tatt opp digitalt. Du kan når som helst trekke deg eller be om at diskusjonene som du har deltatt i, blir slettet.

Du blir ikke bedt om å oppgi navn. Oppbevaringen av data vil skje i tråd med retningslinjer fra Norsk samfunnsvitenskapelig datatjeneste (NSD). Lydopptak og transkripsjoner blir oppbevart i passordbeskyttede datafiler eller låste skap. Doktorgradsprosjektet forventes å være avsluttet april 2018. Etter at prosjektet er avsluttet vil alle lydfiler bli slettet.

Har du spørsmål i forbindelse med dette prosjektet eller ønsker å bli informert om resultatene fra undersøkelsen når de foreligger, kan du gjerne ta kontakt med meg på e-post kristine.ludvigsen@uib.no eller på telefonnummer 55 58 39 10.

Med vennlig hilsen

Kristine Ludvigsen

Appendix E: Interview guide, Study 3

Intervjuguide til fokusgruppe

Erfaringer
(10 minutt)

Åpningsspørsmål (Et generelt spørsmål som alle må svare på)
Si kort hvilken bakgrunn du har, alder).
Introduksjonsspørsmål (Hver deltaker tegner en mind-map)
Hva er din erfaring med bruken av diskusjoner i forelesningen? (støtte til læring i og utenfor forelesningen)

Hva er din erfaring med bruken av klikkere i forelesningen? (støtte til læring i og utenfor forelesningen)

Hva er din erfaring med bruken av flinga i forelesningen. (støtte til læring i og utenfor forelesningen)

Nøkkelspørsmål:
Diskusjoner: Hva må til for at det skal bli en god diskusjon? Hvorfor er de nyttige?

Flinga: Hvordan var det å skrive svar sammen?
Hva lærte dere av å se de andre sine svar? Har dere eksempler på dette?
Opplevde du at flinga hjalp deg til å oppklare misforståelser? Bedre forståelse for konsepter? Hvordan?
Kan bruken av flinga ha noen å si for hvordan dere studenter snakker om faget utenfor forelesningen? Hvordan? Hvorfor? Hvorfor ikke?
Hvilken betydning hadde det for det videre arbeidet i faget?
Diskuterte dere forskjellig når det er klikkespm og når det er flingaspm?
Hva er mest nyttig for å synliggjøre forståelse i faget? Din egen/ medstudenters? Hva er mest nyttig for foreleser tenker dere?
Hvordan er de to måtene å jobbe på (klikkere/ flinga) forskjellig? Støtter de læringen på forskjellige måter? Hvordan? Har dere eksempler? (i og utenfor forelesningen) Hadde det betydning for hvordan du jobbet med faget?

Alt i tatt i betraktning spørsmål:
Alt i alt, hva er det viktigste for deg?
Kan du oppsummere dine erfaringer med disse aktivitetene i forelesningen?
Oppsummeringsspørsmål:
Har jeg forstått det riktig?
Kan det tolkes sånn?
Sluttspørsmål:
Er det noe vi har glemt?
Noe vi ikke har snakket om som vi burde snakket om?

Appendix F: One of the mindmaps

DISCUSS AND CLICK

- It contributed to good discussions with my friends. We told each other what we thought, and then voted

- It showed that I did understand

- It started discussions and improved my understanding

- It helped me read after the lecture

- I used elimination and became aware that I knew more than I thought I did

- I appreciate that the lecture included several questions on the same topic
- It helped me to understand

DISCUSS AND WRITE

- I could participate with my own ideas

- I used it for my exam

- I remembered better the things we had discussed on flinga

- The lecturer reviewed what we had written

- The lecturer elaborated on the post; It was good

- It was engaging

- It started discussions

- Nice to see other views

- I liked that we could discuss with the person beside us first

Appendix G: NSD confirmation letter

Norsk samfunnsvitenskapelig datatjeneste AS
NORWEGIAN SOCIAL SCIENCE DATA SERVICES

Kristine Ludvigsen
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Org.nr. 985 321 884

Vår dato: 26.11.2012   Vår ref:30947 / 3 / MAS   Deres dato: Deres ref:

TILBAKEMELDING PÅ MELDING OM BEHANDLING AV PERSONOPPLYSNINGER

Vi viser til melding om behandling av personopplysninger, mottatt 27.06.2012. Meldingen gjelder prosjektet:

30947	*Formative e-assessment in Plenary Lectures*
Behandlingsansvarlig	*Universitetet i Bergen, ved institusjonens øverste leder*
Daglig ansvarlig	*Kristine Ludvigsen*

Personvernombudet har vurdert prosjektet og finner at behandlingen av personopplysninger er meldepliktig i henhold til personopplysningsloven § 31. Behandlingen tilfredsstiller kravene i personopplysningsloven.

Personvernombudets vurdering forutsetter at prosjektet gjennomføres i tråd med opplysningene gitt i meldeskjemaet, korrespondanse med ombudet, eventuelle kommentarer samt personopplysningsloven og helseregisterloven med forskrifter. Behandlingen av personopplysninger kan settes i gang.

Det gjøres oppmerksom på at det skal gis ny melding dersom behandlingen endres i forhold til de opplysninger som ligger til grunn for personvernombudets vurdering. Endringsmeldinger gis via et eget skjema, http://www.nsd.uib.no/personvern/forsk_stud/skjema.html. Det skal også gis melding etter tre år dersom prosjektet fortsatt pågår. Meldinger skal skje skriftlig til ombudet.

Personvernombudet har lagt ut opplysninger om prosjektet i en offentlig database, http://pvo.nsd.no/prosjekt.

Personvernombudet vil ved prosjektets avslutning, 01.12.2015, rette en henvendelse angående status for behandlingen av personopplysninger.

Vennlig hilsen

Vigdis Namtvedt Kvalheim

Mads Solberg

Mads Solberg tlf: 55 58 89 28
Vedlegg: Prosjektvurdering

Appendix H: NSD: Confirmation letter for change of method

Fra: Hildur Thorarensen [mailto:hildur.thorarensen@nsd.uib.no]
Sendt: 1. februar 2013 10:40
Til: Kristine.Ludvigsen@psych.uib.no
Emne: Prosjektnr: 30947. Formative e-assessment in Plenary Lectures

BEKREFTELSE PÅ ENDRING - METODE

Personvernombudet har registrert at det i tillegg til survey og kvalitative intervju, vil en i prosjektet observere hvordan studenter bruker gruppediskusjoner der feedback-klikkere blir brukt.

Ombudet forutsetter at prosjektet for øvrig gjennomføres i samsvar med vår vurdering og kommentar.

Vi vil ta ny kontakt ved prosjektslutt.

```
--
Vennlig hilsen/best regards

Hildur Thorarensen
Rådgiver/Adviser

Norsk samfunnsvitenskapelig datatjeneste AS
(Norwegian Social Science Data Services)
Personvernombud for forskning
(Data Protection Official for Research)
Harald Hårfagres gate 29, 5007 BERGEN

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```

Doctoral Theses at The Faculty of Psychology, University of Bergen

1980   Allen, Hugh M., Dr. philos.   Parent-offspring interactions in willow grouse (Lagopus L. Lagopus).

1981   Myhrer, Trond, Dr. philos.   Behavioral Studies after selective disruption of hippocampal inputs in albino rats.

1982   Svebak, Sven, Dr. philos.   The significance of motivation for task-induced tonic physiological changes.

1983   Myhre, Grete, Dr. philos.   The Biopsychology of behavior in captive Willow ptarmigan.

Eide, Rolf, Dr. philos.   PSYCHOSOCIAL FACTORS AND INDICES OF HEALTH RISKS. The relationship of psychosocial conditions to subjective complaints, arterial blood pressure, serum cholesterol, serum triglycerides and urinary catecholamines in middle aged populations in Western Norway.

Værnes, Ragnar J., Dr. philos.   Neuropsychological effects of diving.

1984   Kolstad, Arnulf, Dr. philos.   Til diskusjonen om sammenhengen mellom sosiale forhold og psykiske strukturer. En epidemiologisk undersøkelse blant barn og unge.

Løberg, Tor, Dr. philos.   Neuropsychological assessment in alcohol dependence.

1985   Hellesnes, Tore, Dr. philos.   Læring og problemløsning. En studie av den perseptuelle analysens betydning for verbal læring.

Håland, Wenche, Dr. philos.   Psykoterapi: relasjon, utviklingsprosess og effekt.

1986   Hagtvet, Knut A., Dr. philos.   The construct of test anxiety: Conceptual and methodological issues.

Jellestad, Finn K., Dr. philos.   Effects of neuron specific amygdala lesions on fear-motivated behavior in rats.

1987   Aarø, Leif E., Dr. philos.   Health behaviour and sosioeconomic Status. A survey among the adult population in Norway.

Underlid, Kjell, Dr. philos.   Arbeidsløyse i psykososialt perspektiv.

Laberg, Jon C., Dr. philos.   Expectancy and classical conditioning in alcoholics' craving.

Vollmer, Fred, Dr. philos.   Essays on explanation in psychology.

Ellertsen, Bjørn, Dr. philos.   Migraine and tension headache: Psychophysiology, personality and therapy.

1988   Kaufmann, Astrid, Dr. philos.   Antisosial atferd hos ungdom. En studie av psykologiske determinanter.

	Mykletun, Reidar J., Dr. philos.	Teacher stress: personality, work-load and health.
	Havik, Odd E., Dr. philos.	After the myocardial infarction: A medical and psychological study with special emphasis on perceived illness.
1989	Bråten, Stein, Dr. philos.	Menneskedyaden. En teoretisk tese om sinnets dialogiske natur med informasjons- og utviklingspsykologiske implikasjoner sammenholdt med utvalgte spedbarnsstudier.
	Wold, Bente, Dr. psychol.	Lifestyles and physical activity. A theoretical and empirical analysis of socialization among children and adolescents.
1990	Flaten, Magne A., Dr. psychol.	The role of habituation and learning in reflex modification.
1991	Alsaker, Françoise D., Dr. philos.	Global negative self-evaluations in early adolescence.
	Kraft, Pål, Dr. philos.	AIDS prevention in Norway. Empirical studies on diffusion of knowledge, public opinion, and sexual behaviour.
	Endresen, Inger M., Dr. philos.	Psychoimmuniological stress markers in working life.
	Faleide, Asbjørn O., Dr. philos.	Asthma and allergy in childhood. Psychosocial and psychotherapeutic problems.
1992	Dalen, Knut, Dr. philos.	Hemispheric asymmetry and the Dual-Task Paradigm: An experimental approach.
	Bø, Inge B., Dr. philos.	Ungdoms sosiale økologi. En undersøkelse av 14-16 åringers sosiale nettverk.
	Nivison, Mary E., Dr. philos.	The relationship between noise as an experimental and environmental stressor, physiological changes and psychological factors.
	Torgersen, Anne M., Dr. philos.	Genetic and environmental influence on temperamental behaviour. A longitudinal study of twins from infancy to adolescence.
1993	Larsen, Svein, Dr. philos.	Cultural background and problem drinking.
	Nordhus, Inger Hilde, Dr. philos.	Family caregiving. A community psychological study with special emphasis on clinical interventions.
	Thuen, Frode, Dr. psychol.	Accident-related behaviour among children and young adolescents: Prediction and prevention.
	Solheim, Ragnar, Dr. philos.	Spesifikke lærevansker. Diskrepanskriteriet anvendt i seleksjonsmetodikk.
	Johnsen, Bjørn Helge, Dr. psychol.	Brain assymetry and facial emotional expressions: Conditioning experiments.
1994	Tønnessen, Finn E., Dr. philos.	The etiology of Dyslexia.
	Kvale, Gerd, Dr. psychol.	Psychological factors in anticipatory nausea and vomiting in cancer chemotherapy.

	Asbjørnsen, Arve E., Dr. psychol.	Structural and dynamic factors in dichotic listening: An interactional model.
	Bru, Edvin, Dr. philos.	The role of psychological factors in neck, shoulder and low back pain among female hospitale staff.
	Braathen, Eli T., Dr. psychol.	Prediction of exellence and discontinuation in different types of sport: The significance of motivation and EMG.
	Johannessen, Birte F., Dr. philos.	Det flytende kjønnet. Om lederskap, politikk og identitet.
1995	Sam, David L., Dr. psychol.	Acculturation of young immigrants in Norway: A psychological and socio-cultural adaptation.
	Bjaalid, Inger-Kristin, Dr. philos.	Component processes in word recognition.
	Martinsen, Øyvind, Dr. philos.	Cognitive style and insight.
	Nordby, Helge, Dr. philos.	Processing of auditory deviant events: Mismatch negativity of event-related brain potentials.
	Raaheim, Arild, Dr. philos.	Health perception and health behaviour, theoretical considerations, empirical studies, and practical implications.
	Seltzer, Wencke J., Dr. philos.	Studies of Psychocultural Approach to Families in Therapy.
	Brun, Wibecke, Dr. philos.	Subjective conceptions of uncertainty and risk.
	Aas, Henrik N., Dr. psychol.	Alcohol expectancies and socialization: Adolescents learning to drink.
	Bjørkly, Stål, Dr. psychol.	Diagnosis and prediction of intra-institutional aggressive behaviour in psychotic patients
1996	Anderssen, Norman, Dr. psychol.	Physical activity of young people in a health perspective: Stability, change and social influences.
	Sandal, Gro Mjeldheim, Dr. psychol.	Coping in extreme environments: The role of personality.
	Strumse, Einar, Dr. philos.	The psychology of aesthetics: explaining visual preferences for agrarian landscapes in Western Norway.
	Hestad, Knut, Dr. philos.	Neuropsychological deficits in HIV-1 infection.
	Lugoe, L.Wycliffe, Dr. philos.	Prediction of Tanzanian students' HIV risk and preventive behaviours
	Sandvik, B. Gunnhild, Dr. philos.	Fra distriktsjordmor til institusjonsjordmor. Fremveksten av en profesjon og en profesjonsutdanning
	Lie, Gro Therese, Dr. psychol.	The disease that dares not speak its name: Studies on factors of importance for coping with HIV/AIDS in Northern Tanzania
	Øygard, Lisbet, Dr. philos.	Health behaviors among young adults. A psychological and sociological approach
	Stormark, Kjell Morten, Dr. psychol.	Emotional modulation of selective attention: Experimental and clinical evidence.

	Einarsen, Ståle, Dr. psychol.	Bullying and harassment at work: epidemiological and psychosocial aspects.
1997	Knivsberg, Ann-Mari, Dr. philos.	Behavioural abnormalities and childhood psychopathology: Urinary peptide patterns as a potential tool in diagnosis and remediation.
	Eide, Arne H., Dr. philos.	Adolescent drug use in Zimbabwe. Cultural orientation in a global-local perspective and use of psychoactive substances among secondary school students.
	Sørensen, Marit, Dr. philos.	The psychology of initiating and maintaining exercise and diet behaviour.
	Skjæveland, Oddvar, Dr. psychol.	Relationships between spatial-physical neighborhood attributes and social relations among neighbors.
	Zewdie, Teka, Dr. philos.	Mother-child relational patterns in Ethiopia. Issues of developmental theories and intervention programs.
	Wilhelmsen, Britt Unni, Dr. philos.	Development and evaluation of two educational programmes designed to prevent alcohol use among adolescents.
	Manger, Terje, Dr. philos.	Gender differences in mathematical achievement among Norwegian elementary school students.
1998 V	Lindstrøm, Torill Christine, Dr. philos.	«Good Grief»: Adapting to Bereavement.
	Skogstad, Anders, Dr. philos.	Effects of leadership behaviour on job satisfaction, health and efficiency.
	Haldorsen, Ellen M. Håland, Dr. psychol.	Return to work in low back pain patients.
	Besemer, Susan P., Dr. philos.	Creative Product Analysis: The Search for a Valid Model for Understanding Creativity in Products.
H	Winje, Dagfinn, Dr. psychol.	Psychological adjustment after severe trauma. A longitudinal study of adults' and children's posttraumatic reactions and coping after the bus accident in Måbødalen, Norway 1988.
	Vosburg, Suzanne K., Dr. philos.	The effects of mood on creative problem solving.
	Eriksen, Hege R., Dr. philos.	Stress and coping: Does it really matter for subjective health complaints?
	Jakobsen, Reidar, Dr. psychol.	Empiriske studier av kunnskap og holdninger om hiv/aids og den normative seksuelle utvikling i ungdomsårene.
1999 V	Mikkelsen, Aslaug, Dr. philos.	Effects of learning opportunities and learning climate on occupational health.
	Samdal, Oddrun, Dr. philos.	The school environment as a risk or resource for students' health-related behaviours and subjective well-being.
	Friestad, Christine, Dr. philos.	Social psychological approaches to smoking.
	Ekeland, Tor-Johan, Dr. philos.	Meining som medisin. Ein analyse av placebofenomenet og implikasjoner for terapi og terapeutiske teoriar.

H	Saban, Sara, Dr. psychol.	Brain Asymmetry and Attention: Classical Conditioning Experiments.
	Carlsten, Carl Thomas, Dr. philos.	God lesing – God læring. En aksjonsrettet studie av undervisning i fagtekstlesing.
	Dundas, Ingrid, Dr. psychol.	Functional and dysfunctional closeness. Family interaction and children's adjustment.
	Engen, Liv, Dr. philos.	Kartlegging av leseferdighet på småskoletrinnet og vurdering av faktorer som kan være av betydning for optimal leseutvikling.
2000 V	Hovland, Ole Johan, Dr. philos.	Transforming a self-preserving "alarm" reaction into a self-defeating emotional response: Toward an integrative approach to anxiety as a human phenomenon.
	Lillejord, Sølvi, Dr. philos.	Handlingsrasjonalitet og spesialundervisning. En analyse av aktørperspektiver.
	Sandell, Ove, Dr. philos.	Den varme kunnskapen.
	Oftedal, Marit Petersen, Dr. philos.	Diagnostisering av ordavkodingsvansker: En prosessanalytisk tilnærmingsmåte.
H	Sandbak, Tone, Dr. psychol.	Alcohol consumption and preference in the rat: The significance of individual differences and relationships to stress pathology
	Eid, Jarle, Dr. psychol.	Early predictors of PTSD symptom reporting; The significance of contextual and individual factors.
2001 V	Skinstad, Anne Helene, Dr. philos.	Substance dependence and borderline personality disorders.
	Binder, Per-Einar, Dr. psychol.	Individet og den meningsbærende andre. En teoretisk undersøkelse av de mellommenneskelige forutsetningene for psykisk liv og utvikling med utgangspunkt i Donald Winnicotts teori.
	Roald, Ingvild K., Dr. philos.	Building of concepts. A study of Physics concepts of Norwegian deaf students.
H	Fekadu, Zelalem W., Dr. philos.	Predicting contraceptive use and intention among a sample of adolescent girls. An application of the theory of planned behaviour in Ethiopian context.
	Melesse, Fantu, Dr. philos.	The more intelligent and sensitive child (MISC) mediational intervention in an Ethiopian context: An evaluation study.
	Råheim, Målfrid, Dr. philos.	Kvinners kroppserfaring og livssammenheng. En fenomenologisk – hermeneutisk studie av friske kvinner og kvinner med kroniske muskelsmerter.
	Engelsen, Birthe Kari, Dr. psychol.	Measurement of the eating problem construct.
	Lau, Bjørn, Dr. philos.	Weight and eating concerns in adolescence.
2002 V	Ihlebæk, Camilla, Dr. philos.	Epidemiological studies of subjective health complaints.

	Rosén, Gunnar O. R., Dr. philos.	The phantom limb experience. Models for understanding and treatment of pain with hypnosis.
	Høines, Marit Johnsen, Dr. philos.	Fleksible språkrom. Matematikklæring som tekstutvikling.
	Anthun, Roald Andor, Dr. philos.	School psychology service quality. Consumer appraisal, quality dimensions, and collaborative improvement potential
	Pallesen, Ståle, Dr. psychol.	Insomnia in the elderly. Epidemiology, psychological characteristics and treatment.
	Midthassel, Unni Vere, Dr. philos.	Teacher involvement in school development activity. A study of teachers in Norwegian compulsory schools
	Kallestad, Jan Helge, Dr. philos.	Teachers, schools and implementation of the Olweus Bullying Prevention Program.
H	Ofte, Sonja Helgesen, Dr. psychol.	Right-left discrimination in adults and children.
	Netland, Marit, Dr. psychol.	Exposure to political violence. The need to estimate our estimations.
	Diseth, Åge, Dr. psychol.	Approaches to learning: Validity and prediction of academic performance.
	Bjuland, Raymond, Dr. philos.	Problem solving in geometry. Reasoning processes of student teachers working in small groups: A dialogical approach.
2003 V	Arefjord, Kjersti, Dr. psychol.	After the myocardial infarction – the wives' view. Short- and long-term adjustment in wives of myocardial infarction patients.
	Ingjaldsson, Jón Þorvaldur, Dr. psychol.	Unconscious Processes and Vagal Activity in Alcohol Dependency.
	Holden, Børge, Dr. philos.	Følger av atferdsanalytiske forklaringer for atferdsanalysens tilnærming til utforming av behandling.
	Holsen, Ingrid, Dr. philos.	Depressed mood from adolescence to 'emerging adulthood'. Course and longitudinal influences of body image and parent-adolescent relationship.
	Hammar, Åsa Karin, Dr. psychol.	Major depression and cognitive dysfunction- An experimental study of the cognitive effort hypothesis.
	Sprugevica, Ieva, Dr. philos.	The impact of enabling skills on early reading acquisition.
	Gabrielsen, Egil, Dr. philos.	LESE FOR LIVET. Lesekompetansen i den norske voksenbefolkningen sett i lys av visjonen om en enhetsskole.
H	Hansen, Anita Lill, Dr. psychol.	The influence of heart rate variability in the regulation of attentional and memory processes.
	Dyregrov, Kari, Dr. philos.	The loss of child by suicide, SIDS, and accidents: Consequences, needs and provisions of help.
2004 V	Torsheim, Torbjørn, Dr. psychol.	Student role strain and subjective health complaints: Individual, contextual, and longitudinal perspectives.

	Haugland, Bente Storm Mowatt Dr. psychol.	Parental alcohol abuse. Family functioning and child adjustment.
	Milde, Anne Marita, Dr. psychol.	Ulcerative colitis and the role of stress. Animal studies of psychobiological factors in relationship to experimentally induced colitis.
	Stornes, Tor, Dr. philos.	Socio-moral behaviour in sport. An investigation of perceptions of sportspersonship in handball related to important factors of socio-moral influence.
	Mæhle, Magne, Dr. philos.	Re-inventing the child in family therapy: An investigation of the relevance and applicability of theory and research in child development for family therapy involving children.
	Kobbeltvedt, Therese, Dr. psychol.	Risk and feelings: A field approach.
2004 H	Thomsen, Tormod, Dr. psychol.	Localization of attention in the brain.
	Løberg, Else-Marie, Dr. psychol.	Functional laterality and attention modulation in schizophrenia: Effects of clinical variables.
	Kyrkjebø, Jane Mikkelsen, Dr. philos.	Learning to improve: Integrating continuous quality improvement learning into nursing education.
	Laumann, Karin, Dr. psychol.	Restorative and stress-reducing effects of natural environments: Experiencal, behavioural and cardiovascular indices.
	Holgersen, Helge, PhD	Mellom oss - Essay i relasjonell psykoanalyse.
2005 V	Hetland, Hilde, Dr. psychol.	Leading to the extraordinary? Antecedents and outcomes of transformational leadership.
	Iversen, Anette Christine, Dr. philos.	Social differences in health behaviour: the motivational role of perceived control and coping.
2005 H	Mathisen, Gro Ellen, PhD	Climates for creativity and innovation: Definitions, measurement, predictors and consequences.
	Sævi, Tone, Dr. philos.	Seeing disability pedagogically – The lived experience of disability in the pedagogical encounter.
	Wiium, Nora, PhD	Intrapersonal factors, family and school norms: combined and interactive influence on adolescent smoking behaviour.
	Kanagaratnam, Pushpa, PhD	Subjective and objective correlates of Posttraumatic Stress in immigrants/refugees exposed to political violence.
	Larsen, Torill M. B. , PhD	Evaluating principals` and teachers` implementation of Second Step. A case study of four Norwegian primary schools.
	Bancila, Delia, PhD	Psychosocial stress and distress among Romanian adolescents and adults.
2006 V	Hillestad, Torgeir Martin, Dr. philos.	Normalitet og avvik. Forutsetninger for et objektivt psykopatologisk avviksbegrep. En psykologisk, sosial, erkjennelsesteoretisk og teorihistorisk framstilling.

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	Nordanger, Dag Øystein, Dr. psychol.	Psychosocial discourses and responses to political violence in post-war Tigray, Ethiopia.
	Rimol, Lars Morten, PhD	Behavioral and fMRI studies of auditory laterality and speech sound processing.
	Krumsvik, Rune Johan, Dr. philos.	ICT in the school. ICT-initiated school development in lower secondary school.
	Norman, Elisabeth, Dr. psychol.	Gut feelings and unconscious thought: An exploration of fringe consiousness in implicit cognition.
	Israel, K Pravin, Dr. psychol.	Parent involvement in the mental health care of children and adolescents. Emperical studies from clinical care setting.
	Glasø, Lars, PhD	Affects and emotional regulation in leader-subordinate relationships.
	Knutsen, Ketil, Dr. philos.	HISTORIER UNGDOM LEVER – En studie av hvordan ungdommer bruker historie for å gjøre livet meningsfullt.
	Matthiesen, Stig Berge, PhD	Bullying at work. Antecedents and outcomes.
2006 H	Gramstad, Arne, PhD	Neuropsychological assessment of cognitive and emotional functioning in patients with epilepsy.
	Bendixen, Mons, PhD	Antisocial behaviour in early adolescence: Methodological and substantive issues.
	Mrumbi, Khalifa Maulid, PhD	Parental illness and loss to HIV/AIDS as experienced by AIDS orphans aged between 12-17 years from Temeke District, Dar es Salaam, Tanzania: A study of the children's psychosocial health and coping responses.
	Hetland, Jørn, Dr. psychol.	The nature of subjective health complaints in adolescence: Dimensionality, stability, and psychosocial predictors
	Kakoko, Deodatus Conatus Vitalis, PhD	Voluntary HIV counselling and testing service uptake among primary school teachers in Mwanza, Tanzania: assessment of socio-demographic, psychosocial and socio-cognitive aspects
	Mykletun, Arnstein, Dr. psychol.	Mortality and work-related disability as long-term consequences of anxiety and depression: Historical cohort designs based on the HUNT-2 study
	Sivertsen, Børge, PhD	Insomnia in older adults. Consequences, assessment and treatment.
2007 V	Singhammer, John, Dr. philos.	Social conditions from before birth to early adulthood – the influence on health and health behaviour
	Janvin, Carmen Ani Cristea, PhD	Cognitive impairment in patients with Parkinson's disease: profiles and implications for prognosis
	Braarud, Hanne Cecilie, Dr.psychol.	Infant regulation of distress: A longitudinal study of transactions between mothers and infants
	Tveito, Torill Helene, PhD	Sick Leave and Subjective Health Complaints

	Magnussen, Liv Heide, PhD	Returning disability pensioners with back pain to work
	Thuen, Elin Marie, Dr.philos.	Learning environment, students' coping styles and emotional and behavioural problems. A study of Norwegian secondary school students.
	Solberg, Ole Asbjørn, PhD	Peacekeeping warriors – A longitudinal study of Norwegian peacekeepers in Kosovo
2007 H	Søreide, Gunn Elisabeth, Dr.philos.	Narrative construction of teacher identity
	Svensen, Erling, PhD	WORK & HEALTH. Cognitive Activation Theory of Stress applied in an organisational setting.
	Øverland, Simon Nygaard, PhD	Mental health and impairment in disability benefits. Studies applying linkages between health surveys and administrative registries.
	Eichele, Tom, PhD	Electrophysiological and Hemodynamic Correlates of Expectancy in Target Processing
	Børhaug, Kjetil, Dr.philos.	Oppseding til demokrati. Ein studie av politisk oppseding i norsk skule.
	Eikeland, Thorleif, Dr.philos.	Om å vokse opp på barnehjem og på sykehus. En undersøkelse av barnehjemsbarns opplevelser på barnehjem sammenholdt med sanatoriebarns beskrivelse av langvarige sykehusopphold – og et forsøk på forklaring.
	Wadel, Carl Cato, Dr.philos.	Medarbeidersamhandling og medarbeiderledelse i en lagbasert organisasjon
	Vinje, Hege Forbech, PhD	Thriving despite adversity: Job engagement and self-care among community nurses
	Noort, Maurits van den, PhD	Working memory capacity and foreign language acquisition
2008 V	Breivik, Kyrre, Dr.psychol.	The Adjustment of Children and Adolescents in Different Post-Divorce Family Structures. A Norwegian Study of Risks and Mechanisms.
	Johnsen, Grethe E., PhD	Memory impairment in patients with posttraumatic stress disorder
	Sætrevik, Bjørn, PhD	Cognitive Control in Auditory Processing
	Carvalhosa, Susana Fonseca, PhD	Prevention of bullying in schools: an ecological model
2008 H	Brønnick, Kolbjørn Selvåg	Attentional dysfunction in dementia associated with Parkinson's disease.
	Posserud, Maj-Britt Rocio	Epidemiology of autism spectrum disorders
	Haug, Ellen	Multilevel correlates of physical activity in the school setting
	Skjerve, Arvid	Assessing mild dementia – a study of brief cognitive tests.

	Kjønniksen, Lise	The association between adolescent experiences in physical activity and leisure time physical activity in adulthood: a ten year longitudinal study
	Gundersen, Hilde	The effects of alcohol and expectancy on brain function
	Omvik, Siri	Insomnia – a night and day problem
2009 V	Molde, Helge	Pathological gambling: prevalence, mechanisms and treatment outcome.
	Foss, Else	Den omsorgsfulle væremåte. En studie av voksnes væremåte i forhold til barn i barnehagen.
	Westrheim, Kariane	Education in a Political Context: A study of Konwledge Processes and Learning Sites in the PKK.
	Wehling, Eike	Cognitive and olfactory changes in aging
	Wangberg, Silje C.	Internet based interventions to support health behaviours: The role of self-efficacy.
	Nielsen, Morten B.	Methodological issues in research on workplace bullying. Operationalisations, measurements and samples.
	Sandu, Anca Larisa	MRI measures of brain volume and cortical complexity in clinical groups and during development.
	Guribye, Eugene	Refugees and mental health interventions
	Sørensen, Lin	Emotional problems in inattentive children – effects on cognitive control functions.
	Tjomsland, Hege E.	Health promotion with teachers. Evaluation of the Norwegian Network of Health Promoting Schools: Quantitative and qualitative analyses of predisposing, reinforcing and enabling conditions related to teacher participation and program sustainability.
	Helleve, Ingrid	Productive interactions in ICT supported communities of learners
2009 H	Skorpen, Aina Øye, Christine	Dagliglivet i en psykiatrisk institusjon: En analyse av miljøterapeutiske praksiser
	Andreassen, Cecilie Schou	WORKAHOLISM – Antecedents and Outcomes
	Stang, Ingun	Being in the same boat: An empowerment intervention in breast cancer self-help groups
	Sequeira, Sarah Dorothee Dos Santos	The effects of background noise on asymmetrical speech perception
	Kleiven, Jo, dr.philos.	The Lillehammer scales: Measuring common motives for vacation and leisure behavior
	Jónsdóttir, Guðrún	Dubito ergo sum? Ni jenter møter naturfaglig kunnskap.
	Hove, Oddbjørn	Mental health disorders in adults with intellectual disabilities - Methods of assessment and prevalence of mental health disorders and problem behaviour
	Wageningen, Heidi Karin van	The role of glutamate on brain function

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	Bjørkvik, Jofrid	God nok? Selvaktelse og interpersonlig fungering hos pasienter innen psykisk helsevern: Forholdet til diagnoser, symptomer og behandlingsutbytte
	Andersson, Martin	A study of attention control in children and elderly using a forced-attention dichotic listening paradigm
	Almås, Aslaug Grov	Teachers in the Digital Network Society: Visions and Realities. A study of teachers' experiences with the use of ICT in teaching and learning.
	Ulvik, Marit	Lærerutdanning som danning? Tre stemmer i diskusjonen
2010 V	Skår, Randi	Læringsprosesser i sykepleieres profesjonsutøvelse. En studie av sykepleieres læringserfaringer.
	Roald, Knut	Kvalitetsvurdering som organisasjonslæring mellom skole og skoleeigar
	Lunde, Linn-Heidi	Chronic pain in older adults. Consequences, assessment and treatment.
	Danielsen, Anne Grete	Perceived psychosocial support, students' self-reported academic initiative and perceived life satisfaction
	Hysing, Mari	Mental health in children with chronic illness
	Olsen, Olav Kjellevold	Are good leaders moral leaders? The relationship between effective military operational leadership and morals
	Riese, Hanne	Friendship and learning. Entrepreneurship education through mini-enterprises.
	Holthe, Asle	Evaluating the implementation of the Norwegian guidelines for healthy school meals: A case study involving three secondary schools
H	Hauge, Lars Johan	Environmental antecedents of workplace bullying: A multi-design approach
	Bjørkelo, Brita	Whistleblowing at work: Antecedents and consequences
	Reme, Silje Endresen	Common Complaints – Common Cure? Psychiatric comorbidity and predictors of treatment outcome in low back pain and irritable bowel syndrome
	Helland, Wenche Andersen	Communication difficulties in children identified with psychiatric problems
	Beneventi, Harald	Neuronal correlates of working memory in dyslexia
	Thygesen, Elin	Subjective health and coping in care-dependent old persons living at home
	Aanes, Mette Marthinussen	Poor social relationships as a threat to belongingness needs. Interpersonal stress and subjective health complaints: Mediating and moderating factors.
	Anker, Morten Gustav	Client directed outcome informed couple therapy

	Bull, Torill	Combining employment and child care: The subjective well-being of single women in Scandinavia and in Southern Europe
	Viig, Nina Grieg	Tilrettelegging for læreres deltakelse i helsefremmende arbeid. En kvalitativ og kvantitativ analyse av sammenhengen mellom organisatoriske forhold og læreres deltakelse i utvikling og implementering av Europeisk Nettverk av Helsefremmende Skoler i Norge
	Wolff, Katharina	To know or not to know? Attitudes towards receiving genetic information among patients and the general public.
	Ogden, Terje, dr.philos.	Familiebasert behandling av alvorlige atferdsproblemer blant barn og ungdom. Evaluering og implementering av evidensbaserte behandlingsprogrammer i Norge.
	Solberg, Mona Elin	Self-reported bullying and victimisation at school: Prevalence, overlap and psychosocial adjustment.
2011 V	Bye, Hege Høivik	Self-presentation in job interviews. Individual and cultural differences in applicant self-presentation during job interviews and hiring managers' evaluation
	Notelaers, Guy	Workplace bullying. A risk control perspective.
	Moltu, Christian	Being a therapist in difficult therapeutic impasses. A hermeneutic phenomenological analysis of skilled psychotherapists' experiences, needs, and strategies in difficult therapies ending well.
	Myrseth, Helga	Pathological Gambling - Treatment and Personality Factors
	Schanche, Elisabeth	From self-criticism to self-compassion. An empirical investigation of hypothesized change prosesses in the Affect Phobia Treatment Model of short-term dynamic psychotherapy for patients with Cluster C personality disorders.
	Våpenstad, Eystein Victor, dr.philos.	Det tempererte nærvær. En teoretisk undersøkelse av psykoterapautens subjektivitet i psykoanalyse og psykoanalytisk psykoterapi.
	Haukebø, Kristin	Cognitive, behavioral and neural correlates of dental and intra-oral injection phobia. Results from one treatment and one fMRI study of randomized, controlled design.
	Harris, Anette	Adaptation and health in extreme and isolated environments. From 78°N to 75°S.
	Bjørknes, Ragnhild	Parent Management Training-Oregon Model: intervention effects on maternal practice and child behavior in ethnic minority families
	Mamen, Asgeir	Aspects of using physical training in patients with substance dependence and additional mental distress
	Espevik, Roar	Expert teams: Do shared mental models of team members make a difference
	Haara, Frode Olav	Unveiling teachers' reasons for choosing practical activities in mathematics teaching

2011 H	Hauge, Hans Abraham	How can employee empowerment be made conducive to both employee health and organisation performance? An empirical investigation of a tailor-made approach to organisation learning in a municipal public service organisation.
	Melkevik, Ole Rogstad	Screen-based sedentary behaviours: pastimes for the poor, inactive and overweight? A cross-national survey of children and adolescents in 39 countries.
	Vøllestad, Jon	Mindfulness-based treatment for anxiety disorders. A quantitative review of the evidence, results from a randomized controlled trial, and a qualitative exploration of patient experiences.
	Tolo, Astrid	Hvordan blir lærerkompetanse konstruert? En kvalitativ studie av PPU-studenters kunnskapsutvikling.
	Saus, Evelyn-Rose	Training effectiveness: Situation awareness training in simulators
	Nordgreen, Tine	Internet-based self-help for social anxiety disorder and panic disorder. Factors associated with effect and use of self-help.
	Munkvold, Linda Helen	Oppositional Defiant Disorder: Informant discrepancies, gender differences, co-occuring mental health problems and neurocognitive function.
	Christiansen, Øivin	Når barn plasseres utenfor hjemmet: beslutninger, forløp og relasjoner. Under barnevernets (ved)tak.
	Brunborg, Geir Scott	Conditionability and Reinforcement Sensitivity in Gambling Behaviour
	Hystad, Sigurd William	Measuring Psychological Resiliency: Validation of an Adapted Norwegian Hardiness Scale
2012 V	Roness, Dag	Hvorfor bli lærer? Motivasjon for utdanning og utøving.
	Fjermestad, Krister Westlye	The therapeutic alliance in cognitive behavioural therapy for youth anxiety disorders
	Jenssen, Eirik Sørnes	Tilpasset opplæring i norsk skole: politikeres, skolelederes og læreres handlingsvalg
	Saksvik-Lehouillier, Ingvild	Shift work tolerance and adaptation to shift work among offshore workers and nurses
	Johansen, Venke Frederike	Når det intime blir offentlig. Om kvinners åpenhet om brystkreft og om markedsføring av brystkreftsaken.
	Herheim, Rune	Pupils collaborating in pairs at a computer in mathematics learning: investigating verbal communication patterns and qualities
	Vie, Tina Løkke	Cognitive appraisal, emotions and subjective health complaints among victims of workplace bullying: A stress-theoretical approach
	Jones, Lise Øen	Effects of reading skills, spelling skills and accompanying efficacy beliefs on participation in education. A study in Norwegian prisons.

2012 H	Danielsen, Yngvild Sørebø	Childhood obesity – characteristics and treatment. Psychological perspectives.
	Horverak, Jøri Gytre	Sense or sensibility in hiring processes. Interviewee and interviewer characteristics as antecedents of immigrant applicants' employment probabilities. An experimental approach.
	Jøsendal, Ola	Development and evaluation of BE smokeFREE, a school-based smoking prevention program
	Osnes, Berge	Temporal and Posterior Frontal Involvement in Auditory Speech Perception
	Drageset, Sigrunn	Psychological distress, coping and social support in the diagnostic and preoperative phase of breast cancer
	Aasland, Merethe Schanke	Destructive leadership: Conceptualization, measurement, prevalence and outcomes
	Bakibinga, Pauline	The experience of job engagement and self-care among Ugandan nurses and midwives
	Skogen, Jens Christoffer	Foetal and early origins of old age health. Linkage between birth records and the old age cohort of the Hordaland Health Study (HUSK)
	Leversen, Ingrid	Adolescents' leisure activity participation and their life satisfaction: The role of demographic characteristics and psychological processes
	Hanss, Daniel	Explaining sustainable consumption: Findings from cross-sectional and intervention approaches
	Rød, Per Arne	Barn i klem mellom foreldrekonflikter og samfunnsmessig beskyttelse
2013 V	Mentzoni, Rune Aune	Structural Characteristics in Gambling
	Knudsen, Ann Kristin	Long-term sickness absence and disability pension award as consequences of common mental disorders. Epidemiological studies using a population-based health survey and official ill health benefit registries.
	Strand, Mari	Emotional information processing in recurrent MDD
	Veseth, Marius	Recovery in bipolar disorder. A reflexive-collaborative exploration of the lived experiences of healing and growth when battling a severe mental illness
	Mæland, Silje	Sick leave for patients with severe subjective health complaints. Challenges in general practice.
	Mjaaland, Thera	At the frontiers of change? Women and girls' pursuit of education in north-western Tigray, Ethiopia
	Odéen, Magnus	Coping at work. The role of knowledge and coping expectancies in health and sick leave.
	Hynninen, Kia Minna Johanna	Anxiety, depression and sleep disturbance in chronic obstructive pulmonary disease (COPD). Associations, prevalence and effect of psychological treatment.

	Flo, Elisabeth	Sleep and health in shift working nurses
	Aasen, Elin Margrethe	From paternalism to patient participation? The older patients undergoing hemodialysis, their next of kin and the nurses: a discursive perspective on perception of patient participation in dialysis units
	Ekornås, Belinda	Emotional and Behavioural Problems in Children: Self-perception, peer relationships, and motor abilities
	Corbin, J. Hope	North-South Partnerships for Health: Key Factors for Partnership Success from the Perspective of the KIWAKKUKI
	Birkeland, Marianne Skogbrott	Development of global self-esteem: The transition from adolescence to adulthood
2013 H	Gianella-Malca, Camila	Challenges in Implementing the Colombian Constitutional Court's Health-Care System Ruling of 2008
	Hovland, Anders	Panic disorder – Treatment outcomes and psychophysiological concomitants
	Mortensen, Øystein	The transition to parenthood – Couple relationships put to the test
	Årdal, Guro	Major Depressive Disorder – a Ten Year Follow-up Study. Inhibition, Information Processing and Health Related Quality of Life
	Johansen, Rino Bandlitz	The impact of military identity on performance in the Norwegian armed forces
	Bøe, Tormod	Socioeconomic Status and Mental Health in Children and Adolescents
2014 V	Nordmo, Ivar	Gjennom nåløyet – studenters læringserfaringer i psykologutdanningen
	Dovran, Anders	Childhood Trauma and Mental Health Problems in Adult Life
	Hegelstad, Wenche ten Velden	Early Detection and Intervention in Psychosis: A Long-Term Perspective
	Urheim, Ragnar	Forståelse av pasientaggresjon og forklaringer på nedgang i voldsrate ved Regional sikkerhetsavdeling, Sandviken sykehus
	Kinn, Liv Grethe	Round-Trips to Work. Qualitative studies of how persons with severe mental illness experience work integration.
	Rød, Anne Marie Kinn	Consequences of social defeat stress for behaviour and sleep. Short-term and long-term assessments in rats.
	Nygård, Merethe	Schizophrenia – Cognitive Function, Brain Abnormalities, and Cannabis Use
	Tjora, Tore	Smoking from adolescence through adulthood: the role of family, friends, depression and socioeconomic status. Predictors of smoking from age 13 to 30 in the "The Norwegian Longitudinal Health Behaviour Study" (NLHB)
	Vangsnes, Vigdis	The Dramaturgy and Didactics of Computer Gaming. A Study of a Medium in the Educational Context of Kindergartens.

	Nordahl, Kristin Berg	Early Father-Child Interaction in a Father-Friendly Context: Gender Differences, Child Outcomes, and Protective Factors related to Fathers' Parenting Behaviors with One-year-olds
2014 H	Sandvik, Asle Makoto	Psychopathy – the heterogenety of the construct
	Skotheim, Siv	Maternal emotional distress and early mother-infant interaction: Psychological, social and nutritional contributions
	Halleland, Helene Barone	Executive Functioning in adult Attention Deficit Hyperactivity Disorder (ADHD). From basic mechanisms to functional outcome.
	Halvorsen, Kirsti Vindal	Partnerskap i lærerutdanning, sett fra et økologisk perspektiv
	Solbue, Vibeke	Dialogen som visker ut kategorier. En studie av hvilke erfaringer innvandrerungdommer og norskfødte med innvandrerforeldre har med videregående skole. Hva forteller ungdommenes erfaringer om videregående skoles håndtering av etniske ulikheter?
	Kvalevaag, Anne Lise	Fathers' mental health and child development. The predictive value of fathers' psychological distress during pregnancy for the social, emotional and behavioural development of their children
	Sandal, Ann Karin	Ungdom og utdanningsval. Om elevar sine opplevingar av val og overgangsprosessar.
	Haug, Thomas	Predictors and moderators of treatment outcome from high- and low-intensity cognitive behavioral therapy for anxiety disorders. Association between patient and process factors, and the outcome from guided self-help, stepped care, and face-to-face cognitive behavioral therapy.
	Sjølie, Hege	Experiences of Members of a Crisis Resolution Home Treatment Team. Personal history, professional role and emotional support in a CRHT team.
	Falkenberg, Liv Eggset	Neuronal underpinnings of healthy and dysfunctional cognitive control
	Mrdalj, Jelena	The early life condition. Importance for sleep, circadian rhythmicity, behaviour and response to later life challenges
	Hesjedal, Elisabeth	Tverrprofesjonelt samarbeid mellom skule og barnevern: Kva kan støtte utsette barn og unge?
2015 V	Hauken, May Aasebø	*«The cancer treatment was only half the work!»* A Mixed-Method Study of Rehabilitation among Young Adult Cancer Survivors
	Ryland, Hilde Katrin	Social functioning and mental health in children: the influence of chronic illness and intellectual function
	Rønsen, Anne Kristin	Vurdering som profesjonskompetanse. Refleksjonsbasert utvikling av læreres kompetanse i formativ vurdering

	Hoff, Helge Andreas	Thinking about Symptoms of Psychopathy in Norway: Content Validation of the Comprehensive Assessment of Psychopathic Personality (CAPP) Model in a Norwegian Setting
	Schmid, Marit Therese	Executive Functioning in recurrent- and first episode Major Depressive Disorder. Longitudinal studies
	Sand, Liv	Body Image Distortion and Eating Disturbances in Children and Adolescents
	Matanda, Dennis Juma	Child physical growth and care practices in Kenya: Evidence from Demographic and Health Surveys
	Amugsi, Dickson Abanimi	Child care practices, resources for care, and nutritional outcomes in Ghana: Findings from Demographic and Health Surveys
	Jakobsen, Hilde	The good beating: Social norms supporting men's partner violence in Tanzania
	Sagoe, Dominic	Nonmedical anabolic-androgenic steroid use: Prevalence, attitudes, and social perception
	Eide, Helene Marie Kjærgård	Narrating the relationship between leadership and learning outcomes. A study of public narratives in the Norwegian educational sector.
2015 H	Wubs, Annegreet Gera	Intimate partner violence among adolescents in South Africa and Tanzania
	Hjelmervik, Helene Susanne	Sex and sex-hormonal effects on brain organization of fronto-parietal networks
	Dahl, Berit Misund	The meaning of professional identity in public health nursing
	Røykenes, Kari	Testangst hos sykepleierstudenter: «Alternativ behandling»
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